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An undernourished but obstinate infant monitoring system is rescued by its own target, the first Soviet atom shot.

THE DETECTION OF JOE 1

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Alert 112 began just like many of the previous 111 sounded in the Long Range Detection System. A field unit reported on 3 September 1949 that a filter paper exposed for three hours at 18,000 feet on a weather plane flying from Japan to Alaska showed a radioactivity of 85 counts per minute, 35 counts over the recently halved official threshold of significance. But this time the slight indication was to trigger a massive reaction.

Before it was over, the Air Weather Service had mounted 92 special air sampling flights from Guam to the North Pole and from Japan to the British Isles. As the radioactive cloud moved east, British authorities were alerted and the RAF flew missions from Gibraltar to 70°N latitude. Other samples were taken by fixed air sampling stations in the Far East and North America and by Navy rainwater stations in North America.

Analyses of the air filter samples by Air Force's contractor Tracerlab and the Los Alamos Scientific Laboratory provided unambiguous evidence that the Soviets had succeeded in detonating a plutonium bomb. The rainwater samples, analyzed by the Naval Research Laboratory, the Los Alamos lab, and the University of California Radiation Laboratory, later told more about the nature and timing of the shot. The U.S. conclusion was independently confirmed by the British sampling and radiochemical analysis. It was firm enough for Presi-

[1] This is an editorial consolidation of a Secret article by the authors with portions of another study of higher classification.

dent Truman to announce on 23 September that an atomic device had been detonated by the USSR between 26 and 29 August 1949.

How did it happen that an atomic test detection organization was in operation in mid-1949, two years before the earliest estimated time when there would be anything for it to detect?[2]

Genesis

In September 1946 General Hoyt Vandenberg, as DCI, acting upon suggestions from the Army Air Forces (R&D chief General LeMay and A-2 General Samford), wrote General Groves, whose Manhattan Engineering District had not only created the bomb but pioneered methods of detecting foreign atomic development work including test explosions, that the Central Intelligence Group proposed to coordinate U.S. detection efforts, particularly by "continuous surveillance of the physical phenomena in the atmosphere," asked about suitable instrumentation for this purpose, requested data from last summer's "Crossroads" tests at Bikini bearing on it, and invited "advice and opinion" generally. Because such information had been most closely held in the MED and because there was anxiety at the time as to how military interests would be safeguarded in MED's imminent turnover to the new Atomic Energy Commission, there was a good deal of informal

[2] The two-year figure, though conveying the right estimative flavor, is an oversimplification. Under prodding by Senator Hickenlooper of the congressional joint committee on atomic affairs, a series of CIA estimates on the dates for the first Soviet bomb and for substantial stockpiling had been coordinated more or less thoroughly among the agencies concerned. The first of these, dated 15 December 1947, had the first bomb doubtful before 1953, almost certainly not before 1951, no probable date estimatable. The Director of Intelligence of the three-month-old USAF, however, had not been consulted, and he wrote the DCI that it was "difficult for me to appreciate the philosophy which permits an optimistic finding that inevitably will tend to lull those affected by it into a feeling of false security which certainly will be no incentive to action." (It was not yet established in the community that "incentive to action" was not a proper function of intelligence estimates.)

The next estimate, 1 July 1948, threw the earliest "remotely possible" date back to mid-1950 and made mid-1953 the "most probable." Then a year later, less than two months before Joe 1, the interdepartmental Joint Nuclear Energy Intelligence Committee reiterated these dates but fuzzed the earlier one by saying that new information on one method used by the Soviets "suggests that their first atomic bomb cannot be completed before mid-1951." A revised version of this estimate forwarded to the Joint Chiefs within a couple of days of Joe 1 itself made the mid-1951 limit contingent upon this method's being the only one they were using.

consultation between parties on this request before Groves replied in writing at the end of December. He said that instrumentation was practicable, but both instruments and procedure needed development and a rapid communications net would be necessary. He thought a military agency should be designated to work the process out but approved the DCI's "taking the lead." At Crossroads, an annex showed, air sampling by modified B-29s and some acoustic detection devices among other methods had been tried, but the results were not clear and conclusive.

