directly on international control of atomic energy. At the same time, he was urging America's scientists to continue their work to build even more powerful nuclear bombs.

At the London Conference, an uneasy Vyacheslav Molotov, the Soviet foreign minister, twitted Byrnes about America's nuclear monopoly and tried uneasily to minimize its importance. Molotov's humor betrayed Soviet fears. On September 13, three days into the conference, "Molotov asks JFB if he has an atomic bomb in his side pocket. 'You don't know Southerners,' Byrnes replied. 'We carry our artillery in our hip pocket. If you don't cut out all this stalling and let us get down to work I am going to pull an atomic bomb out of my hip pocket and let you have it.'" In response to this veiled threat, according to the informal notes, "Molotov laughed as did the interpreter." Byrnes's barb emphasized American power. A few nights later, after a stormy session during the day, Molotov commented once more, with strained jocularity, that Byrnes had two advantages that the Soviet minister could not match—eloquence and the atomic bomb. . . .

Did the bomb make a critical difference in shaping the early Cold War? Roosevelt's repeated decisions to bar the Soviets from the nuclear project and Truman's decision to use the bomb in combat without explicitly informing the Soviet Union and inviting her to join in postwar control of atomic energy undoubtedly contributed to the Cold War and helped shape the form that it took. Yet, in view of the great strains in the fragile wartime Soviet-American alliance, historians should not regard America's *wartime* policy on the bomb as *the* cause, but only as one of the causes, of the Cold War. The wartime policy on atomic energy represented one of a number of missed opportunities at achieving limited agreements and at testing the prospects for Soviet-American cooperation on a vital matter.

The atomic bomb, first as prospect and then as reality, did influence American policy. The bomb reduced the incentives for compromise and even stiffened demands by the time of the Potsdam meeting in July 1945 because the weapon gave the United States enhanced power. Without the bomb, policy makers probably would have been more conciliatory after V-J Day in dealing with the Soviet Union, especially about Eastern Europe. The president certainly would have been unable to try to use atomic diplomacy (implied threats) to push the Soviets out of Eastern Europe. Rather, he might have speedily, though reluctantly, agreed to the dominance of Soviet power and to the closed door in that sector of the world. The bomb, as potential or actual weapon, did *not*

alter the administration's conception of an ideal world, but possession of the weapon did strengthen the belief of policy makers in their capacity to move toward establishing their goal: an "open door" world with the Soviets acceding to American demands. This ideal world included free elections, an open economic door, and the reduction of Soviet influence in Eastern Europe. Without the bomb, the Truman administration would not have surrendered these ultimate aims, but policy makers would have had to rely primarily on economic power as a bargaining card to secure concessions from the Soviet Union. And economic power, taken alone, would probably have seemed insufficient—as the record of lend-lease and the Russian loan suggests.

The atomic bomb was the most important weapon in the American arsenal, but its promise proved to be disappointing for it did not make America omnipotent. It did not allow her to shape the world she desired, perhaps because in 1945–1946 neither policy makers nor most citizens were willing to use the bomb as a weapon to "liberate" Eastern Europe, a section of the world that was not then deemed worth war or the risk of war.

Without the bomb, in summary, American policy after V-J Day would have been more cautious, less demanding, less optimistic. Such restraint would not have prevented the breakdown of the Soviet-American alliance, but probably the Cold War would not have taken the form that it did, and an uneasy truce, with less fear and antagonism, might have been possible.

David Holloway

FEAR AND COMPETITION: THE SOVIET RESPONSE TO AMERICA'S ATOMIC MONOPOLY

Soviet leaders learned during the Second World War that American and British scientists, backed by their governments, were busily developing an atomic bomb. Joseph Stalin thereupon ordered a Soviet project. The American atomic bombings of Japan gave greater urgency to this work, for, argues David Holloway, the Soviets now read the atomic bomb as a threat.

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Like many other scholars, Holloway notes that Anglo-American wartime secrecy and resolve not to consult with the Soviets on the bomb's development doomed any chances, however small, for international control of the bomb and for avoiding a nuclear-arms race. He further suggests that Moscow positioned forces in Eastern Europe not only as a safeguard for Soviet interests there, but also as a counterweight to superior American air power that could punish Soviet cities with atomic bombs.

