The Soviet Nuclear Archipelago

Robert S. Norris

The dissolution of the Soviet Union has raised new concerns over the fate of the former superpower's nuclear arsenal and the nuclear complex that supports it. And with relations between the republics changing virtually every day—symbolized on the military side by the simmering dispute between Russia and Ukraine over control of the Black Sea Fleet—attention has focused on exactly where the nuclear weapons and facilities are, and how they are secured.

Both the Soviet nuclear arsenal and the nuclear archipelago that supported it were different in some respects, and significantly larger, than their U.S. counterparts. Until recently, for example, the Soviet Union had 14 reactors producing plutonium or tritium for nuclear weapons at four different sites, some of which also provided civilian nuclear power; the United States has not had that many production reactors operating simultaneously since 1964, has never had more than two sites, and has never used its military reactors for power. Nevertheless, both the arsenal and the nuclear complex of the former Soviet Union are concentrated in Russia and a small number of the other major former republics of the new Commonwealth of Independent States, and substantial security measures to protect the weapons against unauthorized seizure or use remain in place.

Bombs Galore

The large and diverse arsenal of nuclear weapons accumulated by the former Soviet Union is being reduced in number and consolidated geographically, a trend which began several years ago. Although there is uncertainty about the exact size of the Soviet nuclear stockpile, the figure of some 27,000 operational weapons has been used repeatedly by both government officials and outside experts. That makes the former Soviet arsenal by far the largest in the world. Over the past few years, thousands of other weapons have been withdrawn, but many of these have probably not yet been dismantled. Thus, the true total of deployed and nondeployed weapons could be 30,000 or more.

"Despite the vast scale of the nuclear archipelago the former Soviet Union created, there is little danger that the world will soon be faced with 12 nuclear-armed states in place of one."

Like the U.S. arsenal, Soviet nuclear forces can be divided into two broad categories: there are some 12,000 strategic and 15,000 tactical weapons (including almost 3,000 for strategic air defense). Largely as a result of the information exchanges included in the Strategic Arms Reduction Treaty (START), precise information on the location of all Soviet strategic weapons is now publicly available (see map, pp.28-29). The entire Soviet offensive strategic arsenal is based exclusively on the territories of the "big four" former republics—Russia, Ukraine, Belarus, and Kazakhstan.

Over 70 percent of this strategic arsenal is in Russia, including 1,067 ICBMs equipped with some 4,308 warheads; the entire Soviet missile submarine force, including 892 missiles carrying some 2,828 warheads; and 22 heavy bombers, probably carrying some 350 warheads. Ukraine hosts 130 six-warhead SS-19 ICBMs and 46 silo-based 10-warhead SS-24s, along with 33 heavy bombers, for an estimated total of over 1,700 warheads. Kazakhstan is home to 104 10-warhead "heavy" SS-18 ICBMs, considered the most threatening weapons in the Soviet arsenal, and 40 bombers, carrying a total of just over 1,400 warheads. The only strategic weapons in Belarus are 72 single-warhead, road-mobile SS-25 ICBMs. Russian officials have recently indicated that all of the strategic weapons outside Russia have been taken off alert or returned to garrison; those in Ukraine are to be eliminated by 1994.

Much less information is available on Soviet tactical nuclear weapons and their locations. Military officials of the former Soviet Union remain secretive about the locations, numbers, and types of nuclear weapons, resembling their U.S. counterparts in neither confirming nor denying their existence anywhere. Nevertheless, it is clear that Soviet tactical nuclear weapons were once much more widely distributed than their strategic counterparts. In December 1990, the late Marshal Sergei Akhromeyev said that "tactical nuclear weapons are deployed in practically all Union republics." Moreover, as recently as last summer, Soviet officials confirmed that Soviet nuclear weapons still remained in the eastern part of Germany. Not until August 31, after the failed coup, did the new minister of defense, Marshal Yevgeny Shaposhnikov, assure the German ambassador that all Soviet nuclear weapons had been removed from his country. There are now no Soviet nuclear weapons remaining outside the territory of the former Soviet Union.

At the same time, there has been consolidation within that territory as well. Most observers agree that all nuclear weapons were removed from the Baltic states before independence, and that they have now been removed from the volatile former republics of Georgia, Azerbaijan, Armenia, and Moldova as well. More recently, Russian President Boris Yeltsin and Defense Ministry officials have indicated that all tactical nuclear weapons have

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also been removed from the Central Asian states, including Kazakhstan. As of this writing, the tactical nuclear weapons of the former Soviet Union are deployed only in Russia, Ukraine, and Belarus. (See table.)

The situation remains very dynamic, with weapons probably in daily transit from Ukraine and Belarus to centralized storage facilities. Newspapers around the world have carried extraordinary photos of nuclear weapons being loaded onto trucks for transport back to Russia. So far, this process appears to have gone smoothly; in November, Defense Minister Shaposhnikov said that the republics were cooperating with central authorities in the transport of tactical nuclear weapons to special depots. Under the accords reached at Alma-Ata and Minsk in December, all tactical nuclear weapons in Ukraine are to be eliminated, and all those in Belarus moved to "central" storage, by July 1 of this year. Ukrainian President Leonid M. Kravchuk was quoted as saying that the ships of the Black Sea Fleet will have all their nuclear weapons removed by June 3.[1]

Loose Nukes?