After the AEC's takeover from MED in January 1947, Commissioner Admiral Strauss was its chief promoter of "continuous monitoring of radioactivity." He discussed the urgency of a detection system with his fellow commissioners, with Navy Secretary Forrestal, and with General Vandenberg and recommended interservice action. Later he apparently thought of himself as the one person primarily responsible for what was eventually done.[3]

On 14 March, whether on Strauss's urging or in consequence of the earlier initiatives, Vandenberg asked War, Navy, the AEC, and the Joint Research & Development Board to join with CIG in establishing a committee of specialists to formulate an over-all long-range detection plan. This was done, and on 30 June Admiral R. H. Hillenkoetter, who had succeeded Vandenberg as DCI, sent the other four agencies the committee's findings. It recommended a network of acoustic stations, a seismographic network based mostly on existing stations, a system for sampling air and rainwater by aircraft and surface stations, arrangements for existing laboratories to analyze the samples, and facilities for reporting to a control central that would direct operations. It thought two years might be required to get such a complete network into operation; but in the meantime standards of normal background radioactivity should be established, and air sampling for this purpose, which could be started immediately "through flights of suitably equipped planes," just might "yield information indicative of an atomic explosion if any should have occurred during the early . . . operations."

Action

Hillenkoetter recommended that the Army Air Forces be given responsibility for the job, the secretaries of War and the Navy concurred, and on 16 September 1947, two days before the Air Force

[3] Lewis L. Strauss, *Men and Decisions* (New York, 1962).

became a separate service, Army Chief of Staff Eisenhower issued this directive:

> The Commanding General, Army Air Forces, is hereby charged with the over-all responsibility for detecting atomic explosions anywhere in the world. This responsibility is to include the collection, analysis and evaluation of the required scientific data and the appropriate dissemination of the resulting intelligence.
>
> In carrying out this responsibility, the Commanding General, Army Air Forces, will utilize to the maximum existing personnel and facilities, both within and without the War Department, will establish appropriate arrangements with other interested agencies for necessary assistance and will effect and maintain liaison with all participating organizations.

With this directive, Long Range Detection, as the Air Force named the program, was launched. Whether or not the directive intended that LRD literally be accomplished without additional money—which was the tenor of some later interpretations and would have been consistent with considerable thinking at the time it was issued—it made no provision for implementing funds and established no priority for the program.

Two days later the Air Force's Special Weapons Group, which had been assigned the detection responsibility, began to plan with the AEC and a score of other agencies trial detection operations in connection with the "Sandstone" tests scheduled at Eniwetok for the spring of 1948. Allocations of the LRD effort, initially for Sandstone but to be continued in what was to be called an Interim Surveillance Research Net, were shortly agreed upon. Air Force would be responsible for air sampling by Air Weather Service aircraft—whose regular flights had been suggested for this purpose even before the specialists' committee met—and at weather ground stations, for setting up a central control center, and for initiating or monitoring research and experimentation by other government agencies and external institutions. It contracted with Tracerlab of Boston (and later California) to do the bulk of radiochemical analysis. Coast and Geodetic Survey would do special monitoring at its existing seismic posts and on discreetly arranged input from foreign stations. Navy would be responsible for underwater sonic observations and rainwater sampling, as well as some research in sample analysis techniques. Army Signal Corps would provide data from its existing and possibly some added acoustic stations. AEC would participate in research and development and in sample analysis.

The hastily made arrangements for the Eniwetok tests turned out quite productive. The capabilities of aircraft air sampling were clearly demonstrated with externally mounted air filters using Chemical Warfare V papers. Extensive meteorological observations indicated a Pacific line of intercept for air masses moving eastward from the USSR. Tracerlab sample analysis proved highly effective. In August 1948, although termed an experimental and developmental program rather than purporting to be operational, and long to be faced with budget difficulties which ruled out research in the desired depth, actual detection surveillance began along lines which generally were those operative at the time of Alert 112 a year later.

