R8

*Tracing an ingredient for the Soviet atomic bomb*

# CHASING BITTERFELD CALCIUM

**Henry S. Lowenhaupt**

In December 1946 a chemical engineer from the former I. G. Farben plant at Bitterfeld in East Germany volunteered in Berlin that this plant "had started in the past few weeks producing 500 kilograms per day of metallic calcium. Boxes of the chemical are sent by truck every afternoon to Berlin, labelled to Zaporozhe on the Dnieper. Calcium is believed to be used as a slowing agent in processes connected with the production of atomic explosive."

This was the lead we in the Foreign Intelligence Section of the Manhattan District Headquarters had been waiting for. We had read the technical investigation reports from FIAT (Field Information Agency/Technical) on the production of uranium at the Auergesellschaft Plant in Berlin/Oranienburg. We also knew that Dr. Nikolaus Riehl—with his whole research team from Auergesellschaft—had met the Russians, volunteering to help them make uranium for their atomic bomb project. We knew from intercepted letters that the group was still together, writing from the cover address PO Box 1037P, Moscow.* We knew Auergesellschaft during World War II had made the uranium metal for the German Uranverein**—the unsuccessful German atomic bomb project—by using metallic calcium to reduce uranium oxide to uranium metal (not as "slowing agent"). We had analyzed the two-inch cubes of uranium metal from the incomplete German nuclear reactor which the Alsos Mission*** had found in the minuscule village of Stadtilm in Thuringia. We knew German uranium was terrible—full of oxides and voids, though it was fairly pure otherwise by non-atomic standards. The files also disgorged that in 1945 the Russians had started to dismantle and take to Russia the small calcium plant at the enormous Bitterfeld Combine, in addition to the big magnesium facility.

Cables went out immediately to the European Command in Germany via G-2 and directly to Col. Edgar P. Dean, Manhattan District representative in London, to locate and interrogate all engineers who had fled Bitterfeld to the West or were currently willing to sell information on their unloved masters. We wanted to know how much calcium was to be produced, what its specifications were, and where it was to be shipped. We wanted to know what non-atomic normal German industries used calcium, and in what quantities. We wished Col. Dean to keep our British colleagues in the Division of Atomic Energy, Ministry of Supply, informed.

At home, the Scientific Division of the Office of Special Operations in the newly-formed Central Intelligence Group was also apprised of our needs. Col. Frank A. Valente of our section was asked to take time out from his task of organizing an atomic detection system† to talk to the U.S. Atomic Energy

*See "On the Soviet Nuclear Scent," *Studies* XI/4.

**See David Irving's *The Virus House*. William Kimber. London, 1967.

***Code name for teams interrogating Italian, French and German scientists in the final months of World War II.

†See "The Detection of Joe-1," *Studies* X/1.

Commission in depth about the use in the U.S. program of calcium to reduce uranium salts to uranium metal. Major Randolph Archer, also of our office, was asked to talk to U.S. firms making calcium metal, and find out what it was used for and in what quantities.

As so often happens, the people involved and their experience were crucial ingredients. On the American side was the Foreign Intelligence Section of the Washington Liaison Office of the Manhattan District, then in the process of transferring as a unit to the newly formed Central Intelligence Group. It was headed by Col. L. E. Seeman, a career Corps of Engineers officer who had run the American engineering forces of the CBI theater during World War II and would go on to become major general. The section was staffed with a few career Corps of Engineers personnel, several officers and civilians trained in science, and the remainder trained in investigative procedures in the Counter Intelligence Corps.

The orientation toward engineering on the part of our management led directly to a pragmatic approach—do what works, and get on with the job. The engineering orientation also led materially toward the estimative method of technical evaluation. Engineering officers are accustomed to laying out engineering tasks to find out how long they will take at a minimum—and then to evaluate likely slippage. They think in quantitative terms—man days, truckloads, cubic yards. The scientific side of the section, Col. Valente, Mr. Charles Campbell, Mr. Donald Quigley, and I learned gradually to ferret out the crucial technical facts, the bottlenecks as it were, that could be used in these engineering-type evaluations.

A remnant of the wartime cooperation in the atomic field was the direct liaison at that time with the Intelligence Section of the British Division of Atomic Energy of the Ministry of Supply. Col. Dean, Assistant Military Attaché, was our representative in London. This cooperation was normalized gradually into more regular country-to-country liaison channels after our section was deployed to the newly formed CIG early in 1947. The Atomic Energy Act of 1946, which restricted much atomic data to "cleared" U.S. personnel, also tended to perpetuate differences between the U.S. and UK intelligence efforts already in being in 1946 because of the "nationalistic" policies on the parts of both General Leslie R. Groves, Manhattan District Commander, and Sir John Anderson, head of the UK atomic effort.

