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NIE 11-2A-69
3 July 1969

NATIONAL INTELLIGENCE ESTIMATE

NUMBER 11-2A-69

(Supersedes NIE 11-2A-67)

Soviet Nuclear Programs

Submitted by

ACTING DIRECTOR OF CENTRAL INTELLIGENCE

Concurred in by the

UNITED STATES INTELLIGENCE BOARD

As indicated overleaf

3 July 1969

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SOVIET NUCLEAR PROGRAMS

THE PROBLEM

To review significant developments in Soviet nuclear programs over the past few years, and to estimate the probable course of these programs over the next five to 10 years.

CONCLUSIONS

A. The USSR has a large stockpile of nuclear weapons which we believe is sufficient in numbers and variety to meet the needs of its military forces. We estimate that future production of fissionable materials will be sufficient to support projected Soviet weapons requirements.

B. It is now more than six years since the Soviets last conducted nuclear tests in the atmosphere. [ ] Accordingly, our estimate of recent developments in Soviet nuclear weapons programs is largely limited to what can be inferred from previous trends in weapon developments, from test yields, from our interpretation of Soviet effects testing, and from estimated Soviet military requirements.

C. In their underground test program, the Soviets could be obtaining data concerning the effect of neutrons, gamma rays, and X-rays upon materials, subsystems, and components. We believe that they have not been testing for X-ray effects on large components or entire systems. We believe they have been obtaining data concerning ground shock effects.

D. Although there is no evidence that the warhead on the Galosh missiles for the ABM system being deployed around Moscow is of other than conventional design, we can have little confidence that it is not. We have insufficient evidence from Soviet nuclear warhead development and testing to decide.

E. Although we have no direct evidence of specific Soviet efforts to harden their warheads against nuclear effects, Soviet warhead and re-entry vehicle design practices appear to provide an inherent hardness.

F. We have no reason to believe that the Soviets plan to resume nuclear testing in the atmosphere. Should they elect to do so, however, we probably would not be able to detect preparations more than a week or so before the test. Even then we could only say that Soviet resumption of atmospheric testing was possible.

G. We believe, on the basis of observed speeds, that Soviet nuclear submarines—both newer ones and modified older ones—have propulsion plants that deliver about 30,000 shaft horsepower from reactors with a thermal capacity of about 150 megawatts.

H. The Soviets have evidently overcome the engineering problems encountered earlier in their nuclear power program. They have in the past two years started construction on large nuclear power stations in the USSR and in some East European Communist countries, and they have tendered proposals for construction of such stations outside the Bloc.

I. The Soviets have a strong and continuing program for peaceful uses of nuclear explosives and lead the world in most applications. They have outlined ambitious plans for future projects and evidence considerable concern for the health and safety aspects. They declare they would be willing to provide nuclear explosive services to other countries.

DISCUSSION

I. AVAILABILITY OF FISSIONABLE MATERIALS FOR NUCLEAR WEAPONS

Production

1. *Plutonium Equivalent.* The USSR has large reactor complexes at Kyshtym in the Urals and at Tomsk in western Siberia. There is also a large nuclear complex at Dodonovo, north of Krasnoyarsk in central Siberia, which, we believe, has one or more reactors installed underground. We believe that reactors at Tomsk went into operation late in 1966 and 1968, respectively, and represent the only addition to production reactor capacity in the past several years.[1] Additional capacity may be under construction at one or more sites.

2. The estimates of cumulative Soviet production of plutonium equivalent through mid-1968 given in Table I represent an estimated error range of about 15 percent above and below a central figure.

3. The projection of future plutonium production through 1974 is derived by adding estimates of production from new facilities to the estimated current production. The low side assumes continuing production from the reactors now in operation, and adds 500 kilograms a year from a reactor that went into operation too late to be included in the estimate for 1968. The high side includes, not only this increase, but also additional production from other new facilities mentioned in paragraph 1, amounting to some 1,500 kilograms a year, starting in 1971.

