1860

23320

24-July 90

Directorate of Intelligence

~~Secret~~ m

Soviet Breeder Reactor Program: Prospects and Weapons Material Production Potential

A Technical Intelligence Report

CIA SW 90-10046

~~Secret~~
SW 90-10046
July 1990
Copy

1.86 1

Warning Notice	Intelligence Sources or Methods Involved (WNINTEL)
National Security Information	Unauthorized Disclosure Subject to Criminal Sanctions

Dissemination Control Abbreviations		
	NOFORN (NF)	Not releasable to foreign nationals
	NOCONTRACT (NC)	Not releasable to contractors or contractor/consultants
	PROPIN (PR)	Caution—proprietary information involved
	ORCON (OC)	Dissemination and extraction of information controlled by originator
	REL...	This information has been authorized for release to...
	WN	WNINTEL—Intelligence sources or methods involved
	A microfiche copy of this document is available from OIR/DLB (482-7177); printed copies from CPAS/IMC (482-5203 or secure 3-37108; or AIM request to userid CPASIMC). Regular receipt of DI reports can be arranged through CPAS/IMC.	Classified b Declassify: OADR Derived from multiple sources

All material on this page is Unclassified.

1862

Directorate of Intelligence

Secret

Soviet Breeder Reactor Program: Prospects and Weapons Material Production Potential

A Technical Intelligence Report

This paper was prepared b /of the Office of Scientific and Weapons Research, with a contribution from

Comments and queries are welcome and may be directed to

OSWR

Reverse Blank

(REVERSE BLANK)

Secret
SW 90-10046
July 1990

1863

Secret

Soviet Breeder Reactor Program: Prospects and Weapons Material Production Potential

Summary

Information available as of 30 June 1990 was used in this report.

The Soviet breeder reactor program has been slowed considerably. Adverse economics and ongoing safety-related design modifications almost certainly will delay the widespread installation of commercial-sized breeders beyond the early part of the next century. [redacted]

Unless uranium prices rise substantially, proven Soviet thermal reactor designs such as the VVER-1000 will remain much more economical and could be built in lieu of BN-800s to supply needed power.

The Soviets have two prototype breeder reactors: the 125-megawatt BN-350 and the 600-megawatt BN-600 [redacted] The current BN-800 design is basically an unimproved, scaled-up version of the BN-600 and probably will be updated to incorporate safety-related design changes, resulting in substantial construction delays.

The Soviets have most of the facilities and infrastructure to develop breeder reactor technology through the demonstration stage. They have a power-reactor-fuel reprocessing facility and a stockpile of non-weapons-grade plutonium to furnish the initial fuel loading for several breeder reactors but lack the commercial-size mixed-oxide (plutonium and uranium) fuel fabrication plant necessary to produce the fuel assemblies.

An active breeder program increases Soviet options and flexibility to produce plutonium for weapons. The Soviets recently stated that they are reprocessing both BN-350 and BN-600 breeder fuel at Kyshtym [redacted] (Because breeders are poor producers of tritium the Soviets probably would not use them to acquire this material.

Secret
SW 90-10046
July 1990

breeder reactors have the best weapons-grade plutonium production potential of any Soviet "civilian" reactor,

after 2000, if existing breeder prototypes operate at full power and new breeders are built, their annual production potential—0.3 ton from the BN-350, 0.4 ton from the BN-600, and 1.2 tons from two new BN-800s—could be as much as 1.9 tons of weapons-grade plutonium. The Soviets contend that they will not use breeders for military purposes,

Contents

	Page
Summary	iii
Introduction	1
Soviet Breeder Program	2
Breeder Development—Types, Sizes, Status	2
Projected Construction and Needs	3
Soviet Breeder Safety Problems	8
Sodium/Water Interactions	8
Lack of Containment Structure	8
Reactor Control Safety Problems	8
Soviet Breeder Reactor Fuel Cycle and Plutonium Production Options	8
Plutonium Production Capability	8
Reprocessing Breeder Reactor Fuel	10
Tritium Production Capability	11
Plutonium and Tritium Coproduction Capability	11
Implications	11
Impact on Civilian Power Program	11
Impact on Total Weapons-Grade Plutonium and Tritium Production	11