The British office was staffed with technical personnel, much as our own was. Mr. David Gattiker, their liaison to our section, had been a chemical engineer with Imperial Chemicals Incorporated before World War II. Mr. Kenneth Townley, one of the London members, was a geologist by profession with some experience in uranium prospecting. Its leader, Commander Eric Welsh, however, was also a career member of MI-6. Commander Welsh had masterminded the sabotage of Norsk Hydro in Norway in 1943 to prevent the Germans from getting heavy water and completing an operating reactor at Stadtilm. In 1940 he had been instrumental in smuggling the great nuclear physicist Niels Bohr out of occupied Denmark. A: d in the thirties he had been a chemist at Bitterfeld.

Returning to the calcium problem, by mid-January 1947 the Bitterfeld activity was definitely confirmed, and indeed amplified: Russian requirements were for 30 tons of metallic calcium per month, and distillation was needed to achieve adequate purity. A number of former Bitterfeld engineers were soon interviewed, especially by Major Paul O. Langguth working for Col. Dean in London. As we learned more, some were even re-interviewed. I remember, for instance, flying to Wright Patterson Airbase in late 1947 to talk once again to a

Bitterfeld metallurgist whom Langguth had previously interrogated, and who had in the interim come to the U.S. as a member of the Air Force's Operation PAPERCLIP.

These interviews also soon established the non-atomic usage of calcium: during the war Bitterfeld had produced about 5 tons per month of 95% pure calcium metal for use by the Osram and Philips Companies to eliminate the remnants of oxygen and nitrogen from radio tubes. Some 20 tons per month of calcium aluminum and calcium-zinc alloys were produced for bearings for the German railroads, and the German Navy and Air Force bought calcium hydride for use in inflating balloons. The concept of 30 tons per month of calcium so pure it had to be distilled was clearly foreign to German industrial practice.

At home, Col. Valente selected Dr. Frank H. Spedding at the Institute of Atomic Research, Ames Laboratory, Ames, Iowa, as the man who would know most about uranium metallurgy—having been concerned with that aspect of atomic energy since the early forties. Spedding was quite firm, to make uranium metal for reactor use, the U.S. normally reduced uranium fluoride with magnesium metal—because it was cheaper. The magnesium had to be made by the Pidgeon process, in which dolomite is reduced with ferro silicon at very high temperatures; normal magnesium produced from sea water by electrolysis was not pure enough.

Reduction of uranium oxide with calcium, Spedding continued, always gave a poor product. However, reduction of uranium fluoride with calcium gave properly liquid melts, and an excellent product on cooling. The calcium had to be distilled for adequate purity. Elements like boron, vanadium, manganese, should they become incorporated into the uranium metal even in minute amounts, would tend to absorb neutrons and stop the nuclear reaction. Thus these elements also had to be kept to exceedingly low amounts in the calcium used to make the uranium metal. He gave Col. Valente a list of maximum allowable impurities in U.S. uranium metal used for our Hanford reactors, and in U.S. atomic-grade calcium. Of these, the worst actor was boron.

Major Archer reported that in the United States, only Union Carbide and Carbon and New England Lime made calcium metal, and only three to five tons per year at that for non-atomic uses.

Informed of the Russian calcium project at Bitterfeld, our British colleagues became quite active. Several Bitterfeld chemical engineers chose to resettle at I. G. Farben plants in British-occupied Germany, thoughtfully taking with them copies of reports on calcium production written for the Russian management. The British also followed our lead in making a thorough survey of non-atomic uses of calcium both on the continent and in Britain, to make absolutely sure this was no red herring.

Meanwhile, the general intelligence net was far from idle. The U.S. Army interviewed a border-crosser, Dr. Adolf Krebs, and learned that he had been taken to Moscow by the Russians for an interview with several MVD colonels and one MVD General "Kravchenko." In the course of these interviews he went to Elektrostal, a town some 40 miles east of Moscow, where the best crucible steel plant in all of Russia is located. Here he was interviewed by Dr. Riehl of Auergesellschaft fame, who was "segregating uranium on a production scale using a new process which utilized electric furnaces." On return to East Germany (after declining the position offered) Krebs fled to the West, fearing reprisals. Confirming this story was the word from the British that Frau Blobel, Riehl's former secretary at Berlin/Oranienburg, had mentioned to an agent that Riehl's last letter to her had been postmarked 7 October 1946 from Elektrostal in the USSR, rather than the usual 1037P Moscow. A search of the files on Elektrostal quickly disgorged a British report of the preceding autumn indicating three carloads of uranium ore had been sent from the famous Jachymov (Joachimstal) Mines in Czechoslovakia to Electrostahl (sic) in the USSR. The circumstantial evidence that Elektrostal was the site of the Russian uranium metal plant was becoming impressive.

