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The Russian-A(merican) Bomb: The Role of Espionage in the Soviet Atomic Bomb Project

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Introduction

There was no "Russian" atomic bomb. There only was an American one, masterfully discovered by Soviet spies."[1]

This claim echoes a new theme in Russia regarding the Soviet atomic bomb project that has arisen since the democratic revolution of the 1990s. The release of the KGB (Commissariat for State Security) documents regarding the role that espionage played in the Soviet atomic bomb project has raised new questions about one of the most remarkable and rapid scientific developments in history. Despite both the advanced state of Soviet nuclear physics in the years leading up to World War II and reported scientific achievements of the actual Soviet atomic bomb project, strong evidence will be provided that suggests that the Soviets did not truly develop their own atomic bomb in 1949, but rather, through Soviet spies' heroic acts of espionage, copied the plutonium bomb devised by the Manhattan Project and detonated at Nagasaki in 1945.

Alhough the claim that the Soviets copied the American atomic bomb is not unique, it is based on newly surfaced KGB information that calls its validity into question. The KGB is releasing substantial information regarding its role in the Soviet atomic project at a precarious time in its existence. With the end of the Cold War, the KGB is seeking glory at a point in history when its future is in question.[2] Nonetheless, scientific and intelligence experts who have seen both the material released by the KGB and other still-secret information have remarked that "even Edward Teller and Andrei Sakharov could not have built a bomb on that information."[3] Historian Paul Josephson remarked that by the eve of the Nazi invasion, the Soviets could not only boast of scientists who contributed significantly to the worldwide growth of nuclear physics, but had laid the foundation for work on an atomic bomb.[4] Still, a war-torn nation was able to develop an atomic bomb in only four years, the same amount of time it took the United States, Canada, and Great Britain, with the "massive industrial might and accumulated efficiency of duPont, General Electric, Tennessee Eastman, and Bell Systems,"[5] research and development expenditures totaling $2 billion,[6] and nearly the entire scientific community mobilized in the Manhattan Project, to develop their bomb.

In order to assess the validity of the KGB's claim, it is necessary to look at the three primary factors of the Soviet atomic bomb project. First, it is necessary to analyze the state of physics in the Soviet Union prior to World War II and the 1941 Nazi invasion in order to investigate whether the Soviet Union actually had the scientific capacity to embark on an atomic bomb project during World War II. Second, the progress and achievements of the Soviet bomb physicists and project coordinators ought to be analyzed so as to achieve an understanding of the project itself, and given the circumstances and problems of the project, just how successful those scientists could have been. Third and finally, the role that espionage played will be analyzed, investigating the various pieces of information handed over by Soviet spies and its overall usefulness and contribution to the bomb project.

Soviet Nuclear Physics—Pre-World War II

As aforementioned, Paul Josephson believes that by the eve of the Nazi invasion of the Soviet Union, Soviet scientists had the technical capability to embark upon an atomics weapons program. He cites the significant contributions made by Soviet physicists to the growing international study of the nucleus, including the 1932 splitting of the lithium atom by proton bombardment,[7] Igor Kurchatov's 1935 discovery of the isomerism of artificially radioactive atoms, and the fact that L. D. Landau, Kirill Sinelnikov, and A. I. Leipunskii were the first scientists in the world to repeat Cockcroft and Walton's experimental splitting of the atom by artificial means.[8] Additionally, Semenov established the conditions necessary for the nuclear fission chain reaction between 1939 and 1941, work for which he would later receive the 1956 Nobel Prize in physics.[9] The advanced state is evidenced in hindsight by the numerous Soviet physicists who received Nobel Prizes for their work in nuclear physics during the 1930s. This list included Semenov in 1956, P. A. Cherenkov, I. E. Tamm, and I. M. Frank awarded in 1959 for their work on the Cherenkov effect studied between 1934 and 1937, and Kapitsa, awarded in 1978, and Landau, awarded in 1962, for their work in the late 1930s and early 1940s on superfluidity.[10]