Table	
Selected Design Parameters for the Soviet BN-800 and BN-1600 Plants	6

Insets	
The Concept of Breeding and the Fast Breeder Reactor	1
Breeder Reactor Fuel Management	9

Soviet Breeder Reactor Program: Prospects and Weapons Material Production Potential

Introduction

Soviet nuclear officials have indicated for many years that they are aggressively developing breeder reactor technology, despite the higher cost of building and operating breeder reactors, because they use nuclear fuel more efficiently than other reactors. A breeder reactor produces more nuclear fuel than it uses, giving it a great advantage over other nuclear reactors for conserving uranium resources (see inset). Breeders provide heat needed for electricity generation; they simultaneously produce an excess of fissionable material that can be recovered for use as fuel for other reactors but that also could be used in nuclear weapons (see figure 1)

The breeder reactor programs of most countries have been halted or slowed dramatically by a number of factors. Current low prices for low-enriched-uranium (LEU) reactor fuel are projected to continue at least into the early part of the next century, reducing the need for the uranium-conserving breeder. The construction costs of breeders are higher than for other nuclear reactors and exceed the cost benefit of efficient fuel utilization. A persistent disadvantage of breeders is that their spent fuel is much more radioactive than other civilian reactor fuel because of longer exposure in the reactor known as "high burnup"—about 100,000 versus 40,000 megawatt days per metric ton of fuel (MWd/ton)—which produces a proportionately higher concentration of radioactive fission products. The increased radiation level complicates the reprocessing of breeder fuel for the recovery of uranium and plutonium

The high costs associated with breeder reactors, along with safety concerns, have significantly slowed the Soviets' planned breeder deployment. Soviet nuclear publications in 1987 cited figures that show the capital cost of the BN-600 to be 30 to 50 percent greater than that of a VVER-1000 pressurized-water reactor and the energy production cost to be substantially more expensive. The Soviets believe, however, that they can significantly reduce costs in future breeders by a number of measures. These include increasing fuel burnup and core cycle duration, changing the fuel to mixed plutonium/uranium oxide from the current medium-enriched uranium oxide,

---

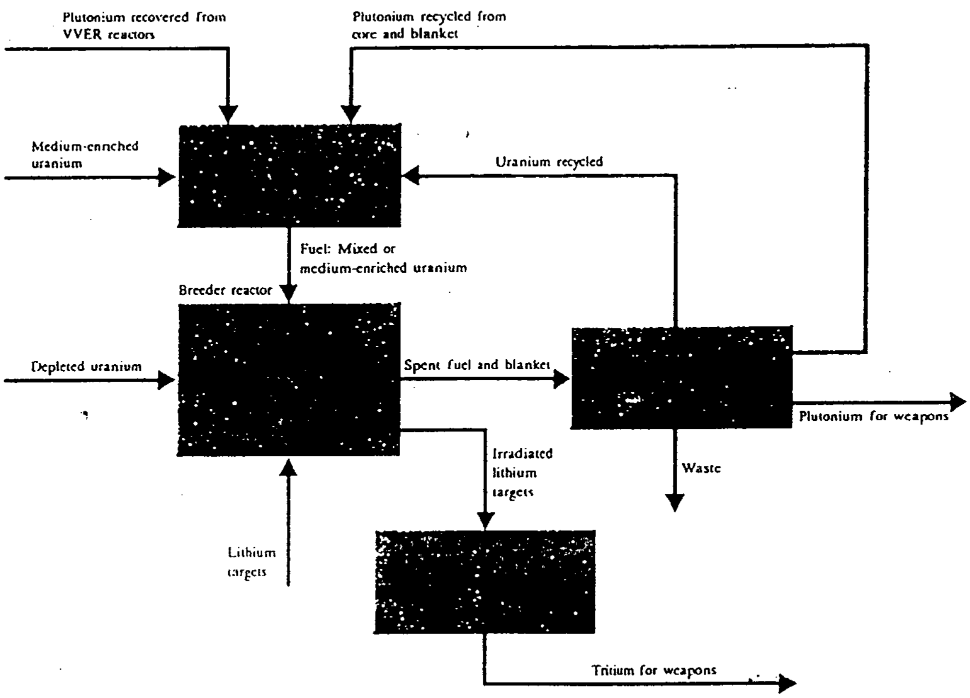
The Concept of Breeding and the Fast Breeder Reactor