The Soviet military, no less than its U.S. counterpart, established elaborate procedures to safeguard its nuclear weapons against theft or unauthorized use, and it appears that these are still in place (see p.18). Secretary of Defense Dick Cheney has repeatedly said that Commonwealth handling of nuclear security has been "very responsible," and Robert Gates, director of Central Intelligence, told a Senate committee on January 15 that "under current and foreseeable circumstances, we believe the new national command authorities will be able to maintain effective control over their nuclear arsenal." In the Alma-Ata and Minsk accords, the states of the new Commonwealth agreed to maintain single, unified control over all nuclear weapons, with Russian President Boris Yeltsin in charge of "the button," but with the presidents of Ukraine, Belarus, and Kazakhstan having the right to veto any use of nuclear weapons as long as such weapons remain on their soil.

Strategic weapons in the former Soviet Union are believed to be particularly secure. According to a variety of Soviet accounts, all Soviet strategic weapons are equipped with electronic locks (known in the United States as "permissive action links," or PALs) making it impossible to launch the weapons without receiving one or more codes from higher authority. Many of the weapons themselves are also believed to be equipped with electronic sensors known in the United States as "environmental sensing devices" (ESDs), that will only allow them to be armed after they experience the environments of their normal path from launch to target (such as high acceleration followed by zero gravity for a ballistic missile). Thus, if an unauthorized group somehow managed to remove one of these weapons from a missile, it would be very difficult—though not impossible, over the long run—for them to get it to detonate.

Special attachments of troops are assigned to guard strategic bases, which are protected by fences.

Tactical nuclear weapons are more numerous, more widely dispersed, easier to transport, more varied in design, and some are quite old. But here too, extensive security precautions are in place. Like strategic weapons, most tactical weapons are believed to be equipped with electronic locks, and some may have environmental sensing devices; indeed, *Krasnaya Zvezda*, the main military newspaper of the former Soviet Union, asserted on December 19, 1991, that *all* tactical nuclear weapons are equipped with locks to prevent unauthorized use. Moreover, each warhead, bomb, or artillery shell has a serial number, making possible a comprehensive inventory. Tactical weapons are stored separately from their launchers, in specially designed high-security bunkers guarded by troops organizationally separate from those who would use the weapons in wartime, so that to ready the weapon for launch would require the complicity of two groups. Reportedly, each weapon sits atop a sensor that would sound an alarm if the weapon was improperly moved. Moreover, any such unauthorized movement would reportedly send a signal to central command, and no such signals have been received.[2]

Little is publicly known about the detailed design features of the storage "igloos" that hold Soviet tactical nuclear weapons, but, like their U.S. counterparts, they are likely to be equipped with several layers of security. U.S. nuclear depots are encircled by high fences, well-lit, and protected by specially trained guard forces. A modern U.S. weapon storage igloo has a heavy front door held shut by multiple deadbolts, which can only be opened by a special code. The weapons stored inside are kept in heavily bolted containers with hard-to-access locks. Also inside are coils of barbed concertina wire that are lowered to cover the weapon containers, and smoke generators that would fill the igloo with an irritating smoke if it were entered without authorization. Only a military guard with the proper equipment can lift the concertina wire blanket for authorized access.[3]

Transportation of nuclear weapons involves equally extensive security—an important issue, as thousands of nuclear weapons in the former Soviet Union are to be moved over the next few months. In the United States, vehicles carrying nuclear weapons are reportedly "specially designed to withstand collisions, to immobilize the wheels of trucks if drivers suspect they are about to be hijacked, and to fill with a sticky foam to immobilize intruders if breached."[4] Similarly, in the Soviet case, weapons are moved using special trucks or tracked vehicles, under heavy military guard. As an added security feature, these special vehicles reportedly will only work when a secret code is entered into the dashboard. As in the U.S. case, only authorized personnel are allowed to move the weapons, and many people must be in-

Nuclear Weapons In the Commonwealth of Independent States

(Estimate as of January 1992)

State	Strategic Offensive	Ground Forces	Air Defense Forces	Air Force	Navy	Total	(%)
Russia	8,750	4,200	2,675	2,375	2,750	**20,750**	77%
Ukraine	1,750	600	125	1,050	500	**4,025**	15%
Kazakhstan	1,400	0	0	0	0	**1,400**	5%
Belarus	100	0	0	575	150	**825**	3%
TOTAL	**12,000**	**4,800**	**2,800**	**4,000**	**3,400**	**27,000**	**100%**

Source: Natural Resources Defense Council

volved in every stage, either as participants or as observers, so that if anything unusual occurred it would be immediately recognized and preventive action could be taken.[5]

The Nuclear Archipelago

In addition to the weapons themselves, the former Soviet Union's nuclear weapons complex is another focus of concern, as it is a potential source of nuclear weapon designs, components, materials, and know-how. Like the United States, the Soviet Union created an enormous complex to design, produce, and test nuclear weapons and the myriad components and materials used in their manufacture. The CIA reportedly estimates that some 900,000 people in the former Soviet Union have clearances to work with nuclear weapons in one way or another, including both military personnel responsible for nuclear operations and the employees of the weapon complex. Of these, 2,000 reportedly have detailed knowledge of weapons design, and 3,000 to 5,000 more have worked in uranium enrichment or plutonium production.[6] While *glasnost* has permitted a glimpse into the workings of this vast archipelago of secret cities and facilities, the full story is far from complete. What follows is an overview of what is known about the complex, based on articles in the Soviet press, visits to the former Soviet Union, and interviews with officials from the United States and the former Soviet Union. Fortunately, despite the vast scope of the Soviet nuclear weapon complex, with a few exceptions—such as the nuclear test site in Kazakhstan—all of its most sensitive facilities, from bomb design to fissile material production, are located within Russia.