Money Trouble

Even before the Sandstone tests at Eniwetok, however, the difficulty of funding research under the conservative eye of the Research and Development Board became evident. The RDB, coordinator of the United States' burgeoning postwar defense-related research and development, in effect exercised command authority over agency budgets and so adjudicated interservice rivalries in this field. Its consistent views on LRD were such as to reduce the scope of research to air sampling and limited seismic studies. The accomplishments at Sandstone were made possible by an AEC loan of left-over Manhattan Project funds, obtained through the good offices of Admiral Strauss, and advances from other participating agencies.

Thus when the newly organized Air Force Office of Atomic Energy (AFOAT-1 for short), as it began interim surveillance in August 1948, submitted a research and development program which would have obligated $30 million in FY 1949 and $13.4 million in FY 1950, the RDB's Committee on Atomic Energy under Chairman J. Robert Oppenheimer would approve only that portion of it devoted to work on nuclear debris sampling and studies to tell whether an explosion could be distinguished from an earthquake. The Committee said that acoustic methods showed so little promise of success at long ranges and were so ambiguous in comparison with radiochemical methods that they did not justify additional effort. AFOAT-1 challenged this position and asked for a review by the RDB Committee on Geophysics and Geography, but the Board supported its Committee on Atomic Energy.

From then on AFOAT-1 was engaged in a continuous running battle with the Committee, first under Oppenheimer and then under James

B. Conant. The initial program requirements of $30 million were cut first to $12 million and then to $6 million.

In March 1949 General Vandenberg, now Air Force Chief of Staff, wrote to the Joint Chiefs:

> If the JCS cannot agree to furnish the RDB strategic guidance which will indicate that . . . intelligence on atomic explosions . . . is of sufficient importance to justify the . . . research and development now under consideration by the RDB, I will be compelled . . . to place the problem before the Secretary of Defense for decision.

The JCS did send a memorandum, but the RDB did not regard it as sufficiently specific guidance and appointed a new panel of consultants which was to report its views after some months of study. Meanwhile, pending a definite determination, the RDB's Committee on Atomic Energy voiced its "belief, the Air Force dissenting, that the $20 million total cost of Long Range Detection could be spent more wisely in other fields of research and development."

Practice for Real

While all this budget battle was being waged, operational experience was accumulating in the running of the interim experimental net. There were communications problems to overcome, specialized logistical support for the technical teams in the field to be arranged, operating manuals to be written, criteria of significance to be refined, and a host of similar matters to be taken care of. It was arranged that the Navy should establish on Kodiak Island, in the interests of a naval research program, an experimental station which would also form part of AFOAT-1's net. It had a 700-sq.-ft. aluminum roof and a specially designed run-off collection tank. If there was no rain when a radioactive cloud passed over the station, "roof scrubbing" would be directed to collect the dry fallout.

Air Weather now had roughly 55 filter-equipped B-29s and was reckoned to be using some 1,300 personnel in direct and secondary support of the interim net. A substantial number of this complement, stationed in the continental United States, were available for alert scrambling to back up the programmed surveillance along the arcs from Guam-Bermuda to the Pole, which required six to seven regular long-range flights each 48 hours. It was calculated that the schedule would provide at least 90-percent effective coverage.

After the Sandstone tests the minimum level of significant radioactivity was set at 100 counts per minute for aerial filters and 300 for those at ground level. These were made criteria for an alert in the experimental detection system. When a new operating procedure was put into effect on 1 August 1949, the aerial minimum was dropped, on the basis of accumulated experience, to 50 counts per minute. Every alert was treated as indicating a possible Soviet nuclear test, but each of the first 111 could be shown beyond reasonable doubt to reflect nothing more serious than a volcanic explosion, earthquake, or normal variation in background radioactivity. One source of confusion was eliminated when it was found that certain B-29s which consistently indicated radioactive contact upon return to base had been contaminated on close-in flights at Eniwetok. Air sampling settled into something of a routine.