The discovery of nuclear fission in the late 1930s provided hope for a clean and relatively inexpensive new source of energy. Although the basic nuclear fuel—uranium—is sufficiently plentiful, early experiments indicated that only specific isotopes of uranium and plutonium were useful for exploiting this new energy source. By the early 1940s, fissile isotopes—uranium-235 (U^{235}) and plutonium-239 (Pu^{239})—were identified that would fission in a self-sustaining chain reaction. Only a small portion (0.7 percent) of naturally occurring uranium, however, is the fissile U^{235}; the balance is essentially nonfissile U^{238}. It was soon recognized that, to derive full benefit from nuclear fission, a process was needed to use the remaining 99 percent of uranium's potential

Although U^{238} will not sustain a chain reaction by itself, it is "fertile"; that is, it may capture neutrons in the reactor's core and be converted into fissile Pu^{239}. Thus, useful fissile fuel can be created from the abundant U^{238}. Typical reactors use low-energy, or thermal, neutrons to sustain the fission reaction. However, a fission chain reaction using high-energy (fast neutrons) will create more new neutrons than a fission chain reaction using thermal neutrons. "Fast" reactors, therefore, have more excess neutrons that can be used to convert U^{238} into plutonium, thus, allowing them to create by conversion more nuclear fuel than they consume. This process is called "breeding," and the fast-neutron reactors that use it are called fast breeder reactors

---

Figure 1
Possible Soviet Breeder Reactor Fuel Cycle



reducing construction material requirements, and reducing on-site fabrication and assembly work. Despite these measures, breeders are unlikely to be economically competitive with similarly improved thermal reactors unless uranium costs rise substantially

Soviet Breeder Program

Breeder Development—Types, Sizes, Status

The Soviets have pursued the development of breeder reactors since the 1950s. The first two Soviet test reactors were a 100-kilowatt mercury-cooled reactor, the BR-2, and a 5-megawatt sodium-cooled reactor, the BR-5; the BR-2 started operation in 1956 and the BR-5 in 1958. At present, the Soviets operate one large experimental reactor and two prototype breeder reactors. These are the BOR-60 at Dimitrovgrad, which started up in 1969; the BN-350 at Shevchenko, which started up in 1973; and the BN-600 at Beloyarsk, which started up in 1980. The BOR-60 produces 60 megawatts thermal (MWt) and 12 megawatts electric (MWe); the BN-350 capacity is 125 MWe; and the BN-600 capacity is 600 MWe.

All Soviet breeders planned and in operation are liquid-metal fast breeder reactors (LMFBR) cooled with liquid sodium. LMFBR designs can use either a loop-type or pool-type heat transport system. The BOR-60 and BN-350 are both loop-type reactors, whereas the more modern BN-600 and BN-800 (see figure 2) are pool-type reactors.

In the loop-type design, the sodium coolant, after exiting the core, flows through an external piping loop, which contains a heat exchanger and pump. Advantages of a loop-type design relative to the pool design are that the reactor vessel is smaller in the loop type; seismic protection is simplified; there is no neutron activation of pumps and intermediate heat exchangers, but there is increased accessibility of them for maintenance; and thermal and hydraulic design is simplified.

In the pool-type design, the primary-loop sodium coolant never leaves the reactor vessel. After exit from the core, sodium circulates through heat exchangers and pumps that are placed inside the reactor vessel itself. This is accomplished by flow baffles and structures that channel its flow. Both loop and pool designs have a secondary sodium loop and tertiary steam-generating loop for electric power production. The pool design has been chosen by many countries because it has many advantages. For example, it does not need primary-loop sodium piping outside the reactor vessel, a smaller containment structure is required, and lower neutron irradiation of the pressure vessel results in little embrittlement or activation, thus making the vessel accessible. Also, the larger coolant inventory is an advantage in case of an accident, and the pressure vessel is maintained at a uniform temperature, thus reducing stresses in the structure

The Soviets must gain more experience with mixed plutonium/uranium fuel use in breeders to attain the ultimate goal of breeder technology—net production of fissile material. The primary objective of the Soviet prototype reactors thus far has been design, testing, and evaluation of components rather than development of the breeder fuel cycle. The Soviets have used mostly medium-enrichment uranium-oxide fuel in their breeders, and they have not put emphasis on the use of a significant quantity of mixed-oxide (plutonium and uranium) fuel. Handling plutonium for the production of mixed-oxide fuel is much more difficult than handling uranium. Most fabrication operations must be performed remotely because of the greater radiation hazard of plutonium, greatly adding to the cost. However, the Soviets have fabricated some mixed-oxide fuel elements for testing in their LMFBRs.