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Victory over Germany brought the Soviet Union political gains that must have been inconceivable in the early months of the war. Stalin now had a say in the political arrangements of Eastern Europe, and Soviet security was thereby enhanced. Stalin's policy in Eastern Europe, however, soon brought him into conflict with his allies. Strains were evident at the Potsdam Conference in July and August 1945. This was the last meeting of the allied leaders to try to resolve their differences about the post-war settlement. It was also the first occasion on which the atomic bomb cast its shadow over relations between the Soviet Union and the Western powers.

The Americans and the British had pondered for some time what to tell Stalin about the atomic bomb. Neither Roosevelt nor Churchill had been impressed by the advice of the great Danish physicist Niels Bohr that they should inform Stalin before the bomb was tested and try to get agreement on international control. The first atomic bomb test took place on 16 July while the Potsdam Conference was in progress. On 24 July President Truman approached Stalin after the formal session had broken up and "casually mentioned" to him that "we had a new weapon of unusual destructive force." Truman wrote later that Stalin replied that "he was glad to hear of it and hoped we would make 'good use of it against the Japanese.' " Truman and Churchill (who was watching intently from nearby) were convinced that Stalin had not grasped what the President was referring to. They were mistaken, however, for Stalin knew of the Manhattan Project and had initiated Soviet work on the bomb early in 1943.

When nuclear fission was discovered in Berlin in December 1938, Soviet physicists were as quick as their counterparts in other countries to see that one of its potential applications was the creation of a bomb with unprecedented destructive force. In 1939 Igor Tamm, a leading

theoretical physicist, remarked to a group of students, "Do you know what this new discovery means? It means a bomb can be built that will destroy a city out to a radius of maybe ten kilometers."

The discovery of nuclear fission at once stimulated new directions of research in the Soviet Union. Leningrad was the leading centre for this work. Here the prime mover was Igor Kurchatov, who headed the nuclear laboratory at the Leningrad Physicotechnical Institute and was later to be scientific director of the atomic project. He coordinated the research not only of his own laboratory, but also of scientists working at the Radium Institute and at the Institute of Physical Chemistry. The Radium Institute was directed by V. G. Khlopin, a radiochemist who later developed the industrial processes for producing plutonium. The director of the Institute of Physical Chemistry was N. N. Semenov, who had done important work on chain reactions for which he later received a Nobel Prize.

Nuclear physics in the 1930s was the very model of an international scientific community. The dramatic progress of research was built on discoveries by scientists in several different countries. Although they had no centre of nuclear research to compare with Paris, Cambridge or Copenhagen, Soviet physicists followed international progress avidly and made some significant contributions to it. Now their work on nuclear fission paralleled that done elsewhere. In April 1939 two of Kurchatov's junior colleagues established that each fissioned nucleus emitted between two and four neutrons, thus indicating that a chain reaction might be possible. Two physicists at Semenov's institute investigated the conditions under which a chain reaction would take place in uranium, and concluded early in 1940 that an experimental attempt to achieve a chain reaction could now be undertaken. In the same year two other physicists, working under Kurchatov's close direction, discovered the spontaneous fission of uranium (i.e., fission without bombardment by neutrons). Inspired by these results, Kurchatov and his colleagues wrote to the Presidium of the Academy of Sciences, urging an expansion of work on nuclear fission.

In June 1940 the Academy set up a Uranium Commission, with Khlopin as chairman, to direct research on the "uranium problem." This commission was a clear sign of the Academy's interest in nuclear fission. Work was now to proceed on a broad front: exploration for uranium deposits (lack of uranium was an important constraint on early Soviet work); the production of heavy water; rapid construction of cyclotrons; studies of isotope separation; measurement of the nuclear

constants. But Kurchatov was disappointed with the scale of this effort. In August he and a colleague sent the Academy Presidium a plan of research, proposing that an experimental reactor be built. They drew attention to the military and economic importance of nuclear energy and urged the Academy to approach the government for additional funds in view of the exceptional significance the uranium problem had for the defence of the country.