And, by World War II, Soviet physicists understood that nuclear fission had military significance as it could be used to develop and extraordinarily powerful bomb. Igor Tamm explained this realization to some of his students in 1939 when he discussed fission, saying, "Do you know what this new discovery [fission] means? It means a bomb can be built that will destroy a city out to a radius of maybe 10 kilometers."[11] By June 1940, a specific Uranium Commission had been developed, which set out to locate uranium deposits, develop a method for the production of heavy water, provide for the rapid construction of cyclotrons, study isotope separation, and to measure nuclear constants, all in the interests of harnessing the energy of the nucleus.[12]

Yet, by World War II, the Soviets only had the theoretical understanding necessary to embark on an atomic bomb project. Historian David Holloway points out that "Soviet physicists did not lag behind their American, British, or German counterparts in their *thinking* about nuclear fission (emphasis added)."[13] But the Soviet scientists lacked the Western scientists' vision of its practical application to a bomb. Khoplin considered uranium energy to be "a beautiful dream," but "a distant prospect." Ioffe considered it a "matter of the

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next century,"[14] and he openly admitted that although Soviet physicists had made significant advances in the theoretical realm of nuclear physics, there still lingered the "failure of Soviet physicists as yet to achieve 'any kind of practical applications.'"[15] (The West had already begun applying the science to medicine.) Even Kurchatov believed that the materials needed to make a bomb exceeded what the world had.[16]

Furthermore, by the eve of the Nazi invasion, the Soviet Union lacked the organizational setup and governmental support for a large scale project; Holloway notes that the Soviet Union was providing little money for research, the labs were still too spread out, and there was an "irrational distribution of researchers and equipment."[17] The government pressured the scientists to conduct research "divorced from the West," and even exerted pressure for scientists to reject correct theories, such as those of Bohr and Schrodinger, on philosophical grounds.[18]

Thus, despite their theoretical understanding of the power of the nucleus and their many scientific achievements in theoretical nuclear physics, the evidence suggests that the U.S.S.R. lacked the technical ability to apply it to a bomb, and was not ready to build a bomb in 1941.

The Soviet Atomic Bomb Project

Nevertheless, the bomb became an issue in the Soviet Union in May of 1942. Flyorov, while serving in the air force, became alarmed when there was no published response to his discovery of spontaneous fission and when he noticed that the Western physics journals no longer published articles dealing with nuclear fission. He concluded that the Americans must be making a bomb and alerted Stalin of the situation.[19] Consequently, Stalin authorized a small scale project at the Academy of Sciences for the investigation into the possibility of an atomic bomb in 1942, and Igor Kurchatov was appointed director of the project. Although the Soviet Union embarked on such a program in 1942, Kurchatov did not start work until March 1943. He moved slowly to build his team, as the most optimistic of scientists, Flyorov, predicted that the project would take 10-12 years, while Leipunskii estimated 15 to 20.[20] Kurchatov built his team of young, idealistic scientists in their thirties, as the older scientists did not believe that the bomb would work soon enough to have an impact on the war or the immediate future thereafter. He did not even have the aid of two of the foremost physicists in the Soviet Union, Landau and Kapitsa.[21] Kapitsa refused to work under Lavrenti Pavlovich Beria, head of Stalin's security network and overseer of the bomb project, and Landau was considered politically unreliable after his 1937 arrest and release in 1938.

Kurchatov faced many other significant barriers as well. He had to find a home for the lab, which later became known as Lab Number 2, obtain significant amounts of uranium and graphite, fix the Leningrad Physico-Technical Institute (LFTI) cyclotron, and try to efficiently link the central government, industry, and the bomb project. He recognized that though the bomb was possible in principle, "enormous difficulties remained to be overcome" for practice.[22] By the end of 1943, the Soviet project paled in comparison to the Manhattan Project, as they had only 50 scientists working on the project; by the end of 1944 this number had only grown to 100.[23] (The Manhattan Project had 500 scientists at Los Alamos alone in 1943.)[24] They still believed that a bomb was at least ten years away.