The BN-350 has been used to test some mixed-oxide assemblies

The Soviets probably will not build a costly, large-scale mixed-oxide fuel plant, however, until at least one BN-800 is almost complete. We estimate this completion date to be no sooner than the late 1990s.

The Soviets have published general design specifications for a BN-1600 reactor (see figure 3) that would basically be a scaled-up BN-800 producing twice as much power (see table). The Soviets have stated that this reactor probably will not be built earlier than 2020 to 2030

Projected Construction and Needs

Soviet nuclear generating capacity goals have decreased because of safety concerns and programmatic delays but still are ambitious

safety reevaluation after the Chernobyl' accident and local citizen opposition have caused numerous reactor cancellations. As of early 1990, the Soviets had only 37,000 MWe of nuclear generating capacity compared with about 100,000 MWe for the United States. The USSR clearly needs substantially increased generating capacity to meet its economic objectives. Soviet energy planners have been strongly committed to nuclear power since alternative fossil fuel energy resources are located far away from population and industrial centers. The large majority of the new nuclear power stations that will be completed during the 1990s will use VVER-1000 pressurized-water reactors

1869

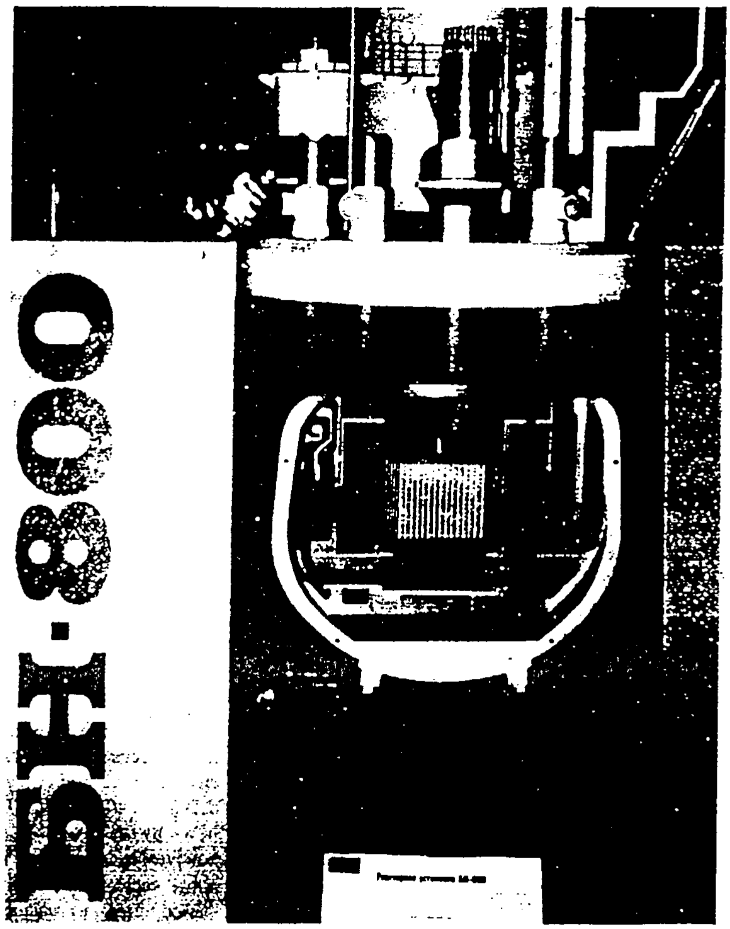
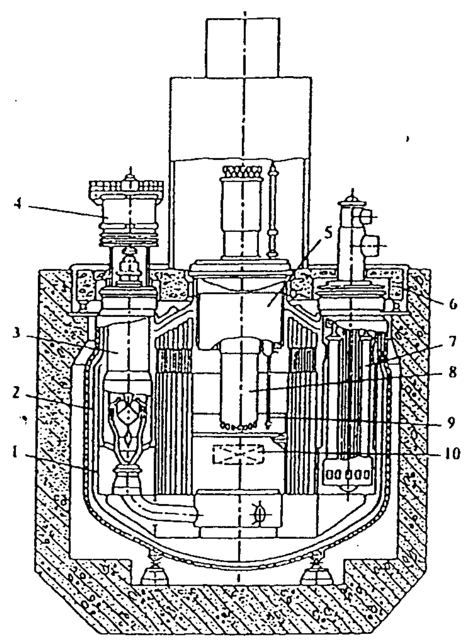


