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NATIONAL INTELLIGENCE ESTIMATE
NUMBER 11-2-60

THE SOVIET ATOMIC ENERGY PROGRAM

LIMITED DISTRIBUTION

Submitted by the

DIRECTOR OF CENTRAL INTELLIGENCE

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Concurred in by the

UNITED STATES INTELLIGENCE BOARD

on 21 June 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 SOVIET ATOMIC ENERGY PROGRAM

NIE 11-2-60

21 June 1960

This estimate consists of an updating of those subjects in NIE 11-2-59 about which significant new information has become available, and which merit a restatement. It includes topics under the following main headings from NIE 11-2-59:

- The Soviet Nuclear Reactor Program
- The Soviet Nuclear Materials Program
- The Soviet Nuclear Weapon Program
- Possible Soviet Allocations of Fissionable Materials to Weapon Stockpiles
- The Soviet International Atomic Aid and Exchange Program

The reader should refer to NIE 11-2-59 for information on the following portions of the Soviet Atomic Energy Program: Organization; General Technical Capabilities; Controlled Thermonuclear Reactions; Production of Uranium Metal, Lithium, Heavy Water, U-233, and Tritium; Nuclear Weapon Proving Grounds and Test Program; Atomic Energy Detection System; and Economic Aspects.

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 21 June 1960.

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THE PROBLEM

To review significant recent developments in the USSR's atomic energy program and to estimate the probable future course of that program to mid-1965.

SUMMARY AND CONCLUSIONS

GENERAL

1. In updating NIE 11-2-59, we have reflected delays in the estimated Soviet nuclear power reactor program and incorporated new information into our estimates of the Soviets' nuclear propulsion program and of their nuclear weapon facilities. We have reduced our estimate of Soviet U-235 production by approximately 20%. We believe that the estimate of Soviet plutonium production [redacted] represents the most likely value for current cumulative production, whereas in the past it was only considered to be a reliable minimum.[1] Consequently, our

[1] The Director for Intelligence, The Joint Staff does not agree that the most likely value of Soviet cumulative plutonium equivalent production through mid-1960 [redacted] Instead he believes sufficient justification exists to warrant considering the uranium ore-based estimate of plutonium equivalent as an equally likely value.

This view is based on the following:

a. The marked difference between the estimated amounts of uranium ore procured and processed and the smaller amount required for [redacted] estimate of plutonium equivalent production (Table 4), coupled with the notation that this difference would involve a 3½ year stockpile of ore plus pipeline and local reserves—utilization which is not considered the most reasonable. (Paragraphs 54 and 55)

b. [redacted]

c. [redacted]

d. The possibility that the Soviets have stored irradiated slugs from plutonium production reactors because of delays in construction or operation of chemical separation facilities. (Paragraph 57)

e. The possibility that plutonium is produced at an unidentified site. (Paragraph 59)

f. The judgement that calculated maximum possible reactor capacities at Kyshtym and Tomsk are not inconsistent with a plutonium production value about twice as large (16,800 kg) [redacted] (Paragraphs 53 and 59)

g. The possibility that Angarsk may produce plutonium. (Paragraph 45)

h. The unknown status of the facilities at Krasnoyarsk previously estimated as a plutonium producing and chemical separation site. (Paragraph 51).

estimate of Soviet plutonium production, at least through mid-1960, is significantly lower than that made a year ago. However, certain factors indicate that Soviet plutonium equivalent production could be considerably higher and any planning should give serious consideration to the alternate estimate based on ore availability presented herein. Table 4 presents the probable estimate and an alternative estimate.[2] In addition, we have modified our estimate of future Soviet nuclear weapon capabilities in view of the continuing moratorium, revised our allocations of fissionable materials to weapon stockpiles, and added a discussion of US–USSR exchanges in the atomic energy field.

NUCLEAR REACTOR PROGRAM

2. *Power Reactors.* It is apparent that the USSR will fall far short of the 2000–2500 electrical megawatt nuclear generating capacity originally projected for 1960 in the Sixth Five-Year Plan. After considering the delays the Soviets have experienced in both research and power reactor programs, we now estimate that the USSR will have only about 1100 electrical megawatts of nuclear generating capacity installed by mid-1965.

3. *Naval and Marine Nuclear Propulsion Systems.* The ice-breaker LENIN was commissioned in December of 1959 and is expected to operate in the Arctic in the summer of 1960. There have been increasing numbers of reports that the Soviets are constructing a number of nuclear submarines, but we have no firm evidence that any are in operational status. Based on the status of Soviet reactor technology, we estimate that late 1957 was the earliest date that a nuclear propulsion reactor for a submarine could have been available, and that at least one Soviet nuclear submarine could have been in a trial status by the end of 1958.

4. *Reactor Systems for Aircraft.* Our information indicates that the Soviets are attempting to produce an aircraft nuclear propulsion (ANP) system, but we have not determined the exact systems under development. We estimate that the Soviets are now capable of flying a nuclear testbed with at least one nuclear power unit providing useful thrust during a phase of the flight. By 1962, such a program could lead to an ANP system suitable for cruise on nuclear heat alone in a subsonic aircraft of marginal performance. We believe that a nuclear propulsion unit for a first subsonic aircraft with substantially improved performance could be available by sometime in 1964. Supersonic applications of ANP would require a long test and development program, and we do not believe that a prototype will be achieved during the period of this estimate.

[2] The Assistant Chief of Naval Operations (Intelligence), Department of the Navy considers the alternative estimate based on ore availability to be too tenuous and hypothetical for useful guidance. He believes, therefore, that the estimated quantity of uranium ore procured and mined by the USSR is not a suitable parameter for estimating plutonium production. The Assistant Chief of Naval Operations (Intelligence), Department of the Navy, recognizes the fact that estimated Soviet uranium ore acquired in excess of that used in producing the amount of plutonium [redacted] amounts to a stockpile of several years. He believes such a stockpile to be normally consistent with general Soviet stockpiling practices, with the unpredictable quality of the uranium deposits in the USSR, and with delays and cutbacks in their nuclear power program. He would therefore omit from NIE 11-2-60 the uranium-based plutonium equivalent estimate.

5. *Reactor Systems for Rockets and Ramjets.* We believe that the USSR is now conducting research on a nuclear rocket engine, and that the Soviets could conduct a first static test firing of a prototype system possibly as early as 1965. While there is evidence of Soviet research applicable to nuclear ramjets, we believe that the complexity of the problem makes it unlikely that the Soviets will flight test a nuclear ramjet during the period of this estimate, although such flight testing is possible.

FISSIONABLE MATERIALS PRODUCTION

6. *Uranium Ore.* Recent information indicates that the Soviets have matched many mining and ore concentration methods used in the US, and that uranium mining and ore concentration within the Soviet Bloc continued to expand at a modest rate during 1959. We estimate that by the end of 1959 about 110,000 metric tons of recoverable equivalent uranium metal would have been available to the Soviets and that about 200,000 metric tons will have been available by the end of 1964 (Table 3, page 14). As in previous years, these amounts are in excess of the recoverable equivalent uranium metal required to support our current estimate of fissionable materials production.

7. *Uranium-235.* Two large gaseous diffusion plants have been positively identified in the USSR, one at Verkh-Neyvinsk, the other at Tomsk. We estimate that a probable third plant started operating recently at Angarsk. We also believe that no other large Soviet gaseous diffusion plant exists.

8. We now estimate that the Soviets will have produced the equivalent of 52,000 kg of weapon-grade U-235 by mid-1960 and that the cumulative total will have increased to about 220,000 kg by mid-1965 (Table 4, page 19). These values represent a reduction of approximately 20% from those we estimated in NIE 11-2-59. This reduction results primarily from a firmer estimate of the electric power use at the first two gaseous diffusion plants. The actual production could range between +25% and −50% of the mid-1960 value. A fairly good confidence level can be assigned to a ±50% error range for the mid-1963 value. Thereafter, a meaningful margin of error cannot be assigned.[3]

9. *Plutonium Equivalent.*[4] While we have identified major facilities for plutonium production at Kyshtym and near Tomsk, we now believe, in contrast to our previous estimates, that the atomic energy site near Krasnoyarsk probably does not produce plutonium. [redacted]

[3] In order to accept the estimate of Soviet cumulative U-235 production (Table 4) the Assistant Chief of Naval Operations (Intelligence), Department of the Navy, finds that he would have to accept major factors of Soviet capability which are in his opinion not sufficiently supported by available evidence. These factors include: (a) initial operation dates of the production plants, (b) power consumption, and (c) use of a new diffusion technology and new equipment. However, he believes that improvements in Soviet basic technology and plant efficiency have been incorporated in the plants installed during 1953–1960.

The Assistant Chief of Naval Operations (Intelligence), Department of the Navy, believes that the lower limits of the estimated values for the cumulative production of U-235, although high, are the more nearly correct.

[redacted] the term plutonium equivalent is used to cover all reactor products, such as plutonium, tritium, U-233, polonium, etc.

[redacted]

10. We estimate that the most likely value of Soviet cumulative plutonium equivalent production through mid-1960 [redacted] This value is consistent with several interpretations of the available site information. However, in view of the large estimated Soviet ore supply, we believe that any planning should also give serious consideration to the possibility of higher plutonium equivalent production values. We have, therefore, presented an alternative estimate based on what we would consider to be a more reasonable, although not complete, utilization of the estimated Soviet uranium ore than that indicated [redacted] Table 4, page 19, presents the probable estimate and an alternate estimate.[6]

11. It is very unlikely that actual cumulative Soviet plutonium production as of mid-1960 is more than 20% below the [redacted] or much greater than those given by the ore-based estimate. While no meaningful error ranges can be assigned to post-1960 estimates, we believe that the more likely future values of Soviet plutonium production may lie between the two estimates, and may approach the upper values given in Table 4 for the latter part of the 1960–1965 period.[7]

NUCLEAR WEAPONS

12. *Fabrication and Stockpiling.* Recent reports have confirmed our previous estimate that the installation at Sarova is the main nuclear weapon research and development center. They also indicate that nuclear weapon fabrication and stockpile sites are located in the Urals at Nizhnyaya Tura and possibly at Yuryuzan. We have also confirmed the existence of a few additional operational nuclear weapon storage sites at airfields of the Long Range Aviation (LRA). While we have no firm evidence of operational nuclear weapon storage facilities except at LRA bases and a few naval airfields, we continue to estimate that such facilities are available to the Soviet tactical and naval aviation, to the naval surface forces, and to the ground forces.

13. *Weapon Development.* Further analysis of the data from the Soviet nuclear test series conducted in the fall of 1958 has led to only minor changes in our estimate of present Soviet weapon capabilities. However, we now estimate that only marginal improvements will be made in future weapons unless and until nuclear testing is resumed. We do not believe that the Soviets will stockpile nuclear weapons of radically new designs

[5] For the view of the Director for Intelligence, The Joint Staff, see footnote 1, page 1.

[6] For the view of the Assistant Chief of Naval Operations (Intelligence), Department of the Navy, see footnote 2, page 2.

[7] The Assistant Chief of Naval Operations (Intelligence), Department of the Navy, believes that more likely future values of Soviet plutonium production will continue, as in the past, to lie near the values in [redacted] estimate.

without nuclear testing, and we have no evidence that any Soviet nuclear tests have been conducted since November 1958, although covert tests could have been conducted.*

14. We estimate that the Soviets have available suitable weapon types to meet their present basic requirements. On the basis of test data alone, these range from fission devices yielding approximately 1 KT [redacted] to thermonuclear devices yielding about 7 MT [redacted] (Tables 6 and 7, pages 30 and 31).

POSSIBLE ALLOCATIONS OF FISSIONABLE MATERIALS

15. We believe that the long-range striking forces have been given the largest allocation of fissionable materials, and that the weapons allocated to these forces in 1960 may consume about 80 percent of the estimated U-235 stocks and 50 percent or more of the plutonium equivalent supply. We believe that at present the USSR's weapon stockpile can support massive nuclear attacks against targets in North America and Eurasia by the long-range striking forces estimated in NIE 11-8-59. The size and nature of the materials stockpile imposes limitations on the numbers of weapons available for other air, ground, and naval operations. However, we consider it unlikely that the availability of fissionable materials for nuclear weapons is a factor which in itself significantly limits Soviet policy (see Figure 4, Tabular Summary of Possible Weapon Stockpiles, Mid-1960 and Mid-1963, page 39.*

16. We have estimated a considerable growth in the Soviet fissionable materials stockpile by mid-1963, which should keep pace with the estimated growth in Soviet missile capabilities for long-range attack, and also ease the limitations noted above.