Our "Summary Report of the Status of the Russian Nuclear Energy Program" on 1 June 1947 reflected this, stating that the "indication from metallic calcium production . . . appears to be the construction of two plutonium producing reactors . . . with 500 megawatts (MW)" of total power.* "It is particularly significant that a project of this size cannot be supported by the estimated reserves of uranium ore available to the Russians . . . 514 tons uranium oxide already available and 2200 tons of uranium in reserves. . . . The best information indicates that this program is not proceeding well, and in fact uranium metal appears to have been produced in insufficient quantity to operate more than a very small pilot reactor, such as that first operated in this country in December 1942. Thus, if it is assumed in the worst case that Russian progress from this date will proceed at a rate comparable to that of the American project . . . then to produce a single bomb, January 1950 represents the absolute lower limit."

Not a single thought that—just possibly—the Russians were planning in the light of full engineering information, and that our estimates of their expected available uranium were low. The Greeks called it "hubris"—unreasonable pride.

In mid-1947 our earlier discussions with G-2 and OSO began to pay off. First, engineer [redacted] one of the [redacted] sources on Bitterfeld and by then a resident at Leverkusen in the British Zone of Germany, decided to cash in on a good thing by selling his research papers on calcium distillation to the American S-2 in Berlin as well as to the British. Aside from the delicate problems with the British raised by this particular sale, [redacted]s information indicated that the Bitterfeld people had developed a new copper-calcium alloy process for making calcium electrolytically which was much more efficient than the old electrolytic "carrot" process. It was this alloy that was partially distilled at high temperatures to give the very pure calcium metal needed, the reject alloy going back into the electrolytic baths. Further, bottlenecks had been developing in obtaining the high-temperature sicromal or similar type steel needed for containers, and the firm Pfeiffer in Wetzlar in the American Zone of Germany was tardy in manufacturing needed vacuum pumps.

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Headquarters, European Command forthwith stopped all further shipments of vacuum pumps and sicromal to the East Zone. We in the U.S. had already put vacuum pumps on the "COCOM" export control list in April 1946, thereby stopping a tidy order recently placed by AMTORG, the Russian trading organization in New York. Thus export control pressure against the Russian atomic program was being applied as rapidly and as forcefully as we could arrange it. How much, if at all, it slowed the Russian atomic program down is problematical, but it certainly forced Russian and Bloc industries to widen the scope of their manufactures rapidly.

Of more importance from an intelligence viewpoint were the samples of raw and distilled calcium which Miehe gave to S-2, Berlin. These found their way to Col. Valente of our office, who passed them to the AEC for shipment to Dr. Spedding at Ames. By late 1947 we had his detailed analysis of the calcium the Russians were using, along with a comparison to U.S. atomic-grade calcium and

*Presumably based on our graphite plutonium producing reactors at Hanford, which were then rated and operated about 250MW apiece.

U.S. specifications: the Bitterfeld distilled calcium was quite adequate by our atomic standards.

Simultaneously, OSO produced a winner—a reporting source at Bitterfeld itself who had access to the firm's records. He brought in documentary evidence that on 26 July 1947 three rail cars carrying metallic calcium—consignment No. 179-4363—left Bitterfeld for "Elektrostahl Moskau," Post Box 3, Kursk Railroad. The shipment of carload lots of both calcium and uranium ore to Elektrostal confirmed it as the site of a production-sized uranium metal production facility, and not just the location of a research effort under Nikolaus Riehl.

Digressing a moment, we turned out to be lucky—or wise—in accepting Elektrostal as the destination. We eventually had enough destinations to keep the most eager analyst busy. The initial report mentioned Zaporozhe on the Dnieper—which turned out to be where the magnesium plant cells were being sent. Later, air shipments to Leningrad were mentioned. It was said the Russian calcium electrolysis plant would probably be erected at Magnitogorsk, the distillation plant at Kiev, Dzerzhinsk or "Samarov." Knowing mention was made of two German technicians, Drs. Springmann and Kroesel, said to be capable of supervising the erection of a calcium plant, and who reportedly wrote letters from Dzerzhinsk in the USSR.