Figure 2. Model of Soviet BN-800 reactor

Figure 3
Sectional Diagram of Soviet BN-1600 Reactor



1. Reactor vessel support belt
2. Reactor vessel
3. Primary sodium pump
4. Pump electric drive
5. Rotating plugs
6. Upper deck/shielding
7. Intermediate heat exchanger
8. Central column with control rod drives
9. Reloading mechanism
10. Core

The BN-800 was to be the first series-produced Soviet LMFBR and would have placed the USSR far ahead of other countries in commercialization of breeders. A Soviet 1985 "pre-Chernobyl'" plan called for 20 BN-800 reactors by 2000. In mid-1989 the Soviets announced a drastically revised plan calling for building up to four BN-800s at two sites, Kyshtym and Beloyarsk, by the year 2000. However, high costs and unresolved design and safety problems are almost certain to postpone the commercialization of breeder technology for the foreseeable future.

The Soviets stated in mid-1989 that they tentatively plan to build up to three BN-800s at the South Urals Atomic Power Station near the Kyshtym weapons material production reactor complex. This certainly leaves open the option of using these reactors for military plutonium production

In mid-1989, a first deputy minister of the Ministry of Atomic Power and Industry, Boris Nikipelov, stated that construction of the South Ural breeders has been suspended until an ecological review is complete and that work is only proceeding on auxiliary installations. Nikipelov further stated that construction of the breeders, which has encountered much public opposition, will only resume when the citizens of the Chelyabinsk Oblast consent to building then

The Soviets have revealed plans for a BN-800 at Belovarsk

In fact, the safety problems of the BN-800 design may be such that a serious attempt to correct them would produce a reactor design so different from the original that it would be tantamount to canceling the project and starting anew. This course would delay startup of the next Soviet LMFBR to 2005-10 or beyond.

Selected Design Parameters for Soviet BN-800 and BN-1600 Plants

	BN-800	BN-1600
Thermal capacity (*MWt*)	2,100	4,200
Electrical capacity (*MWe*)	800	1600
Number of coolant loops	3	4
Sodium temperature at heat exchanger inlet (*degrees Celsius*)	547° C	547° C
Sodium temperature at core inlet (*degrees Celsius*)	354° C	354° C
Sodium temperature at steam generator inlet (*degrees Celsius*)	505° C	505° C
Sodium temperature at steam generator outlet (*degrees Celsius*)	309° C	309° C
Steam pressure at steam generator outlet (*MPa*) [a]	13.7	13.7
Steam temperature at steam generator outlet (*degrees Celsius*)	490° C	490° C
Number of turbogenerators	1	2
Turbogenerator capacity (*MWe*)	800 MWe	800 MWe
Maximum burnup percentage	10	10
Shutdown time for fuel unloading (*days*)	6 days	8 days
Core height (*centimeters*)	95 cm	100 cm
Core diameter (*centimeters*)	245 cm	345 cm
Number of fuel assemblies	517	384
Number of enrichment zones	3	2 or 3
Breeding ratio	1.27	1.31
Breeding gain	0.25	0.28
Number of control and protection rods	30	36
Period between fuel reloadings (*months*)	3.7 months	5 months

[a] Megapascals (1 MPa = 145 psi).

