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The Soviet Atomic Energy Program

Submitted by

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DIRECTOR OF CENTRAL INTELLIGENCE

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THE SOVIET ATOMIC ENERGY PROGRAM

THE PROBLEM

To review significant recent developments in the Soviet atomic energy program and to estimate the probable course of that program over the next five to ten years.

SCOPE NOTE

NIE 11-2A-65, "The Soviet Atomic Energy Program," 19 May 1965, remains the comprehensive estimate of Soviet capabilities and intentions with regard to their atomic energy programs, and should be retained. This memorandum updates information on those subjects about which significant new information has become available during the past year and which merit a restatement. It also assesses the significance of new developments of importance not covered in NIE 11-2A-65.

CONCLUSIONS

A. We estimate that during the past year production of fissionable materials in the USSR has continued at the rates estimated in NIE 11-2A-65, and that as of mid-1966 the total amounts of plutonium equivalent and weapons grade U-235 in stockpiled weapons will reach approximately 26 and 210 metric tons, respectively.¹ The USSR continues to complete and place in operation production facilities already under construction, but has not, we believe, started any major new facilities in the past few years. (*Paras. 1-5*)

B. [

do not believe that Soviet requirements will become so pressing as]We

¹ For the views of the Assistant Chief of Naval Operations (Intelligence), Department of the Navy, see his footnote to paragraph 4, page 4.

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to cause the Soviets to resume atmospheric testing in the near future. We believe, however, that they will continue occasionally, as they did in the past year, to test in ways which involve considerable risk that debris will escape outside Soviet borders in violation of the treaty. (Paras. 6-7)

C. We estimate that the Soviets have continued to improve their fission weapons and low-yield thermonuclear weapons. We now believe there is about an even chance that the Soviets have already developed an ABM warhead yielding [] If they have not already done so, they could develop such a weapon on the basis of existing technology without violation of the Test Ban Treaty. (Paras. 8-11)

D. We believe that during 1965, the Soviets conducted at least two nuclear explosions for peaceful purposes, indicating an apparent step-up in their program for peaceful uses of nuclear explosives. In addition, their weapons test programs may have contributed valuable information. We believe the Soviets will continue to explore the techniques of using nuclear explosives for peaceful uses. (Paras. 12-13)

E. During the past year, the Soviets have continued to progress in their nuclear power and propulsion program, but we foresee no breakthroughs. In fact, Soviet nuclear power continues to be plagued by technical and cost problems. The 1966-1970 Five Year Plan, in contrast to previous plans, makes no mention of nuclear power construction or goals. (Paras. 14-19)

F. We have no evidence of, and do not anticipate, Soviet transfer of nuclear weapons or significant quantities of fissionable materials to other countries. In the event the US enters into a multilateral arrangement for sharing nuclear arms, the Soviets have implied that they would do likewise. Whatever multilateral machinery they may adopt, the Soviets would almost certainly reserve to themselves alone the final decision on use of nuclear weapons. (Paras. 20-21)

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DISCUSSION

I. SOVIET FISSIONABLE MATERIALS PROGRAMS

1. The Soviet program for production of fissionable materials has proceeded during the past year generally along the lines estimated in NIE 11-2A-65. Facilities under construction when that estimate was published are now coming into operation. The estimates of production made in NIE 11-2A-65 included production from these new facilities and still represent our best judgment. Table I presents these estimates, extended one year. During the past year we have detected no starts on new production facilities. We believe that, with the completion of facilities now under construction, the Soviets will have sufficient

TABLE I
ESTIMATED CUMULATIVE PRODUCTION AND AVAILABILITY OF SOVIET
FISSIONABLE MATERIALS IN METRIC TONS

YEAR	U-235 ^{a, b}		PLUTONIUM EQUIVALENT ^c	
	CUMULATIVE PRODUCTION ^d	IN WEAPONS IN STOCKPILE ^e	CUMULATIVE PRODUCTION ^f	IN WEAPONS IN STOCKPILE ^g
1965	200	170	25	22
1966	250	210	29	26
1967	300	260	33	30
1968	350	310	39	35
1969	410	360	45	40
1970	460	400	51	46
1971	520	450	58	52
1972	580	510	65	58
1973	640	560	72	64
1974	690	610	79	71
1975	750	660	86	78
1976	810	710	94	85