An early January 1948 report from the UK, for example, indicated that "those German scientists who were deported from Bitterfeld and who had knowledge of the production of pure metallic calcium ore are at Sverdlov near Gorki." Welsh, according to a handwritten note, later "reviled this report," for there is no town of Sverdlov near Gorki. Just to prove that old analysts fade gradually, I took this report the other day to the appropriate section of CIA's Central Reference Service, and out popped the famous explosive manufacturing and shell loading plant "Sverdlov" in the town of Dzerzhinsk, just west of Gorki. Next to Sverdlov is the Chemical Plant "Kalinin," which makes the sulfuric and nitric acids used at Sverdlov for the production of explosives, and the chlorine which would be needed for calcium chloride production for feed for a calcium plant. I would not be surprised to find that the special calcium chloride plant designed at Bitterfeld for erection in the USSR was actually built at either the Kalinin or Sverdlov plant in Dzerzhinsk.

In addition to the "hot tips" on destinations mentioned above, Russian bureaucracy coupled with security produced another bizarre batch for us to unscramble. First, I. G. Farben Bitterfeld became Elektrochemisches Kombinat, Bitterfeld, of the Aktiengesellschaft für Mineraldünger. Later the overall administration was changed to Abteilung der Staatlichen S.A.G. "Kaustik." Initially, the official consignee was c/o Raznoimport, Moscow. By 1948 both "Verwaltung der Aktiengesellschaft für Elektrochemische Industrie 'Kaustik,' Moscow" and "Verwaltung GUSIMZ, Moscow Chkalov St. 36," were used as addresses on two shipments in a single freight car. Possibly there really were two different destinations for raw and distilled calcium metal, but it seems doubtful. By 1950 the address became simply APN 27301, Frankfurt/Oder, although the same type of Ministry of Foreign Trade order and transshipment numbers that had been attached from the very beginning continued in use. Again OSO helped immensely when it tapped banking and trade circles in East Germany who understood in exhaustive detail that Soviet property abroad (GUSIMZ) was subordinate to the Ministry of Foreign Trade, just like the older subordinate trade sections such as Raznoimport. Further, they made it clear that the Trade Representation in Berlin and Amtorg in New York were vehicles or umbrellas in each foreign country under which all these trading or property organizations were "housed." A misassigned German POW (yes—the Russians also make security mistakes) returned to *West* Germany and told us about APN 27301: it was just the Russian equivalent of a military post office number, in this case simply the address of a labor battalion at the transshipment yards in Frankfurt/Oder which handled the transshipment* of all special atomic goods going east or west.

Another facet of the problem investigated thoroughly was the possibility that the Russians would eventually turn from calcium to magnesium, much as the U.S. had done. Unfortunately, the Germans had been developing a Pidgeon-type process for making magnesium during the war, and there was evidence from Bitterfeld that experimentation on making calcium by this process was under way. There were, indeed, reports that one of these furnaces had been sent to the atomic people. Then we learned that Soviet technicians had been intensely interested in the similar Hansgirg process furnaces at the Hungnam Chemical Complex in North Korea when that country came under Soviet control in 1945. In the end, all too much effort was spent on this red herring of our own devising.

Returning to the calcium problem itself, Commander Welsh in the UK decided in mid-1947 that clandestine penetration of the Bitterfeld calcium program was *the* way of getting at the Soviet atomic program from East Germany. He felt he had the assets and the official backing from the MI-6 hierarchy.

He also attempted to force U.S. agreement to lay off Bitterfeld, allowing the British a free hand and reducing the possibility that too many (American) cooks would alert the Russians. When full agreement was not forthcoming, he tried to use an (unwitting) attempt by an American Army officer as a for-instance case to back up his plea. Col. Seeman and Charles Campbell on the American side spent hours discussing the matter with both OSO and G-2 representatives, but in the end legitimate self-interest forced the decision that the Americans would try not to use the same sources as the British. Actually Welsh's fear of American "clumsiness" was misplaced. His sources at Bitterfeld were never in jeopardy from American actions; indeed we may have helped. What saved him—and us—was his penchant for operating directly for "C,"** [redacted] His real danger lay in the Soviet penetration of MI-6 and the British Foreign Office: Donald McLean, secretary to the Combined U.S.-UK (atomic) Policy Committee, and "Kim" Philby, MI-6 representative to CIA at the time, were later both shown to be active members of the Russian Intelligence Service. (b)(1) (b)(3)

Welsh's confidence in his Bitterfeld penetration, however, was not misplaced at all. From its inception it produced long sheets of monthly shipment statistics on a box-by-box basis. Selected product analyses were received periodically, and Russian specifications and requirements as they occurred. These data were interpreted in the light of the design reports which the British (and to a lesser extent we ourselves) had already received. In addition, the agent usually added comments as needed for understanding. Indeed it is fair to say that as far as the technical side of the Bitterfeld calcium operation was concerned, by 1948 the British (and in turn we ourselves) knew as much about it as the Russians did.