The USSR's need for additional power could be supplied more economically by building additional VVER-1000 reactors in lieu of the BN-800 breeder reactor program. The current BN-800 design is an unimproved scaled-up version of the operating BN-600, which itself lacks containment or seismic design consideration

Significant efforts on breeder design improvements to increase safety and decrease costs could continue without building a BN-800, because experimental proof testing can be done in the existing BN-600 for as long as it is operational. Alternatively, the Soviets may perceive the need to build at least one BN-800 this decade in order to ensure that they have a large-scale breeder available into the next century, especially if they feel the need to shut down the BN-600 n mid-1989, Evgeny Mikerin, the Soviet official stated his personal belief that only one BN-800 should be completed for demonstration purposes. A BN-800 built in this decade probably would incorporate some design changes that recently have been considered in order to gain some safety improvement over the existing BN-600

Soviet Breeder Safety Problems

The largest problems for the Soviet breeder program are safety issues. These include the need to limit the possibility of an explosive sodium/water interaction in the steam generator and the need to design a containment to withstand a major accident. Potential reactor control problems must be dealt with, and a lack of seismic design must be considered.

Sodium/Water Interactions

If water leaks into the sodium coolant of an LMFBR through cracks in steam generator equipment, an explosive sodium/water interaction could result.

the Soviets have relied on a modular steam-generator design with many discrete, isolatable sections and a hydrogen-monitoring leak detection warning system. A module, therefore, could be shut off if a leak develops and the reactor could continue to operate at near full power. However, the use of many modules adds substantially to breeder construction costs.

Lack of Containment Structure

A serious deficiency in existing Soviet breeders is their lack of a containment structure. Before the Chernobyl' disaster, Soviet breeder design called for housing the reactor and other equipment in a standard industrial building lacking containment. Since Chernobyl', the Soviets have recognized the need for containment and are incorporating it in design revisions for the BN-800—a process that will radically alter much of the current architect-engineering design work and substantially delay reactor construction. However, little can be done for the existing prototype breeder reactors without containment. Thus, an accident resulting in severe core damage to one of these plants could lead to a major release of radioactive material.

Reactor Control Safety Problems

The Soviets' ability to compute core reactivity in order to ensure stable core behavior during abnormal conditions is questionable. Conditions required to optimize breeding—historically a priority in Soviet breeder designs—create the potential for:

- A positive void coefficient; that is, an undesirable power increase if the liquid sodium coolant is lost.
- Reduced safety benefit from the Doppler power coefficient. This reactor characteristic, which helps ensure against power surges by decreasing power when fuel temperature increases, is substantially weakened in Soviet LMFBR core designs

LMFBR reactivity safety problems are somewhat more difficult than those for thermal reactors because neutron lifetimes are relatively short in an LMFBR and the proportion of delayed neutrons, which assist control and shut down systems, is relatively small. The Soviets are considering core design changes to ameliorate these problems, but at the cost of additional engineering rework and delay

Soviet Breeder Reactor Fuel Cycle and Plutonium Production Options

Plutonium Production Capability

The Soviets have stated that they will not use their breeders to produce plutonium for nuclear weapons.

The experimental and prototype breeders have been showcases for the Soviet nuclear power program, and each has had several tours by foreign visitors. The BOR-60 and BN-600 have been either involved in reactor safeguards development for the International Atomic Energy Agency or offered for safeguards. These actions do not preclude plutonium production for weapons.

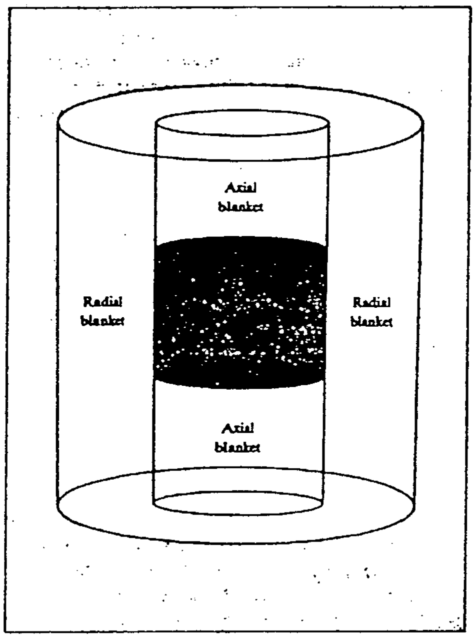
On the other hand, breeders are inherently capable of being operated in a manner entirely consistent with their civilian purpose while producing substantial quantities of weapons-grade plutonium.