Then shortly after dinner on Saturday evening, 3 September 1949, the report from Alaska that set off Alert 112 came in to the AFOAT-1 Data Analysis Center in Washington—85 counts per minute on a filter paper airborne three hours over the north Pacific. Almost immediately thereafter a companion paper from the same plane was clocked at 153 counts per minute; this was dispatched to Tracerlab in California, whither it would be three days in transit by ordinary flights. In the meantime the Alaska station made regular measurements of decay rates on the first paper.

As successive measurements were reported and plotted at the Washington Center, it became more and more evident there that there must be fresh fission products in the atmosphere. Still, it could hardly be bomb debris; a classified chart left in the Center from Friday's intelligence briefing gave the latest estimate on the date of the first Soviet nuclear test as follows:

Earliest possible	1951[4]
Most likely	1953
Possibly	1955

Unless there was something wrong with this timetable.

Sunday and Monday of the Labor Day weekend found the AFOAT-1 staff anxiously following the bi-hourly decay measurements on the sample and sending out more sampling missions. Was this pickup from the leading edge or from the tail end of a radioactive cloud?

[4] See footnote 2 above.

To answer this question, B-29 flights were scheduled from Alaska to Hawaii on Sunday and from California to Alaska on Monday, tracing one westerly and one easterly intercept arc. Later a special mission was sent from Alaska to search the area north and east over the Beaufort Sea.

But the question was answered without these special flights. Monday evening, 5 September, an electrifying report arrived from Japan. A paper exposed at 10,000 feet just east of Japan on a routine weather flight from Guam measured over 1,000 counts per minute—20 times the designated threshold of significance. This sample was dispatched by special aircraft to Tracerlab's establishment in California and arrived the next day. Meanwhile, other decay measurements indicated the collection of long-lived radioactivity by USAF ground-based air filtering units at Fort Randall and Shemya in the Aleutian chain early on 5 September and by a station in northern Japan on 6 September. Positive interception was reported from the California-Alaska and Alaska-Hawaii flights.

Massive Confirmation

At 3:30 in the morning of 7 September Tracerlab telephoned that the fission isotopes of barium and cerium had been identified in its samples; five hours later it confirmed the presence of the fission isotope of molybdenum. Concluding now that the nuclear debris was very likely the result of a Soviet test, AFOAT-1 ordered an all-out effort to collect as many samples as possible. All told, between 3 and 16 September, the 92 special Air Weather flights sampling the area from Guam to the North Pole and from California to the British Isles collected more than 500 radioactive samples, 167 of them above 1,000 counts per minute.

The flight crews had not been briefed on the highly classified detection mission. They only knew that at approximately three-hour intervals on routine flights the B-29s would be depressurized so that a new piece of paper could be inserted in the sampler mounted on top. Now during the JOE 1 operations the filter papers had to be changed more frequently. After each change it took 20 or 30 minutes to regain cabin pressure and heat, and then within a few minutes it would all be spilled again for the next change. On missions 16 or 18 hours long in Arctic regions this became a real hardship. Rest

periods, moreover, because of the large number of special flights, were short or virtually nonexistent.

On 8 September the sampling yield indicated that the air mass with the bomb debris was leaving the North American continent headed for the British Isles. The President's approval was obtained to notify British authorities, and in an all-night classified teleconference on 10 September British scientists and intelligence experts were passed the information necessary to mount an independent sampling exercise. There had been filtering flights every other day in the vicinity of the UK and south to Gibraltar. A special flight to 70°N sent out on 10 September and the Gibraltar flight on the 12th collected fresh nuclear debris. Then other UK flights were vectored to make further collections.

By 10 September Tracerlab had completed its analysis of the aerial filter papers, and the results made possible a preliminary estimate of the date of origin of the debris (26-29 August) and the type of fissionable material it came from (plutonium 239). Since the end of the Sandstone tests Tracerlab had been engaged in perfecting radiochemical techniques, making calibration measurements on material irradiated at the Los Alamos Scientific Laboratory. One calibration not yet made concerned neptunium 239. A hurry-up call to Los Alamos arranged for the required irradiation over the weekend of 10 September and delivery of the sample to Tracerlab on Monday. This permitted the additional firm conclusion that large amounts of normal uranium were employed in the Soviet device, [redacted]

For further confirmation, the naval research station on Kodiak Island, where gamma ray detectors began about 9 September to show a rise in background radioactivity, made two rain collections—from 9-12 September and 12-16 September—which were subsequently found to contain large samples of the nuclear debris. To get another independent analysis an aerial filter paper was sent to the Los Alamos Scientific Laboratory.