In November, at a conference on nuclear physics in Moscow, Kurchatov received a reply to his proposal. Speaking after a paper by Kurchatov, Khlopin, the head of the Uranium Commission, declared that some young physicists, in particular Kurchatov's students, were so captivated by the uranium problem that they forgot about current needs. Nuclear energy, he said, was still a distant prospect, still a beautiful dream; it would be wrong to draw creative minds and national resources into unreal schemes. Khlopin thus made it clear that the Uranium Commission would not act on Kurchatov's proposal.

Work on nuclear fission continued, though not at the pace or on the scale that Kurchatov desired. He made a further attempt to put his case before the authorities. Semenov wrote on his behalf to the government about the possibility of creating a bomb, the destructive power of which would be incomparably greater than that of any existing explosive. This letter, written at the end of 1940 or early in 1941, elicited no response before the German invasion brought nuclear research in the Soviet Union to a halt.

Early in 1942 the possibility of an atomic bomb became a serious issue for the Soviet leadership, as a result of information obtained about British, American and German work on the bomb. In April M. G. Pervukhin, Deputy Premier and People's Commissar (i.e., Minister) of the Chemical Industry, was sent for by Molotov, who gave him a thick file containing secret reports about the foreign work. Soviet sources do not say what was in the file, but it may have contained Klaus Fuch's earliest reports on British work; it appears also that the Soviet Union had by this time received information about German interest in the bomb. Molotov told Pervukhin that he was giving him the papers on Stalin's instruction, and that he was to read them and advise what should be done. Pervukhin recommended that the papers be shown to physicists who would be able to make a precise evaluation of their significance. He himself was given responsibility for the uranium problem.

Information came also from an unexpected source. In May 1942 G. N. Flyorov, one of Kurchatov's former students, wrote to Stalin that

"it is essential not to lose any time in building the uranium bomb." Flyorov, now a lieutenant in the Air Force, was serving at the front in Voronezh, where he had visited the University library to look at the physics journals. He was anxious to see if there had been any response to the discovery, which he had helped to make, of spontaneous fission. A note about this had been published in the American journal *Physical Review*. On looking through the journals, however, he found no reaction to this discovery; moreover, he saw that little of importance was being published about nuclear fission, and that the big names in the field had vanished from the journals. He concluded, rightly, that research was now secret and that the Americans must be working on an atomic bomb. Hence the letter to Stalin.

In the course of 1942 Soviet leaders held consultations with prominent scientists about the development of an atomic bomb. In one meeting Stalin made clear his anger that it was a young lieutenant at the front, and not the members of the Academy, who had drawn the possibility of such a bomb to his attention. He was worried about the cost of developing a bomb, for he was advised by two of the scientists that it would cost as much as the whole war effort. He decided, nevertheless, to initiate a small-scale project. Kurchatov, who had abandoned nuclear research on the outbreak of war, was chosen as scientific director. He finally began work in February or March 1943.

The decision to build an atomic bomb was taken when the war with Germany still hung in the balance. (The counteroffensive at Stalingrad, planned in September and October 1942, had the code name *Uran*, which though normally translated as Uranus, is also the Russian for uranium. This may indicate that the atomic bomb was preying on Stalin's mind at the time.) There were many who thought the effort a pointless waste of resources which could be used to meet more pressing needs. Stalin can hardly have thought that a Soviet bomb could be built in time to affect the outcome of the war. Soviet physicists had estimated in 1942 that the development of a uranium bomb would take between ten and twenty years. Perhaps Stalin had it in mind that after the war the Soviet Union would have to face a nuclear-armed Germany, for at this early period he may have had only minimum war aims, which did not necessarily include the destruction of the Nazi state. Perhaps he foresaw that even with the defeat of Germany the Soviet Union would come into conflict with Britain and the United States; after all, they were conducting their atomic projects in great secrecy, without informing the Soviet Union. More probably, the decision should be

seen as a hedge against uncertainty. Given that Germany, Britain and the United States were interested in the atomic bomb, was it not as well to initiate a Soviet project, even though the circumstances in which the new weapon might be used could not be foreseen?

