

Research Note

David Holloway

Soviet Thermonuclear Development

The development of thermonuclear weapons marked one of the major turning-points in the history of Soviet-American strategic arms competition. In his book *The Advisors* Herbert York enhances our understanding of this turning-point by showing that the first Soviet thermonuclear test device (commonly known as "Joe-4"), which was exploded on 12 August 1953, was not a superbomb but had a different configuration and a substantially lower yield.¹ The first Soviet superbomb was tested in November 1955. York's analysis is important because it makes it possible to assess more accurately the progress of Soviet nuclear weapons development in the 1950s, and to understand more clearly the nature of Soviet-American strategic arms competition.

The object of this note is to make public a document which gives more detailed information about Soviet nuclear weapons tests in the 1950s. The data given here support York's analysis, and indeed can be seen as a footnote to it; they also raise a question about Joe-4's place in Soviet nuclear weapons development. The document, which is available in the Joint Chiefs of Staff records in the National Archives, is quoted in its entirety at the end of this note.² It was prepared by the Nuclear Weapons Working Group of the Joint Technical Intelligence Subcommittee of the JCS Joint Intelligence Committee in response to a request from the Chief of Staff, Armed Forces Special Weapons Project for intelligence data on the 1955 Soviet nuclear test series. The document, which was classified "Top Secret," is dated 10 February 1956; the version given below includes a correction made on 15 February. It was declassified on 16 November 1976.

The first Soviet fission bomb test took place in August 1949, but Soviet work on thermonuclear weapons had already started in 1947-48. At that time the Soviet government asked Kurchatov, the scientific director of the nuclear

1. Herbert York, *The Advisors. Oppenheimer, Teller and the Superbomb*, W. H. Freeman and Co., San Francisco, 1976.

2. National Archives, Modern Military Branch, RG 218, Records of the U.S. Joint Chiefs of Staff, 1954-56, CCS 334 JIC (12-28-55) Section 3. The figures in this document are not of course as reliable as American figures for American test yields. It is possible that a change in assumptions would lead to a change in yield estimates. But in an area where little specific information is publicly available, the document reproduced below does have a scarcity value.

David Holloway is Lecturer in Politics, University of Edinburgh. During 1978-1979 he was a Fellow of the International Security Studies Program, Woodrow Wilson International Center for Scholars, Washington, DC.

program, and other physicists whether there was any basis to reports from the West of a superbomb. They replied that there was, and a group was set up to study the theory of thermonuclear weapons.³ The Soviet Union had been informed by Klaus Fuchs of the studies of thermonuclear weapons at Los Alamos up to 1946. He could have told them that in the spring of 1946 discussion had taken place of two possible types of thermonuclear bomb: 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).⁴

It is true that Fuchs' 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 Fuchs' report of the Los Alamos discussions of 1946 served to spark the Soviet interest in thermonuclear weapons. He appears to have reported on these discussions to his Soviet contact early in 1947, and it was in 1947 that the Soviet government asked its scientists whether there was any basis for reports on a superbomb.⁵

By the time of the first Soviet fission bomb test on 29 August 1949 the work of the Soviet theoretical group had shown, in the words of one of Kurchatov's biographers, that "the hydrogen bomb could be hundreds or thousands of times more powerful than the atomic bomb."⁶ Two months after the atomic test—that is, about 1 November 1949—Kurchatov began to work on the development of a thermonuclear bomb as a matter of priority.⁷

The results of this development can be seen in the document below. The yield of the first Soviet thermonuclear test (Joe-4), which took place on 12 August 1953, is not given in the document. But the reference to the 6 November 1955 test, which had a yield of 215 kilotons, as a "weaponized version of the 1953 boosted configuration" (that is, of the 12 August 1953 test device) indicates that the yield of the August 1953 test was in the 200–300 kiloton range. This fits in with the upper limit of 400 kilotons estimated by York in his book. The table shows also that the 12 August 1953 test did

3. I. N. Golovin, *I. V. Kurchatov*, 3rd ed., Atomizdat, Moscow, 1978, p. 92.

4. York, *op. cit.*, pp. 20–28.

5. See Alan Moorehead, *The Traitors*, Revd. ed., 1963, Harper and Row, New York, pp. 105–107, 118–120 on Fuchs' meetings with Soviet contacts in 1945–47.

6. Golovin, *op. cit.*, p. 43.

7. *Ibid.*

involve a fusion reaction and the use of lithium deuteride, again fitting in with York's analysis.⁸

The first draft of the document refers to the 6 November 1955 test as a "thermonuclear boosted weapon," while the corrected version, which is given below, speaks of a "boosted fission weapon." It is clear that the device tested on 12 August 1953 was not a superbomb: the yield is far too low. Nor, it seems, was it a boosted fission weapon. It appears to have been a third type of thermonuclear bomb. York has argued that it was "a development step the United States bypassed in its successful search for a configuration that would make it possible to produce an arbitrarily large explosion with a relatively small quantity of fissionable material."⁹ The data in this document do not settle the question, although the presence of lithium deuteride among the nuclear materials indicated that it was not a boosted fission weapon of the American type.¹⁰

A puzzling feature of the table below is the test on 6 November 1955 of a "weaponized version" of Joe-4. This test suggests that the Soviet Union had not abandoned this line of development. If Joe-4 had been merely a step in the development of the superbomb, then one would not expect subsequent tests of a similar device. It is possible that the 6 November test was staged just in case the 22 November superbomb test failed. It is also possible that the Soviet Union decided to develop and deploy weapons with a yield in the 200–300 kiloton range. More information will be needed to resolve this puzzle.¹¹

The table indicates a lower than expected yield for the 22 November 1955 test. In his book York does not quote a figure but suggests that the yield was probably no more than one third that of the U.S. Mike test of 31 October 1952, i.e. no more than 3.5 megatons.¹² The table below gives a yield of 1.6

8. York, *op. cit.*, p. 91.

9. Herbert York, *Scientific American*, October 1975, p. 111.

10. See S. Glasstone and P. Dolan (eds.) *The Effects of Nuclear Weapons*, 3rd. ed., U.S. Dept. of Defense and U.S. Dept. of Energy, Washington, D.C. 1977, pp. 21–22.