Information on what was going on in Russia, however, came hard. Through mid-1950, the only additional informant on Elektrostal was Dr. Hans Kerschbaum, who had been arrested and interned in the USSR, gone to Elektrostal for an interview with Riehl, instead worked on electronics at Shchelkovo near

*From Russian standard gauge (five British feet inside-to-inside on the rails) to European standard gauge (five Roman feet center-to-center on the rails). The British, of course, designed both.

**"M" to James Bond fans.

Moscow, returned in early 1949 to East Germany, and then fled to the West. He merely confirmed that Riehl was reducing uranium with calcium, though he did add that he thought it was from uranium fluoride, rather than uranium oxide. The Russian defector "Icarus" in July 1950 confirmed many of our conclusions about Elektrostal, Bitterfeld, transshipment offices, etc., but his information was primarily non-technical.

At Bitterfeld, Russian security about atomics in the USSR was almost absolute. There were, however, rumors in March 1948 that the Soviets had a calcium distillation plant in operation in the USSR at that time. In 1949 a high-level Soviet official at Bitterfeld was reported as saying "that the USSR was engaged in the production of calcium by electrolysis and distillation." In 1950 a "very accurate" source stated "we have been informed that crude calcium is not being used and the quantities delivered by us would be distilled in Russia." Finally, there was a rumor in East Germany in December 1948 to the effect that Riehl had received a 100,000-ruble Stalin Prize. Useful, but hardly earthshaking.

Our only recourse was to infer what was going on in Russia from requirements and specifications given to Bitterfeld, a straightforward, though far from simple technical intelligence problem. To this end, Major P. O. Langguth, temporarily back in the United States, early in 1948 visited both the main offices of the Union Carbide and Carbon Corporation in New York City, and their laboratories and calcium production plant at Niagara Falls, N.Y. He took with him such detailed specifications as were by then available on the Bitterfeld calcium operation. As had happened on previous occasions, Union Carbide was most cooperative. They produced full technical data on their own process, requiring only that it be kept within CIA "and not given to the USAEC," to whom Carbide was selling the majority of its calcium and all its high-purity product. They studied the Bitterfeld data and either judged technical factors (such as efficiencies) in the light of their own experience, or estimated these factors if they were missing from the Bitterfeld data. The analysis extended to the technical factors and material efficiencies involved in producing uranium by calcium reduction of the fluoride. As a result, Major Langguth returned with a comprehensive technical understanding of the Bitterfeld operation and of the expected performance of both calcium and uranium metal facilities designed for Russians for erection in their country. Finally, Carbide's files produced, of all things, a translation of a 1938 paper in Russian entitled "Regarding certain questions on the founding of the calcium industry." Because of the almost certain interruption by the war of any 1938 plans for new facilities, this report settled negatively the question whether the USSR had had any sizable native calcium industry.

Incidentally, I have often been asked "Does technical intelligence help American industry?" Usually I have had to hedge the reply because customarily we have had all too little technical data. For metallic calcium, however, we had detailed design data on a new, definitely more efficient process, copper-calcium electrolysis followed by distillation. Carbide did not want it in 1948, nor has the AEC been interested subsequently. The reason given has always been the same: the (then) current operation was a small one with no expectation of significant expansion. Any major change would have been economically disadvantageous over any reasonable amortization period. Thumbs down.

We, however, gleefully accepted all the data, drawings, plans, evaluations, and specifications we could assemble on the Bitterfeld operation, attempting to collate it in every way we could think of in the hope of squeezing out one more drop of information on the Russian atomic program. We turned to surprisingly complete photointerpretation reports written in 1943 on the Bitterfeld complex to locate the calcium facilities and get exact building dimensions—something the sources never seemed to have available. In the precess we discovered just how enormous an operation the Bitterfeld Combine really was. No wonder bombing had never completely halted operations.

Events pertinent to calcium were placed in chronological order. The process was properly described and quantified. The names of Russian and German personnel were arranged alphabetically with intelligence data attached. Process yields were evaluated and recorded. Shipment data were tabulated and quantified. The results were eventually all pulled together and published by Donald M. Brasted as a Scientific Intelligence Report early in 1952 after the Bitterfeld operation had been mothballed.