All sources were also checked for geophysical evidence or confirmation. But no acoustic waves from the explosion could be found in the records of the Signal Corps' acoustic net, and the Coast Survey's teleseismic network showed no seismic waves from an explosion in the USSR. The absence of acoustic and seismic data prevented any close determination of the location, time, and yield of the Soviet test.

Stop and Go

A clowning fate picked this juncture to have the RDB study panel formed in the spring present its report. It recommended on 12 September to the RDB Committee on Atomic Energy that the need for detection by instrumental means be reexamined "with a view to cancelling the research and development phase of the long range detection program" and that the LRD budget for FY '50 be reduced to a figure $1.7 million lower than what had already been obligated. By 16 September this recommendation had been approved on up the line, and the RDB issued a stop order cancelling all further LRD expenditures. In view of what LRD was expending its effort on at the moment, however, AFOAT-1 was able to persuade RDB chairman Compton to reverse this order.

Dr. Vannevar Bush, wartime head of the Office of Scientific Research and Development, was asked to chair a panel to review the LRD findings. A meeting was held before the panel on 19 September, attended by representatives of all agencies concerned, the radioanalysis laboratories, and the British government. AFOAT-1 summarized the technical data available and presented its conclusions.

Analysis of samples had identified neptunium 239 and fission products Ag^{111}, Ba^{140}, Mo^{99}, Zr^{95}, Ce^{144}, Ce^{143}, Ru^{103}, and Ru^{106}. Ratios of these products established the date of fission as between 26 and 29 August, a date confirmed by gross decay curves of the mixed products. Autoradiographs showed that the radioactive material, some of it particulate, was chemically different from that from the Bikini and Eniwetok tests. [redacted] Analysis of air mass movement out of the Soviet Union and the radiochemical dates 26-29 August placed the source somewhere over Asia between the east 35th and 170th meridians. It was concluded:

. . .

4. The observed phenomena are all consistent with the view that the origin of the fission products was the explosion of an atomic bomb whose nuclear composition was similar to the Alamogordo bomb.
5. A variety of alternative explanations have been proposed. Upon examination none of these turns out to be technically likely. Of those which although unlikely are yet consistent with the data, all call for the use of enough plutonium to have made an atomic bomb.
6. We therefore believe that an atomic bomb has been detonated as stated.

The findings of the Bush panel were reported to President Truman, and on 23 September a meeting was held in the office of the President's Press Secretary, Steven Early, to discuss the text and timing of a presidential announcement. There was a recommendation for a few days' delay to permit a more complete radiochemical analysis. Before the chairman could act on this recommendation, Mr. Early was interrupted by a telephone call. After listening briefly he hung up the phone and said, "Gentlemen, the President's announcement must be released immediately. I have been informed that a rumor of the Soviet atomic test has just crossed the UP desk and will be on the streets in an hour."

Later, plutonium was separated from the Kodiak rainwater by the Naval Research Laboratory. This plutonium sample, purified at Los Alamos, was found by a plutonium chemist at the University of California lab to have an isotopic composition indicating origin in a nuclear explosion rather than in a reactor accident. Then a minute reexamination of acoustic records revealed weak signals at two stations. These established the location of Joe 1 at Semipalatinsk, the time as 0100 GMT on 29 August 1949, and the yield as about 20 kilotons.

On 17 October Dr. Bush wrote General Vandenberg that his panel, which included Oppenheimer among others, had asked him to commend the excellent work done by the agencies involved. His letter concluded:

> It is fortunate that the Air Force instituted this work early, and that it was pushed with thoroughness and skill. This is one undertaking which has most certainly paid off. . . . It now has tasks which are . . . not lessened in importance, and I trust its performance in the future will conform to the high standards which it has already set.