However, the Soviets did begin to make scientific progress in the development of the bomb. Kurchatov, who performed the actual bomb calculations, made the decision early in the project to proceed with a plutonium bomb, for he believed that plutonium could be more easily separated in its pure form, whereas uranium-235 separation was too demanding an endeavor for the Soviet industrial base.[25] Soviet scientists such as I. K. Kikoin and Artsimovich, who had been exposed to U.S. methods of isotope separation, introduced methods of electromagnetic isotope separation and proceeded to improve upon them.[26] When the question arose about whether to pursue a heterogeneous or homogeneous reactor, Gurevich and Isaak Pomeranchuk showed the "decisive advantage of heterogeneous reactors."[27]

By the Potsdam Conference of July 27 to August 1, 1945, the U.S.S.R. was officially engaged in a full scale atomic bomb project under the overall control of Beria. Beria brought the project up to full steam, setting up technical schools for training, screening industry more carefully for qualified engineers and scientists, and set up important research centers in isolated, sparsely populated areas for secret research and testing. The project assumed a tempo that was called "inhumane" by several scientists, as no participant ever took a holiday.[28] But by June 10, 1948, the Soviet scientists had achieved their first chain reaction.[29]

Despite such rapid success in their development of a chain reaction, and subsequently of an atomic bomb, the Soviet program was plagued by an array of problems. The Soviet scientists were not as technologically advanced as their success might have indicated, as they had never before obtained uranium and needed the aid of German scientist Nikolaus Riehl to develop uranium suitable for a reactor. They also had limited resources of uranium and graphite, lacked Geiger counters (a tool necessary for finding such deposits), used impure uranium that lacked the proper number of neutrons for a chain reaction, and employed a very poor diffusion techniques, using a metal sheet with pin-punched holes as the barrier for gaseous diffusion.[30] German refugee scientists were needed to develop nickel pipes gauged to the proper porosity for diffusion.[31]

German reports also reflect the simplicity of the approaches the Soviet engineers Kikoin and S. Sobolev took in developing the bomb. The Soviet mathematics team was comprised of only two scientists, German physicist Hans Barwich and Soviet mathematician Krutkov, who were responsible for developing the differential equations describing the cascade of the diffusion diaphragm—a project which involved 30 mathematicians in the United States.[32] The Soviets ran into problems with uranium hexaflouride corrosion in their separation facility[33] and Vasily S. Yemelyanov, a Soviet scientist working on the project, explained in 1987 that the Soviets were not even sure that their plutonium was plutonium.[34]

Notwithstanding Soviet claims that German scientists were not involved in the actual bomb development, but only separated isotopes and produced metallic uranium,[35] Riehl estimates that without the aid of German refugee scientists, the bomb project would have taken an additional 1-2 years.[36] He attributes many successes of the Soviet project to unconventional measures that the Germans employed, disregarding much of the routine procedure used by the Soviets.[37] Germans Baron von Ardenne, Gustav Hertz, and Peter Thiessen made important contributions to isotope separation, gaseous diffusion, and chemical research respectively.[38] Riehl developed weapons-grade uranium for the project, producing a few tons of pure uranium by a fractionated crystallization technique.[39] Barwich showed the Soviets how to automate the control of uranium gas without the special devices the Soviets believed were necessary; these devices would have taken an extra two years to develop. Theissen and Barwich found the source of corrosion in the separation facility that plagued the Soviets, who could not explain the extremely low yield of useful uranium which had resulted from the corrosion.[40]

Hence, with German aid and the breakneck pace demanded by Beria, the project was finished by mid-August 1949. On August 29, 1949, the Soviet Union detonated an atomic plutonium bomb similar to the Trinity bomb tested by the U.S. four years before. Thus, this war-ravaged nation completed the project in an astonishingly short period of time—four years after the 1945 decision to proceed with a full-scale project. It took the U.S.S.R. the same amount of time (32 months) to move from the first stage of the project (the development of a reactor), to the second stage (bomb detonation), as the United States.[41] However, even though many scientific achievements of the Soviet project have been chronicled, and even though German refugee scientists were able to fill in the pieces where the project went awry, the speed with which the Soviets attained the bomb and the numerous problems organizationally and scientifically that the Soviets encountered suggest that other factors, outside of the scientific realm of the project, contributed to the development of the bomb. The fact that the Soviets could not develop reactor grade uranium or plutonium, attacked the problem with simplistic engineering procedures and an inadequate mathematics team, and historically had problems with the practical application of physics demands a closer look at the role espionage played in their bomb development.