In 1948 and 1949, however, these collations were being used in estimates as fast as they were being made. We lined up a sequence of events dominated by (a) the orders of April 1946 to expand production severalfold, to 30 tons per month of calcium with essentially normal specifications, (b) the coincidence in October of air shipments of raw calcium to Moscow with the Russian decision to build a large calcium distillation plant at Bitterfeld, (c) the arrival in November of production specifications based simply on the theoretical neutron absorption rates of impurities, followed in February 1947 by (d) much more realistic (and adequate) specifications, and in March by (e) orders to draw up engineering plans for Russian calcium facilities. This sequence was interpreted much as follows:

> "... In August 1945 there was no coordinated plan of action for the development of nuclear energy. About January 1946 the USSR decided it was necessary and desirable to use for atomic purposes the production capacity of the occupied countries. ... By June 1947 uranium metal appears to have been produced in sufficient quantity to operate no more than a very small pilot reactor...."

Actually, we could have pointed up our conclusions: as we later learned, Russia's first "Fursov" research reactor went critical at the Moscow Institute of Atomic Energy at 6 p.m. on Christmas Day 1946.* That was why the realistic specifications were sent to Bitterfeld in February 1947. At the time we thought this change in specifications came from Russian measurements on how the chain reaction fell off in an exponential pile (a portion of a reactor mockup about 1/10th size) after the neutron source was removed. Our guesses were running six months too late.

On the designs for Russian calcium facilities drawn up at Bitterfeld between October 1946 and March 1947, we knew that the calcium chloride feed plant had a capacity of 15 tons per day, "with the possibility of being doubled"—enough for a calcium electrolysis plant producing 30 tons per month. The raw (carrot) calcium electrolysis plant was supposed to be similar (or identical) to the 30-ton-per-month plant at Bitterfeld, and the distillation plant would have had to match at 25 tons a month, to give 50 to 60 tons per month uranium metal capacity. Brasted in his 1952 paper arrived at better founded, but not materially different estimates, through a more sophisticated analysis which melded actual Bitterfeld production data with the extreme design possibilities for the Russian plants. These were used in the mid-fifties as basic data.

In the estimates of 1948 and 1949 (by then these were interagency estimates by the Joint Atomic Energy Intelligence Committee under CIA chairmanship) the prime conclusion was that the Russians were headed at least for a plutonium bomb. Even as late as the mid-1949 estimate, it was recognized that if the uranium fuel were irradiated at reasonable values to yield between 200 and 400 grams of plutonium per ton of uranium, then one could assume by analogy a Russian

*_Soviet Atomic Science and Engineering_, p 48 (Atomic Energy Publishing House, Moscow, 1967).

long-range target of perhaps two 250-MW graphite-moderated Hanford reactors using about 500 tons of uranium per year, with an additional 200 tons for initial loading. These numbers always conflicted with the uranium ore estimates, which tended to be lower. In mid-1949, for instance, the distilled calcium stockpile of 680 tons easily could have produced 1500 tons of uranium metal, compared to the 850 tons probable and 1320 tons possible of uranium as judged from the ore estimate. So in the mid-1949 estimate, one 250-MW Hanford-type graphite-moderated reactor was assumed as one alternative, a heavy-water-moderated reactor being assumed as the other one. Any additional later reactors were subsumed in the stated errors. These estimates consistently placed mid-1950 as the earliest possible date for the first Russian nuclear test, with mid-1953 being more likely. The general feeling that the first Russian pilot reactor went operational in mid- to late-1947 was, of course, crucial to the minimum estimate.

Actually, from the quantitative point of view the estimates weren't too bad: we learned in 1956 that the first reactor had been a graphite-moderated 100-MW reactor. This one was soon followed by additional reactors reaching perhaps a total of 700 to 800 MW by the mid-fifties. None of us even guessed in 1949 that that "possibility of doubling the calcium chloride plant" was the clue we really should have followed in long-term thinking.

Inasmuch as the final Russian calcium specifications and the American analysis of the Bitterfeld calcium product both were adequate for graphite-moderated reactors, it is odd that no conclusion was ever drawn that the initial reactor must be of that type, especially as it was known that heavy water reactors could tolerate many more impurities. The reason, I suppose, was that having learned how to make really pure uranium, we would and did use that purity for our heavy-water-moderated research reactor in Chicago as well as the graphite-moderated production ones at Hanford. We assumed the Russians might well act the same way. But the reverse would not have been true. Had the Russians established "reasonable" specifications for heavy water reactors, the resultant uranium would have stopped a graphite reactor in its tracks. In actual fact, the Russians did not even get a heavy-water-moderated research reactor operating until 1951.