11. The table below provides a clearer picture of the early Soviet test program than has hitherto been available in public. The U.S. Department of Energy's *Announced Foreign Detonations* lists six tests up to the end of 1954, although it notes that the three tests listed for 1953 and 1954 were elements of different test series. From the left-hand column of the table it is clear that the Department of Energy chronology omits eight tests for 1953 and 1954; these eight are presumably the unlisted tests in the 1953 and 1954 series. Further, by referring to the 6 November 1955 tests as a "weaponized version of the 1953 boosted configuration" the document implies that there were no Soviet thermonuclear tests between August 1953 and November 1955.

12. York, *op. cit.*, p. 92.

megatons, which is compatible with York's general analysis. Although Soviet sources give the yield of the test as "several megatons," Khrushchev is reported to have said in a speech in India on 26 November 1955 that the yield was "a megaton";¹³ the figure of 1.6 megatons can perhaps, with some stretching, be interpreted either way. More importantly, the low figure gives a clearer picture of Soviet progress in nuclear weapons development in the 1950s, and provides a context in which later Soviet claims can be evaluated. The 1.6 megaton yield of the 22 November 1955 test shows that the Soviet Union had still not matched the explosive power of the first American thermonuclear tests. The device exploded in the Mike test of 31 October 1952 (which was not a deliverable bomb) yielded 10.5 megatons. The Bravo test of 28 February 1954 was a test of the first large American hydrogen bomb and yielded 15 megatons.

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 President Truman's decision of 31 January 1950 to accelerate development of the superbomb as providing any impetus to their own efforts. Development of a Soviet thermonuclear bomb had begun about 1 November 1949. In the striking absence of evidence to the contrary, I assume that President Truman's announcement did not provide a major stimulus to Soviet work. The American Mike test of 31 October 1952 did, however, speed up Soviet efforts. One of Kurchatov's biographers writes that after the Mike test "Kurchatov and those taking part in the creation of the new terrible weapon increase the tempo of work. Alongside the design work, experiments

Table I (continuation)

| No. | Date | Nuclear Materials | Yield | Possible Diameter |
|------------|----------------|----------------------------|--------------|--------------------------|
| XV | July 29, 1955 | Pu(?) | 5 | — |
| XVI | Aug. 2, 1955 | Pu(?) | 25 | — |
| XVII | Sept. 21, 1955 | Pu(?) | 20 | — |
| XVIII | Nov. 6, 1955 | U-235, U-238, LiD | 215 | — |
| XIX | Nov. 22, 1955 | U-235, U-233 U-238, LiD | 1600 | — |

13. York, *op. cit.*, p. 165, note 16.

are conducted to investigate different variants.”¹⁴ This implies that besides continuing to work on the Joe-4 device Soviet physicists increased their efforts to develop a superbomb. In other words, the Mike test stimulated them to work more intensively on the mechanism behind the very high yield of that test and analysis of the fallout would have helped them to discover that mechanism. The Soviet test of 22 November 1955 seems to have embodied something equivalent to the Teller-Ulam idea which enabled the United States to develop the superbomb.

If this reconstruction of the Soviet thermonuclear decisions is correct (and it can only be provisional pending further evidence), then it suggests two conclusions which are of interest from the point of view of understanding Soviet-American strategic interaction. First, although there are clear elements of reciprocal influence in the Soviet and American nuclear weapons decisions of 1949–52, the actions that are salient on one side are not necessarily so on the other. American accounts of the period highlight President Truman’s announcement of 31 January 1950. The Soviet accounts, however, suggest that Truman’s decision was not as important to their own decisions as the early reports of American work on thermonuclear weapons and the Mike test of 1952. In strategic interaction the salience of actions depends not on the actor’s context but on that of the observer.

Second, Soviet decision making shows elements both of reaction to American actions and of an internal dynamic. The early thermonuclear studies were stimulated by reports of American work. The decision to proceed to development of a fusion bomb followed the first fission bomb test and was not directly triggered by American actions. The search for the superbomb was intensified by the Mike test. Yet if we can find elements both of reaction and of an internal dynamic in Soviet policy, the overall effect of American actions was to speed up the Soviet effort to develop thermonuclear weapons.

*Intelligence Information For Use in the AFSWF Weapons Oriented Course
(Advanced)*

In 1955 five nuclear explosions were detected. The first two of these were air bursts with yields of approximately 5 and 25 kilotons respectively, probably using plutonium warheads of small and medium size. The third was an

14. Golovin, *op. cit.*, p. 94.

underwater burst in the Barents Sea. The energy of the explosion was on the order of 20 kt. The atomic device or warhead was probably moored at a depth of 100 feet or more. The fourth was an air burst of a boosted fission weapon using a U-235 core which obtained an energy yield of approximately 215 kt. It was probably a weaponized version of the 1953 boosted configuration reduced to a more easily deliverable size. The last test of the 1955 series was the largest explosion achieved by the USSR. It was a two-stage thermonuclear weapon or device with a yield of about 1600 kt. Both U-235 and U-233 were employed. It was exploded several thousand feet in the air over the Semipalatinsk test site and was carried in an aircraft.