Role of Espionage

Yemelyanov claims that although the speed with which the Soviet Union created the bomb astonished the world, the American prediction that the Soviets would need ten years to develop the bomb was "simply taking their desires for reality. Moreover, they made as if they did not know what a contribution Russian science had made in uncovering the mystery of the atom's construction."[42] Still, several prominent Soviet scientists predicted that the project would take at least ten years. So how did this nation devastated by World War II pull off such an astounding accomplishment? The answer to that question lies in the role Soviet spies played in the development of the atomic bomb.

Between the years 1942 and 1954, the KGB obtained thousands of pages of technical information about the Manhattan Project. Sergei Leskov reports that this information included:

> *calculations for the construction of the plutonium charge; calculations for the critical mass of fissile material; information on detonation devices; information on the gaseous diffusion factory that produced U-235; information about a plutonium production report; a report on the study of secondary neutrons; a report on the metallurgy of uranium and plutonium; and information on the kinetics of atomic reactions.*[43]

Such information would have been unfathomably important to the development of a bomb. Thus, energy could be focused along the successful lines of the American project rather than approaching the situation blindly and attacking all possible avenues. Kurchatov admitted in a memo of March 4, 1943, that certain information "came as a surprise to our physicists and chemists,"[44] such as the centrifugal method of isotope separation. The Soviets also had reached an impasse on the "problem of nuclear explosion and combustion." Stolen documents revealed that this problem could be rectified by mixing uranium oxide and heavy water together—a method the Soviet scientists thought was impossible.[45] Moreover, the Soviets were provided with information on the "physical process" of the inner workings of the uranium bomb, which Kurchatov said "revised views on many problems," and, most importantly, told the Russians that an atomic bomb was a realistic possibility.[46]

Furthermore, Klaus Fuchs, a German scientist who worked on the Manhattan (and Tube Alloy) Project and who was one of the primary Soviet atom bomb spies, confessed to the U.S. War Department and FBI on January 27, 1950, that he had given the Soviet Union the principle design of the plutonium bomb.[47] In his confession of January 30, 1950, he admitted that the information about the plutonium bomb included material on the use of implosion detonation rather than the gun technique, the critical mass for plutonium bombs (5-15 kilograms), information on the solid plutonium core, details of the initiator, specifying that it used 50 curies of polonium, the two types of explosives, "Baratol" and "Composition B,"[48] and "full details of the tamper, aluminum shell, and high explosive lens system."[49] He also provided the equations of state of the bomb, information about the problems of pre-detonation, the blast calculations for Hiroshima and Nagasaki, and the ideal ignition temperature. All told, Fuchs provided the Soviets with "the size of the bomb, what it contained, how it was constructed, and how it was detonated."[50] Such important details were quite accurate as Fuchs explained that he had had "access to all relevant files, so he could be sure all figures mentioned were correct."[51]

Additionally, he confessed to aiding the Soviets before he had clearance to Los Alamos, explaining that he turned over information on gaseous diffusion in 1942. Between 1943 and 1944, he provided information on electromagnetic diffusion, the site of the U.S. plant, and gaseous diffusion information, including the use of membranes of sintered nickel powder.[52] (The U.S.S.R. was having difficult problems with corrosion at this point.) Allan Nunn May even gave samples of enriched U-235 to his Soviet contact for analysis.[53]

The espionage information was so complete and valuable to the Soviets that when the U.S.S.R. began to build its atomic installation, "its plutonium plant was almost identical in size and specifications to 'secret' Reactor 305 at Hanford, Washington." The odds of such similarity were astronomical.[54] The astronomical comparison:

	R305	Russian PRS
Power	10 watts	10 watts
Diameter	19 feet	19 feet
Lattice Spacing	8.5 inches	8 inches
Loading	27 tons U	25 tons U
Rod Diameter	1.4 inches	1.6 inches[55]