While all tactical nuclear weapons have been withdrawn from Kazakhstan, Kazakh President Nursultan Nazarbayev (shown above with Russian President Boris Yeltsin) has blown hot and cold on the fate of the strategic weapons in the huge Central Asian state. Now, U.S. officials report agreement that all these weapons will be dismantled under START.

The agency responsible for the nuclear weapons complex is the Ministry of Atomic Power and Industry (MAPI)—the closest Soviet counterpart to the U.S. Department of Energy (DOE)—which has now been taken over by the Russian government. MAPI supervises the entire chain of production for nuclear weapons, from the mining of uranium ore through the fabrication of warheads, and is responsible for the production of all nuclear materials; uranium enrichment; production reactors; nuclear waste management; and warhead research, development, testing, and production. MAPI is also responsible for civilian nuclear power activities, and other work, ranging from high-energy physics to the production of dairy equipment. Once the warheads are produced, MAPI delivers them to the Main Administration for Nuclear Weapons (the 12th Main Administration or Directorate) of the Ministry of Defense.

MAPI was created in mid-1989, from the Ministry of Medium Machine-Building, the organization previously in charge of the nuclear weapons complex. Vitali F. Konovalov was then appointed MAPI minister, but was removed after the failed August coup; First Deputy Minister Boris K. Nikipelov, now acting MAPI minister, is in charge of the branch of MAPI responsible for nuclear materials and warhead production, while First Deputy Minister Viktor A. Sidorenko is responsible for the civilian side. Under Nikipelov, Deputy Minister Viktor N. Mikhailov is responsible for the Department of Defense Industry, which covers nuclear warhead research, testing, and production. The Department of Isotope Separation, Reprocessing, and Isotope Production, headed by Yevgeny Mikherin, is responsible for fissile material production, including both uranium enrichment and plutonium production and reprocessing.

Building Bombs

With hundreds, if not thousands, of employees who know how to build a nuclear bomb, the nuclear weapon design laboratories are among the most sensitive facilities in the former Soviet weapon complex. The former Soviet Union had two such laboratories in operation, both located in Russia.

The Scientific Research Institute of Experimental Physics, the older of the two, was founded in 1946 as "KB-11" (Design Bureau 11). Also called "Arzamas-16," for its post office designation, it is situated on lands of the former Sorovskiy Hermitage, destroyed in 1927, at Sarova, 60 kilometers southwest of Arzamas. First set up in the 1940s, it was here that the first Soviet nuclear bomb was created. It is also known informally as "Khariton's Institute," after academician Yuliy B. Khariton, who has been the laboratory's scientific director since its inception. Yuri Trutnev is Khariton's first deputy.

The second design lab is the Institute of Technical Physics, better known as Chelyabinsk-70. It is located just east of the Ural Mountains, 20 kilometers north of Kasli. It was created in 1955, three years after the establishment of the analogous Lawrence Livermore Laboratory in the United States. Academician Yevgeny I. Zababakhin was the lab's scientific director from its creation until his death around 1984. He was succeeded by Yevgeny N. Avrorin, who has been at Chelyabinsk-70 since its inception, and has visited the United States on several occasions since 1989.

How the Soviet design process works remains somewhat of a mystery. In the United States, the two national laboratories, Los Alamos and Livermore, compete with their own designs for a new warhead or bomb, and the winning laboratory then oversees the warhead through its life cycle. "Weaponization" of the initial design is handled by a separate

laboratory, Sandia; bomb components are built at a variety of plants all over the country; and final assembly of nuclear weapons is carried out at the Pantex plant near Amarillo, Texas, which also disassembles retired nuclear weapons.

While we know that the first Soviet atomic bomb was designed at Arzamas-16 with plutonium from Chelyabinsk-40, there is almost no publicly available information on current nuclear warhead and component manufacturing facilities in the former Soviet Union. We are told, however, that the Soviet labs are more involved in the warhead production process than their U.S. counterparts; it may be, for example, that weaponization of a new design is carried out by the lab that originated it, and that the labs either produce or oversee production of some nuclear weapon components.

The location and capacity of Soviet final assembly plants is of particular interest, as these would likely also be the sites where nuclear weapons, to be eliminated under current nuclear cutback accords, would be dismantled. We believe that the principal final warhead assembly plant is at Nizhnyaya Tura, located on the eastern edge of the Urals, 200 kilometers north of Yekaterinberg (formerly Sverdlovsk). Mikhailov, the deputy MAPI minister in charge of weapon production, has indicated that there is more than one assembly plant, and that these plants have been dismantling roughly 1,500 weapons a year, though that rate could be substantially increased if necessary. CIA Director Robert Gates has also recently used the 1,500-weapons-per-year figure, and indicated that "Soviet dismantling facilities are very limited and located only in Russia."

In addition, there are two main nuclear test sites, whose locations are well known: one in eastern Kazakhstan, near the city of Semipalatinsk, established in 1948; and the other on the Russian island of Novaya Zemlya, north of the Arctic Circle, established in 1954. Semipalatinsk was formally closed by the president of Kazakhstan, Nursultan Nazarbayev, on August 29, 1991. On October 26, Russian President Boris Yeltsin issued a decree that supported the one-year test moratorium that then-President Mikhail Gorbachev had announced on October 5, and stated that Novaya Zemlya "is no longer to be used for nuclear tests."