INTERNATIONAL AID AND EXCHANGE

17. During the past year the USSR has concluded bilateral atomic aid agreements with North Korea, Iraq, and Indonesia. As with previous agreements, the Soviets have shown no haste in fulfilling commitments, and appear to be continuing their policy of offering atomic aid only when tangible political return can be expected.

18. A number of exchanges and visits with nuclear aspects have resulted from the over-all US-USSR Agreement on Exchanges and the memorandum of cooperation regarding atomic energy for peaceful purposes. The Soviets have been relatively cooperative in implementing specific exchanges and apparently carry out a well-organized information and collection program during these exchanges. However, both sides have gained information and first-hand observations on each other's nuclear energy program.

* For the likelihood of Soviet evasion of a moratorium and the possible gains from such evasion, see Annex A to NIE 11-2-60, SNIE 11-9-59 (SECRET), and SNIE 11-9A-59 (SECRET/RD).

* For the views of the Assistant Chief of Staff for Intelligence, Department of the Army and the Assistant Chief of Naval Operations (Intelligence), Department of the Navy, see footnote 36, page 39.

DISCUSSION

I. INTRODUCTION

19. In updating NIE 11-2-59, we have added a discussion of US-USSR exchanges in the atomic energy field, revised our estimates of the Soviet nuclear power reactor program to reflect the delays experienced, and incorporated new information into our estimate on Soviet nuclear propulsion applications.

20. New information has led us to increase our estimate of the uranium ore available to the Soviets, to decrease our estimate of U-235 production by approximately 20%, and to conclude that [redacted] provide the most likely estimate of plutonium equivalent production to date, but has led us to include an alternative, higher estimate of plutonium production.

21. Recent reports have added significantly to our understanding of the Soviet facilities for nuclear weapon research and development, fabrication, and storage. However, we are still unable to confirm the existence of operational nuclear weapon storage facilities except at Long Range Aviation bases and certain naval airfields.

22. Further analysis of the data from the Soviet nuclear test series in the fall of 1958 has not required major revisions in our estimate of present Soviet nuclear weapon capabilities. However, the continued moratorium on testing and the uncertainties as to whether limited or unlimited testing will ever resume have required us to modify the estimate of future Soviet nuclear weapon capabilities presented in NIE 11-2-59.

23. We believe that at present the USSR's weapon stockpile can support massive nuclear attacks against targets in North America and Eurasia by the long-range striking forces estimated in NIE 11-8-59, but that the size and nature of the materials stockpile imposes limitations on the numbers of weapons available for other air, ground, and naval operations.

II. THE SOVIET NUCLEAR REACTOR PROGRAM

RESEARCH REACTORS

24. There are presently 13 reactors available to the USSR for research purposes, and we have identified two more which are to become available during 1960 (Table 1, page 8). Nevertheless, there was considerable lag (up to 15 months) between the actual operational dates and the date of operation for each unit announced at the 1958 Geneva Conference on the Peaceful Uses of Atomic Energy. Such lags for experimental facilities were probably caused by engineering difficulties with the components of the primary system, although changes in planning cannot be discounted. Of special importance was the fact that the experimental fast reactor, BR-5, did not reach its full design power of 5 megawatts until July 1959, over one year after becoming critical. Such a delay indicates that difficulties were experienced with this sodium-cooled reactor. The pulsed reactor to be installed at the Joint Institute of Nuclear Research in Dubna will not become operational until late 1960, also a year behind schedule.

POWER REACTORS

25. It is apparent that the USSR will fall far short of the nuclear power objectives laid down in the Sixth Five-Year Plan. This Plan called for the installation of 2000-2500 electrical megawatts of nuclear generating capacity by the end of 1960, but the Soviets claim that they have reduced the nuclear power program for economic reasons and this claim seems reasonable.

26. This program will be centered around the types of reactors under construction at Beloyarsk and Voronezh and the four prototype reactors at Ul'yanovsk. The Beloyarsk and Voronezh stations should produce a total of 410 MW of electricity while the Ul'yanovsk reactors are expected to generate about an additional 100 electrical megawatts (EMW).

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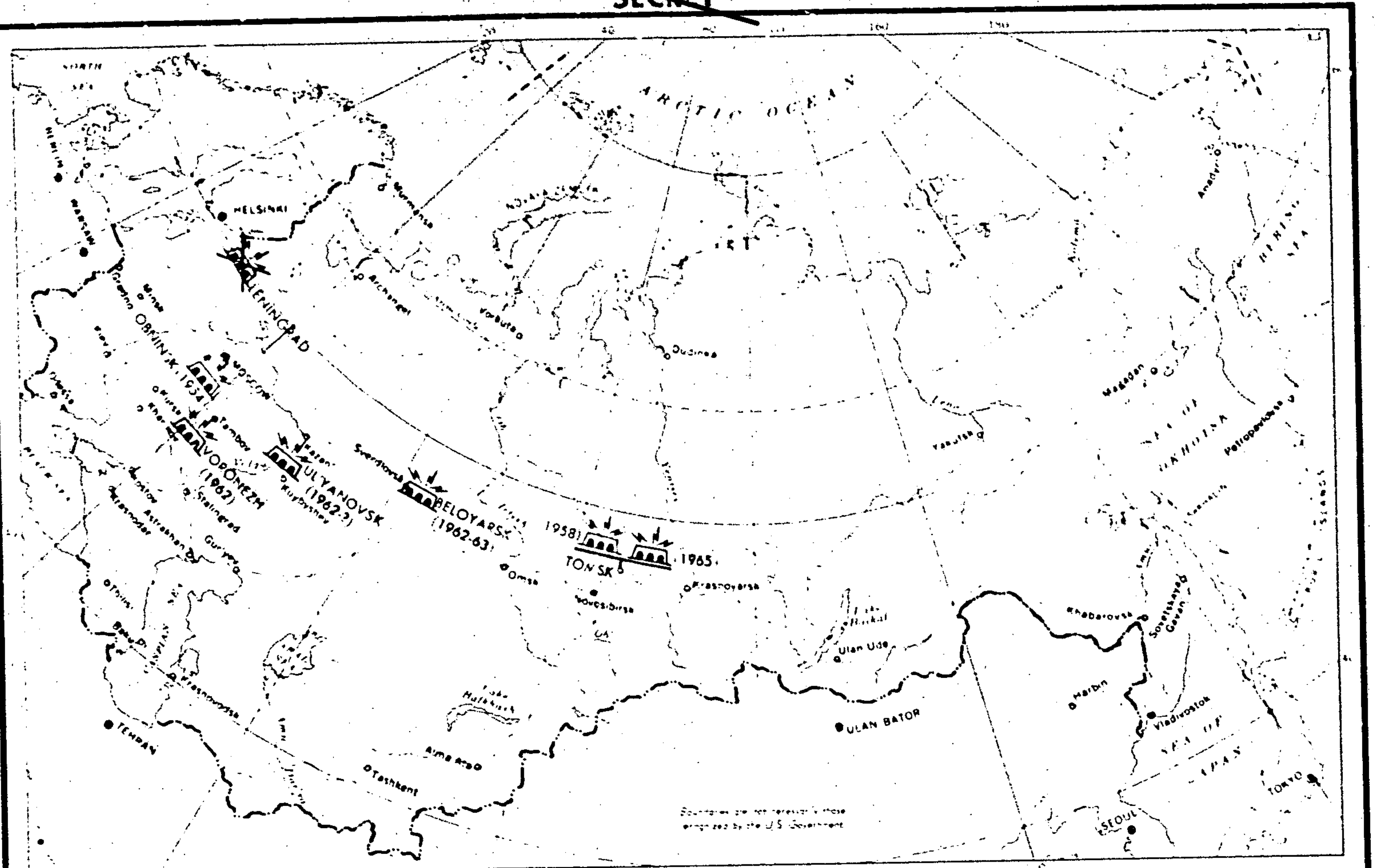
Figure 1



In Operation (date of full power)

Under Construction, expected date of full power

Indefinitely Postponed

USSR NUCLEAR-ELECTRIC POWER REACTOR SITES

Statute Miles: 0 250 500 1000 1500 2000

Kilometers: 0 250 500 1000 1500 2000

Railroad

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We estimate, therefore, that the USSR will have about 1100 megawatts of nuclear generating capacity installed by mid-1965. The Soviets have repeatedly emphasized that they will not select future large power reactors until they have obtained sufficient operating experience with the reactors now under construction to select the reactor system meriting further development. The locations and dates of operation of the nuclear-electric power stations are indicated in Figure 1 and Table 2.

27. We estimate that the total reactor thermal power required for the above nuclear electric power program in 1965 will produce approximately 1500 kilograms of plutonium annually, some of which may not be used for weapon purposes. This production will consume about 280 kg of equivalent top product U-235 each year.

NUCLEAR PROPULSION SYSTEMS FOR NAVAL AND MARINE VESSELS

28. The Soviet Union has exhibited a definite interest in nuclear propulsion for several types of merchant vessels and submarines.

a. The nuclear powered icebreaker, LENIN, was commissioned in December 1959 and is expected to operate in the Arctic during the summer of 1960 if reported operational difficulties are overcome. The pressurized-water reactor system of the LENIN was viewed several times by US scientists who reported that it is adequate but that it did not exhibit startling advances. Until sufficient operational experience is obtained with the LENIN to permit a detailed analysis, the USSR does not plan to construct any of the nuclear surface ships announced in the past.

b. There have been an increasing number of reports which indicate that the USSR is constructing nuclear submarines at Severodvinsk and Komsomolsk. In addition, two high Soviet officials have stated that the USSR has nuclear submarines. However, we have no evidence that any are in operational status. We estimate, based on the status of Soviet reactor technology, that late 1957 was the earliest date that a nuclear propulsion reactor for a submarine could have been available for installation, and that the Soviets could have had at least one nuclear submarine in a trial status by the end of 1958.

c. All Soviet nuclear-propelled vessels constructed through 1963 will probably utilize pressurized water reactors with enriched fuel. After 1963 the Soviets might use other types of propulsion reactors.

REACTOR SYSTEMS FOR AIRCRAFT, MISSILES, AND SPACE VEHICLES

29. *Aircraft.* A thorough survey of the literature and current Soviet research indicates that the Soviets are engaged in an effort to produce some type of aircraft nuclear propulsion system. We have not determined the exact type of aircraft nuclear propulsion (ANP) system under development. The Soviets have been active in the development of beryllium oxide for nuclear applications from 1947 to 1959. However, recent information indicates that beryllium oxide for fuel element uses is gaining disfavor because of poor mechanical properties. Work with other materials could lead to other approaches to the problem. The Soviets have been actively engaged in the development of nickel base alloys since 1947, and their capabilities to use Nichrome as a fuel element material are quite high. Since 1957 the USSR has become increasingly active in the development of chrome base alloys.

a. We estimate that the Soviets are now capable of having a flying testbed airborne with at least one nuclear power unit providing useful thrust during a phase of the flight. By 1962 such a program could be expected to lead to an ANP system suitable for cruise on nuclear heat alone in a subsonic aircraft of marginal performance.

b. An alternate development based on an improved fuel element could lead, by sometime in 1964, to a nuclear propulsion unit for a first subsonic aircraft with substantially improved performance.

c. Supersonic application of ANP would require a long test and development program and we do not expect that a prototype will be achieved during the period of this estimate.