4. After 1974 annual Soviet production of plutonium equivalent in production reactors will increasingly be affected by current and future decisions and actions that we cannot now detect or confidently predict. Fulfillment of military needs and the increasing availability of plutonium from power and propulsion reactors might lead to the shutdown of a large portion of the Soviet production reactor capacity. Conversely, additional needs for reactor products, perhaps in connection with employment of large numbers of nuclear explosives for peaceful purposes or for weapons programs which we cannot now project, might lead to significant increases in annual rates of production after 1974. If, for example, the Soviets were in 1975 to shut down production reactors at Kyshtym and Tomsk, then cumulative production in 1979 could be as low as about 70 metric tons; alternatively, if they were to start up new reactors with a capacity equivalent to that

[1] We believe the entire effect of these additions was not yet reflected in production in 1968.

TABLE I

CUMULATIVE PRODUCTION AND AVAILABILITY
OF SOVIET FISSIONABLE MATERIALS
(Metric Tons at Mid-year)

Year	Cumulative Production: Plutonium Equivalent[a] — Production Reactors[b]	Cumulative Production: Plutonium Equivalent[a] — Power and Propulsion Reactors	Cumulative Production: U-235[c d]	Available for Weapons in Stockpile: Plutonium Equivalent[e]	Available for Weapons in Stockpile: U-235[f]
1966	24–31	Negl–1	180–320	22–28	150–280
1967	27–35	1–2	210–385	24–31	180–340
1968	31–40	1–2	240–450	28–36	200–390
1969	36–46	1–2	270–515	32–41	220–440
1970	41–53	2–3	300–580	37–48	240–500
1971	46–60	2–4	330–645	41–54	270–550
1972	51–68	3–6	360–710	46–61	290–600
1973	56–75	4–7	390–775	50–67	310–660
1974	61–83	5–9	420–840	55–75	330–710

[a] Includes both plutonium and tritium. One kilogram of plutonium is equivalent to 12 grams of tritium.

[b] These ranges represent limits within which we think the true value lies. A figure midway between the top and the bottom of the range is the most probable.

[c] In terms of uranium enriched to 93 percent U-235 content.

[d] The range reflects different methodologies and assumptions. We have no good basis for selecting a most probable single figure within the range. (See paragraphs 7 and 8.)

[e] Calculated from cumulative production in production reactors, less a 10 percent allowance for production and reworking pipeline, plutonium equivalent used in weapons tests, and losses through tritium decay.

[f] Cumulative production, less a production and reworking pipeline estimated to be 10 percent of cumulative production, and less equivalent top product U-235 used in the test program and in power, propulsion, and research reactors.

at Kyshtym or Tomsk then cumulative production in 1979 could be as high as 130 metric tons.

5. The Soviets also produce plutonium in a growing number of power and propulsion reactors.[

]We believe, however, that the Soviets are more likely—at least during the next five years—to accumulate their relatively small stocks of plutonium produced in power and propulsion reactors to meet future needs for fast breeder reactor fuel. For this reason we have listed this production separately in Table I, and have not included it in the amounts available for weapons. After 1974 the rapidity with which the cumulative plutonium production from power reactors grows will depend entirely upon the pace and extent of their power and propulsion programs. If all the reactors estimated or projected in Table VI were to be completed, and they build nuclear-powered submarines as we now project, they could be producing 7-10 tons of plutonium a year from power and propulsion reactors by 1979. Such a level of production, however, assumes Soviet achievement of goals that have often been unrealistic in the past.

6. *U-235*. The USSR has four large gaseous diffusion complexes for the production of uranium enriched in U-235: Verkhne-Neyvinsk in the Urals, Tomsk in western Siberia, and Angarsk and Zaozerniy in central Siberia. We believe construction at Zaozerniy is nearing completion. We have no evidence of initiation of new construction of major U-235 production facilities.

7. [

]

8. The Soviets may be experimenting on a pilot-plant scale with the gas centrifuge process for enrichment of uranium, but this is highly speculative. Projections of cumulative production through 1974 assume continued operation of gaseous diffusion buildings now in operation, at current efficiencies and assays, and no additional production facilities.

