The USSR’s elaborate countermeasures were intended to prevent the West from learning about its nuclear program.

Since its inception in the early 1940s and through much of the Cold War, the Soviet atomic project was the focus of a massive intelligence effort by the United States and its allies. Of primary interest were the issues of uranium availability; the production of highly enriched uranium (HEU) and plutonium; nuclear warhead R&D and testing; and the nuclear weapons production and management infrastructure.¹

Washington needed such information to assess the Soviet nuclear strike capability. Estimates of the Soviet inventories of HEU and plutonium when put together with data on warhead designs would allow CIA analysts to gauge the size and composition of the Soviet nuclear weapons stockpile. Information on Moscow’s knowledge of nuclear weapons effects was needed to evaluate the capability of the Soviet Union to design warheads for air-defense and anti-missile missiles and to develop hardened warheads capable of surviving US ballistic missile defenses. Analysis of the


This period is of particular interest. The 1950s and 1960s were the formative years of the Soviet nuclear program. By the end of this period, Moscow had a mature nuclear weapons technology base and a thoroughly integrated and redundant weapons complex, the configuration of which remained largely the same until the end of the Cold War. In many ways, these were also the most dangerous years of the Cold War. The 1962 Cuban missile
Nuclear facilities were built in 10 closed cities that did not appear on maps.

Denial of Access

Secrecy considerations were paramount in the development of the nuclear infrastructure. While some research and design laboratories were established in Moscow and other open cities, the more critical fissile material production centers and nuclear weapons research and production facilities were built in 10 closed nuclear cities, which are now known by their Russian acronym ZATO. The construction of the first-line nuclear weapons R&D center (Sarov) and fissile material production facilities (Ozersk, Novouralsk, and Lesnoy) began during 1946–47. Subsequently, they were joined by a cluster of second-line facilities (Snezhinsk, Trekhgorny, Seversk, Zheleznogorsk, Zelenogorsk, and Zarechny), most located in the Urals and western Siberia.

To conceal operations from foreign spies and increase survivability against an atomic bombardment, nuclear cities were built in densely forested areas deep inside the USSR’s land mass. The cities did not appear on maps. In non-secret documents, they were assigned
The USSR's 10 Closed Nuclear Cities

<table>
<thead>
<tr>
<th>New Name</th>
<th>Old Name</th>
<th>CIA Name</th>
<th>Established</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sarov</td>
<td>Arzamas-16</td>
<td>Sarova</td>
<td>1946</td>
<td>Nuclear Weapons R&amp;D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Warhead assembly/disassembly</td>
</tr>
<tr>
<td>Snezhinsk</td>
<td>Chelyabinsk-70</td>
<td>Kasli</td>
<td>1957</td>
<td>Nuclear Weapons R&amp;D</td>
</tr>
<tr>
<td>Ozersk</td>
<td>Chelyabinsk-65</td>
<td>Kyshtym</td>
<td>1947</td>
<td>Plutonium production</td>
</tr>
<tr>
<td></td>
<td>(Chelyabinsk-40)</td>
<td></td>
<td></td>
<td>Nuclear component manufacturing</td>
</tr>
<tr>
<td>Zheleznogorsk</td>
<td>Krasnoyarsk-26</td>
<td>Dodonovo</td>
<td>1950</td>
<td>Plutonium production</td>
</tr>
<tr>
<td>Seversk</td>
<td>Tomsk-7</td>
<td>Tomsk</td>
<td>1949</td>
<td>Plutonium production</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>HEU production</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Nuclear component manufacturing</td>
</tr>
<tr>
<td>Novouralsk</td>
<td>Sverdlovsk-44</td>
<td>Verkh-Neivinsk</td>
<td>1946</td>
<td>HEU production</td>
</tr>
<tr>
<td>Zelenogorsk</td>
<td>Krasnoyarsk-45</td>
<td>Zaozeriy</td>
<td>1956</td>
<td>HEU production</td>
</tr>
<tr>
<td>Lesnoy</td>
<td>Sverdlovsk-45</td>
<td>Nizhnaya Tura</td>
<td>1947</td>
<td>HEU production until late 1950s; then</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>warhead assembly/disassembly</td>
</tr>
<tr>
<td>Trekhgorny</td>
<td>Zlatoust-36</td>
<td>Yuryuzan</td>
<td>1952</td>
<td>Warhead assembly/disassembly</td>
</tr>
<tr>
<td>Zarechny</td>
<td>Penza-19</td>
<td>Penza</td>
<td>1955</td>
<td>Warhead assembly/disassembly</td>
</tr>
</tbody>
</table>

the names of nearby towns and a numerical suffix. The use of post-box numbers continued until the early 1990s.