Making Materials

Soviet plants for producing plutonium, highly enriched uranium (HEU), and tritium are all located in Russia. Other, less sensitive material sites are located in several other former republics, however.

The nuclear fuel cycle begins with mining and milling natural uranium. Uranium mines and mills are heavily concentrated in the central Asian states (especially Kyrgyzstan) and Kazakhstan, but there are uranium mines in Ukraine as well. The uranium mined from these sites is then converted to uranium hexafluoride for enrichment; little information is available on plants for this purpose.

That uranium is then enriched, for reactors or for weapons. In a mid-November interview in the industry trade journal *Nuclear Fuel*, Mikherin indicated that Soviet uranium enrichment facilities have produced "well over" 500 metric tons of highly enriched uranium. With such a plethora of material, the Soviet government announced in October 1989 that "this year it is ceasing the production of highly enriched uranium."

Nevertheless, production of low-enriched uranium continues. In the same interview, Mikherin indicated that only four plants, all located in Russia and all using gas centrifuges, are still enriching uranium. Gaseous diffusion plants still exist, Mikherin said, but are not actively enriching uranium; Mikherin had told an American group in 1989 that there were five such diffusion plants. The four operating enrichment plants are at the Urals' Electrochemistry Combine at Verkniy-Neyvinskiy (formerly Kefirstadt), near Yekaterinberg; the Electrochemistry Plant near Krasnoyarsk; the Electrolyzing Chemical Combine at Angarsk, 30 kilometers northwest of Irkutsk, near Lake Baikal; and the Siberian Chemical Combine at Tomsk, also a plutonium production reactor site (discussed below). These plants' capacity, according to Mikherin, is about 14 million "separative work units" per year, in theory enough to produce 60 metric tons of HEU per year.

Producing Plutonium

Soviet plutonium and tritium production for weapons takes place at three locations, all in Russia: Chelyabinsk-40, 15 kilometers east of the city of Kyshtym, in Chelyabinsk Province; Tomsk-7, on the Tom River 15 kilometers northwest of Tomsk; and at Krasnoyarsk-26, on the Yenisey River 50 kilometers northeast of Krasnoyarsk in Siberia. Prior to 1987, there were as many as 14 production reactors operating at these three sites: six at Chelyabinsk-40, five at Tomsk-7, and three at Krasnoyarsk-26. Between them, these sites have produced an estimated 120 tons of separated plutonium for weapons.

Between 1987 and the end of 1990, the five graphite production reactors at Chelyabinsk-40 and two at Tomsk were shut down, leaving six or seven reactors operating today—three graphite reactors each at Tomsk-7 and Krasnoyarsk-26, and possibly a single heavy water reactor at