1874

Breeder Reactor Fuel Management

A typical breeder reactor contains nuclear material in three different regions within a cylindrical volume: core, axial blanket, and radial blanket (see figure). The core region contains the fuel that can be made of either medium-enriched (about 20-percent U^{235}) uranium or a mixture of about 20-percent plutonium and 80-percent depleted uranium (about 0.3-percent U^{235}). The axial blankets, contained in the same rods with the fuel but placed above and below it, are made of depleted uranium, as are the radial blanket rods

Reactor-grade plutonium recovered from Soviet VVER pressurized-water reactors is too isotopically impure (about 70-percent Pu^{239}) to be readily used in weapons. It can be used, however, in breeder reactor fuel to produce much more pure (greater than 92-percent Pu^{239}) weapons-grade plutonium in the blankets while producing electricity.



The Soviets recently stated that they are reprocessin fuel from both the BN-350 and BN-600 reactors. Th fuel from both of these breeder reactors is loaded wit medium-enriched-uranium fuel (see inset) and is wor thy of reprocessing for both plutonium and uranium recovery because it contains weapons-grade plutonium and uranium with a high (10-to-20-percent) resic ual uranium-235 content

each new BN-800, when fueled with medium-enriched uranium fuel to maximize the production of weapons-grade plutonium instead of plutonium/uranium mixed fuel, could produce about 0.6 ton per year from both the core and blanket. The existing BN-350 and BN-600, which currently use medium-enriched uranium fuel, have the potential tc produce up to 0.7 ton of weapons-grade plutonium pe year in their cores and blankets [redacted] BN-800 reactor, initially fueled wi[th] mixed-oxide fuel using about 2.5 tons of reactor-gra[de] plutonium, could produce 0.2 ton of weapons-grade plutonium per year in its radial blanket. The axial blanket material also contains weapons-grade pluton[i]um, but it is not recoverable because both low-grade plutonium from the core and weapons-grade plutonium from the axial blanket reside in the same spent fuel pins and would be blended together during reprocessing

[redacted] Mikerin stated that reprocessed plutonium is reserved for use in breeders, and uranium is recycled into fuel for Soviet RBMK reactors [redacted]

[redacted]

The Soviets announced in late 1989 that construction on a facility to reprocess spent fuel—predominantly from VVER-1000 reactors—had been indefinitely postponed, partly because of a lack of need to recover reactor-grade plutonium. This plant was to have been completed in the late 1990s, have a capacity of 1,500 tons/year of spent fuel, and be able to recover uranium for use in thermal reactor fuel and reactor-grade plutonium for use in mixed-oxide fuel for breeders and other reactors. This announcement is consistent with a Soviet decision to substantially slow their breeder program

Reprocessing Breeder Reactor Fuel

Nuclear fuel reprocessing is an indispensable element of a nuclear power program using breeder reactors. This capability must include reprocessing of thermal reactor fuel to obtain plutonium for initial breeder loads, as well as breeder fuel reprocessing to continue the plutonium fuel cycle. Reprocessing breeder fuel is somewhat more difficult than reprocessing the[rmal] reactor fuel for a number of technical reasons

Despite its difficulty, the Soviets should be able to reprocess spent mixed-oxide breeder fuel, probably by adapting solvent-extraction technology that is successfully used on spent VVER reactor fuel. The Soviets have done pilot-scale reprocessing of breeder fuel to select the best strategy for building a large-scale facility. However, the high burnup of the discharged breeder core compared with VVER reactor fuel, about 100,000 versus 40,000 MWd/ton, makes it more highly radioactive and higher in plutonium content, as well as of more complex radionuclide composition—all of which complicate reprocessing. Although it would be desirable to let spent fuel cool and decrease in radioactivity for three or more years before reprocessing, breeder fuel should be reprocessed within about one year to obtain reasonable fuel cycle economics by decreasing out-of-core inventories of plutonium

A. M. Petrosyants edited a book in 1987 that outlined a reprocessing scheme for spent breeder reactor fuel by a modification of the solvent extraction method. He recommended that the axial blankets and core be reprocessed together for two reasons: the blanket material's low concentration of radioactive fission products helps to offset the high concentration in the core material, and both the core and axial blanket material are contained in the same fuel pins. Breeder fuel is being reprocessed at Kyshtym, and the Soviets probably are taking advantage of this technique [redacted]