Table 1

USSR RESEARCH REACTORS AND REACTOR EXPERIMENTS

Research Reactors

Reactor Designation	Location	Power Thermal (KW)	Max. Thermal Neutron Flux (neutrons/cm²sec)	Fuel	Moderator	Coolant	Date Critical	Remarks
Fursov Pile	Moscow, Inst. of AE	10 (Max.)	....	45 tons of Natural U	Graphite	Air	1947	Similar to US CP-1, served as prototype for 1st Soviet production reactor.
TR	Moscow, Thermotech. Laboratory	500	2.2×10^{13} (average)	2,100 kg of natural U	Heavy Water 4.5 tons	Heavy Water	Apr 1949	Prototype for Soviet heavy-water production reactors.
TR (rebuilt)	Moscow, Thermotech. Laboratory	2,500	2.5×10^{13}	270 kg of enriched U	Heavy Water	Heavy Water	June 1957	9 vertical channels, 52 horizontal channels.
RPT	Moscow, Inst. of AE	10,000	8×10^{13}	1,200 kg of 10% enriched U	Graphite and Water	Water	Apr 1952	Full power Dec. '52. Five in-pile loops, 3 water-cooled, 1 gas-cooled, 1 liquid metal cooled. 4 vertical channels.
RPT (rebuilt)	Moscow, Inst. of AE	20,000	1.8×10^{14}	6.1 kg of 90% enriched U	Graphite and Water	Water	1957	Reconstruction accomplished during normal shut-downs. Now 11 in-pile loops 15 vertical channels.
VVR-2	Moscow, Inst. of AE	300	2×10^{13}	35 kg of 10% enriched U	Water	Water	1952	Tank-type reactor designed for testing of shielding materials and configurations.
VVR-2 (rebuilt)	Moscow, Inst. of AE	3,000	4×10^{13}	45 kg of 10% enriched U	Water	Water	1955	Now has 5 horizontal channels with choppers, 3 vertical channels, and a "neutron multiplier" (spent fuel elements in a tank adjacent to reactor).
VVR-S	Moscow, Moscow* State University	2,000	2.5×10^{13}	60 kg of 10% enriched U	Water	Water	1955	Tank-type, 10 vertical channels, 9 horizontal channels. Supplied to Rumania, Hungary, Czechoslovakia, E. Germany, Poland and Egypt.
IRT	Moscow, Inst. of AE Tbilisi	2,000	3.2×10^{13}	40 kg of 10% enriched U	Water	Water	Nov 1957 Nov 1959	Swimming-pool prototype for use in universities and insts. A 1,000 KW version, IRT-1,000 will be built in Bulgaria, Minsk, Sverdlovsk, Tomsk and Riga.

VVR-M	Leningrad and Kiev Physical-Technical Institutes	10,000	1 x 10^{14}	20 kg of 20% enriched U	Water	Water	30 Dec 1959 (Leningrad) 12 Feb 1960 (Kiev)	Beryllium reflected, used for isotope production, prod. of trans-U elements; also neutron diffraction studies, probably in connection with solid-state work in Leningrad.
VVR-Ts	Unknown	10,000	1 x 10^{14}	25 kg of 20% enriched U	Water	Water	Unknown	Specialized radio-chemical research reactor.
Intermediate Flux Trap	Maldek, Ulyanovsk Oblast	50,000	2.2 x 10^{13}	11.7 kg of 90% enriched U	Water	Water	Probably 1960	Be or BeO reflected, central water cavity where max. thermal neutron flux is obtained.
Pulsed (Merry-go-round)	Being built at Obninsk for use at Dubna Joint Inst. of Nuclear Research	1 Ave 100,000 max.	10^{17} during burst	U-235			Late 1960	To be used with a 1 km time-of-flight neutron spectrometer.
Reactor Experiments								
BR-1 Fast Reactor	Obninsk	0.05		Pu	None	None	Early 1955	Uranium and copper reflectors.
BR-2 Fast Reactor	Obninsk	100	10^{14} (fast)	Pu-U	None	Mercury	Early 1956	Uranium reflector. (Dismantled to make BR-5).
BR-3 Combined Fast Thermal Reactor	Obninsk	0.05		Pu	None	None	Mid-1957	Uranium and water reflector. (BR-1 w.modif. refl.).
BR-5 Fast Reactor	Obninsk	5,000	10^{15} (fast)	50 kg Pu Oxide	None	Sodium	June 1958 (Full Power July 1959)	Uranium and nickel reflector.
UF_4 Gas-Fueled Reactor	....	1.5	2.7 x 10^{10}	UF_4 with 90% enriched U	Beryllium metal	None	August 1957	
Beryllium Physical Reactor (BFR)	Obninsk	0.05	....	U_3O_8 with 2% enriched U metal	Beryllium Metal	None	August 1954	Zero-power critical assembly, bare and reflected.
Isotope Reactor (IR)	Possibly Moscow Inst. of AE or Kyshtym	50,000	3-4.5 x 10^{13}	3 tons of 2% enriched U metal	Graphite	Water	1952	Experimental facility for production of isotopes.

Table 2

SOVIET NUCLEAR POWER STATIONS AND EXPERIMENTAL CENTERS

Nuclear Power Stations

Location	No. of Reactors and Type	Elec. Power (Total MW)	Thermal Power (Total MW)	Fuel Loading Per Reactor	Conversion Ratio	Annual Consumption ETP U-235 (KG)	Annual Production Pu (KG)	Fuel Lifetime	Estimated Date of Full-Pwr. Operation	Remarks
Siberia	6 Dual-Purpose	600	3,000 (claimed) 4,200 (assumed)	220–250 tons of natural U metal	0.8 assumed	....	1,200	....	1965	First reactor in operation in September 1958.
Beloyarsk	2 Graphite-Moderated, Water-Cooled, Pressure Tube Configuration	200	570	90 tons of 1.3% U metal	0.65 at beginning of cycle, 0.55 at end	148	132	2 yrs.	1962–63	Employs nuclear superheat. Est. schedule: 1st reactor, 1962; 2nd reactor, 1963.
Voronezh	1 Water-Moderated, Water-Cooled, Pressure Vessel Configuration	210	760	23 tons of 1.5% UO_2 and 17 tons of natural UO_2, (820 kg U-235 metal equivalent)	0.48	108	117	1.5 yrs.	1962	Zr-Nb alloy clad fuel elements.
Leningrad	Same as Voronezh	INDEFINITELY POSTPONED								
Obninsk	1 Graphite-Moderated, Water-Cooled, Pressure Tube Configuration	5	30	550 kg of 5% U metal	0.3	....	3	100 days	1954	First Soviet nuclear power station. Prototype of Beloyarsk reactors. Used extensively for experiment as well as power production.
Obninsk	1 Package Power, Water-Moderated, Water-Cooled, Pressure Vessel	2	10	....	0.7 assumed	....	3	....	1960	Will be assembled for testing at Obninsk and probably moved to another location after testing.
Ul'yanovsk	1 Boiling Water Reactor	50	240	....	0.50 assumed	25	43	....	1962	Same type fuel element as large PWR's.

Ul'yanovsk	1 Fast Plutonium Breeder (BN-50)	50	200	PuO_2 or Pu-U-Mo Alloy	1.6–1.8 breeding ratio claimed	....	36	....	1963-65 (Although may have been post-poned indefinitely)	Designation, BN-50, sodium-cooled with intermediate NaK loop; may use neutral diluents in fuel elements.
	1 Fast Plutonium Breeder (BN-250)	250	1,000	....	1.8–2.0 breeding ratio claimed	....	720–800	....	After 1965	Now in early planning stage. May never be built.
Ul'yanovsk	1 Graphite-Moderated, Sodium Cooled	50	180	....	0.6 assumed	....	43	....	Indefinitely postponed	Intermediate NaK loop.
Ul'yanovsk	Homogeneous Thorium Breeder assumed	5	35	....	1.0 assumed	....	14 kg U-233 on hand after U-233 cycle reached	....	1964	Suspension or solution of U in heavy water, boiling.
Probably Ul'yanovsk	1 Graphite-Moderated, CO_2-Cooled	35–50 (assumed)	170 (assumed)	....	.8	....	50	....	1964	Gas Cooled.

30. *Ramjets.* An examination of Soviet literature indicates that, in addition to feasibility studies on nuclear ramjets, they have published a very comprehensive mathematical analysis of inlets, diffusers and exhaust nozzles that could be applicable to both nuclear and chemical systems. There is also evidence of metallurgical research which could be applied to a nuclear ramjet program as well as to several other high-temperature reactor applications. We believe that the complexity of the nuclear ramjet problem makes it unlikely that the Soviets will have a nuclear ramjet engine in a flight test status during the period of this estimate, although such flight testing is possible.

31. *Rockets.* We estimate that the Soviet Union is at this time engaged in research on a nuclear rocket engine. Their research in high-temperature refractory compounds, high neutron flux reactor facilities, and high-pressure containment vessels for reactor cores would give them a development capability in this field. Based on the present status of applicable research facility construction and metallurgical research, we estimate that the Soviets could conduct a first static test firing of a prototype system possibly as early as 1965.

NUCLEAR PROPULSION FOR LAND VEHICLES

32. There is no evidence that a formal program for land vehicle propulsion is under way. However, since 1954 Soviet scientists and officials have discussed in the popular press, technical journals, and books the feasibility of nuclear propulsion for land vehicles and have alluded to the existence of a development program. Vehicles mentioned in these discussions as having nuclear propulsion possibilities include railway locomotives, truck-trailer trains for cross-country hauling, and "commercial vehicles." Among the reactor types under study by the Soviets which are potentially adaptable to land vehicle propulsion are the pressurized water, homogeneous, and liquid-metal cooled reactors. Small, compact power reactors, an announced Soviet development objective, would be particularly adaptable for land propulsion purposes.

NUCLEAR ELECTRICAL PROPULSION SYSTEMS FOR SPACE APPLICATIONS [10]

33. Electric propulsion using nuclear energy sources offers the possibility for producing a low thrust, high specific impulse system suitable for outer space and inter-orbital applications, although such systems would be useless for takeoff.

34. Although the Soviets have shown continued interest in electrical propulsion systems, no positive identification of associated personnel and institutes has been made to date. However, since much of the basic magneto-hydrodynamic research is common to both the controlled fusion and the electric propulsion programs, it is logical to assume that fusion research organizations could also be associated with electric propulsion research.

35. The Soviets are estimated to have the capability to pursue an extensive research program directed toward electric propulsion systems, but the extreme complexity of the associated problems precludes the development of an operating prototype electric propulsion system until well after 1965.

NUCLEAR AUXILIARY (NON-PROPULSION) POWER SUPPLIES

36. We have no evidence that the Soviets have utilized nuclear heat sources for auxiliary power supplies in their space program, although their outstanding work in the development of thermoelectric materials has been well substantiated. Based on their capabilities in reactor technology, in the utilization of radioisotopes, and in thermocouple development, we estimate that the Soviets can develop nuclear heat sources for auxiliary power supplies suitable for use in missiles and space vehicles at any time during the period of this estimate.

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[10] This includes ionic, plasma, and magnetohydrodynamic propulsion.

III. THE SOVIET NUCLEAR MATERIALS PRODUCTION PROGRAM

SOVIET URANIUM ORE PROCUREMENT

37. We now estimate that by the end of 1959 the Soviet Union had procured a cumulative total of about 110,000 metric tons of recoverable uranium. (Table 3, page 14.) Uranium mining and ore concentration within the Soviet Bloc continued to expand at a modest rate during 1959. Within recent years the annual production of ore concentrates has been several thousand tons greater than our estimate of Soviet nuclear energy program needs.

38. The most significant trend in the satellites was the continuing shift in East German mining operations from the largely depleted vein-type Saxony ores to the sedimentary-type Thuringia ores. A new concentration plant is being built at Seelingstadt which will use modern ion-exchange recovery methods and possibly have a daily capacity of 12,000 tons. East German uranium production is therefore expected to increase gradually in the next five years. Reports of a new concentration plant being built near Porubka in eastern Czechoslovakia also indicate that uranium ore production is undergoing a planned modest increase there. While Poland discontinued shipment of ore to USSR after 1958, Bulgaria, Hungary and Rumania are estimated to have supplied the USSR with several thousand tons of recoverable equivalent uranium metal in 1959 and to continue to do so at a slightly expanding rate during the next five years.

39. An increasing amount of evidence on the Chinese Peoples Republic uranium procurement program suggests that a fair-sized uranium raw materials base has been established. However, we now believe that uranium mined in China is meant to supply the Chinese nuclear energy program and is not intended for shipment to the USSR.

40. In the USSR, the Krivoy Rog district in the Ukraine is now estimated to be the leading uranium producer. The Fergana Valley in Central Asia is believed to be the second largest producing area followed by the Frunze-Lake Issyk-Kul' district and the Pyatigorsk district in the northern Caucasus. The 1959 visit to the Krivoy Rog area by the McCone party and a defector's report on the ore concentration facilities in the area have supplied information indicating that yearly uranium production is on the order of 2700 metric tons of equivalent uranium metal. The information also suggests that uranium mining and ore concentration began as early as 1948 and by about 1951 exceeded that of the Fergana Valley. We believe the new information on Krivoy Rog makes this portion of our estimate quite firm. Excellent 1956 and 1958 military attaché photography of the Pyatigorsk plant in the northern Caucasus leads to a fairly firm estimate of production from this area. Information received on the other uranium mining sites has been more limited, but it does suggest that the Soviets' domestic uranium mining and ore concentration program is expanding at a modest pace. It also demonstrates that the Soviets have been able to extract uranium from a variety of deposits including veins, sandstones, oil-shales, limestones and sub-bituminous coals. The last type of deposit contributes a significant percentage of uranium to their program (15 to 20 percent), and its use demonstrates an ability to develop a type of deposit largely ignored in the western world. The Soviets have matched many mining and ore concentration methods used in the US; and their recovery of uranium from coals, as well as from Krivoy Rog iron ore slags, indicates native developments requiring considerable engineering capability.