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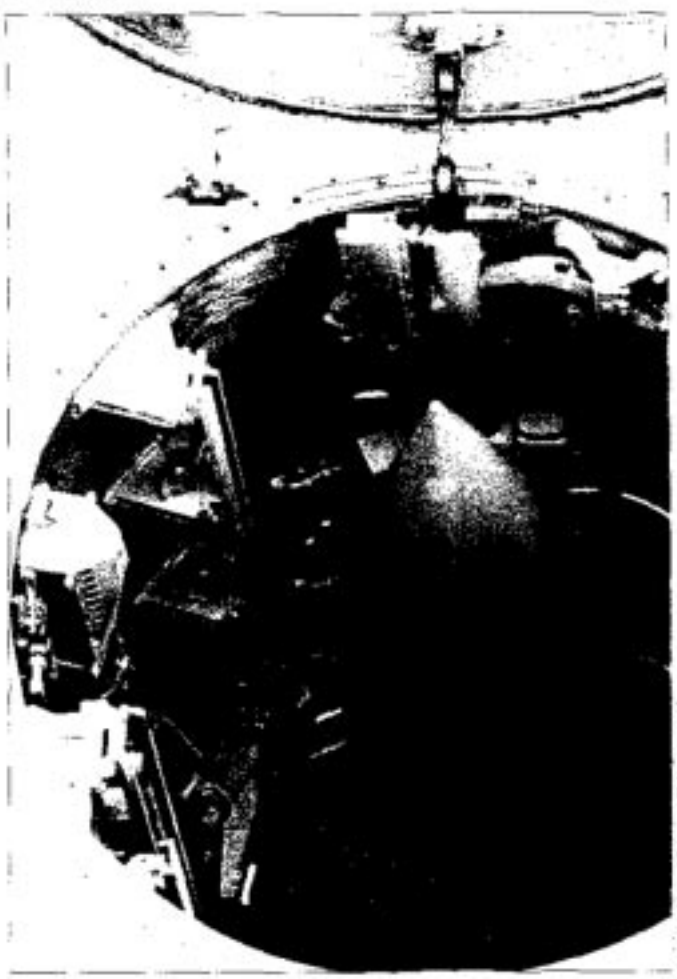
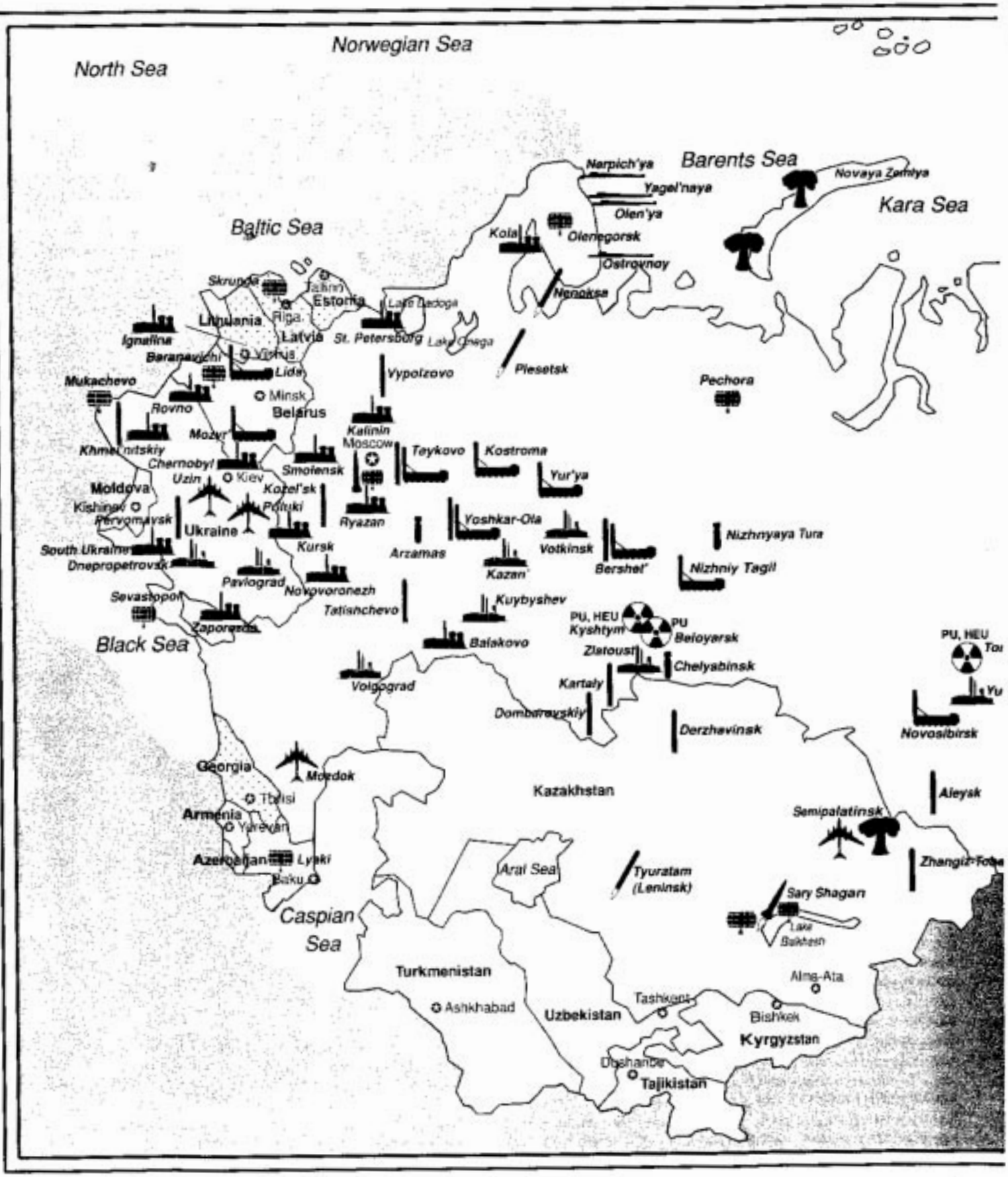


Sea-based tactical nuclear weapons, like this nuclear sea-launched cruise missile from the Black Sea Fleet are all being withdrawn from ships and submarines. All tactical nuclear weapons are slated to be withdrawn to Russia by July 1.