Kurchatov drew up a plan of research with three main goals: to achieve a chain reaction in an experimental reactor using natural uranium; to develop methods of isotope separation; to study the design of both the U-235 and the plutonium bombs. He built up his team slowly, drawing largely on those with whom he had worked before. By the end of 1943 he had fifty people working in his new laboratory; by the end of 1944 he had one hundred scientists. This was a tiny effort compared with the Manhattan Project. As the country was liberated, other institutes were drawn into the project, and in 1945 some German scientists and technicians were brought to the Soviet Union to take part. In the spring of 1945 Kurchatov ordered work to begin on the design of an industrial reactor for producing plutonium. By the time of the Potsdam Conference the Soviet Union had a serious atomic bomb project under way.

In spite of this, however, the American success in building the bomb came as a blow for the Soviet Union. Alexander Werth, who was in Moscow at the time, wrote that the news of Hiroshima had "an acutely depressing effect on everybody." The atomic bomb was seen as a threat to Russia, and "some Russian pessimists . . . dismally remarked that Russia's desperately hard victory over Germany was now 'as good as wasted.' " In December 1945 the British Ambassador wrote to the Foreign Secretary:

> the German invasion caught them still unready and swept them to what looked like the brink of defeat. Then came the turn of the tide and with it first the hope and then a growing belief that the immense benison of national security was at last within their reach. As the Red Army moved westwards belief became confidence and the final defeat of Germany made confidence conviction . . . Then plump came the Atomic Bomb. At a blow the balance which had now seemed set and steady was rudely shaken. Russia was balked by the west when everything seemed to be within her grasp. The three hundred divisions were shorn of much of their value.

Ambassador Harriman reported to Washington in much the same terms.

The small Soviet project laid the basis for the all-out effort that was now launched. Stalin's immediate reaction to Truman's casual

remark was to tell Kurchatov to speed up his work. In the middle of August, shortly after his return from Potsdam, Stalin summoned B. L. Vannikov, the People's Commissar of Munitions, and his deputies to the Kremlin. There they were joined by Kurchatov. "A single demand of you, comrades," said Stalin. "Provide us with atomic weapons in the shortest possible time. You know that Hiroshima has shaken the whole world. The balance has been destroyed. Provide the bomb—it will remove a great danger from us." Kurchatov and his colleagues were asked how long it would take to build the atomic bomb if they received all-round support. Five years, they replied. In the event, the first Soviet test took place four years to the month after that August meeting with Stalin.

Compared with his failure to heed the warnings of a German attack in 1941, Stalin's decision about the atomic bomb in 1942 showed considerable foresight. The last thing he can have wanted to hear then was that Germany, Britain and the United States were working in great secrecy to develop a weapon of unprecedented destructive force. In spite of the critical war situation, he took the precautionary step of setting up a small-scale project. The Soviet leaders were nevertheless shaken by the American success in building a bomb. When Molotov heard what Truman had said at Potsdam, he saw it as an attempt to gain concessions from the Soviet Union. The Soviet leaders regarded the use of the bomb in Japan as part of an effort to put pressure on them, as a demonstration that the United States was willing to use nuclear weapons. Soviet security now seemed to be at risk from a new threat.

If Niels Bohr's advice had been heeded, and Stalin had been told officially about the bomb, his post-war policy might have been just the same. But Western secrecy contributed to Soviet suspicion and spurred the Soviet Union to develop its own bomb. As [the scholar] Margaret Gowing has written, "If Russia had been formally consulted about the bomb during the war . . . it might have made no difference. The fact that she was not, guaranteed that the attempts made just after the war to establish international control, which might have failed anyway, were doomed. . . ."

On 8 August 1945, two days after Hiroshima, the Politburo initiated work on a new Five Year Plan, which was formally adopted in March 1946. The Soviet leaders had to make decisions about the plan in the context of the new weapons programs. The then Minister of Finance has written in his memoirs that finding the financial resources

for the plan proved more difficult than anticipated because the drop in defence spending was not as great as expected, and because "significant resources" were required for the development of military technology.