9. Soviet production of U-235 after 1974—if projected on the same assumptions of no changes in the size, performance, or operating status of the present isotope separation plants—would provide the Soviets with a cumulative production of some 570-1,170 metric tons by mid-1979. These assumptions, however, are increasingly unlikely in the late 1970's. While Soviet weapons stockpiles will probably require decreasing shares of the cumulative production, the requirements of Soviet power and propulsion reactors will grow. Although present Soviet production capacity could probably satisfy their internal needs, worldwide needs for U-235 or for uranium enrichment services are expected to grow rapidly in the latter part of the 1970's. A Soviet entry into this market could generate significant demands on their separative capacity and perhaps lead to modernization and expansion of their plants.

Non-Weapons Uses and Pipeline

10. The Soviets do not put all their fissionable materials into weapons. The principal non-weapons use of U-235 is in propulsion systems in nuclear sub-

marines, and in other power, propulsion, and research reactors that require uranium enriched in U-235. These non-weapons uses and losses probably do not now amount to more than about five percent of the total cumulative production of U-235; however, the share is likely to grow in the future. The non-weapons uses of plutonium are negligible; considering the plutonium available from power reactors, we doubt the Soviets would have to use plutonium from production reactors for non-weapons uses in the future.

11. Fissionable materials in pipeline or in weapons withdrawn from the stockpile for quality control or reworking are also not available for weapons use. We have no information on Soviet practice in these areas. In estimating the fissionable materials available for weapons, we have assumed that about 10 percent of total cumulative production will be involved in pipeline, reworking, and quality control checks, or used for weapons tests and replacements for tritium decay.

In Weapons in Stockpile

12. The estimates in Table I of the amount of plutonium equivalent and enriched uranium available for use in weapons in stockpile take the foregoing considerations into account. We estimate that the Soviets have sufficient fissionable materials to meet the current needs of their military forces. Considering the choices of weapons design and allocation priorities available to the Soviets, we believe that future Soviet military planning will not be limited by the amounts of fissionable materials available.

II. SOVIET NUCLEAR WEAPONS TEST PROGRAMS [2]

Test Activity

13. The Soviets have continued underground testing in the past two years at about the same rate as in 1966, with 17 tests detected in 1967, 16 in 1968, and 5 so far in 1969. (See Table II.) Through June 1969 [redacted] 259 Soviet nuclear tests, of which 73 were underground tests detonated since the Limited Test Ban Treaty was signed in 1963 [redacted]

14. Most of these tests have been in the Degelen Mountain Test Area (some 100 n.m. west-southwest of Semipalatinsk). Over the past two years, tests in this area have averaged somewhat less than one per month, with yields ranging from less than 1 kiloton (kt) to 125 kt. Testing of larger weapons with yields of 150 kt or greater have continued at Novaya Zemlya, in the Soviet Arctic, at a rate of one per year. Three tests in 1967 at the Konystan Test Area (some 20 n.m. northwest of the Degelen area) and one in 1968 near the Shagan River,

[2] Tests of peaceful uses of nuclear explosives are discussed in Section VI below.

TABLE II

SOVIET UNDERGROUND TESTS

JUNE 1967 – JUNE 1969

Joe No.	Date	Location	Estimated Most Probable Yield (kt)
227	29 Jun 1967	Degelen Mountain Test Area (DMTA)	20
228	15 Jul 1967	DMTA	30
229	4 Aug 1967	DMTA	25
230	2 Sep 1967	DMTA	1
231	16 Sep 1967	Konystan Test Area (KTA)	18
232	22 Sep 1967	KTA	15
233	6 Oct 1967	Tyumen [a]	8
234	17 Oct 1967	DMTA	62
235	21 Oct 1967	Novaya Zemlya Test Area (NZTA)	170
236	30 Oct 1967	DMTA	32
237	22 Nov 1967	KTA	2
238	8 Dec 1967	DMTA	20
239	7 Jan 1968	DMTA [b]	9
240	24 Apr 1968	DMTA	8
241	21 May 1968	Karshi [a]	40
242	11 Jun 1968	DMTA	16
243	19 Jun 1968	Shagan River Test Area (SRTA)	45
244	1 Jul 1968	Azgir [a]	65
245	12 Jul 1968	DMTA	18
246	20 Aug 1968	DMTA	6
247	5 Sep 1968	DMTA	33
248	29 Sep 1968	DMTA	125
249	21 Oct 1968	Taylan Test Area (TTA) [a, b]	1
250	29 Oct 1968	DMTA	3
251	7 Nov 1968	NZTA	260
252	9 Nov 1968	DMTA [c]	4
253	12 Nov 1968	TTA [a]	2
254	18 Dec 1968	DMTA	13
255	7 Mar 1969	DMTA [c]	60
256	4 Apr 1969	DMTA	1
257	13 Apr 1969	DMTA	2
258	16 May 1969	DMTA	25
259	31 May 1969	KTA	15