Nuclear Sites in the



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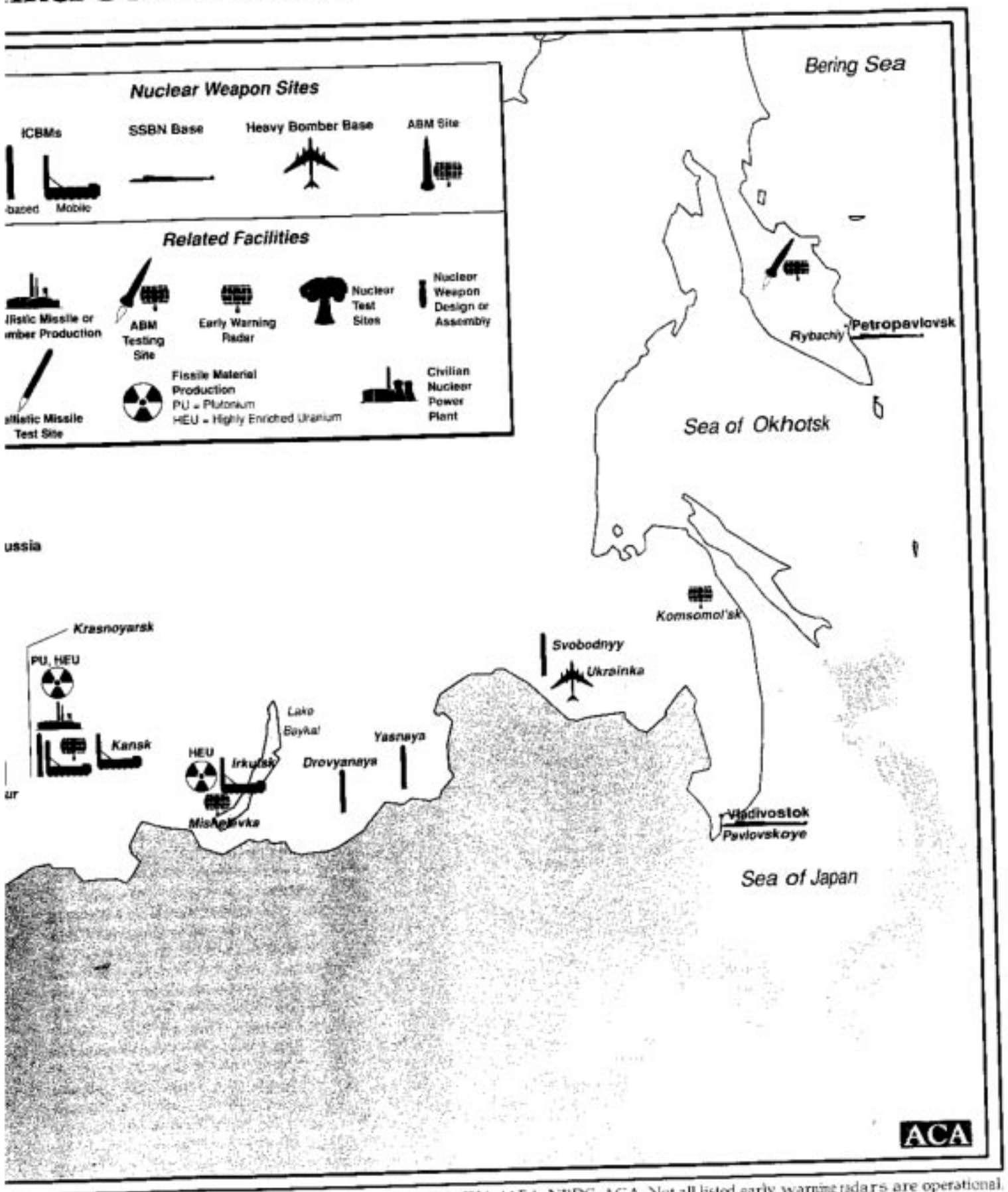


Sources: CIA, DIA, IAEA, NRDC, ACA. Not all listed early warning radars are operational.

Continued from page 27

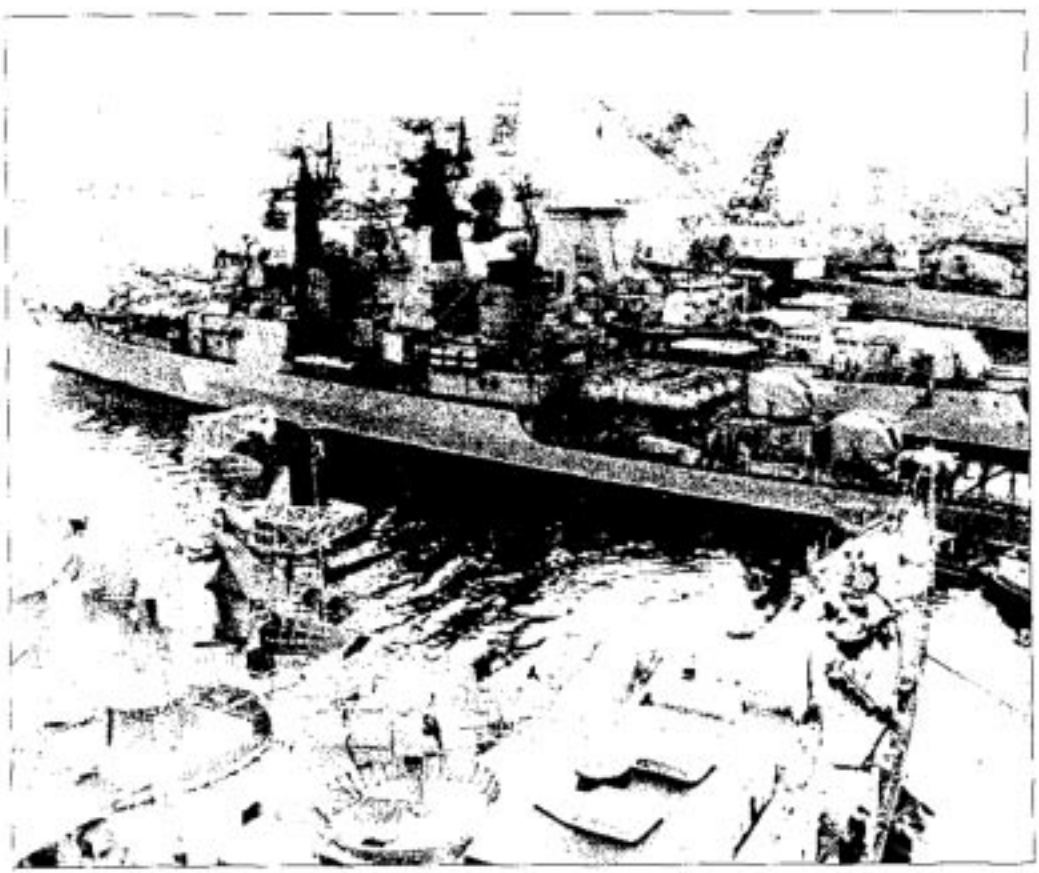
Chelyabinsk-40, whose status is unknown. The Soviet Union announced in October 1989 that it planned to close down all plutonium producing reactors by the year 2000, including three by 1996 and three more over the following four years. This schedule could well be accelerated, however, as the former Soviet Union had long proposed a negotiated cutoff of plutonium and HEU production, as have many experts in the United States.