D&D considerations at times were decisive in determining the design and location of new nuclear facilities. For example, secrecy was the main factor in moving the first plutonium production complex (now the Mayak complex) from the initially proposed remote location near the Ufa River to its current location in Ozersk, near Lake Kyzyltash. According to a letter from the atomic project's science director Igor Kurchatov to Beria:

> [I]n considering issues related to the construction of Plant 817 [the code-name of the Mayak complex] it was established that water in cooling towers would have a temperature of about 80°C. The resulting steam, which would be inevitably produced in large quantities (especially during winter), would thereby compromise the concealment... siting the plant near a lake would simplify the problem considerably because large quantities of water would allow cooling without cooling towers... and steam formation would be avoided.... The site near Lake Kyzyltash was proposed to the Special Committee The [main] argument against this site... is that the lake could serve as a navigation landmark for aerial reconnaissance. I consider this argument unconvincing because the site is located in the part of the Urals, which, within a small area, contains a very large number of similarly shaped lakes. I therefore urge you to consider moving Plant 817's site to Lake Kyzyltash.3

This was how the closed city of Ozersk and the plutonium complex, a source of several major

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environmental disasters in the Urals, was established.

The closed cities represented an integral part of the layered security system built around nuclear weapons facilities. Each city occupied a large restricted area—232 square kilometers in the case of Sarov, for example—that was surrounded by double fences. Inside the restricted area were a town for the facility workforce, large wooded areas, and several isolated technical areas that housed primary research and production facilities, testing areas, and support infrastructure. Technical areas within the restricted area were surrounded by their own double or triple fences, which were patrolled by armed guards.4

A layer outside the perimeter was designated as a special regime zone, where every resident had to have a permit and a passport. Temporary residence—even overnight accommodation of non-residents—was prohibited. Non-residents could not even pick mushrooms and berries or hunt in the zone. Ex-criminals and other undesirable elements were prevented from residing in the special regime zones.

Critical nuclear facilities were on the government’s priority list for “active air defense measures.”5 All military and civilian overflights were prohibited. The U-2 plane piloted on 1 May 1961 by Gary Powers over the plutonium complex in Ozersk (and shot down shortly thereafter by an SA-2 surface-to-air missile near Yekaterinburg) was the first airplane over this facility in the almost 15 years of its operation.

### Personnel Isolation

The isolation of construction workers and facility personnel to prevent potential recruitment by foreign spies was another critical security task. The construction force was particularly difficult to control. At least 15 of 114 GULAG camps supported the construction of nuclear facilities.6 In late 1947, over 20,000 prisoners were working in Ozersk, and about 10,000 were in Sarov. There were over 18,000 prisoners in Novouralsk during 1950–51. Over 27,000 were in Zheleznogorsk in 1953.

The Soviet government adopted several measures to minimize the security risk posed by the prison labor force. The KGB’s policy was not to send prisoners with sen-


6 These 15 camps contained about 100,000 prisoners out of the 2.7 million in the GULAG as of 1950. E. Animitsa, N. Vlasova, E. Dvoryadkina, N. Novikova, and V. Safronov, Russia’s Closed Nuclear Cities: Features of Development and Management (Yekaterinburg: Urals State Economics University, 2002).
Prisoners from at least 15 GULAG camps supported the construction of nuclear facilities.

Soviet D & D
tence terms of less than five years or those with sentences expiring in less than three years to nuclear sites. After completing nuclear construction projects, the prisoners finished their terms at the Vorkuta camps in Siberia, which were famous for their remoteness and harsh conditions. When released from the camps, the prisoners were sent to far away regions in the north and to Central Asia. Only in 1955, after several cooling-off years, were some of them allowed to return to central Russia. According to a journalist’s account: “[T]he news spread quickly throughout all GULAG camps that [a nuclear construction assignment] was effectively the same as a death sentence.”

Soldiers comprised the other large segment of the nuclear construction force. Once they completed their service, they all had to sign a 25-year non-disclosure agreement. The KGB, the agency in charge of construction, was directed to retain discharged soldiers and to hire them as civilians to work on other special projects.

German and Austrian scientists and engineers, who became involved in the Soviet nuclear program after World War II, presented the Soviet security apparatus with a particularly delicate problem. The program needed their expertise. Yet, it was clear that most of them eventually would go home and become accessible to Western intelligence organizations. Moscow decided to concentrate them to the extent possible at NKVD-run facilities (such as the Sukhumi laboratory on the Black Sea); to exclude German scientists from work that was directly related to nuclear weapons R&D and production; and to institute a two-year cooling-off period prior to repatriation. Even so, German scientists gave the West much of the initial data on the facilities, personalities, and technical directions of the Soviet project.