[a] These tests are believed to have been for peaceful purposes.

[b] Debris *unambiguously* attributable to this test was collected outside the borders of the USSR.

[c] Debris *probably* attributable to this test was collected outside the borders of the USSR.

some 40 n.m. east of the Degelen area, are also not assessed to be for peaceful uses. We believe the Soviets will be limited to yields of about 450 kt at Degelen Mountain and 5 megatons (MT) at Novaya Zemlya if they continue their past practices with regard to risk of venting. Since 1967 they have conducted all of their tests at about 150 kt and above at Novaya Zemlya.

15. In addition to weapons testing, several other activities are going forward in the Semipalatinsk area. We believe one of these is a pulsed reactor, probably for simulation of nuclear weapons effects. Research and development on a nuclear rocket may also be under way, but a number of considerations appear inconsistent with such a development.

Effects Analysis

16. We believe Soviet interest in obtaining weapon effects or device output information from underground testing has increased in the past two years.

17. Although we have no information concerning the goals of Soviet effects test programs, analogy with those of the US permits some judgments. Such analogy suggests that the Soviets could be obtaining data concerning the effect of neutrons, gamma rays, and X-rays upon materials, subsystems, and components.

18. We believe the Soviets have also tested to obtain data concerning the response of structures to seismic ground shock effects. Additional tests may occur.

Testing and the Limited Test Ban Treaty

19. Debris unambiguously attributable to six of the 73 Soviet underground tests was collected beyond the borders of the USSR; debris probably attributable to five others has similarly been collected, and a number of other debris collections can possibly be attributed to discrete tests. The Soviets have thus continued to risk violation of the Limited Test Ban Treaty when they felt it was in their interest to do so.

20. We have no reason to believe that the Soviets intend to resume nuclear testing in the atmosphere. We believe the Soviets expect to continue underground testing for several years in the future. Should they elect to resume atmospheric or exoatmospheric testing, intelligence sources would have only very limited capability to provide advanced notice[

]

III. DEVELOPMENT OF SOVIET NUCLEAR WEAPONS

Weapons Now in Stockpile

21. *Thermonuclear Weapons.* Through the end of their atmospheric testing in 1962 the Soviets emphasized the development of multimegaton thermonuclear (TN) weapons, rather than relatively small, lightweight weapons of lower yield; they achieved high TN performance in the multimegaton range.[

]Weapons based on designs first tested in the 1961 and 1962 test series probably began to enter stockpile in 1964-1965. Older TN weapons designed for and used in older weapon systems could of course still be in stockpile. Some TN weapons based on underground tests may now be entering stockpile, but we have no basis for estimating their characteristics,[
]

22.[

]

23. *Fission Weapons.* The Soviet fission weapons program had through 1962 been directed toward the development of reliable, efficient, and economical devices.[

]Most of the newer fission weapons entering the stockpile forces over the past few years, at least for Soviet general purpose forces, have probably been these improved low-yield weapons; they probably now make up a substantial portion of the fission weapons stockpile.

24.[

]

[ ]

Soviet Weapon Developments During the Past Six Years

25. It is now more than six years since the Soviets last tested in the atmosphere. [ ] Our estimate of recent Soviet nuclear weapon developments therefore is largely limited to what can be inferred from previous trends in weapon developments, from test yields, from our interpretation of Soviet effects testing, and from estimated Soviet military requirements. The number of underground tests and their associated yields suggest that the Soviets could have made advances in weapons ranging in yields from sub-kiloton up to a few megatons.