I believe we were correct—with regard to the estimates—in assigning the cessation of calcium distillation at Bitterfeld between 1 July 1948 and August 1949 to the start-up of the Russian distillation plant, and simply putting the equivalent uranium into stocks during the rather high distillation rate in the August 1949–November 1950 period. I'm sure that widely varying needs for stocking reactors or letting them "cook" for an initial period of four to six months without any additional uranium played its part in the actual course of events. However, without additional specific data, or at least hints, it is pretty hard to take these vagaries into account.

Operation Spanner is perhaps of more interest: in the spring of 1948 Eric Welsh was musing along with Charlie Campbell—presumably, as usual, about which way the cat would jump—when he broached the idea of sabotaging the Russian plutonium effort. Both were aware of the Russian specifications on distilled calcium which called for less than one part per million of either boron or cadmium. These substances simply soak up neutrons, thereby tending to stop nuclear reactions. Welsh was all for dropping in a pinch of boric acid and "buggering the works." But he had been a chemist and was afraid his man at Bitterfeld would be caught through routine batch analysis. Then Charlie Campbell remembered that in 1944 the Manhattan District had a really secret plant for making boron enriched in the neutron-catching boron-10 isotope. In nature, boron contains 20% boron-10. The Manhattan District product was nearly 90% pure. It should work fine.

Col. Seeman liked the idea and arranged for discreet inquiry to be made at the appropriate levels of the AEC. The answer came back they'd be glad to loan us some excellent material, but if we lost any of it, not to admit it!

Then came the usual period of agonizing detail. British analysis of 1947 Bitterfeld calcium disagreed with U.S. analyses in the boron content. Who really knew how to analyze accurately for boron, and could the other laboratory learn to reproduce the method? What really was the accuracy of the Bitterfeld analyses? How much boron would they really let pass? Could anyone obtain reliable isotopic analyses of millionths of a gram of boron?

Professor A. J. Demster of the University of Chicago indicated he had just received a mass spectrograph which could handle these small amounts of boron. He knew a microchemist who could prepare the samples for his analysis. It was agreed on 11 June 1948 to exchange old Bitterfeld calcium samples with the UK, and analyses as well.

All went well at first. The analytic problems were worked out. The amounts of enriched boron per batch of distilled calcium were worked out. Calculations indicated there was some risk, but the Russians would be hard put to conclude anything except some extra boron contamination in the billets—there was no indication they had mass spectrographs of the sophistication of Prof. Demster's. If, however, a simple neutron absorption test—a routine test in the U.S.—were performed, it would reveal that a whole batch of uranium (that made from the contaminated calcium) was bad. It was decided to go ahead. The sabotage chemical was transferred without records to us, and then on to the British.

Then calcium distillation at Bitterfeld stopped for a year. Welsh's agent started to worry. On grounds that he would be caught, he refused to add to the raw calcium the amount of enriched boron needed to make sure that enough contamination would pass through the distillation process into the uranium.

Finally, in August 1949, the Russians detonated their first plutonium bomb secretly. The Air Force Technical Applications Center intercepted the radioactive debris almost by happenstance. The July issue of *Novy Mir* carried a symbolic poem:

> "You shuddered. The distant hollow rumble of your carriage sounded like a wind.
> Sleep my baby. . . .
> At the pre-arranged hour, the explosion occurred.
> The granite was blown asunder to dust,
> The Taiga around the mountain was illuminated
> By golden radiance. . . .
> . . . Sleep, my baby"

Admiral Hillenkoetter, Director of Central Intelligence, established a Nuclear Intelligence Panel to determine why we had estimated mid-June 1950 as the earliest possible date, when in fact it occurred in August 1949.

There was no longer any sense to Operation Spanner. The prepared material came back from Bitterfeld to London to Washington, finally being reinserted onto a shelf somewhere in the AEC, again without any paper work. All was as if it had never been. The Russians put the Bitterfeld calcium plant in mothballs in December 1950. In September of 1961 I threw the last pieces of Bitterfeld calcium into the Potomac River, watching the water boil with the reaction.