Tens of thousands of workers and engineers were required to operate the newly built facilities. Personnel selection was under the control of the Communist Party’s Central Committee, the Council of Ministers, and regional party organizations. There was a process of double selection of personnel based on recommendations by those already working in the program and background investigations by the KGB and its predecessor organizations.

Closed cities made the job of insulating and controlling nuclear workers relatively straightforward. Upon arrival, new residents received instruction in security procedures and signed a nondisclosure agreement, which, among other things, prohibited them from disclosing information about the city and the nuclear facility; the names of nearby towns, rivers, lakes, and other landmarks; the transportation routes to the area; and other information that could help in locating the city. New workers were also encouraged to limit correspondence with people outside the closed cities. Personal phone contacts with

Uranium was assigned such codenames as lead, tar, phosphorus, bismuth, A-9, and BR-10.

Compartmentalization of information and operations was near absolute. Mikhail Gladyshev, former chief of the plutonium purification shop at the Mayak complex in Ozersk, has remarked:

"Activities of the "regime services," headed by Beria, were very stern and bordered on insanity . . . . Often, there was a threat to the safety of workers . . . . As you see, our work had double risks—losing health and losing freedom. This was the difficult fate of those who made the atomic bomb."

Information about production outputs was particularly sensitive. According to Gladyshev:

"We put the [plutonium] paste in a box and transferred it to the consumer plant. How much plutonium was in that box we didn’t know and it was not recommended for us to know. Even later, when I was the plant’s chief engineer, the plans for plutonium production were known only to the facility’s

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9 Vladislav Larin, Combine "Mayak"—The Problem for Centuries (Moscow: KMK, 2001), 8.
10 USSR’s Atomic Project II, Book 1.
The effectiveness of KGB counterintelligence led, in part, to increasing US reliance on technical collection systems.

The USSR's Communist Party and the government called on the KGB to maintain an enhanced counterintelligence posture at nuclear facilities. A 1947 resolution of the USSR Council of Ministers regarding security at the warhead R&D facility in Sarov, for example, directed that, "[I]n order to prevent infiltrations of Object No. 550 (code-name of the R&D center) by spies, saboteurs, and other enemies . . . the USSR Ministry of State Security (comrade Abakumov) is obligated to step up its operational and chekist work at Object No. 550 and in the areas of Mordov republic and Gorky region adjacent to the special regime zone."13

In response, the KGB established a Department K in its headquarters in Moscow and "K" units in the regions.14 The KGB worked with nuclear facilities to develop suitable cover stories to conceal their true missions, monitored information protection measures, and implemented countermeasures against technical collection systems (see below). It also conducted classic counterintelligence operations involving the penetration of foreign intelligence organizations, working against suspected and confirmed foreign intelligence officers in the Soviet Union, and monitoring nuclear facilities and their surroundings.15

According to KGB analysis, its success in preventing the insertion of clandestine agents inside the Soviet Union from the late 1940s to early 1950s forced Western intelligence services to rely on intelligence officers operating under diplomatic cover and agents entering the country via such other legitimate channels as tourism, scientific meetings, and cultural exchanges.16 This allowed the KGB to focus its operational resources on a relatively small number of targets. In 1961, KGB surveillance against Canadian and British diplomats led to the exposure of Col. Penkovskiy, who had provided the West with information on a range of nuclear-related matters. Later on, according to the KGB's 1967 Annual Report:

[I]n the course of counterintelligence countermeasures with regard to enemy intelligence officers under diplomatic cover and other foreigners under suspicion of being affiliated with the enemy's special services, a number of Soviet citizens who established contact with the aim of passing secret information were discovered and unmasked. Among those persons brought to justice were . . . a technician [named Malyshev] from an installation of special significance of the Ministry of Medium Machine-Building.17

Technical Countermeasures

The effectiveness of the KGB's counterintelligence operations, on one hand, and improvements in US signals intelligence, overhead imagery, and nuclear test
Soviet efforts to reduce venting from underground nuclear tests made US radiological analysis ineffective.