26. *Fission Weapons.* We believe that about 60 of the Soviet tests that we have detected since the signing of the Limited Test Ban Treaty were primarily for weapons development or testing of weapons effects. Some 60 percent of these had yields of 30 kt or less. [ ] Most of the tests at 30 kt or less probably represented improvements in fission weapons technology, particularly in reducing diameters and developing special effects warheads.

27. Based on these tests, the Soviets might now be in a position to stockpile smaller fission warheads. They might also be developing small fission weapons for such applications as atomic demolition charges. We have, however, no indications of the use of nuclear projectiles for artillery in Soviet exercises. If they did not utilize earlier weapons, the Soviets probably have developed in their underground test series a nuclear warhead for use on SAMs; these would probably be fission warheads with a yield of up to a few tens of kilotons. We have no evidence concerning the weights of Soviet safing, arming, fuzing, and firing (SAFF) systems, but based on US experience, we believe the Soviets should have a capability to reduce SAFF weights for weapons entering stockpile in the near future. Some of the fission weapons tests in the low-yield ranges may have been for testing these new SAFF systems.

28. *Thermonuclear Weapons.* About 40 percent of the underground tests detected since 1963 had yields above 30 kt. Six in ranges above 100 kt probably represented TN device or weapon testing. The largest Soviet underground test was a 1,200 kt test in the fall of 1966 at Novaya Zemlya.

29.[

]If they have pursued the development, and have been successful, they could now have in stockpile limited numbers of TN weapons of some new types for some of their high priority delivery systems. These could become generally available in the 1970's.

]

30. We have no direct evidence of specific Soviet efforts to harden their nuclear warheads against nuclear effects. However, in their past test programs they have gained considerable experience with blast and thermal effects. Moreover Soviet warhead and re-entry vehicle design practices appear to provide an inherent hardness. After a reassessment of some of the earlier Soviet high altitude tests at Sary Shagan in 1961-1962, we still believe that those tests, while highly sophisticated in their missile involvement and probably well instrumented, lacked the characteristics of tests designed to give detailed information on weapon vulnerability. We continue to believe that they were conducted primarily to obtain radar blackout data. We believe that the Soviets are capable of expanding their knowledge of the effects of radiation on systems and components both by means of their current underground test program and through the use of various simulation techniques.

31. Although there is no evidence that the warhead on the Galosh missiles for the ABM system being deployed around Moscow is of other than conventional design, we can have little confidence that it is not. We have insufficient evidence from Soviet nuclear warhead development and testing to decide.

Future Weapons Development and Requirements

32. The Soviets could probably test up to several megatons under the current Limited Test Ban Treaty, and thus could probably meet any present or future weapon development requirements below that figure. We believe they could make significant advances in TN weapons in the sub-megaton and low-megaton yield range. This is an area in which they appear to have a major requirement for

improved warheads for new strategic missile delivery systems, and possibly for multiple warhead application.

33. If the Soviets have not already developed a special design in the low megaton range for ABM warheads, they could probably do so with relative ease on the basis of existing technology, and test them without violating the Limited Test Ban Treaty. They could also test underground the response of various materials, components, and systems. Some developments would, however, involve considerable effort and great costs.

IV. STORAGE AND CONTROL OF SOVIET NUCLEAR WEAPONS

Storage

34. The Soviets have an extensive nuclear storage system progressing from national stockpile sites and regional sites to operational storage and handling sites for all the major operational force elements that have a nuclear capability. In the event of war, the initial needs of Soviet forces for nuclear weapons would probably be met by the operational storage sites, with backup from rear echelons. Movement of nuclear warheads in the USSR is primarily by rail. Large cargo planes and helicopters are a far more rapid, if limited, means of weapons supply in times of crisis, and the Soviets have acknowledged such supply. Some of the stockpile sites are close enough to the borders of the USSR in the west and east to provide direct support to Soviet forces outside the USSR.

35. We believe the Soviets have operational storage sites at a few of the airfields occupied by the Soviet Tactical Air Force (TAF) in Eastern Europe. As no tactical missile nuclear warhead storage sites have been identified in Eastern Europe, it is possible that airfield sites provide limited storage for tactical missile units as well as for TAF. We do not know if the Soviets now store nuclear weapons at the sites in Eastern Europe.