41. The Soviet Bloc is estimated to have reserves of at least 300,000 tons of recoverable equivalent uranium metal present in deposits similar in nature to those now mined. Of the known deposits being worked only the Thuringia deposit in East Germany and the Krivoy Rog deposit have apparent reserves matching many uranium mining districts of the western world. Nevertheless, the Soviet exploitation of numerous small-reserve deposits has sup-

plied, and can continue to supply, all the uranium required in the Soviet nuclear energy program. Present mining and ore concentration costs are high, but this situation can be altered quickly by the discovery of one or more large reserve deposits similar to the Ambrosia Lake deposit in New Mexico or the Blind River deposit in Canada. The probability of such a find seems excellent due to the geological diversity of the USSR.

42. The rate of future expansion of uranium production in the Soviet Bloc is estimated to be 400 metric tons of recoverable equivalent uranium metal a year. At this rate, approximately 230,000 metric tons of equivalent uranium metal will have been available to the USSR through 1965. (Table 3, below.) This figure is subject to large margins of error, however, since actual production will depend upon Soviet policies and plans.

Table 3

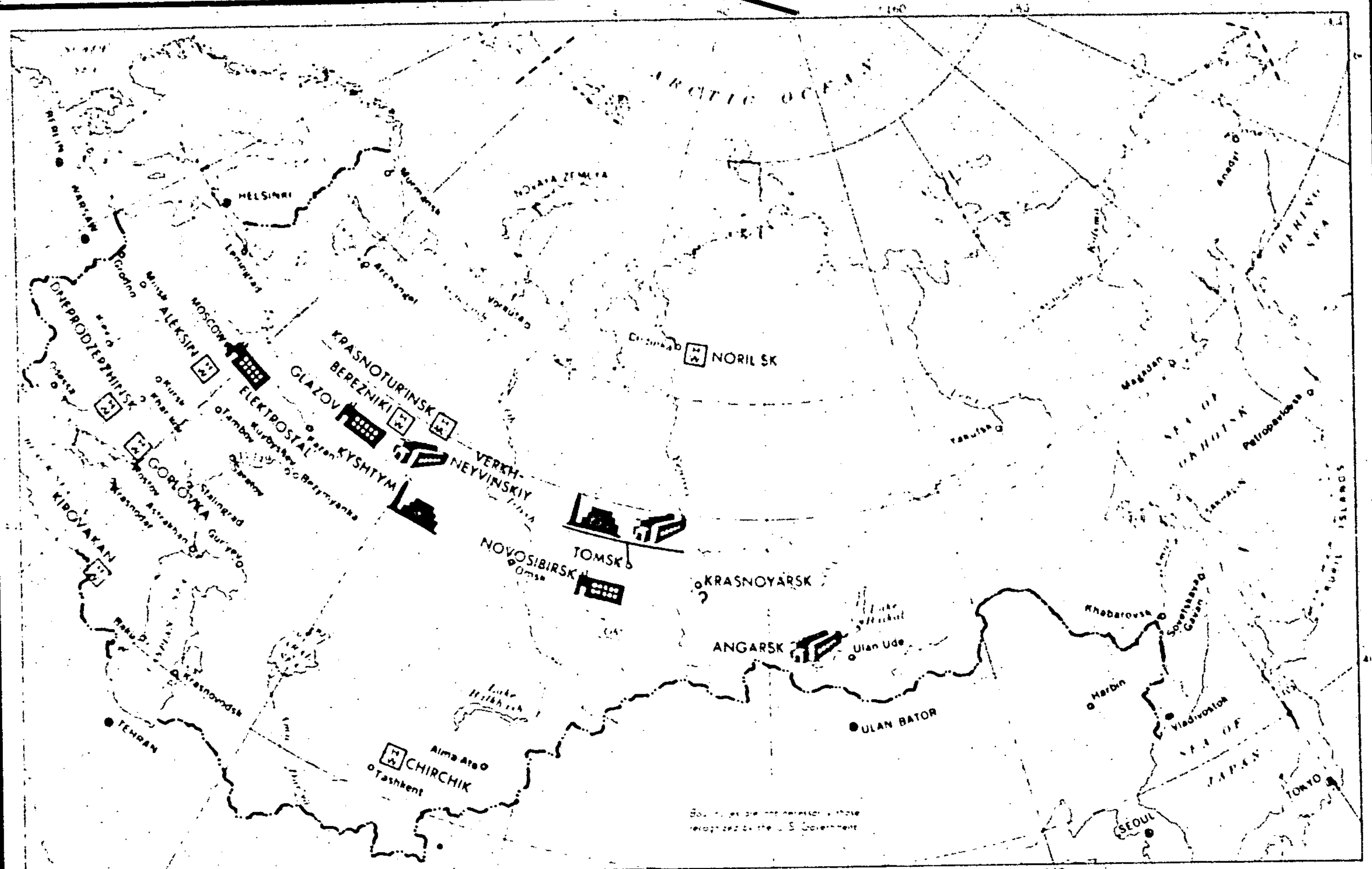
ESTIMATED SOVIET BLOC RECOVERABLE EQUIVALENT URANIUM METAL PRODUCTION THROUGH 1965

(Metric Tons, Rounded)

End of Year	USSR	E. Germ.	Czech.	Bulgaria	Poland	Rumania	Hungary	China	Total Annual	Total Cumulative
Pre 1946 Stocks	20	200	70	Nominal	..	..	..	..	300	300
1946	130	60	30	Nominal	..	..	..	..	200	500
1947	190	300	50	20	Nominal	..	..	..	600	1,100
1948	625	500	150	30	20	..	..	..	1,300	2,400
1949	1,065	1,000	250	60	40	..	..	..	2,400	4,800
1950	1,335	1,300	400	100	40	..	..	..	3,200	8,000
1951	2,470	1,700	500	150	40	..	..	Nominal	4,900	13,000
1952	2,680	2,400	600	200	40	50	..	*(40)	6,000	19,000
1953	4,345	3,300	800	300	40	150	..	(40)	8,900	28,000
1954	4,565	3,800	1,000	400	40	300	..	(60)	10,100	38,000
1955	5,570	4,300	1,200	600	40	500	..	(60)	12,200	50,000
1956	6,270	4,600	1,400	800	40	600	Nominal	(80)	13,700	64,000
1957	7,140	5,000	1,600	900	40	700	100	(100)	15,500	79,000
1958	7,700	5,000	1,600	1,000	40	700	200	(200)	16,200	96,000
1959	7,800	5,000	1,700	1,000	*(40)	800	300	(400)	16,600	110,000
1960	7,800	5,000	1,700	1,000	(40)	800	400	(500)	16,700	130,000
1961	8,200	5,200	1,800	1,200	(40)	800	500	(700)	17,700	150,000
1962	8,600	5,400	1,800	1,200	(40)	1,000	600	(1,000)	18,500	170,000
1963	9,000	5,600	2,000	1,200	(40)	1,000	700	(1,200)	19,500	190,000
1964	9,400	5,800	2,000	1,400	(40)	1,200	800	(1,200)	20,500	210,000
1965	9,800	6,000	2,000	1,400	(40)	1,200	900	(1,200)	21,300	230,000

* Production retained by China or Poland (after 1958) and not included in total annual or total cumulative production which is all shipped to or produced in the USSR.

Figure 2



USSR
NUCLEAR MATERIALS PRODUCTION SITES

Plutonium
U-235
U-Metal
Heavy Water

Statute Miles: 0 250 500 1000 1500 2000
Kilometers: 0 250 500 1000 1500 2000

Railroad

SECRET

23918 5-60

U-235 PRODUCTION

Basis For Estimating U-235 Production

43. Two operating gaseous diffusion U-235 separation plants have been positively identified in the USSR, one at Verkh-Neyvinsk in the Urals, the other north of Tomsk in central Siberia. A third plant is estimated to have started operating recently near Angarsk in the Lake Baykal area (Fig. 2). We believe, based on our analysis of Soviet electric power statistics and the difficulty of hiding very large power consumers, that no other large gaseous diffusion U-235 plant exists. Significant cumulative Soviet U-235 production by ultracentrifuge or other methods is unlikely.

44. During the past year considerably more precise information has led to a reduction in our estimate of the electric power used by the first two gaseous diffusion plants. At Verkh-Neyvinsk in recent years, installed 220-kv transformer capacity lagged the installed capacity of 220-kv power lines feeding into the site, and an additional line was delayed more than a year beyond published Soviet expectations. An additional delay in providing more power for Verkh-Neyvinsk from Verkhne Tagil has also become apparent. The first of two 200 MW generators at Verkhne Tagil was originally scheduled, according to Soviet press reports, to begin operation in 1958, but in late 1959 it appeared that this generator would not become operational until late 1960. Estimates of recent power use at Tomsk have also been somewhat reduced due to a better understanding of the performance and construction schedule of the on-site, dual-purpose reactor station there. The decreases in our gaseous diffusion power estimates largely account for the 20% reduction we have now made in our previously estimated value for mid-1960 cumulative U-235 production. (Table 4, page 19.)

45. The date when operations started at the U-235 plant believed to be in the Angarsk area is in considerable doubt, since available information leads to dates in either early 1958 as we estimated last year, or late 1959, the date of the probable start-up of the large, on-site power plant. We have selected the earlier date to account for construction time schedules and an increase in unidentified power use in the area in 1958. [redacted] We cannot exclude the possibility that Angarsk, like Tomsk, may produce plutonium as well as U-235.

46. Of considerable significance is the evidence suggesting that the Soviets began to supply an additional 500 MW to the plant at Verkh-Neyvinsk during the mid-1959 to late-1961 period. Reports also indicate that no new buildings were to be added to the plant during this period. The installation of a new barrier is consistent with this information. Installation of a new barrier would permit increased efficiency in electric power utilization and an increase in production without an increase in plant area.

47. We have assumed a moderate rate of expansion in production capacity through 1966. This assumption is based on the indicated increase at Verkh-Neyvinsk through 1961, the assumption that Tomsk will expand by 1965 to the size of Verkh-Neyvinsk, and the assumption that Angarsk will reach equal size by 1967. No additional increase in plant efficiency is forecast for this period, though additional barrier improvement is certainly possible. Although possible, no expansion after 1966 has been included in the production we calculated for 1970.

Estimated U-235 Production

48. Our estimate of Soviet U-235 production is tabulated below (Table 4, page 19) in terms of cumulative production of uranium enriched to 93% U-235 content. It includes the 93% equivalent of materials produced at lesser enrichments.

[redacted]

[redacted]

Margins of Error

49. It is very unlikely that actual Soviet cumulative U-235 production lies outside +25% to −50% of the 52,000 kg value estimated for mid-1960.[11] Our estimate of post-1960 expansion in the Soviet U-235 program is subject to wide margins of error, especially as Soviet intentions for the period after 1965 are probably not yet formulated. However, a fairly good confidence level can be assigned to a ±50% error range for the estimated mid-1963 cumulative production. Thereafter, a meaningful margin of error cannot be assigned.

PLUTONIUM EQUIVALENT PRODUCTION

50. Major facilities for the production of plutonium have been identified near Kyshtym in the Urals and north of Tomsk in central Siberia. (Fig. 2.) Plutonium production facilities may exist at other localities, but none have been identified to date. It is believed unlikely that they would have remained undetected had they started producing more than five years ago.

51. Detailed study during the past year of all available information relevant to the large unexplained atomic energy site near Krasnoyarsk in central Siberia has led us to believe now that it probably does not produce plutonium. No other suspect early plutonium production site has been identified in this general area. [redacted]

52. [redacted]

53. [redacted]

54. However, the continuing major discrepancy between the estimated amounts of uranium ore procured and processed, and the much smaller amounts required for the estimated quantities of U-235 and of plutonium equivalent [redacted] can not be explained without making one or more of the following assumptions: a) that the Soviets have deliberately maintained a large stockpile of uranium feed material; b) that

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[11] In order to accept the estimate of Soviet cumulative U-235 production (Table 4) the Assistant Chief of Naval Operations (Intelligence), Department of the Navy, finds that he would have to accept major factors of Soviet capability which are in his opinion not sufficiently supported by available evidence. These factors include: (a) initial operation dates of the production plants (b) power consumption, and (c) use of new diffusion technology and new equipment. However, he believes that improvements in Soviet basic technology and plant efficiency have been incorporated in the plants installed during 1953–1960.