^a Captain Maurice H. Rindskopf, USN, the Assistant Chief of Naval Operations (Intelligence), Department of the Navy, believes that there is a lower total amount of U-235 (see footnote to paragraph 4). For the amount of U-235 available for weapons use for mid-1966, for example he would use a base of 190 metric tons and apply the 15 percent factor for non-weapons use, thereby arriving at a figure of 161 metric tons.

^b In terms of uranium enriched to 93 percent U-235 content.

^c Includes both plutonium and tritium. One kilogram of plutonium is equivalent to 12 grams of tritium.

^d These estimates involve wide margins of error of minus 40 percent and plus 30 percent at present, widening to minus 50 percent and plus 35 percent in the future.

^e These estimates are subject to margins of error at least as great as those associated with production.

^f These estimates are subject to margins of error which grow from ± 15 percent in 1965 to ± 20 percent in 1966 and to ± 40 percent in 1976.

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capacity to meet their needs, and we continue to project no new additional facilities.

2. *Plutonium Equivalent.* The question of whether an underground facility at Dodonovo houses plutonium production reactors is under re-examination. However, our estimate of current Soviet plutonium production remains unchanged. We believe the cumulative estimate for mid-1966 of 29 metric tons to be accurate to within 20 percent. We estimate that by mid-1976 the cumulative production of plutonium equivalent will have reached some 94 metric tons, of which over 10 metric tons will come as a by-product from reactors other than production reactors. Our margins of error become greater in estimates of future production, and reach 40 percent by mid-1976.

3. *U-235.* The new plant at Zaozerniy is probably based on improved gaseous diffusion technology, but our information is insufficient to determine the nature of the improvements. We have no evidence that the Soviets have made the technological advances necessary to make a gas centrifuge process competitive with the gaseous diffusion process.

4. We estimate that the cumulative Soviet production of U-235 in mid-1966, expressed in terms of uranium enriched to 93 percent U-235, is not more than 320 metric tons nor less than 150 metric tons. This wide range continues to reflect largely our uncertainty with regard to the efficiency of the Soviet gaseous diffusion process. Our best estimate for mid-1966 is 250 metric tons. Our best estimate of future production assumes the operation at full power of all gaseous diffusion cascade buildings; on this basis we estimate that cumulative production by mid-1976 will reach about 810 metric tons. We believe, with a fair degree of confidence, that cumulative production will not be less than 400 metric tons, nor more than 1,100 metric tons by mid-1976.²

5. *Material in Weapons Stockpile.* In calculating fissionable materials available in the weapons stockpile, we continue to make a small deduction—less than five percent—for non-weapons use of U-235 and a deduction of ten percent from both U-235 and plutonium equivalent to take account of pipeline requirements and weapons withdrawn for reworking and quality control checks.

² Captain Maurice H. Rindskopf, USN, the Assistant Chief of Naval Operations (Intelligence), Department of the Navy, believes with respect to cumulative U-235 production that there is insufficient evidence to support the production efficiency which would be required by the figures in the estimate. Moreover, in order to arrive at such production figures, he would have to postulate, without supporting evidence, Soviet employment of axial-flow compressors and new improved barrier in gaseous diffusion plants. His figures are therefore lower. He estimates the total cumulative Soviet production of U-235 as of mid-1966 to be between 140 and 240 metric tons, with the most probable value about 190 metric tons. Even this value assumes incorporation by the Soviets of all possible improvements within the gaseous diffusion technology that is known to have been employed, but excludes the employment of axial-flow compressors and new improved barriers.