36. There are 10 large, self-contained, highly secured, military installations located throughout European USSR which we call Sensitive Operations Complexes (SOCs). They contain large hardened structures, extensive rail and road facilities, and extensive housing and operational support. The multiplicity of facilities at each of the SOCs suggests that the SOCs have multiple functions. These functions, however, remain unclear. We believe that one of the functions of the SOCs includes storage and maintenance of nuclear weapons. We have identified no specific military force or weapon system associated with the SOCs.

Command and Control

37. Use of nuclear weapons would require authorization by the Politbureau, which would in wartime exercise control of the nuclear units through the Supreme High Command (a body of the top political and military leaders)

and thence through the Minister of Defense and major force commanders. Little is known about actual Soviet operational procedures for the control of firing nuclear weapons. We have no conclusive evidence concerning how operational nuclear warheads on ready missiles on land or at sea are controlled, but we assume that some form of authentication system and/or permissive link in weapons is used to maintain a high degree of control.

38. We have evidence that once the Politbureau has decided that nuclear weapons are to be deployed and may be used, control over the allocation and use of tactical weapons—both air and missile—resides with the Front or independent army commanders. We believe that control by Front commanders over the specific employment of tactical weapons would be fairly tight.

V. MARINE PROPULSION

39. The pressurized water type reactors of the early Soviet nuclear submarines built in the late 1950's apparently had problems. Operating levels were limited to a thermal output of about 90 megawatts (MWt), judging from the speeds observed during the first few years of operation. Modifications made during the early to mid-1960's apparently overcame these limitations. Observed speeds of some of these early submarines in the last few years, along with theoretical calculations, indicate that these improved submarines have propulsion plants of about 30,000 shaft horsepower, equating to an operating level on the order of 150 MWt. This is probably close to the capacity originally intended. Preliminary information on the new nuclear powered submarines now entering the fleet indicates that they have at least an equivalent shaft horsepower, and by implication, reactor power.

40. The nuclear icebreaker Lenin has not been in operation since the 1965 navigational season. Following an apparent nuclear accident, repair and modernization that involves extensive work in the reactor area is now in progress at Severodvinsk. Improved fuel element technology reported by the Soviets in 1966 and 1968 is expected to be incorporated into the Lenin's new reactor systems. The Soviets also will probably utilize this new reactor technology in their new Arktika class of icebreaker, which they plan to commission in the early 1970's. The new icebreakers reportedly will have two reactors of an improved type, providing 1.5 times the power of the Lenin's original "ship power." This would equate to about 60,000 shaft horsepower.

VI. PEACEFUL USES

41. The use of nuclear energy for peaceful purposes has also taken a share of the R&D and material resources put into Soviet nuclear energy programs. The nuclear electric power program has been moving forward, but at a much slower pace than the Soviets originally publicized. In contrast, their unpublicized pro-

gram for the peaceful uses of nuclear explosives is an area in which they lead the world in most applications. The Soviets apparently intend to enter the free world market for nuclear electric power stations and nuclear explosive services.

Power and Dual-Purpose Reactors

42. The Soviet nuclear power program announced in 1956 called for electric generating capacity of 2,000-2,500 megawatts (MWe) by 1960. It now appears it will reach a capacity of 2,000 MWe in 1970. During the past two years the Soviets have placed in operation the second section of the Beloyarsk nuclear power station, a new section of the Tomsk dual purpose reactor complex, and the experimental sodium fast test reactor at Melekess. Construction has continued on schedule on the second section of the Novovoronezh nuclear power station, and the packaged power reactors at Bilibino. However, construction has fallen a year behind schedule on the sodium fast reactor for desalination and power at Shevchenko. (See Table V.) Capacity has now reached 540 MWe in reactors primarily for production of electricity, 1,300 MWe in the dual purpose Siberian Nuclear Power Station at Tomsk, and over 60 MWe in stations at experimental reactor centers.