By the summer of 1946 the basic institutional framework had been created for developing nuclear weapons, long-range rockets, radar and jet propulsion. Special bodies were set up in the Party, the government, the secret police and the Armed Forces to direct these programs. In 1945 Scientific-Technical Councils were created for atomic bomb and rocket development. These consisted of scientists, engineers and industrial managers, and discussed the major technical and industrial problems connected with the programs. B. L. Vannikov headed the atomic council, with Pervukhin and Kurchatov as his deputies. The rocket council was chaired by D. F. Ustinov, the present Minister of Defence, who was then the People's Commissar of Armament. A special department of government, also headed by Vannikov, was set up to manage the nuclear program. The secret police had a department for atomic energy; half of all research for nuclear weapons development was done in prison institutes, while most of the construction and mining was done by prison labour. Overall control of the nuclear program lay in the hands of [Lavrenti P.] Beria, the chief of the secret police.

The object of these arrangements was to exercise tight central control over the new weapons programs, and to ensure that they had first claim on resources. Soon after the Potsdam Conference Kurchatov became a regular visitor to the Kremlin. One of the industrial managers remarked to him that "It's easy for you to solve problems: you meet Stalin every day." Kurchatov replied that problems were indeed solved quickly in meetings with Stalin. (The Soviet authors who recount this exchange comment that Kurchatov kept to himself the thought that dealing with Stalin almost every day was more difficult than walking a tightrope across an abyss; and it can have been no easier to deal with Beria, who is never mentioned now in Soviet accounts of their early nuclear program, but with whom Kurchatov must have had frequent contact.) Policy was developed in meetings between the Party leaders and those directly in charge of the programs. In April 1947, for example, Stalin summoned scientists, industrial managers and military men to the Kremlin for a series of meetings to decide on an overall plan for rocket development. Stalin's personal interest ensured that these programs had the highest priority; the best scientists, engineers, workers and managers were assigned to them. Each decision was backed by

Stalin's authority, and this helped to overcome obstacles in the way of executing policy.

The war provided the Soviet Union with a major infusion of foreign technology, mainly in the form of captured German scientists, technicians, equipment and production plant. Foreign technology also came through Lend-Lease, and by more fortuitous routes. The Tu-4 bomber, for example, was a copy of the American B-29, three of which made a forced landing on Soviet territory in 1944. Foreign technology was important for the post-war programs, but its contribution varied from field to field. In 1945 the Soviet atomic bomb project was better organized than the German, and while the Soviet Union acquired some scientists, technicians and equipment, most of the leading German nuclear scientists fell into Western hands. The information passed by Klaus Fuchs and other atomic spies was more important for the Soviet effort, perhaps speeding up the development of the atomic bomb by as much as a year or two. But it is certainly wrong to say that this is how the Soviet Union acquired the "secret" of the atomic bomb, for, as Niels Bohr remarked, the only secret of the atomic bomb is that it can be built.

The Soviet Union gained more from German rocket technology. In 1945 a team of Soviet rocket scientists was sent to Germany to study the German effort, and the first Soviet long-range rocket, the R-1, which was test-fired in October 1947, was a modification of the German V-2. The United States too gained from the German rocket program, for as the Red Army approached Peenemunde, the main centre of German rocketry, Wernher von Braun took his team and their most important papers to meet the American forces. Unlike the United States, however, the Soviet Union gave high priority to rocket development. In October 1946 thousands of German engineers and technicians were taken to the Soviet Union, where they worked under Soviet supervision. In spite of the purge, there was still a cadre of experienced and gifted rocket scientists who were able to build on the German technology. In 1947 a Council of Chief Designers was set up to coordinate the Soviet program. In was chaired by S. P. Korolev, who was later to design the first Soviet intercontinental ballistic missile. The other leading designers of the time, who were probably on the Council, were V. P. Glushko (whose design bureau was to develop the liquid-propellant rocket motors for most of the Soviet strategic missiles), A. M. Isaev (Chief Designer of a bureau for rocket motors since 1944), and A. N. Pilyugin (Chief Designer of Control Systems). In 1950 the Soviet

Union test-fired the R-2, a development of the R-1, but with a range of 600 km, about twice that of the earlier rocket. By this time work had begun on the SS-3, which was deployed in the mid-1950s.