The Assistant Chief of Naval Operations (Intelligence), Department of the Navy, believes that the lower limits of the estimated values for the cumulative production of U-235, although high, are the more nearly correct.

[redacted] the term plutonium equivalent is used to cover all reactor products, such as plutonium, tritium, U-235, polonium, etc.

major delays have occurred in site construction, or [redacted]

55. The USSR normally maintains large state reserves of a wide variety of strategic materials which are considered a high priority necessity. However, we lack specific information indicating either the existence of a uranium state reserve or of the magnitude of state reserves of comparable strategic materials. The surplus indicated by the above comparison of uranium production with that required by the krypton-based fissionable material production estimate is equivalent to all ore mined during the preceding three and one-half years after making allowance for pipelines and local reserves. On the other hand, there is recent evidence of production operations which, if generally adopted, would make more economical use of uranium and would create even further imbalances between our estimates of ore production and [redacted] plutonium equivalent production. At the same time, the procurement of about half the uranium, of most of the surplus from non-USSR sources, could be explained through overexploitation to pre-empt these sources.

56. [redacted]

57. It is also possible that the Soviets have encountered major delays in the construction and operation of reactors or chemical processing plants. For example, the chemical separation plant at Tomsk was not completed until about three-to-four years after the start of construction and two-to-three years after the startup of the first Tomsk reactor. Unless the irradiated fuel elements from this reactor were processed at Kyshtym, there could have been a delay of one or two years in their processing [redacted]

58. [redacted]

59. We estimate that the most likely value of Soviet cumulative plutonium equivalent production through mid-1960 [redacted] This value is consistent with several interpretations of the available site information. However, in view of the large estimated Soviet ore supply, we believe that any planning should also give serious consideration to the possibility of higher plutonium equivalent production values. We have therefore presented an alternative estimate based on what we would consider to be a more reasonable, although not complete, utilization of the estimated Soviet uranium ore than that [redacted] The alternative values would require that the Soviets have an unknown third site or the maximum possible reactor capacity consistent with available data on known sites [redacted]

[redacted]

[redacted] Table 4 presents the probable estimate and an alternative estimate.[14]

Future Plutonium Production

60. [redacted] cumulative estimate has been extrapolated to later years by adding estimated production from currently known expansion of facilities through mid-1961, and thereafter adding 300 kg. per year in each year to account for construction of the planned dual-purpose reactors and for power level increases. After 1965 no additions are assumed, although they are well within the Soviets' capabilities. The alternative uranium-based cumulative plutonium production estimate has been extrapolated on a similar basis.

[14] The Assistant Chief of Naval Operations (Intelligence), Department of the Navy considers the alternative estimate based on ore availability to be too tenuous and hypothetical for useful guidance. He believes, therefore, that the estimated quantity of uranium ore procured and mined by the USSR is not a suitable parameter for estimating plutonium production. The Assistant Chief of Naval Operations (Intelligence), Department of the Navy, recognizes the fact that estimated Soviet uranium ore acquired in excess of that used in producing the amount of plutonium [redacted] amounts to a stockpile of several years. He believes such a stockpile to be normally consistent with general Soviet stockpiling practices, with the unpredictable quality of the uranium deposits in the USSR, and with delays and cutbacks in their nuclear power program. He would therefore omit from NIE 11-2-69 the uranium-based plutonium equivalent estimate.

61. If there have been major delays in the completion of chemical processing facilities, or if there is a recently constructed unidentified reactor site, we would expect a much more rapid increase in Soviet plutonium equivalent production than that assumed in our extrapolation of the [redacted] estimate. Further, it is within the Soviets' capabilities to make greater yearly additions during the 1960–1965 period than we have assumed. In view of the strong incentives for the USSR to increase fissionable material production and to increase utilization of available uranium, we believe the more likely future values may lie between the two estimates and may approach the upper values in the latter part of this period.[15]

Margins of Error

62. [redacted] While uranium is available to support much larger estimates, actual production values much greater than those given by the uranium-based estimate become increasingly improbable even when allowances are made for a large undetected site. No meaningful error can be assigned to post-1960 estimates. Actual future production will depend on Soviet plans and policies, particularly those regarding the stockpiling of small-yield tactical and air defense weapons.

[15] The Assistant Chief of Naval Operations (Intelligence), Department of the Navy, believes that the more likely future values of Soviet plutonium production will continue, as in the past, to lie near the values in the [redacted] estimate.

Table 4

ESTIMATED SOVIET FISSIONABLE MATERIALS PRODUCTION [a] [16]

(Cumulative Production in Kilograms, Rounded)

Mid-Year	U-235 (93%) [b]: Total	U-235 (93%) [b]: Available for Weapon Use	Plutonium Equivalent.[c] (The [redacted] values are considered to be more likely through mid-1960.[17] The more likely future values may lie between the two values, and may approach the uranium-based values during the latter part of the period.): [redacted]	Plutonium Equivalent: Uranium-Based
1950	25	..	120	80
1951	160	..	370	320
1952	600	500	600	840
1953	1,550	1,400	1,100	1,500
1954	3,300	3,000	1,600	2,500
1955	6,300	6,000	2,300	3,800
1956	10,600	9,900	3,100	5,600
1957	16,500	16,200	3,800	7,800
1958	24,000	23,700	4,700	10,500
1959	36,000	35,600	6,400	13,300
1960	52,000	51,000	8,400	16,400
1961	76,000	74,000	10,700	19,700
1962	106,000	103,000	13,300	23,300
1963	140,000	135,000	16,200	27,200
1964	175,000	167,000	19,400	31,500
1965	220,000	212,000	23,000	36,000
***				
1970	450,000	..	40,400	63,400

[a] See paragraphs 49 and 59–62 for the uncertainties and ranges of error in these estimates.

[b] Production of less-highly enriched uranium is included as equivalent quantities of 93% material.

[c] Non-weapon uses of plutonium are expected to be negligible during the period of this estimate.

[16] For the view of the Assistant Chief of Naval Operations (Intelligence), Department of the Navy on cumulative U-235 production and plutonium equivalent production see footnote 11, page 16, and footnote 14, page 18.

[17] The Director for Intelligence, The Joint Staff does not agree that the most likely value of Soviet cumulative plutonium equivalent production through mid-1960 is that based on [redacted] (Paragraph 59). Instead he believes sufficient justification exists to warrant considering the uranium ore-based estimate of plutonium equivalent as an equally likely value.

This view is based on the following:

a. The marked difference between the estimated amounts of uranium ore procured and processed and the smaller amount required for the [redacted] estimate of plutonium equivalent production (Table 4), coupled with the notation that this difference would involve a 3½ year stockpile of ore plus pipeline and local reserves—utilization which is not considered the most reasonable. (Paragraph 54 and 55).

[redacted]

c. The possibility that plutonium is produced at an unidentified site. (Paragraph 59).

f. The judgment that calculated maximum possible reactor capacities at Kyshtym and Tomsk are not inconsistent with a plutonium production value about twice as large (16,800 kg) [redacted] (Paragraphs 53 and 59).

g. The possibility that Angarsk may produce plutonium. (Paragraph 45).

h. The unknown status of the facilities at Krasnoyarsk previously estimated as a plutonium producing and chemical separation site. (Paragraph 51).

IV. THE SOVIET NUCLEAR WEAPON PROGRAM

NUCLEAR WEAPON RESEARCH AND DEVELOPMENT

63. The Soviet nuclear weapon program has undoubtedly been supported by research conducted at a number of institutes and laboratories in the USSR, particularly the Institute of Atomic Energy of the Academy of Sciences (formerly Laboratory II), Moscow.

64. The main Soviet center specifically concerned with nuclear weapon research, development, and design is located at Sarova [redacted] about 250 miles east of Moscow (Fig. 3). During the 1950–1953 period, the installation was composed of a number of secure compounds dispersed within a wooded restricted zone about 100 square miles in area. The various compounds included laboratory-type buildings, machine shops, an underground installation which shipped out a product under heavy security, and at least one high explosive test facility. High-quality technical personnel worked in the restricted area, and frequent explosions were heard in the vicinity.

65. There are indications that the Sarova installation has been active in the Soviet nuclear weapon program since at least 1947. Nuclear test devices were probably assembled here and technical personnel from the center were undoubtedly intimately concerned with the nuclear testing at the Semipalatinsk proving ground, Novaya Zemlya, and other test areas.

FABRICATION AND STOCKPILING

66. There have been indications for some years that a large industrial installation at Nizhnyaya Tura [redacted] in the north central Urals is involved in some way in the Soviet atomic energy program. Recent information indicates that this installation is concerned with the fabrication and stockpiling of nuclear weapons (Fig. 3). The complex includes several factory areas, one of which reportedly processes explosives; several areas containing partly-buried buildings; and one area with a transformer yard and cooling tower.

67. A large thermoelectric power plant near the old town of Nizhnyaya Tura probably went into operation early in 1951. Although most of the power generated is exported southward, we believe that the atomic energy installation at Nizhnyaya Tura commenced operations at about the same time that large amounts of electric power became available locally.

68. A second nuclear weapon fabrication and stockpile complex may be located in the vicinity of Yuryuzan [redacted] (Fig. 3). We are uncertain as to the date of initial operation of this complex, but it apparently was constructed at a later date than the Nizhnyaya Tura installation.

69. The general Urals region contains a large number of atomic energy enterprises which since 1951 would have been able to provide the Nizhnyaya Tura and Yuryuzan plants with the materials necessary for the fabrication of nuclear weapons; i.e., U-235 from Verkh-Neyvinsk, uranium metal from Glazov, and plutonium and tritium from Kyshtym. Heavy water plants at Berezniki and Krasnotur'insk could have provided deuterium. (see Figure 2).

National Assembly and Stockpile Sites

70. We believe that early weapons produced at Nizhnyaya Tura were stored in the general vicinity of the production area, and that a central stockpile facility still exists in the Nizhnyaya Tura complex. After two or three years' production, however, the requirement probably developed for a dispersed storage system. There are indications that planning for an extensive assembly and storage system was underway by 1952, and the first dispersed national assembly and stockpile sites were probably under construction during the 1952 to 1954 period. [redacted]

[redacted]

Storage Sites at Arctic Staging Bases

71. At least [redacted] nuclear weapon storage facilities are believed to be located in the vicinity of probable major Long Range Aviation staging airfields in the arctic. [redacted] These sites may have some assembly capability. It is possible that other similar sites exist in the far north, the most likely location being in the central arctic.

Soviet Airfield Storage Sites

72. We have evidence that operational storage facilities for nuclear weapons are associated with certain airfields in the Soviet Union [redacted] All of the above airfield sites are home bases for Soviet Long Range Aviation units except two which appear to serve Naval Aviation. There are indications that similar storage sites exist at other Soviet airfields, and we estimate that all primary LRA bases have a nuclear weapon storage capability.

Other Operational Storage Facilities

73. We have no firm evidence of the existence of operational storage facilities specifically designed for nuclear weapons other than those at LRA and naval airfield sites. However, the Soviets may well have a nuclear storage capability at a number of tactical and naval airfields. Soviet tactical doctrine and training, and nuclear testing specifically oriented to ground and naval requirements, indicate that nuclear weapon storage sites are probably also available to units of the Soviet ground forces and to certain naval surface and submarine forces.

74. The Soviet guided missile program has clear requirements for nuclear warheads, particularly in strategic attack and certain air defense applications. Although there is to date no confirming evidence, we might expect to find special security arrangements and provisions for check-out and storage of nuclear warheads associated with appropriate operational missile installations.

WEAPON DEVELOPMENT PROGRAM

75. [redacted] we have no evidence that any Soviet nuclear tests have been conducted since that date, although covert tests could have been conducted.[18] In view of the continuing mora-

[18] For the likelihood of Soviet evasion of a moratorium and the possible gains from such evasion, see Annex A to NIE 11-2-60, SNIE 11-9-59 (SECRET), and SNIE 11-9A-59 (SECRET/RD).

torium on nuclear testing, we are assuming that Soviet stockpile weapons will only undergo marginal improvements from 1959 designs (See Table 5). We have discussed future capabilities if testing were resumed only in general terms.

76. No significant changes in our previous estimates have resulted from further analysis of the data from the last Soviet test series. Minor revisions have been made in Table 5, page 23, Evaluation of Soviet Nuclear Tests, and in our estimate of present capabilities.