[redacted] The Soviets believe further research is necessary to find a substitute for the organic solvent typically used in reprocessing VVER spent fuel. This solvent, tri-alkyl phosphate, degrades rapidly because of the high concentrations of plutonium [illegible] fission products in dissolved spent breeder fuel

Soviet publications indicate that research is under way on nonaqueous gas-fluoride extraction technology in order to avoid solvent degradation difficulties. This technology, however, probably is not a good candidate for commercialization

Although the Soviets have given priority to the use of oxide fuel for breeders, they have experimented with metal fuel, which may have use in future breeder reactors. Pyrometallurgical reprocessing techniques for mixed metallic breeder reactor fuel have been successfully demonstrated on a pilot scale in the United States. The Soviets, however, have not invested heavily in this technology

Tritium Production Capability

Tritium is a manmade radioactive isotope of hydrogen (H^3) that is typically produced by neutron bombardment of lithium "targets" in a nuclear reactor. Virtually all of the tritium contained in the world's nuclear arsenals has come from dedicated military production reactors. However, any source of neutrons, such as a commercial power reactor, can be used with an appropriate "target" to produce tritium

[redacted] Although a BN-80 reactor can produce about 3.6 kilograms/year of tritium in radial blankets loaded with target materia the costs of such production are prohibitive. These costs would include forgoing the production of 0.2 ton of weapons-grade plutonium in the radial blanket, the requirement for an increased fissile material inventory in the core, and rendering the breeder a net user rather than producer of plutonium. Breeders are poor choices for tritium production when compared with other Soviet civilian reactors, particularly the RBMI graphite-moderated reactors. These reactors could make 1.3 kilograms/year of tritium without an increase in operating cost

[redacted]

Plutonium and Tritium Coproduction Capability

A BN-800 reactor could annually produce from a maximum of 0.2 ton of plutonium and no tritium, to a maximum of 3.6 kilograms of tritium and a net deficit of plutonium, or a combination of both. Tritium production can be substituted for plutonium production with roughly 72 kilograms of plutonium production sacrificed for each kilogram of tritium produced. This trade-off would be accomplished by varying the amount of lithium targets and depleted uranium assemblies in the radial blanket

Implications

Impact on Civilian Power Program

The fraction of Soviet nuclear electricity generated by breeders is unlikely to exceed 5 percent for the next 15 years. If the Soviets complete two BN-800 reactors by the year 2000, these breeders, in addition to the prototypes, would supply only about 2,300 megawatts of electrical capacity [redacted]

Impact on Total Weapons-Grade Plutonium and Tritium Production

Production of plutonium for nuclear weapons is decreasing in the Soviet Union [redacted] Soviet Foreign Minister Eduard Shevardnadze, in a 26 September 1989 speech to the United Nations General Assembly, stated that by the year 2000 the USSR will have shut down all reactors producing weapons-grade plutonium [redacted] Even though the USSR's requirements for plutonium for weapons apparently are

~~Secret~~

decreasing, they will continue to need tritium prc tion

If the Soviets decide to increase their plutonium inventory for weapons, their breeder reactor program could be a substantial plutonium production resource after 2000, depending on how many new reactors are built and which prototypes are operable. By the year 2000, the 20-year-old BN-600 will be at or approaching the end of its useful life. It is unclear if the 27-year-old BN-350 will be operated

If the existing prototypes can operate at full power and new breeders are built, the production potential of Soviet breeders after 2000—0.3 ton from the BN-350, 0.4 ton from the BN-600, and 1.2 tons from two BN-800s—could be up to 1.9 tons of weapons-grade plutonium.

if the Soviets decide to use any of their civilian power reactors for weapons-material production in the future, the breeders would be the first resource they would turn to for urgent, additional weapons-grade plutonium production. The breeders are the most efficient of the Soviet civilian reactors for this purpose and would require little or no modifications for the task. the Soviets are unlikely to use the breeders for tritium production under similar circumstances because their VVER reactors and especially the RBMK civilian power reactors would be more cost-effective tritium producers.