Furthermore, the Soviets used the U.S. measurement term "barns" (referring to the large size of a barn) in order to describe nuclear capture cross-sections,[56] even though the closest word in the Russian language to barn is *baran*, which means sheep or ram. David Greenglass also provided the Soviets with a drawing of the implosion lens[57] and Igor Gouzenko reported the exact amount of U-235 used daily at the U.S. metallurgical laboratory.[58]

With the great deal of information stolen by Soviet spies, the question of its usefulness and applicability still remains. It has already been pointed out that the Soviet plutonium reactor mirrored the U.S. reactor at Hanford. Another crucial factor in the development of the bomb was developing a method for isotope separation and diffusion. The United States tried three methods of diffusion before settling on gaseous diffusion. This process cost the U.S. four hundred million dollars, used up 86,000 tons of silver, and occupied 24,000 skilled men; 128 carloads of electrical equipment arrived at Oak Ridge every two weeks during the effort. The U.S.S.R. simply lacked the electric power for such an undertaking, yet had the information on gaseous diffusion delivered to its scientists by Klaus Fuchs, thus saving significant time in their bomb developments.[59]

Additionally, one participant of the Soviet project said that the first Soviet atomic bomb was designed based on the American bomb to the extent that it could fit into the bomb hatch of the American B-29 plane. Using a photo of the U.S. suspension in an American magazine, the dimensions of the bomb hatch and the thickness of the ballistics case could have allowed the Soviets to determine the dimensions for the spherical charge.[60]

Igor Kurchatov claims that he only used the American materials to check the scientific results obtained by his team and to evaluate the probability that the stolen secrets might contain "planted disinformation."[61] Yet, Igor Golovin, a scientist who worked on the project and was a deputy to Kurchatov, said that the first Soviet atom bomb was based on a drawing of the U.S. bomb provided to the researchers by spies. He also later added that the Soviet program lagged behind the futile German effort, and that the information provided by the spies allowed the U.S.S.R. to "avoid blind alleys" on which the U.S. and Great Britain had already embarked.[62]

Even Piotr Kapitsa, who never officially worked on the bomb project, but who was closely connected to it through his liquid oxygen research, wrote several letters to Stalin complaining that much of the work was being dictated by stolen technical information, and not through Soviet scientific achievements, which he believed was causing the Soviet project to falter. He wrote:

> *In the organization of work on the atom bomb, it seems to me there is much that is irregular. At any rate, the way we're going about it is not the shortest and cheapest way of creating it.*[63]

Kapitsa claimed that "our inventors are strong," and that "we underestimate our own strengths and overestimate the value of foreign strength."[64] He remarked that "we will progress only if we profit from our own scientific achievements rather than applying the technology of other countries."[65] According to Kapitsa, the U.S.S.R. was "doomed to development by imitation."[66]

This development by imitation was confirmed by "Hero of Socialist Labor" Yuli Khariton. He claims that it was the only logical choice for the war-torn U.S.S.R. given the state of international affairs. The Soviet Union's first concern was attaining a bomb in the shortest amount of time, according to Khariton, and he admitted that the "Soviets stayed as close to the American bomb in Arzamas-16 as it could." Nevertheless, he added in his account, the Soviet scientists still had to perform "a great number of experiments and calculations."[67]

Conclusion

Regardless of these meticulous experiments and calculations, it is evident that the atom bomb spies played an extremely vital role in the Soviet project. This war-ravaged nation, which suffered approximately 13,600,000 military and 7,720,000 civilian casualties in World War II,[68] whose industrial base, and country for that matter, was devastated by the war, was able to complete one of the greatest undertakings in the history of science in only four years. Its own premier scientists, such as Abram Ioffe, believed that the U.S.S.R. "did not have the expertise of the top-flight scientists working for the Western allies"[69] and would not be able to finish the project in the near future. But this nation was provided with information on the development of the Allied bomb that Ioffe noted was "precise and complete." At the time, Ioffe stated that the "information reduces the volume of work by many months, facilitates the choice of direction, and frees the Soviets from extended searches."[70] Boris Nitkin, director of the Soviet Radium Institute, even noted that it was "often sufficient to test the information instead of doing special research."[71] Many months, and perhaps years, of laborious phases of the project were bypassed due to the information provided to the scientists by the NKVD (Commissariat of Internal Affairs, precursor to the KGB).[72]