Present Capabilities

77. Based on our analysis of their nuclear test program, we believe that the Soviets have suitable weapon types available to meet their present basic requirements.

78. We estimate that at present the Soviets have the capability to produce thermonuclear (TN) weapons in the following yield and weight classes [redacted]

79. We believe that the Soviets also have the capability to produce fission weapons in a variety of types and yields, including boosted and pre-initiation proof thermonuclear primaries and fission weapons (See Table 7, page 31).

SECRET

SECRET

Table 5

EVALUATION OF SOVIET NUCLEAR TESTS

No.	Date	Location [1, 2]	Burst Height [3]	Yield (KT) [3]
1	29 Aug 49	Semi	Surface	20
2	24 Sep 51	Semi	Surface	30
3	18 Oct 51	Semi	Air	15
4	12 Aug 53	Semi	Surface	300
5	23 Aug 53	Semi	Air	25
6	3 Sep 53	Semi	Air	8
7	10 Sep 53	Semi	Air	8
8	14 Sep 54	Totskoye 53.1N, 51.9E	1,000 / 1,500	35 / 100
9	3 Oct 54	Semi	Air	4
10	5 Oct 54	Semi	Air	45
11	8 Oct 54	Semi	[7] <few 1,000	[7] <20
12	23 Oct 54	Semi	Air	90
13	26 Oct 54	Semi	Air	[4]
14	30 Oct 54	Semi	Air	25
15	29 Jul 55	Semi	Surface	4

See footnotes at end of table.

Table 5 (*Continued*)

No.	Date	Location [1, 2]	Burst Height [3]	Yield (KT) [3]
16	2 Aug 55	Semi	Air	30
17	21 Sep 55	NZ 70.6N, 54.2E	Underwater	6
18	6 Nov 55	Semi	3,500	200
19	22 Nov 55	Semi	4,500	1,600
20	2 Feb 56	Caspian Sea	Air	6
21	16 Mar 56	Semi	Surface	30
22	25 Mar 56	Semi	Surface	25
23	24 Aug 56	Semi	Tower	60
24	30 Aug 56	Semi	3,300	2,200
25	2 Sep 56	Semi	>1,500	100
26	10 Sep 56	Semi	1,500 / 3,000	90
27	17 Nov 56	Semi	7,800	2,700

28	14 Dec 56	Semi	Air	50
29	19 Jan 57	Kapustin Yar 49.5N, 48.0E	Air	7
30	8 Mar 57	Semi	Air	15
31	3 Apr 57	Semi	Air	70
32	6 Apr 57	Semi	Air	70
33	10 Apr 57	Semi	6,800	1,300
34	12 Apr 57	Semi	Air	30
35	16 Apr 57	Semi	5,000 / 7,000	750
36	22 Aug 57	Semi	>2,000	500
37	7 Sep 57	NZ 7036N, 5412E	Surface	25
38	13 Sep 57	Semi	Unk	<20
39	24 Sep 57	NZ 7348N, 5524E	7,000 / 10,000	3,200
40	26 Sep 57	Semi	Air	8

See footnotes at end of table.

Table 5 (*Continued*)

No.	Date	Location [1, 2]	Burst Height [3]	Yield (KT) [3]
41	6 Oct 57	NZ 7348N, 5500E	7,000	4,300
42	10 Oct 57	NZ 7036N, 5412E	Underwater	10
43	28 Dec 57	Semi	Air	7
44	4 Jan 58	Semi	Unk	1.5/3
45	17 Jan 58	Semi	Unk	<5
46	23 Feb 58	NZ 7418N, 5348E	10,500	1,200
47	27 Feb 58	NZ 7418N, 5400E	10,300	2,500
48	27 Feb 58	NZ 7424N, 5336E	10,800	520
49	13 Mar 58	Semi	Air	<10
50	14 Mar 58	NZ 7415N, 5420E	Air	30
51	14 Mar 58	Semi	Air	30
52	15 Mar 58	Semi	Air	10

53	20 Mar 58	Semi	Air	15
54	21 Mar 58	NZ 7400N, 6000E	>7,500	1,000
55	22 Mar 58	Semi	Unk	20
56	30 Sep 58	NZ 7345N, 5445E	6,800	1,200
57	30 Sep 58	NZ 7324N, 5500E	8,500	2,100
58	2 Oct 58	NZ 7345N, 5430E	Air	350
59	2 Oct 58	NZ 7338N, 5730E	Air	50
60	4 Oct 58	NZ 7037N, 5445E	Air	5
61	5 Oct 58	NZ 7037N, 5445E	Air	25
62	6 Oct 58	NZ 7042N, 5455E	Air	2.5
63	10 Oct 58	NZ 7338N, 5415E	Air	200
64	12 Oct 58	NZ 7330N, 5500E	5,400	2,100
65	15 Oct 58	NZ 7400N, 5500E	7,600	3,000
66	18 Oct 58	NZ 7342N, 5454E	6,500	7,600

See footnotes at end of table.

Table 5 (*Continued*)

No.	Date	Location [1, 2]	Burst Height [3]	Yield (KT) [3]
67	19 Oct 58	NZ 7350N, 5735E	Air	35
68	20 Oct 58	NZ 7335N, 5418E	Air	400
69	21 Oct 58	NZ 7038N, 5445E	Air (?)	<5
70	22 Oct 58	NZ 7348N, 5506E	7,000	6,100
71	24 Oct 58	NZ 7400N, 5800E	7,600	2,200
72	25 Oct 58	NZ 7400N, 5500E	Air	200
73	1 Nov 58	Kapustin Yar 4930N, 4800E	Air (?)	3.5
74	3 Nov 58	Kapustin Yar 4930N, 4800E	Air (?)	3

[1] Semi = Semipalatinsk.

[2] NZ = Novaya Zemlya.

[3] Values of burst height and yield are best values.

[6] Where a range of values have been reported, they are written as minimum/maximum.

[7] Greater than: >; Less than: <; Approximately: ~.

80. *Gun-Assembly Weapons.* Although the USSR is not known to have tested nuclear weapons employing gun-type assembly, it is considered that, because of the simplicity of design, weapons of this type could now be available in stockpile. These weapons would, however, require large amounts of fissionable materials. Therefore, we estimate that if the Soviets stockpile gun-assembly weapons at all, they would stockpile only small quantities of these weapons. One possible version of this weapon, suitable for artillery shell applications, could be eight inches in diameter, weigh about 250 pounds, [redacted]

81. *Extremely Light-Weight Devices* [redacted] We have detected no tests in which analysis indicates the [redacted] characteristics which would be associated with the firing of an extremely light-weight device. [redacted]

82. No direct information is available on the specific nuclear weapon types in the USSR stockpile. Our estimate of present Soviet nuclear weapon development capability [redacted] has been based on data acquired in connection with the 74 known Soviet tests and has used US weapon technology as a guide. [redacted]

83. [redacted]

[redacted]

Capabilities Without Further Nuclear Testing [19]

84. We estimate that the Soviets would not stockpile TN weapons of radically new design or with major changes in nuclear material requirements [redacted] without testing. Such changes would require at least a mock-up test.

85. [redacted]

86. We believe that there could be only limited improvement in existing fission weapons to be stockpiled without further nuclear testing. These would probably be limited to changing compositing ratios in cores to variations in the amount of deuterium and tritium to change the yield of boosted weapons, and to improvements in high-explosive components.

[redacted]

Capabilities Under a Limited Test Ban [a]

87. Under the assumed conditions for a limited ban, the Soviets could continue to develop, improve, and proof-test small weapons yielding less than 20 KT. Considerable progress could also be made by using mock-up tests for small TN weapons, but at a slower rate and with less confidence than under conditions of unlimited testing.

Capabilities With Unlimited Testing

88. The uncertainty as to the date on which unlimited testing might be resumed, if in fact it is ever resumed, prevents any specific estimate of future Soviet nuclear weapon capabilities. However, the Soviets undoubtedly will continue to carry out research and development work on nuclear weapons, and thus have new and improved designs ready to test if unlimited testing is resumed. [redacted]

V. POSSIBLE SOVIET ALLOCATIONS OF FISSIONABLE MATERIALS TO WEAPON STOCKPILES, 1960–1963

INTRODUCTION

89. There is still insufficient evidence to support a firm estimate of the Soviet nuclear weapon stockpile by number, type, or mission. In particular, reanalysis of the evidence relating to plutonium equivalent production has given rise to considerable uncertainty as to the quantities available to the USSR. In these circumstances, we believe that it would be unwise to present any detailed estimates on the composition of the Soviet stockpile. However, it is possible to arrive at some broad judgments as to the Soviet employment of nuclear weapons, the relative emphasis on such weapons for various missions, and general Soviet nuclear weapons capabilities. These judgments take into account the following factors:

a. Our evaluation of the Soviet nuclear test program and its implications for weapons development and stockpiling;

b. Our estimates on the availability of fissionable materials;

c. Intelligence information on stockpiling practices and doctrine for the use of nuclear weapons for various purposes;

d. Our assessments of Soviet strategy and military policy as set forth in NIE 11-4-59, "Main Trends in Soviet Capabilities and Policies, 1959–1964," 9 February 1960;

e. Our estimates of Soviet development and deployment of weapon systems as set forth in NIE 11-4-59, and in NIE 11-8-59, "Soviet Capabilities for Strategic Attack Through Mid-1964," 9 February 1960.

90. Our consideration of the Soviet nuclear weapon stockpile deals with the years 1960 and 1963. We have not considered the period after 1963 because our estimates on the development, production and deployment of Soviet weapon systems, and particularly the ICBM, become much more uncertain after that date. Uncertainty also pervades our estimates on the future availability of fissionable materials. No meaningful margin of error can be stated for the estimate of cumulative U-235 production after 1963, or for the estimate of plutonium equivalent production after 1960.

91. We cannot estimate what portion of the Soviet nuclear weapon stockpile is likely to be in a ready status. A small percentage of weapons would be in the pipeline, or undergoing maintenance, retrofit, or refabrication at any given time. These weapons would not be immediately available for use by the military forces.

[a] Assumed to limit testing to completely contained underground nuclear explosions giving a seismic signal less than 4.75 Richter magnitude (the equivalent of 20 KT completely coupled in Rainier tuff).

THE SOVIET TEST PROGRAM

92. The Soviet test program over the years has reflected the development of nuclear weapons to meet a wide variety of military requirements. The 74 Soviet tests detected have been almost evenly divided among the low-yield, medium-yield and high-yield tests.[22] However, some of the low- and medium-yield tests probably were related to the development of thermo-nuclear weapons. Likewise, some of the high-yield shots may have contributed to the improvement of lower-yield weapons. Since November 1955 when the Soviets tested their first [redacted] thermonuclear weapon, greater emphasis has been placed on the high-yield category. Of the 31 tests detected during 1958, about one-half were high-yield shots, and 10 of these were in the megaton range. The weapon designs tested in 1958 could now be stockpiled in significant quantities. On the basis of the evidence provided by Soviet nuclear testing, we conclude that the Soviets now have available a wide spectrum of fission and thermonuclear weapons which is probably adequate to meet their present basic military requirements. [redacted] The USSR is not known to have tested gun-type weapons, but it is considered, because of the simplicity of design, that weapons of this type could have been developed.

AVAILABILITY OF FISSIONABLE MATERIALS

93. Basic to any consideration of the Soviet nuclear weapon stockpile is the estimated amount of fissionable material available for weapons fabrication. A re-examination of the evidence has led to a reduction in our estimates of cumulative Soviet U-235 production, and to two widely differing estimates of plutonium equivalent production. (See Table 4, page 19). The lower plutonium estimate is considered to be more probable at present.[23] We believe that the more likely future values may lie between the two estimates and may approach the higher estimate in the latter part of the 1960-1965 period.[24] [redacted] By 1963, we estimate that the amount of fissionable materials available will have increased markedly, but the same approximate ratio between plutonium equivalent and U-235 probably will persist.

94. Our estimates of Soviet stocks of fissionable materials are subject to wide margins of error (see paragraph 49, 61 and 62). Variations of this order in the actual amounts of fissionable material available would of course sharply affect Soviet allocations. The effect would be felt with greater acuteness in some categories than others, especially if the quantities of fissionable material approach the lower limits of the estimates.