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II. SOVIET NUCLEAR TEST PROGRAMS

A. Test Activity

6. In the year since the publication of NIE 11-2A-65, [] 12 underground Soviet nuclear tests. These tests are listed in Table II. They raise to 23 the number detected since the signing of the Partial Test Ban Treaty. Eleven of the 12 were conducted at the Semipalatinsk Nuclear Test Area. Small amounts of fission products were collected outside the USSR [] from the 450 KT shot on 13 February 1966 and probably from the 200 KT shot on 20 March 1966.

7. The scale and pace of Soviet underground testing has remained generally constant since 1964, but the maximum yield of devices tested has increased. We believe that the pressures on the Soviet leadership for a more vigorous program will grow. However, we do not believe that research, development, and military requirements will become so pressing as to cause the Soviets to withdraw from the Partial Test Ban Treaty or to resume atmospheric testing in the near future. We believe, however, that they will continue occasionally, as they did during the past year, to test in ways that involve considerable risk that debris will escape outside Soviet borders in violation of the treaty.

B. Weapons Development

8. *Thermonuclear Devices.* Since the Test Ban Treaty, the Soviets have conducted three tests with yields large enough to be either thermonuclear mockups or full scale submegaton tests. Of the 23 tests since the signing of the Partial Test Ban Treaty, several yielded around 40-75 KT, assuming that they were fully tamped in granite. []

TABLE II
SOVIET UNDERGROUND NUCLEAR TESTS
CONDUCTED DURING THE YEAR JUNE 1965-MAY 1966

JOE NO.	DATE	LOCATION	ESTIMATED
			MOST PROBABLE YIELD (KT)
198	10 June 1965	Near Ufa	2
199	17 June 1965	Semipalatinsk	20
200	29 July 1965	Semipalatinsk	3
201	17 Sept 1965	Semipalatinsk	15
202	8 Oct 1965	Semipalatinsk	30
203	14 Oct 1965	Semipalatinsk	2
204	21 Nov 1965	Semipalatinsk	60
205	24 Dec 1965	Semipalatinsk	8
206	13 Feb 1966	Semipalatinsk	450
207	20 Mar 1966	Semipalatinsk	200
208	21 Apr 1966	Semipalatinsk	25
209	7 May 1966	Semipalatinsk	5

[

9. *Fission Devices.* Most of the Soviet nuclear tests since the signing of the Test Ban Treaty have been in the 1-30 KT range, assuming that they have been fully tamped in granite. [

] All of these tests could have helped the Soviets make some improvements in their fission as well as thermonuclear weapons technology, in the direction of reducing diameters and developing special effects weapons.

10. *Weapons Characteristics.* [

] We have recently concluded that there is about an even chance that the Soviets have developed an ABM warhead, with a yield of [The main considerations leading us to this conclusion are: (a) reevaluation during the past year of some of the nuclear tests in the 1961-1962 Soviet test series; (b) inference from the apparent Soviet intent to employ the Galosh missile as an exoatmospheric interceptor. We have further concluded that, if the Soviets have not already developed an ABM warhead, they could do so on the basis of existing technology, either without further nuclear tests or with tests which would not violate the Test Ban Treaty.

C. Peaceful Uses³

12. Two underground seismic events [during 1965 were probably experiments in the peaceful uses of nuclear explosives. One occurred on 15 January 1965 near the Semipalatinsk test area and radioactive debris from this event was collected outside the territorial limits of the USSR. The other occurred on 10 June 1965 near Ufa, and was probably nuclear in origin and conducted as an experiment for increasing gas or oil production. In addition to these tests, some Soviet peaceful uses developments could be carried out by means of contained underground detonations. Over the past three years, the USSR conducted a number of tests in alluvium and rock, using both conventional high explosives and nuclear explosives in ranges of yield up to 450 KT. Although we believe that most of these tests were primarily devoted to the development of nuclear weapons, they could also have provided data of value to investigating peaceful uses of nuclear explosives, particularly for excavation work.

³ See Annex for fuller discussion.