On 29 August 1949 the Soviet Union tested its first atomic bomb. (This was a plutonium bomb; the first test of a U-235 bomb took place in 1951.) The United States detected the first Soviet test and made it public, to the apparent consternation of the Soviet government, which had made no announcement. News of the test caused a shock in Washington where, despite some accurate forecasts, it was generally believed that the Soviet Union would not have an atomic bomb until the early 1950s. This shock contributed to the decision announced by President Truman on 31 January 1950 to speed up work on thermonuclear weapons. Such bombs have a yield many times greater than the atomic bombs used in Japan, and the decision to develop them marked a major new stage in nuclear arms competition. . . .

The Soviet atomic bomb test of August 1949 helped to speed up American work on thermonuclear weapons, and American policy in turn stimulated Soviet weapons research and development. Soviet work on the thermonuclear bomb began in 1948 when Kurchatov set up a theoretical group (which included Andrei Sakharov) under Igor Tamm, after reports of a superbomb had been received from the West. Soviet interest in thermonuclear weapons may have been aroused by Klaus Fuchs, who told his Soviet contact about studies of these weapons at Los Alamos. He could have told the Soviet Union that in the spring of 1946 discussion had taken place about two possible types of thermonuclear bombs: one in which a relatively small amount of thermonuclear fuel is ignited by a relatively large fission explosion (later known as a boosted fission weapon) and the other in which a relatively small fission explosion ignites a very large mass of thermonuclear fuel (the superbomb). Fuch's account of these early discussions of the superbomb would have been misleading rather than helpful to Soviet scientists in a scientific sense, because the early ideas were later shown not to work. But it is possible that Fuch's reports stimulated Soviet work on these weapons.

By the time of the first atomic bomb test, Tamm's group had concluded that thermonuclear weapons were possible, and two months after the test—that is, about 1 November 1949—Kurchatov began to work on the development of a thermonuclear bomb as a matter of priority. The first thermonuclear bomb test took place almost four years later, on 12 August 1953. Soviet writers tend to stress the role of American actions in stimulating Soviet nuclear weapons development. It is therefore interesting that they do not mention as providing any impetus to Soviet efforts Truman's announcement on 31 January 1950 of his decision to accelerate development of the superbomb. But one of Kurchatov's biographers does stress that the American test of October 1952 led to an intensification of Soviet work; after the test "Kurchatov and those taking part in the creation of the terrible new weapon increase the tempo of work. Alongside the design work, experiments are conducted to investigate different variants." This implies that besides working on the "Joe-4" bomb, Soviet scientists now worked to develop a superbomb. The American test stimulated Soviet research, and analysis of the fallout from the American test would have helped Soviet scientists to discover the mechanism behind the very high yield of the explosion. The first Soviet superbomb was tested in November 1955. . . .

From August 1945 Stalin faced a dual problem: to build a Soviet bomb as quickly as possible, and to deprive the United States of any military or political advantage from its atomic monopoly. The first part of this problem was solved by launching the new research and development programs. The second was tackled by providing a counterweight to American air power. Soviet forces in Eastern Europe were the main element in this policy. American bombers could threaten Soviet cities and industrial centres, but Soviet forces could not strike the United States. Consequently the Soviet Army was deployed in Eastern Europe not only to safeguard Soviet interests there, but also to strike Western Europe in the event of war. (Soviet forces were certainly not strong enough for Stalin to contemplate an invasion out of the blue.) Conventional weapons were modernized and air defences strengthened.

Stalin took pains to play down the significance of nuclear weapons. In September 1946, for example, he said that "I do not consider the atomic bomb as serious a force as some politicians are inclined to do. Atomic bombs are meant to frighten those with weak nerves, but they cannot decide the fate of wars since atomic bombs are quite insufficient for that." The effort the Soviet Union was making to develop the atomic bomb makes it clear that Stalin did in fact attribute great importance to nuclear weapons. Such statements were designed to weaken any American attempt to use its atomic monopoly to put pressure on the Soviet Union, and also to prevent Soviet troops, who would have to fight without nuclear weapons, from being intimidated by the threat of nuclear war.