In response, the KGB “took measures . . . to bring to further perfection the protection of state secrets from the radio-technical and aerial-space means of reconnaissance of the enemy.” At a test site, for example, operations on nuclear devices in the field were conducted under a tent to prevent visual observation. Furthermore, “[T]he organs of military counterintelligence of the KGB did significant work on camouflaging . . . depots of nuclear weapons and other objects from the enemy’s space reconnaissance.” Moreover, most communications between nuclear facilities and the complex’s headquarters in Moscow were by teletype or telephone and involved the use of landlines and microwave systems. These were considerably more difficult to intercept than short-wave radio transmissions, the target of the National Security Agency’s listening stations at that time. Particularly sensitive documents, such as production data for the nuclear warhead assembly complex, were hand-delivered by couriers.

Radiological analysis of radioactive residues from Soviet atmospheric tests, collected by the US Atomic Energy Detection System (USAEDS), was the primary tool for tracking the progress of the USSR’s nuclear weapons R&D program and its atomic capabilities during the 1950s and 1960s. Indeed, benchmarked by US nuclear test data, the analysis of Soviet nuclear test residues allowed scientists from US national laboratories to determine the Soviet devices’ “design space,” yield, efficiency, materials, and other parameters. After 1963, when the United States and the Soviet Union signed the partial test ban treaty prohibiting nuclear explosions above the ground, each country made a transition to underground nuclear testing. The end of atmospheric testing was a major setback to the US intelligence effort. According to National Intelligence Estimate 11-2A-65, “[O]ur estimates of Soviet nuclear weapon technology . . . are based almost entirely upon analysis of the tests through 1962 . . . and upon extrapolation from that analysis.” The radiological method remained useful to some extent because of radioactive venting from Soviet underground explosions. However, Soviet efforts to reduce venting eventually made the US radiological method ineffective against Soviet targets.

In 1973, the increasing threat from Western technical collection systems caused the Soviet government to establish a new organization, the State Technical Commission, with the main mission of developing and implementing a comprehensive system of countermeasures against technical espionage.

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20 Anatoli Veselovsky, Nuclear Shield (Sarov, Russia: VNII EF, 1999).
By 1965, US intelligence had correctly identified... all Soviet fissile material production centers.

The Soviet Union also was unable to hide from overhead imagery systems its large nuclear weapons production infrastructure. By 1965, the US intelligence program had correctly identified and characterized facilities with more obvious nuclear signatures, including all fissile material production centers, some uranium processing facilities, the Sarov warhead R&D center, the serial warhead assembly facilities in Lesnoy and Trekgorny, and the component manufacturing plant in Zarechny. It appears that some facilities, especially those lacking distinct signatures, escaped detection. It is not clear, for example, that the CIA was aware in the 1960s of the non-nuclear warhead component manufacturing facilities and R&D institutes in Moscow, Yekaterinburg, Novosibirsk, and Nizhni Novgorod.

Soviet D&D measures were very effective in preventing the United States from learning...


25 National Intelligence Estimate 11-2A-65. Washington knew of the existence of Lesnoy as of 1959 but did not know the nature of its activities until later.
The USSR prevented US intelligence from detecting its transition to the more advanced centrifuge uranium enrichment technology.

Perhaps even more importantly, the USSR succeeded in preventing US intelligence from detecting its transition to the more advanced centrifuge uranium enrichment technology. A 1964 National Intelligence Estimate judged that “[T]he present size of the Soviet gaseous diffusion complex . . . tends to indicate that significant U-235 production by the ultracentrifuge and other methods is unlikely.” In fact, a pilot centrifuge facility had begun operation in Novouralsk in 1957. By 1962, the initial phase of a much larger complex at that site had commenced operations, and by 1964 the entire industrial centrifuge enrichment facility had been completed and was fully operational.

The Soviet government worked hard to keep the centrifuge effort secret. The critical point was the repatriation of the German scientists who had participated in the project. According to Nickolai Sinev, the Soviet chief centrifuge designer during the 1950s:  

The score of the US-USSR atomic intelligence competition is unlikely ever to be established.

energy intelligence effort against the Soviet Union. It was countered with a highly effective, defense-in-depth system of countermeasures. The precise score of this competition is unlikely ever to be established. It is clear, however, that long-range, stand-off technical systems proved to be the best collection sources for the United States, allowing for successful tracking of many aspects of the Soviet nuclear program. Overhead imagery enabled the detection and analysis of critical elements of the Soviet nuclear infrastructure. The USAEDS system, designed to monitor radioactive effluents from nuclear explosions and nuclear material processing, yielded important data on the development of Soviet nuclear weapons science and technology. Because of denial and deception countermeasures, however, the USSR’s nuclear program was an exceptionally hard target. The lack of reliable on-the-ground intelligence made it difficult for the West to understand important developments inside the Soviet nuclear complex, which resulted in significant intelligence gaps.