13. As the USSR stands to gain much from a program for the peaceful uses of nuclear explosives in terms of scientific knowledge, of international prestige, and of potential savings in money and time on large construction projects, we believe the Soviets will continue to increase their activity in this program. We believe they will further explore the techniques of using peaceful nuclear explosives, independently of whether any international arrangements are made concerning such use. [

]

III. SOVIET NUCLEAR POWER AND PROPULSION PROGRAMS

A. Nuclear-Powered Submarines

14. We believe that during the past year the Soviets have been overhauling their first E-class cruise missile submarines, probably to refuel the reactors and modify the propulsion systems to improve their reliability as they did earlier with the N-class and H-class submarines. The Soviets appear to have gained considerable confidence in the reliability of their nuclear-powered submarines, and now send them on frequent long patrols and on under-ice operations. The construction of nuclear-powered N-class and E-class submarines has continued at a rate approximating eight a year. The construction of H-class ballistic missile submarines has apparently been terminated; the last unit was delivered in 1963. We believe the Soviets will construct a new class of improved nuclear-powered ballistic missile submarine, but we have as yet no firm evidence of it.

B. Nuclear Applications to Aerospace

15. In September 1965, the Soviets launched two satellites carrying a 10 watt power source using the decay heat of a radioactive isotope which probably operated on the thermoelectric principle.⁴ A more efficient method of producing much larger amounts of electric power in space is thermionic conversion.⁵ Soviet research on thermionic conversion, using nuclear reactors as a source of heat, has intensified during the past year. Soviet scientists presented a comprehensive analysis of a compact thermionic reactor at an international conference in September 1965 and also alluded to a classified program on thermionic conversion. On the basis of Soviet research described at the conference, however, we estimate that the USSR will probably not have an operational thermionic reactor power system in space before the mid-1970s.

⁴ Thermoelectric conversion is used to produce directly small amounts of electricity from the decay heat of radioisotopes, using two materials in the thermocouple in which application of heat induces a flow of electricity.

⁵ Thermionic conversion produces electricity directly from heat by thermal emission of electrons, which in streaming from a cathode to an anode in a vacuum produce an electric current.

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16. We still have no direct evidence of any Soviet nuclear rocket or aircraft nuclear propulsion programs, but there is continuing Soviet materials research which could be applicable to such programs.

C. Nuclear Electric Power

17. During the past year there has been no change in the Soviet nuclear power programs. We now accept, on the basis of further analysis, the Soviet claim of more than 900 megawatts (MW) of nuclear electric power generating capacity in early 1965. If all current expansion plans are executed on schedule, the total generating capacity would be about 2,200 MWe by 1970.

18. The new Soviet Five Year Plan (1966-1970), in contrast to previous plans, makes no mention of nuclear power construction or goals. A nuclear power plant that appeared in the draft plan for Armenia was removed in the final plan. We believe that this reluctance to claim progress, together with the slow pace of the nuclear power program, continues to support our estimate that engineering problems and unexpectedly high costs have caused the program to be stretched out far beyond original goals.

19. During 1965, the chairman of the State Committee for the Utilization of Atomic Energy discussed two new designs for transportable nuclear power stations suitable for use at remote military, construction, or mining bases. The first type—a water-cooled, water-moderated reactor—is to use a steam generator contained within the reactor vessel and has an output of 1.5 MW. The second type is a water-cooled, graphite-moderated reactor with a 12 MW output, designed to be used in multiple units totaling as much as 60 MW. We believe that these types of transportable power stations are within Soviet capabilities in the next ten years.

IV. SOVIET CONTROLS ON FISSIONABLE MATERIALS AND WEAPONS

20. Soviet policy with regard to safeguards on nuclear materials and equipment provided to other countries is unclear. The USSR as well as most East European countries are active members of the IAEA and approve the principle of safeguards, but no reactors have been placed under IAEA safeguards by any of these countries. We do not know what bilateral safeguards, if any, are in force. A power reactor has recently been completed in East Germany with Soviet assistance, and another is under construction in Czechoslovakia, both of which will be capable of producing plutonium for development of weapons. We know of no processing plants for fuel elements in these countries. We believe that the USSR will probably insist that irradiated fuel elements from these reactors be returned to the USSR for processing. In any event the East European countries will almost certainly not undertake independent nuclear weapons programs. To date the USSR has not provided any non-Communist country with a reactor capable of producing enough plutonium to support a significant weapons program.