SOVIET MILITARY DOCTRINE AND POLICY

95. Although the Soviets cannot be certain as to the nature and duration of a general war, they appear to assume that it would commence with massive nuclear attacks upon the homelands of the opponents. Nuclear weapons would also be employed in the subsequent struggle which would be characterized by a

[22]

Number	Yield
27	Low-yield (less than 25 KT)
21	Medium-yield (25 to 100 KT)
26	High-yield (greater than 100 KT—includes 16 tests in the megaton range)

[23] For the view of the Director for Intelligence, The Joint Staff, see footnote 17, page 19.

[24] For the view of the Assistant Chief of Naval Operations (Intelligence), Department of the Navy, see footnote 15, page 18.

total commitment of remaining forces and weapons. In any future conflict short of general war we have estimated that the Soviets probably would seek to exclude the use of nuclear weapons because of their superiority in conventional forces. At the outset of such a conflict they would probably make a considerable effort to avoid being the first to use nuclear weapons, but would undoubtedly respond, in kind, to Western use of nuclear weapons, if they considered it militarily necessary.

96. On the basis of our estimates on Soviet strategy and military doctrine, we believe that their military policy will almost certainly continue to rest on their concept of an appropriate balance between conventional and nuclear capabilities. They apparently continue to believe that a general war launched with strategic nuclear attacks would turn into a protracted conflict in which other forces would be needed on a large scale. But more important is their belief that their military policy requires a range of capabilities permitting flexibility in the choice of means and the scale of operations in accordance with the political objectives sought in a particular area. Therefore, we believe that the Soviets will almost certainly continue to maintain substantial ground, air, and naval forces.

97. To the maximum extent feasible, these forces will be dual purpose, capable of employing either nuclear or non-nuclear weapons. The principal obstacle to the achievement of this goal is to be found not in Soviet nuclear technological capabilities, but in the nature of the Soviet fissionable materials stockpile, specifically in the limited amount of plutonium equivalent estimated to be available. If, as we estimate, the Soviets have not yet achieved a state of "nuclear plenty" the various missions would necessarily have to compete for allocations of fissionable material. In line with our estimates of Soviet strategy and, considering the characteristics and numbers of the available delivery vehicles, we believe that the USSR has probably given the largest allocation of fissionable material to its long-range air and missile weapon systems. The remaining material probably has been apportioned to delivery systems employed in other air, ground, and naval operations.

LONG RANGE STRIKING FORCES

98. *Ballistic Missiles.* We have estimated that within the next few years, ballistic missiles will constitute the main element of Soviet long-range striking forces. Included in this category are ICBMs and submarine-launched ballistic missiles estimated to be in operational inventory and such medium-range (700 and 1,100 n.m.) missiles as are estimated to be available for an initial salvo capability against land-based retaliatory targets within their range.[25] Their most effective use would clearly be with high-yield thermonuclear warheads, and Soviet nuclear tests indicate the development of weapons suitable for missile applications. There is little evidence as to the deployment of these ballistic missiles, and none on the storage of nuclear warheads for these missiles.

99. Consideration of all factors leads us to estimate that the Soviets would equip all ballistic missiles in the category described in paragraph 98 with thermonuclear warheads. For purposes of this estimate, we have assumed that they would equip these missiles with warheads of the maximum yields attainable.[26]

[25] In addition to these medium range missiles which constitute an "on launcher" capability, the USSR probably is also producing such missiles for subsequent use in the initial phase of a general war and for employment in later phases of a sustained conflict. See NIE 11-8-59, paragraphs 66-67.

[26] The Assistant Chief of Staff for Intelligence, Department of the Army, and the Assistant Chief of Naval Operations (Intelligence), Department of the Navy, do not concur with the implied judgment that the Soviets would equip all of these ballistic missiles with warheads of the maximum yields available. In their opinion, many of the missions assigned to the 700 and 1,100 n.m. range missiles could be as effectively, and more efficiently, performed with lower yield warheads. See, also, their footnote to Figure 4.

[redacted] These weapons would have an aggregate yield of about 1,000 MT. About one-half of this aggregate yield could be directed against the continental US through the use of ICBMs and submarine-launched missiles.

100. The number of ballistic missiles in the category described in paragraph 98 is expected to increase markedly over the next few years. [redacted] These weapons would have an aggregate yield of about 4,000–5,000 MT, at least 80% of which could be directed against the continental US.[29]

101. *Long Range Aviation.* There is ample evidence that the Soviets, early in their nuclear weapons program, decided upon the extensive deployment of nuclear weapons to Long Range Aviation. In 1952, the Soviets probably began construction of the nuclear storage sites which have been identified at numerous Long Range Aviation bases, and we estimate that all primary LRA bases have a nuclear weapon storage capability. In their test programs, the Soviets clearly stressed the rapid development of thermonuclear weapons. All of these weapons would be suitable for bomber delivery. At present, Soviet long-range attack capabilities rest primarily upon bombers, all capable of delivering high-yield nuclear weapons.

[redacted]

102. We believe that the Soviets will seek to provide nuclear weapons for all long-range bombers intended for weapons delivery in the event of general war. They may also wish to provide a certain number of weapons for multiple bomb loads in some attacking aircraft and for restrikes by surviving aircraft. We believe that virtually all of these weapons would be high-yield thermonuclear types, and that most of these probably would be in the megaton range.

103. The numbers of weapons allocated to Long Range Aviation in mid-1960 could vary widely depending upon operational planning, the size of weapons employed, and other factors. However, we believe that Long Range Aviation could now have on the order of a thousand nuclear weapons [redacted] The aggregate yield of these weapons could vary widely, but we believe that it may be on the order of 2,000–3,000 MT.

104. We have estimated that the Soviet long-range bomber force will decrease in size during the period of this estimate. For this reason and because of the heavy demands of the growing Soviet missile forces, we do not believe that the numbers of nuclear weapons allocated to Long Range Aviation in mid-1963 will increase greatly above present levels, if at all. The total megatonnage of the Long Range Aviation stockpile could be increased markedly by 1963, with no increase in the

[29] The Assistant Chief of Staff, Intelligence, Department of the Air Force, believes in view of larger numbers of Soviet operational ICBM's estimated by the USAF for mid-1963, that a substantially higher aggregate yield (6,000–7,000 MT) will be allocated to strategic missile forces. (See NIE 11-8-59)

[30] The Assistant Chief of Staff for Intelligence, Department of the Army, and the Assistant Chief of Naval Operations (Intelligence), Department of the Navy, believe that in mid-1960, it is equally as valid to estimate that Long Range Aviation could now have no more than 500 nuclear weapons and still be considered adequately armed for general war tasks. See, also, their footnote to Figure 4.

number of weapons, by replacement of a portion of the stockpile with higher yield weapons of existing types.

AIR DEFENSE EMPLOYMENT

105. A few Soviet nuclear tests appear to have been related to the development of air defense warheads. However, there is no evidence of nuclear weapon allocations to present SAM sites. If nuclear warheads are available at these sites we believe it likely that they would be mounted on missiles, since no nuclear weapon storage facilities have been identified. We have estimated that the Soviets probably are developing a low-altitude surface-to-air missile system (SA-3) which could appear in 1961 or possibly late 1960. It is possible that they will also develop a long-range, high-altitude surface-to-air missile system which could become operational later in the period of this estimate. Both of these systems could employ nuclear warheads.[31]

106. One of the nuclear devices tested by the Soviets appears suitable for use in an air-to-air missile, and we believe that such a system could become available this year, although there is as yet no evidence of its development or production. In the absence of further nuclear testing, progress in the very low-yield devices suitable for air-to-air missiles would be seriously hindered.

107. Two of the thermonuclear devices tested in 1958 might lend themselves to application in an anti-missile missile, and we have estimated that such a system is probably being developed and could become available sometime in the 1963-1966 period. Because we do not believe that it will become operational before 1963, this system has not been considered in terms of its nuclear materials requirements. However, if such a system were widely deployed, it would place new and heavy demands upon Soviet stocks of fissionable materials, which would be felt even before actual deployment.

108. The rapid and extensive deployment of surface-to-air missile sites in the USSR is indicative of the high priority probably accorded the air defense mission. Although Soviet surface-to-air missiles are designed to be effective with HE warheads against aerodynamic targets, nuclear warheads would be required to give a significant probability for destruction of the nuclear weapons themselves. Such warheads would also increase the kill probability against the delivery vehicles. We believe these considerations so decisive that, [redacted] the Soviets would seek to provide some portion of their surface-to-air missiles with nuclear warheads. Given the large allocation to long-range air and missile systems that we have estimated, or even a substantially smaller allocation, the Soviets would not have sufficient nuclear material to provide nuclear warheads for all of their surface-to-air missiles. However, considering all factors, we believe that they could now have on the order of 600 nuclear-armed surface-to-air missiles available.[32]

109. Priorities of various defended areas and operational factors probably would cause variations in the numbers of nuclear warheads allocated to particular surface-to-air missile sites. We have estimated that SA-2 missile sites are deployed at some 50 urban-industrial areas, and that by the end of the year such sites could be deployed at about 70-80 locations, including about 60-65 urban-industrial areas.[33] A more extensive program involving a greater density of SA-2 defenses in certain locations, defense of additional targets, and allocation to field forces could be completed sometime in 1961. We believe that nuclear

[31] See NIE 11-5-60: "Soviet Capabilities in Guided Missiles and Space Vehicles," 9 May 1960.

[32] The Assistant Chief of Staff for Intelligence, Department of the Army, and the Assistant Chief of Naval Operations (Intelligence), Department of the Navy, do not concur that the estimate of 600 nuclear-armed surface-to-air missiles is any more valid than an estimate of several hundred more or less which would result from different assumptions as to operational planning, priorities, and availability of fissionable material. See, also, their footnote to Figure 4.

[33] See NIE 11-3-60: "Sino-Soviet Air Defense Capabilities Through Mid-1965," 29 March 1960.

warheads probably have now been provided for the defense of Moscow and other areas which the Soviets consider of great importance, but we doubt that nuclear-armed surface-to-air missiles are available in all of these areas. Allocation of nuclear warheads for surface-to-air missiles will probably increase through 1963, but we consider it unlikely that the Soviets will seek to provide such warheads for all missile sites and mobile units.

EMPLOYMENT IN SUPPORT OF GROUND OPERATIONS

110. There is ample evidence in current Soviet military doctrine and training that the Soviets plan to use nuclear weapons on the battlefield in support of ground operations, although apparently not in very large numbers. This doctrine visualizes delivery of nuclear weapons by a variety of methods including rifled artillery, free rockets, guided missiles, and aircraft. Evidence on the stockpiling of weapons for such purposes is slight, relating mainly to possible nuclear weapon storage sites at certain tactical airfields. Soviet nuclear tests have reflected an interest in a broad spectrum of fission weapons with yields from about one to 100 KT. The larger medium and high-yield weapons could be delivered by aircraft or by the types of surface-to-surface missiles now believed available for ground support. We have estimated that the Soviets could now have as many as a few thousand missiles of ranges up to 350 n.m., but we believe that only a small portion of these would now be equipped with nuclear warheads. Virtually all medium-range missiles (700 and 1,100 n.m.) available for support of field forces would be equipped with nuclear warheads of varying yields.

111. Assuming allocations to long-range attack and air defense on the order of those noted above, we do not believe that the present Soviet stockpile permits the use of very large numbers of low-yield nuclear weapons for tactical uses. The smaller, more probable plutonium stockpile estimated for mid-1960 could provide on the order of a thousand low-yield and medium-yield weapons (including those for tactical aviation and 700 and 1,000 n.m. missiles) for support of field forces.[34] Given the alternate plutonium estimate, these numbers could be increased markedly.

112. By 1963, the limitations imposed by the availability of fissionable materials will have eased considerably, but ground support weapons will have to compete with increasing numbers of long range missiles for allocations from a stockpile which will still be characterized by a low plutonium to U-235 ratio. However, Soviet nuclear ground support capabilities will be greatly improved, particularly by the increased numbers of nuclear-armed short and medium range missiles which will then be available for such use.

NAVAL EMPLOYMENT

113. There is firm evidence supporting the development of nuclear weapons for naval missions. Of the weapons tested by the USSR, a number of medium and low-yield weapon types would be suitable for use against naval targets. There have been nuclear tests in the Novaya Zemlya area which almost certainly relate to naval effects or to the development of naval weapons. We have evidence of nuclear weapon storage facilities at naval airfields and believe that nuclear weapon storage sites are probably also available to certain naval surface and submarine-launched ballistic missiles, which require nuclear warheads for maximum effectiveness.