The announced shutdown schedule makes no reference to the heavy water reactor at Chelyabinsk-40, which may be dedicated to producing the perishable isotope tritium, rather than long-lasting plutonium. While Mikherin estimated in 1989 that the Soviets would have a continuing requirement for "two to three tritium production reactors," in his mid-November interview he suggested that the Soviet Union would forego building a new tritium reactor "unless the U.S. chooses to do so and forces our hand."

Chelyabinsk-40: Chelyabinsk-40, referred to in the West as the Kyshtym Complex, is located in the area around Lake Kyzyltash, in the upper Techa River drainage basin, among numerous other lakes with interconnecting watercourses. It is the home of the "A-plant," the Soviet Union's first plutonium production reactor, and the oldest plant for chemically separating plutonium from spent fuel (known as reprocessing), both of which began operating in 1948. About 10 kilometers from the reactor area is Chelyabinsk-65, the military-industrial city built to house the Chelyabinsk-40 work force. (It may also be that Chelyabinsk-65 is a new name for Chelyabinsk-40.) Once the city bore the name of Beria, the head of Joseph Stalin's secret police. Today, local inhabitants call it Sorokovka ("Forties Town").

Chelyabinsk-40 was the site of a devastating accident on September 29, 1957, when wastes in a 300-cubic-meter storage tank exploded, throwing 70-80 metric tons of waste containing 20 million curies of radioactivity over the surrounding area. The total release of long-lived fission products was comparable to the Chernobyl accident, though the distribution was much more localized. About 90 percent of the activity fell near the waste vessel, but over 2 million curies formed a kilometer-high radioactive cloud, and was carried over an area of thousands of square kilometers, contaminating tens of thousands of people. Today, most of the affected land has been returned to use, though some radioactivity may linger.

The five graphite-moderated, water-cooled production reactors at Chelyabinsk-40, which reportedly had a total capacity of 6,000 megawatts-thermal, have now all been shut down. As for the reprocessing plant, while it was originally used to separate plutonium from the production reactors for weapons, both its input and its output have changed: it now processes fuel from naval and civilian reactors, and the plutonium it separates is intended for the country's troubled breeder reactor program rather than for weapons. A civilian stockpile of about 25 tons of plutonium has now accumulated for this purpose, in addition to the 120 tons of plutonium for weapons. A plant to produce mixed-oxide (plutonium and uranium) reactor fuel from this stockpile is under construction. Also at Chelyabinsk are some 60 tanks of high-level radioactive waste, a vitrification plant, various other production-related facilities, and three unfinished breeder reactors (described in more detail below).



Russia and Ukraine have hotly disputed control of the Black Sea Fleet, some of which is nuclear-capable, but the dispute now seems headed toward a negotiated solution. Above, ships of the fleet at its home port of Sevastopol.

Tomsk-7: The closed city of Seversk, also called Tomsk-7, is a satellite town of Tomsk, with over 100,000 inhabitants. At Tomsk-7, on the Tom River, there are five graphite-moderated reactors, used for both plutonium production and electricity generation, whose total capacity reportedly "considerably exceeds" 600 megawatts-electric. Three of the reactors have been shut down, with the first closed in August 1990. Also at the site are a reprocessing plant, an enrichment plant, and nuclear waste management facilities. Additional power is provided by a fossil fuel plant, whose smoke can be seen in civilian satellite images.

Krasnoyarsk-26: In the early 1950s, Stalin authorized construction of the "radiochemical enterprise" now known as Krasnoyarsk-26, on the mountainous shores of the Yenisey River in the Siberian taiga. There are reportedly three reactors currently operating at the site. One reactor will be shut down at the beginning of July 1992, and the second within a year or two. Plans for the third are unclear, since it also provides electricity for a city of almost 100,000 people. Two streams of thermal effluent into the Yenisey are visible on civilian satellite images,

but the graphite-moderated reactors themselves are hidden, buried 250 meters underground to protect them from a nuclear strike.

While plutonium and highly enriched uranium are the most critical nuclear weapon materials, they are by no means the whole story. Production of other materials used in nuclear weapons is more widespread. Heavy water—used as a coolant and moderator in production reactors, and to make lithium deuteride for thermonuclear weapons—is reportedly produced at two sites in Ukraine and one in Armenia, and perhaps in Tajikistan as well. Production of zirconium and beryllium, both metals used in nuclear weapons or reactors, is carried out at the Ulbinskiy Metallurgy Plant at Ust-Kamenogorsk in eastern Kazakhstan.

Unfortunately, very little information is publicly available about the details of security for the various nuclear facilities in the former Soviet Union, and the components and materials they produce. In particular, it is not known how much of the 500-700 tons of highly enriched uranium and the 145 tons of separated plutonium produced in the Soviet Union is incorporated in weapons, how much is simply in storage, or how that storage is secured.