Furthermore, not only was time saved due to the stolen information, but the nature of the information is astounding. The Soviet scientists received explicit information on how to build a plutonium bomb. They received sketches, which "might have seemed primitive to those with but a high school knowledge of physics," but experts have testified that "they were invaluable in any attempt to reproduce American nuclear weapons."[73] When Philip Morrison, one of the chief Manhattan Project physicists, saw a copy of the detailed atomic bomb drawing Klaus Fuchs handed over to the Soviets, he remarked, "this is the real thing."[74] They received specific numbers on the size of the bomb, the dimensions, the explosives, the initiators, and the fuel. With such valuable information, it is hard not to make the case that a great deal of the success of the Soviet atomic bomb project was due to espionage. Even Kurchatov explicitly said that Soviet espionage accounted for 50% of the project's success.[75] The Soviet Union certainly had world-class physicists and, by 1945, an organized project that mobilized the scientific and industrial parts of the nation towards the goal of developing a nuclear bomb, but the evidence provided here suggests that the ability to develop the bomb in just four years ought to be attributed to the great contributions made by the NKVD and the atom bomb spies. Would the Soviet Union have eventually built a bomb? The answer is undoubtedly "yes," but most likely not by 1949 without the aid of espionage. The first Russian bomb really was an American one, masterfully stolen by Soviet spies.

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(2) A new book, *Special Tasks: The Memoirs of an Unwanted Witness*, by Pavel Sudoplatov, a high-ranking Soviet intelligence officer during the Stalin era, asserts that the chief Western architects of the atomic bomb acted as spies for the U.S.S.R. and KGB. Sudoplatov, head of atomic intelligence from 1944 to 1946, accuses Niels Bohr, Enrico Fermi, George Gamow, J. Robert Oppenheimer, and Leo Szilard of aiding the KGB in their efforts to steal the secrets of the bomb. He claims that these scientists planted moles at Los Alamos and left secret information in conspicuous places to be discovered by those spies. Although intriguing, the accusations do not seem to be valid. The claim that Oppenheimer placed the infamous Soviet spy and British physicist Klaus Fuchs at Los Alamos is erroneous because Fuchs was part of the British team that came to Los Alamos form the "Tube Alloys" Project as part of the Quebec Agreement between the United States, Canada, and Great Britain. Additionally, Szilard never actually worked at Los Alamos and was watched closely by the FBI and Army Intelligence day and night throughout the project. Although Sudoplatov's book provides insight into the workings of Stalin's intelligence service, it lacks documentary evidence and will not effect the development of this paper.

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(17) Holloway, "Entering the Nuclear Arms Race," 10.

(18) Josephson, P. R. 1988. "Physics and Soviet-Western Relations in the 1920s and 1930s." *Physics Today* (Sept.): 61.

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(28) Albrecht, 361-2.

(29) Yemelyanov, V. S. 1987. "The Making of the Soviet Bomb." *The Bulletin of Atomic Scientists* (Dec.): 39.

(30) Albrecht, 367-70.

(31) Ibid., 370.

(32) Ibid., 371.

(33) Ibid., 372.

(34) Yemelyanov, 40.

(35) Khariton and Smirnov, 23.

(36) Albrecht, 366.

(37) Ibid., 367.

(38) Holloway, "Entering the Nuclear Arms Race," 33.

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(40) Ibid., 372.

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(44) Radosh, R., and Breindel, E. 10 June 1991. "Bombshell: The KGB Fesses Up." *The New Republic*: 11.

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(46) Ibid.

(47) Williams, R. C. 1987. *Klaus Fuchs, Atom Spy* (Cambridge: Harvard University Press): 18.

(48) Baratol is a castable explosive mixture of barium nitrate and TNT. Composition B is a castable explosive mixture containing RDX and TNT, $C_{6.85}H_{8.75}N_{7.65}O_{9.3}$(from Hawkins, Truslow, and Smith, 447).

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(51) Williams, 191.

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(53) Hyde, 56.

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(57) Hyde, 91.

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(61) Sagdeev, 33.

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