114. The allocation to Soviet naval forces almost certainly is being increased with the growth in the numbers of guided missiles available to naval units. We have estimated that all submarine-launched ballistic missiles probably will be equipped with high-yield thermonuclear warheads. Nuclear warheads

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[34] The Assistant Chief of Staff for Intelligence, Department of the Army, and the Assistant Chief of Naval Operations (Intelligence), Department of the Navy, believe that other equally as valid assumptions as to operational planning, priorities, and availability of fissionable material would result in far different numbers of weapons than cited here. See, also, their footnote to Figure 4.

probably have also been provided for some portion of the air-to-surface missiles employed by Naval Aviation, and for some of the cruise-type missiles now employed by a few surface vessels. Limited numbers of nuclear bombs, depth charges, torpedoes, and mines are probably available for direct support of naval operations. Aside from the nuclear warheads for submarine-launched ballistic missiles, Soviet naval forces may now have about 300 nuclear weapons available.[35] By 1963, we believe that the allocation to naval forces will have increased markedly with the more extensive deployment of missile systems. A further increase is indicated by the growing requirement for more effective anti-submarine weapons to meet the threat posed by US missile submarines.

[35] The Assistant Chief of Staff for Intelligence, Department of the Army, and the Assistant Chief of Naval Operations (Intelligence), Department of the Navy, believe that other equally as valid assumptions as to operational planning, priorities, and availability of fissionable material would result in far different numbers of weapons than cited here. See, also, their footnote to Figure 4.

SOVIET NUCLEAR CAPABILITIES

115. We believe that the long-range striking forces have been given the largest allocation of fissionable materials, [redacted] We believe that at present the USSR's weapons stockpile can support massive nuclear attacks against targets in North America and Eurasia by the long-range striking forces estimated in NIE 11–8–59. The size and nature of the materials stockpile imposes limitations on the numbers of weapons available for other air, ground, and naval operations. However, we consider it unlikely that the availability of fissionable materials for nuclear weapons is a factor which in itself significantly limits Soviet policy. (See Figure 4, Tabular Summary of Possible Weapon Stockpile—Mid-1960.)

116. We have estimated a considerable growth in the Soviet fissionable materials stockpile by mid-1963, which should keep pace with the estimated growth in Soviet missile capabilities for long-range attack, and also ease the limitations noted above.

Figure 4

TABULAR SUMMARY OF POSSIBLE WEAPON STOCKPILES, MID-1960 AND MID-1963 [36]

(as discussed in Section V)

	Mid-1960 [a]	Mid-1963 [b]
Long Range Striking Forces		
Long Range Aviation		
Virtually all high-yield weapons	On the order of 1,000	On the order of 1,000
Surface-to-surface missiles for strike against CONUS and US retaliatory bases overseas (ICBM's, SLBM's, initial salvo of 700 and 1,100 n.m. missiles)		
High-yield weapons	About 300	On the order of 1,200
Air Defense		
(Surface-to-air and air-to-air missiles)		
Low-yield weapons (1960)	On the order of 600	On the order of 1,500
Medium and low-yield weapons (1963)		
Employment in Support of Ground Operations		
(Tactical Aviation, short-range missiles and artillery, and 700 and 1,100 n.m. missiles less initial salvo)		
Medium and low-yield weapons (1960)	On the order of 1,000	On the order of 1,700
High, medium, and low-yield weapons (1963)		
Naval Employment (less SLBM's)		
(Bombs, mines, missiles, depth charges, torpedoes)		
Medium and low-yield weapons	About 300	About 700

[a] Uses the more probable [redacted] estimate of cumulative plutonium production in 1960.[37]

[b] Stockpile figures for 1963 are subject to greater uncertainty than those for 1960, and are based on the lower [redacted] plutonium estimate. Cumulative plutonium production may exceed this value for 1963, permitting a larger weapon stockpile than shown.

[36] The Assistant Chief of Staff for Intelligence, Department of the Army, and the Assistant Chief of Naval Operations (Intelligence), Department of the Navy, do not concur with the "possible weapon stockpiles" presented in Figure 4. In view of the insufficiency of evidence on this subject (as indicated in paragraph 89) and the recognized wide margins of error inherent in the estimates of stocks of fissionable materials, the "possible stockpiles" presented for mid-1960 and mid-1963 are merely speculative possibilities selected from a great number of equally valid alternative possibilities. Such a presentation with the arbitrary exclusion of the many other possible stockpiles based on different but equally valid assumptions at best does a disservice by creating a high risk of inadvertent misuse; for example, in briefings for budgetary or planning purposes, leading to the danger of serious miscalculation by those responsible for national security.

The Assistant Chief of Staff for Intelligence, Department of the Army, and the Assistant Chief of Naval Operations (Intelligence), Department of the Navy believe that, on the basis of available intelligence, the most definitive presentation that can be made of the availability of nuclear weapons in the Soviet stockpile is one indicating a broad range of technological possibilities as shown graphically in Figure 4a, which is based on estimated total quantities of available fissionable materials using the [redacted] estimate for plutonium.

To portray similarly the broad range of possibilities deriving from consideration of estimated total quantities of fissionable materials using the alternative ore-based plutonium estimate, the ACSI/DA would include Figure 4b.

[37] For the view of the Director for Intelligence, The Joint Staff, see footnote 1, page 1.

VI. THE SOVIET INTERNATIONAL ATOMIC AID AND EXCHANGE PROGRAM

INTERNATIONAL AID AGREEMENTS

117. During the past year the USSR has concluded bilateral atomic aid agreements with North Korea, Iraq and Indonesia; the first such agreements since the initial round of bilaterals negotiated with most of the bloc nations and with Yugoslavia and Egypt in the mid-1950's. The agreements with North Korea and Iraq were similar to those previously entered into by the Soviet Union and will provide both countries with a research reactor, isotope laboratories and technical training. In addition, North Korea is to get a betatron and cobalt irradiation apparatus, while Iraq will receive assistance in prospecting for radioactive ore. As with previous agreements, the USSR has shown no haste in fulfilling these commitments and little has been accomplished since the conclusion of the original negotiations. While Indonesia has requested a subcritical assembly, a small educational reactor, and a 10 KW research reactor, negotiations have not been completed and the extent of Soviet assistance has not been determined.

118. The offers to North Korea, Iraq and Indonesia seem to fit the pattern of past Soviet international atomic aid activity. From the Soviet point of view the agreement with North Korea is a step to improve and tighten relations with another Communist nation, and may have been prompted by US aid to South Korea. The offers of atomic aid to Iraq and Indonesia were plainly inspired by the same types of political considerations which led to the earlier agreement with Egypt. Thus, these new developments do not presage any shift in Soviet policy toward furnishing basic atomic know-how to underdeveloped countries. In the foreseeable future the USSR can be expected to continue to follow an opportunistic policy of offering atomic aid when tangible political return can be expected.

119. It has been reported that the Soviets are ready to offer assistance to India in the design and construction of a nuclear power station, but the nature and extent of this assistance has not been specified. The Indian Third Five Year Plan (1961-66) calls for the construction of a 250 MW (electrical) nuclear power reactor of the Calder Hall type or a two-reactor station producing 300 MW. If the USSR were to assist in this program it would be a significant departure from the pattern of aid thus far offered to countries outside the bloc. In fact, a 250 MW reactor would be significantly larger than any of the power reactors thus far promised to the Satellites. Soviet support of the ambitious Indian program would be dictated by overriding political considerations, as it appears that the Soviet domestic atomic energy program is lagging. (see para 25, page 6.)

120. The Soviet Union has continued its support of the Chinese Communists in developing a cadre of nuclear scientists and technicians and has furnished the Chinese both a research reactor and a cyclotron. A number of Soviet scientists and technicians have been sent to China to assist that country in the development of its atomic energy program. In addition, we have firm evidence of joint Soviet-Chinese exploration of Chinese uranium resources.

THE INTERNATIONAL ATOMIC ENERGY AGENCY

121. The Soviets have continued to give only lukewarm support to the International Atomic Energy Agency (IAEA) and have frequently opposed agency projects. In particular, they have refused to recognize the necessity for establishing standard criteria to insure that fissionable materials supplied by IAEA member nations to other countries are not used to fabricate nuclear weapons. Apparently, they have not required safeguards as part of their own bilateral agreements and profess to see little or no requirement for any sort of control measures except perhaps when very large quantities of materials are involved. Nevertheless, in view of the heavy majority of supporters for safeguards in the IAEA membership, the Soviets will probably agree eventually to some form of standard safeguards procedure.

US-USSR EXCHANGE AGREEMENT

122. The US-USSR Agreement on Exchanges which was established in January 1958, has resulted in a number of exchanges of delegations and visits with nuclear aspects. In addition, a memorandum on cooperation was adopted by the two countries for the arrangement of exchanges of visits and information, and of meetings to examine the feasibility of joint enterprises in the utilization of atomic energy for peaceful purposes.

123. The Soviets have been relatively cooperative in implementing specific exchanges under this agreement, have initiated a considerable number of East-West contacts at conferences and in private exchanges, and have aggressively sought entrance into atomic energy facilities in the US. The Soviets apparently carry out a well-organized information collection program during these exchanges. The general objectives of the Soviet team which toured with Emelyanov appeared to be the assessment of the US atomic energy research and development program in relation to published information available in the USSR, with particular emphasis on the engineering and metallurgical aspects of both reactor and accelerator development. The team also exhibited a keen interest in nuclear-chemical and radio-biological research, but much of this information was denied to them because of a similar denial to the American delegation in the Soviet Union. Both sides have gained information and first-hand observations of each other's nuclear energy programs.

ANNEX A

ANNEX A

(This study was approved by The United States Intelligence Board on 22 December 1959 in response to specific questions as to the possibility of covert Soviet nuclear testing, the probability of its detection, and the possible technical gains resulting from such testing.)

1. *If the Soviets have been conducting carefully planned underground or deep space nuclear tests during the period of the unpoliced test moratorium, does the intelligence community assume that we would have been able to detect these tests?*

Carefully planned underground and deep-space tests could have been conducted and not detected by existing technical detection systems. However, other intelligence sources might give indications of impending nuclear tests. (See Question 2)

[redacted]

There is, at present, very little US capability for detecting or confirming a nuclear test in deep space.

2. *If not, does the intelligence community assume the Soviets have or have not been testing weapons on a covert basis?*

Since the beginning of the unpoliced moratorium following the Soviet tests of 1 and 3 November 1958, we have observed no indications of Soviet nuclear testing. We have no clear indications from intelligence sources of suspicious activities at their regular test sites, nor of atomic energy interest in unusual mining operations, in new geographic areas having no usual connection with atomic energy activities, or in any of the Soviet space vehicle launchings. On balance, and in view of the considerations discussed in SNIE 11-9A-59, the intelligence community has no reason to believe that the Soviets have been testing nuclear weapons on a covert basis.

3. *If covert testing has been proceeding to date, what effect might such tests have had upon improving Soviet weapons technology? Would these effects be negligible or significant?*

The table below summarizes briefly, by yield class and possible test method, the improvements the Soviets could possibly have achieved if they have been conducting covert nuclear tests. The term "significant" is used to indicate improvement in the particular device class indicated, not for the over-all nuclear capability.

4. *If the unpoliced moratorium continues for another (a) six, (b) twelve months, or (c) longer, and if the Soviets continue a covert test program through this period, what might be the effects on Soviet weapon technology? Would such effects be negligible or significant?*

(a) and (b). A covert test program during the period of the next six to twelve months probably would contribute significantly to their overall nuclear weapon capability in the area of small low-yield tactical or air defense weapons, small [redacted] TN weapons.

(c). For periods extending beyond the next twelve months, extensive use of decoupling or tests of larger devices in deep space (still unproven techniques) could lead to significantly improved designs.

TABLE

1. Up to a few hundred pounds of nuclear yield	Laboratory	(1 & 2) Improvements in light-weight weapons with full-scale yields up to 10-20 KT, [redacted] or tactical weapons yielding 10-20 KT full scale. *Significant.*
2. 100-200 tons of nuclear yield	Atmospheric or underground	
3. Zero to few tons of nuclear yield	Atmospheric or underground	[redacted]
4. From a few hundred tons to about 50 KT of nuclear yield	a) Underground, including decoupled	a) Proof and diagnostic tests of improved weapons developed under 1 and 2. Possibly mock-up tests of small [redacted] devices. *Significant.*
	b) Deep-space	[redacted]
5. Greater than about 50 KT of nuclear yield	Deep-space	Proof and diagnostic tests and weapon effects. *Possibly significant* improvement in presently estimated development capability, as well as increased and useful weapon effects information. The increased confidence might be the deciding factor in a decision to stockpile a weapon of advanced design.