Large portions of the nuclear weapon complex of the former Soviet Union remain in the shadows. On November 17, 1991, the Japanese newspaper *Yomiuri Shimbun* published what it said was a classified Russian document that listed the names of 10 closed cities where nuclear weapon research and manufacture takes place; all are in Russia. From what we know from other sources about some of these cities, the list appears to be authentic. Consistent with traditional Soviet secrecy practices, these cities are not found on any maps. In addition to their primary names, they are code-named after cities 50 to 100 kilometers away, though their precise locations are not always known. They are sealed off from the outside world, and each is guarded by a special regiment from the Ministry of Internal Affairs. The population figures for the 10 cities, also provided, total 755,800 people. The 10 cities cited are Kremlev (Arzamas-16; Kremlev, misspelled "Kremryuv" in the newspaper account, was a temporary name that is no longer used); Sunezhinsk (Chelyabinsk-70); Ozhorsk (Chelyabinsk-65); Seversk (Tomsk-7); Zherzunogorsk (Krasnoyarsk-26); Zernogorsk (Krasnoyarsk-45); Novouralsk (Sverdlovsk-44); Rusnoy (Sverdlovsk-45); Zarchinuy (Penza-19); and Torifugornuy (Zlatoust-36).

As described above, the first two sites are the Soviet weapon design labs, and the second three are major plutonium production sites. What goes on at the other five is less certain. NBC reporter Jim Maceda visited Krasnoyarsk-45 in mid-December 1991, and interviewed "a specialist in processing plutonium"; it is probably the chemical separation plant that processes the plutonium from the reactors at Krasnoyarsk-26. Given its location, the warhead assembly plant at Nizhnyaya Tura could very well be Sverdlovsk-44 or Sverdlovsk-45. Zlatoust is very close to Chelyabinsk, but it is not known what nuclear weapon activities go on either there or at Penza, 220 kilometers southeast of Sarova. At Zlatoust, however, there is a final assembly plant for submarine-launched ballistic missiles.

Breeder Business

In addition to its role in the military production of plutonium, Chelyabinsk-40 is also a focus of ambitious plans for breeder reactors—plants that run on a plutonium fuel cycle, raising additional proliferation concerns. This facility is the home of the South Urals Project, the site of three "BN-800" liquid metal fast breeder reactors in the early stages of construction. These reactors were begun in 1984, in part to provide employment for the workers who would lose their jobs as plutonium producing reactors shut down. But construction was halted in the late 1980s, as a result of environmental protests and apparent funding limitations. Only the concrete footings of the first two reactors are in place. Construction of one of these reactors was renewed prior to the breakup of the Soviet Union, but whether it will now continue is an open question.

In some respects, these difficulties mirror the problems throughout the breeder reactor program. In addition to the inherent proliferation risks of using plutonium fuel, the former Soviet Union's breeders are plagued by safety concerns—leaks in the sodium-water heat exchangers and the possibility of a runaway chain reaction during an overheating accident—and by problems encountered in the development of mixed-oxide fuel. The BN-600 breeder at Beloyarskiy—predecessor to the BN-800s—continues to operate at half power, and with HEU rather than plutonium. Moreover, the breeder program is increasingly vulnerable because it is uneconomical. Its backers cheerfully admitted to a Natural Resources Defense Council-Soviet Academy of Sciences group in 1989 that breeder-generated electricity is "2.5 times more expensive" than power from conventional power plants. Although 1.5 billion rubles have been authorized for the breeder project, under current economic conditions it is unlikely that the BN-800s, or the BN-1600 on the drawing board, will ever be completed.

Summing Up

Despite the vast sale of the nuclear archipelago the former Soviet Union created, there is little danger that the world will soon be faced with 12 nuclear-armed states in place of one. Nuclear weapons are concentrated in just four of the former republics, and they remain under unified control and under considerable security—conditions each of these emerging states has pledged to maintain. Moreover, with the exception of the Semipalatinsk test range in Kazakhstan, essentially all of the most sensitive facilities in the nuclear complex—including nuclear weapon design and assembly, and production of both plutonium and enriched uranium—are in Russia. There is much to be concerned about in the dissolution of a nuclear superpower, but the dangers should not be overstated—nor the opportunities for disarmament overlooked. ACT

NOTES

1. James F. Clarity, "Ukraine Sees a Smoothing of Issue With Russia," *The New York Times*, January 14, 1992, p.A3.

2. R. Jeffrey Smith, "Ukrainian Minimizes West's Nuclear Fears," *The Washington Post*, December 25, 1991, p.A26; and TASS, in English, December 18,1991.

3. *Sandia Lab News*, August 23, 1991, p.8.

4. *Soviet Nuclear Fission: Control of the Nuclear Arsenal in a Disintegrating Soviet Union*, Kurt M. Campbell, Ashton B. Carter, Steven E. Miller, and Charles A. Zraket, Cambridge, MA: Center for Science and International Affairs, Harvard University, November 1991.

5. See Smith, "Ukrainian."

6. Elaine Sciolino, "U.S. Report Warns of Risk in Spread of Nuclear Skills," *The New York Times*, January 1, 1992. The rest of this section is adapted from Thomas B. Cochran and Robert S. Norris, "Soviet Nuclear Warhead Production," Nuclear Weapons Databook, Working Paper, Washington, DC: Natural Resources Defense Council, 1991.

7. Mikhailov, remarks at the International Workshop on Verified Storage and Elimination of Nuclear Warheads, co-hosted by the Natural Resources Defense Council and the Federation of American Scientists, Washington, DC, October 18-19, 1991; Gates, testimony before the Defense Policy Panel of the House Armed Services Committee, December 10, 1991.