43. The Soviets have evidently overcome the engineering problems encountered earlier in their power program. They have in the past two years started construction on three types of a third generation of nuclear power station. They now apparently expect to double their nuclear generating capacity by 1975, and double it again by 1980 or so, so that by the latter date they will have some 8,000 MWe of nuclear generating capacity. With the construction of these larger plants, they expect to be able to compete with thermal power stations in high cost areas. With the construction of fourth generation plants, including fast breeder reactors with a generating capacity of 1,000 MWe or larger in the 1980's, they expect nuclear power to be fully competitive.

44. The main new construction program is based on the development of pressurized water reactors (PWR) at the Novovoronezh nuclear power station. The Soviets have been able to upgrade the first reactor to a power level of 278 MWe. Their second unit is expected to become operational in late 1969 and should reach 365 MWe.

45. Utilizing the experience gained from these two units, the Soviets have designed a "standard" 440 MWe pressurized water reactor (PWR) unit. Two of these standard units would be put together to make a standard PWR nuclear power station with a capacity of 880 MWe. Construction on the first unit of such a station has begun at Novovoronezh and in the Kola power system near Murmansk; the Soviets say they expect to build a similar power station near Yerevan.

TABLE V
SOVIET NUCLEAR POWER STATIONS

Location & Units	Moderator/Coolant	Power Level MWe/MWt[a]	Year in Operation
Dual Purpose Reactors			
Tomsk			
1	Graphite/Water	625/3,700 (units 1 and 2)	At 100 MWe in 1958; modified to 200 MWe in 1963
2	Graphite/Water		1961
3	Graphite/Water	350/1,900	1966
4	Graphite/Water	350/1,900	1968
Power Reactors			
Beloyarsk			
1	Graphite/Water Pressure tube, with nuclear superheat	100/286	Full power in 1965
2	Similar to 1	200/560	Full power in 1968
3	Sodium Fast Reactor	600/1,430	Estimated by 1975
Novovoronezh			
1	Water/Water Pressure vessel	240/760	Full power in 1965
2	Similar to 1	365/1,400	1969
3	Similar to 1	440/1,370	Estimated by 1971
4	Same as 3	440/1,370	Estimated in 1972
Shevchenko			
1	Sodium Fast Reactor	150/1,000[b]	Estimated 1971-1972
Bilibino			
4 Units, Total	Packaged power reactor	12 MWe each	Estimated 1970-1972
Kola			
1	Water/Water	440/1,370	Estimated in 1974
2	Same as 1	440/1,370	Estimated in 1975
Yerevan			
1	Water/Water	440/1,370	Projected
2	Same as 1	440/1,370	Projected
Leningrad			
1	Graphite/Water	1,000/4,000-5,000	Estimated in 1973
2	Same as 1	1,000/4,000-5,000	Estimated in 1974
Kursk			
1	Graphite/Water	1,000/4,000-5,000	Projected
2	Same as 1	1,000/4,000-5,000	Projected
Experimental Power Centers			
Obninsk			
1	Graphite/Water	5/30	1954
2	Water/Water	1.5/10	1959
Melekess			
1	Graphite/Boiling Water	50/300	Full power in 1965
2	Sodium Fast Test Reactor	12/60	1968
3	Organic/Organic Packaged power reactor	0.75/5	Full power in 1964

[a] MWe: capacity of the electric power generating equipment in megawatts of electric power. MWt: capacity of the reactor in megawatts of thermal power.
[b] Part of the thermal power is for a desalination plant.

46. The Soviets are attempting to enter the world power market with the 880 MWe PWR power station. They have started construction of such a station in East Germany; they have signed agreements to construct similar stations in Hungary, Bulgaria, and Finland; and they are carrying out a cost study for a 440 MWe station of this type in East Pakistan. These stations will probably be built widely in Soviet Bloc countries, but indications of plans for sales elsewhere are limited. The Soviets will probably provide enriched uranium feed to nuclear power stations built within the Bloc. Their entry into the world market for enriched uranium feed probably would depend upon political rather than economic considerations. They have indicated informally that they would meet the US price, although we believe their production costs are higher.