# DECEPTION

In April 1972, the Joint Chiefs of Staff sponsored a week-long Strategic Planning Seminar concentrating on the question of deception. Seminar presentations by participating U.S. Government departments and agencies, and by the Syracuse University Research Corporation (SURC) under contract to the Advanced Research Projects Agency, have been summarized in JCS's *Strategic Planning Seminar, 17–21 April 1972, Vol. I* (SECRET/NO FOREIGN DISSEM). They appear in full in a 525-page *Volume II* which is TOP SECRET/NO FOREIGN DISSEM. *Studies in Intelligence* reproduces the presentation made by Euan G. Davis, Director of the National Indications Center, and prepared in collaboration with Cynthia M. Grabo of the NIC staff, because it relates the question of deception and the entire scope of the seminar to the intelligence warning function.

As an introduction, we also summarize a preceding paper by Prof. Barton S. Whaley, of the Fletcher School of Law and Diplomacy at Tufts University, on *Deception and Surprise—the Lessons from History.*

Dr. Whaley has analyzed the element of surprise in 168 battles in 17 wars from 1914 through 1968.* He comes up with some impressive statistics on the efficacy of surprise:

> Out of 50 battles in which intense surprise was achieved, 17 far exceeded the objectives of the initiators, and only one ended in defeat.
>
> Conversely, out of 50 battles fought *without* the advantage of initial surprise, 30 ended in defeat for the initiators, and only one substantially exceeded the attacking commander's expectations.
>
> The average mean casualty ratio in favor of the attacking force was 1-to-15 when surprise was achieved, but only 1-to-1.7 without surprise.
>
> How, then, to achieve the desired surprise? The classic security precautions? Dr. Whaley finds that in 61 battles which achieved strategic surprise, this could be attributed to passive security measures by the attacking force in only four instances. Of 54 cases of tactical surprise, seven at most could be attributed to effective security.
>
> Deception, however, was either the main cause or a significant factor in 82% of all cases of strategic surprise, and 57% of the tactical surprises. "The greater the effort put into the deception plan," Dr. Whaley notes, "the greater the degree of surprise gained."
>
> Thus, Whaley summarizes, "Your chances of obtaining or exceeding your goals are almost four times better if you can achieve at least some degree of surprise. Your chances of gaining surprise are eight times better if deception planning is used. And finally, you can greatly improve on even these most favorable odds, the more comprehensive and sophisticated is your deception."

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Another participant in the same seminar cited a statement by Princeton football coach Jake McCandless, worthy of the late Herman Hickman: "An

*Whaley's *Stratagem: Deception and Surprise in War* was issued as a manuscript by Massachusetts Institute of Technology in 1969. It will soon be published in book form.

ounce of deception is worth a 240-pound tackle." The language of the gridiron may be unfathomable to potential enemies of the United States, but there is nothing to prevent such enemies from performing the same calculations Dr. Whaley has made, and arriving at the same attractive odds. Indications intelligence officers, accordingly, expect any opposition undertakings to seek maximum deception and surprise.

The Editor

## STRATEGIC WARNING AND DECEPTION

**Euan G. Davis**
**and**
**Cynthia M. Grabo**

I welcome this opportunity—a rare opportunity, I might add—for some of us in the intelligence field to meet with the operational planners on a subject of mutual interest and great importance to us all: deception.

The subject is a two-faced problem. It may be important for the security and success of our own operations in many cases that we have an effective deception plan. But it may be equally important, and sometimes more important, that we understand what the enemy's deception capabilities may be and what deception he may be practicing at the moment. The latter is peculiarly the function of the intelligence community—and particularly of those elements of intelligence which are concerned with warning. For the perception of the enemy's deception plan, and even the recognition that he may be practicing deception at all, clearly is a most important element in the warning process. In some cases, it could be the most important element in warning, and particularly of strategic warning, of the recognition of the enemy's intention to attack.*

In his manuscript, Mr. Whaley identifies five general types of deception, noting that there is more than one approach to this problem. The military planner, seeking surprise, may attempt to conceal or mislead as to his:

*Intention*, that is, that he is preparing to attack at all.
*Time* of attack.
*Place* of attack.
*Strength* of the attacking forces.
*Style* of the attack, that is, the form the military operation will take, or the weapons that may be employed.

Now, we in the strategic warning business today are not unconcerned with matters of the time, place and strength of enemy attacks. We do deal from week to week with questions such as a North Vietnamese attack on Long Tieng, or Israel's response to new attacks by the fedayeen. We deal with these because this is the type of problem which comes up from day to dry.

But this is not our primary function. Our primary function is to assess the *intentions* of our enemies to attack us at all, anywhere, at any time in the foreseeable future. We are concerned above all with whether the USSR, the People's

*On the general subject of warning, see Davis, "A Watchman for All Seasons," *Studies* XIII/2; on the timing factor in strategic warning, see Grabo, "Strategic Warning: The Problem of Timing," *Studies* XVI/2.