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21. We believe that the USSR has not furnished nuclear weapons to any other country, and that any nuclear weapons which may be in Warsaw Pact countries are under strict Soviet control. Under present circumstances, we do not expect the Soviets to enter into any multilateral arrangements for sharing nuclear weapons. They have implied, however, that if the US were to enter into such an arrangement, they would do likewise. We would expect, under these circumstances, that the Soviets would publicize such an arrangement as a counter to US actions. Whatever the nature of a multilateral machinery, they would almost certainly reserve to themselves alone the final decision on use of nuclear weapons.

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ANNEX

SOVIET PEACEFUL USES OF NUCLEAR EXPLOSIVES

1. The USSR has had extensive experience in the use of massive chemical explosions for industrial purposes, such as mining and the construction of canals and dams. As early as the late 1950s the Soviets had conducted some tests which cratered. Prior to 1964 Soviet spokesmen claimed that the US Plowshare program was a disguise for military tests. However, by mid-1964 the Soviets had apparently established a program for the peaceful uses of nuclear explosives. At the Geneva Conference on the Peaceful Uses of Atomic Energy, in August 1964, the Deputy Chairman of the State Committee for the Utilization of Atomic Energy, USSR, discussed with a US scientist three programs for peaceful uses of nuclear explosions in mining, water resource development, and in production of natural gas, and inquired about US cooperation. Another scientist discussed the possibility of using nuclear explosions for excavation. In March 1965, an official of the Atomic Energy Institute in Moscow stated that his institute and the Siberian Institute both had programs for investigating peaceful nuclear explosions.
2. In 1965 the USSR appears to have stepped up its program for developing peaceful uses of nuclear explosives. Two underground seismic events] during 1965 were probably experiments in the peaceful uses of nuclear explosives. One occurred on 15 January 1965 near the Semipalatinsk test area and radioactive debris from this event was collected outside the territorial limits of the USSR. The other occurred on 10 June 1965 near Ufa, and was probably nuclear in origin and conducted as an experiment for increasing gas or oil production. Thus, it appears the Soviets have already conducted experiments in some of the applications which USSR scientists discussed with US scientists in Geneva in 1964.
3. Over the past three years the USSR conducted a number of tests in alluvium and rock, using both conventional high explosives and nuclear explosives in ranges of yield up to 450 KT. On several occasions since the limited Test Ban Treaty radioactive debris was detected outside the territorial limits of the USSR. Except in the case of the 15 January 1965 test, it has not been possible to attribute debris to any specific event, but we believe that all debris came from Soviet nuclear explosions which cratered.

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4. Although we believe most of these tests were primarily devoted to the development of nuclear weapons, they could also have provided data of value to nuclear excavation purposes. An underground nuclear test, in any medium, which produces a crater, presents an opportunity to the tester to acquire information of value to nuclear excavation technology, regardless of the primary purpose for which the test was conducted and regardless of whether the test was expected to produce a crater. The technology for producing craters in hard rock would be important to a program investigating the feasibility of nuclear excavation.

5. In any peaceful use of nuclear explosives, there are a number of factors which must be taken into consideration. These include the cost of the nuclear device compared with the cost of conventional methods of earth moving and the dangers of radiation and shock. The USSR will probably seek to develop clean thermonuclear devices to minimize radioactive fallout which might drift across national boundaries in violation of the Partial Test Ban Treaty.

6. We believe the Soviets will continue to increase their activity in this program, since the USSR stands to gain much from a program for the peaceful uses of nuclear explosives in terms of scientific knowledge, of international prestige, and of potential savings in money and time on large engineering projects. We believe that they will further explore the techniques of using peaceful nuclear explosives, independently of whether any international arrangements are made concerning such use. The success of the program, for example, would greatly increase the feasibility of large programs such as the development of the Karakum irrigation system in the Turkmen SSR and the now dormant Davydov plan to divert water from the Ob and Yenisey Rivers to the arid regions of Central Asia.

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