47. The Soviets are also planning to build nuclear power stations using two graphite moderated, water cooled reactors, with a station capacity of 2,000 MWe. The prototype for these stations is probably the Tomsk dual purpose reactor. The first of these stations is under construction near Leningrad; the Soviets have said they plan to build a similar station near Kursk.

48. The fast breeder reactor program is receiving heavy emphasis and greater publicity, but is apparently also encountering substantial difficulties. Two large fast breeder reactor power stations are under construction—a power and desalination facility at Shevchenko on the eastern shore of the Caspian Sea, with a planned capacity of 150 MWe and 32 million gallons of fresh water per day, and a 600 MWe power station at Beloyarsk. Both reactors will start with enriched uranium fuel, but are expected to use plutonium fuel in the future. We estimate that the fuel inventory required for each of these large fast breeder reactors will be about 3-4 metric tons of plutonium, assuming a one year processing pipeline. These reactors, which are bold extrapolations of existing technology will, if successful, be major steps toward the development of 1,000-2,000 MWe fast breeder nuclear power stations.

Peaceful Uses of Nuclear Explosives

49. The Soviets have a strong and continuing program for peaceful uses of nuclear explosives. At a recent meeting in Vienna, the Soviets admitted they had conducted several nuclear tests for peaceful purposes in various media, but described only two of these tests. Other evidence indicates that since January 1965, they have conducted at least 11 nuclear tests primarily related to peaceful uses; 4 of them have been in the past year. They have tested in at least 6 media, for a variety of purposes.

50. At Vienna the Soviets described a 1 kt cratering event they conducted "several years ago." The reported yield fits that of a shot on 14 October 1965 in the Konystan area of the Semipalatinsk test site. The Soviets said they had conducted extensive radiation measurements, including some within the lip formed by throwout material. In October 1968, they used explosives with a yield

on the order of 1 kt in the Taylan area of the Semipalatinsk nuclear test area. As debris from this test was picked up outside the USSR, it is possible that the test produced a throwout crater. Another test a month later in the same area may also have tested nuclear explosives for moving earth. The Soviets have also used kiloton amounts of conventional explosives to derive data useful to the application of nuclear explosives to earth moving.

51. Four tests in the past four years (two in the past two) have been related to the oil and gas industry. The Soviets have used nuclear explosives near Karshi in Central Asia at estimated depths of 7,000 and 11,000 feet; these depths are greater than tried by any other nation. One of these was to curb a wild gas well; the other was probably also for the same purpose. Two other tests, near Tyumen and Ufa were possibly to produce underground storage for petroleum and to stimulate oil production.

52. Other tests can best be characterized as oriented toward understanding the phenomena of nuclear explosions underground. One of these was described at Vienna by the Soviets as a 1.1 kt test in a shallow salt dome conducted "several years ago for the purpose of seismic studies, learning about phenomenology of salt shots and to evaluate the use of nuclear explosion cavities for storage and waste disposal." The location of this test has not been determined. Two tests were detected near salt domes at Azgir, north of the Caspian Sea, at higher yields; they may have been to study explosion-produced phenomena or decoupling in a salt medium.

53. The demonstrated Soviet knowledge of pertinent effects in wide ranges of rock types, the depth of their understanding of specific effects, the quality of data derived from their experiments, and the degree of sophistication revealed in their projects planned for the future show that the Soviets have devoted considerable thought and effort to the peaceful uses of nuclear explosives. They have developed detailed plans for future projects that include concern for health and safety aspects. Their plans also include projects for damming of rivers, removal of overburden, shattering an ore body, gas and oil stimulation, cavity creation for gas storage, as well as for research in cavity stability. They declared they would be willing to provide nuclear explosion services to other countries.

54. The Soviet delegates to the meeting in Vienna showed great interest in the radiation problems brought about by peaceful nuclear explosions, and were interested in developing health and safety guidelines to facilitate peaceful nuclear applications. The delegates appeared to consider the Vienna meeting as only the beginning of a dialogue on peaceful uses. The Nuclear Proliferation Treaty obligates the nuclear powers, including the US and the USSR, to provide support to nuclear "have not" nations in the field of peaceful uses of nuclear explosives.

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