Task Groups

As previously related, the scientific task group 7.1, had been wiped out in late 1959. The other task groups were soon to have their own problems.

Task Group 7.2 (Army) apparently had a very small flurry in early January when there was a proposal to reassign the Army personnel at the Nevada Test Site to 7.2 which would now be headquartered in Arlington. However, consistent with previous plans, on January 17, 1960, Task Group 7.2 left the Eniwetok Proving Ground and was transferred without personnel or equipment to Arlington Hall Station.

The Navy Task Group (TG 7.3) had found other work to do unrelated to test readiness in addition to their normal function. They supported a series of tests off the Florida coast in February and March of 1960 which evaluated various methods of locating and recovering pods for DASA. These tests investigated various configurations for recovering pods which might be ejected from missiles at high altitudes during Operation Willow. They continued to study precise positioning of targets using deep sea mooring. (Admiral D.M. Tyree was still Commander of 7.3, continuing from Operation Hardtack.) From March to May, the Task Group was involved in a series of mine damage tests conducted near Puerto Rico.

Apparently because most of 7.3's work at this time was actually for DASA, the Task Group was reassigned to Headquarters, DASA, on March 22, 1960. (That was one way of relieving the Commander of JTF-7 of his responsibilities.)

Task Group 7.4 (Air Force), whose capability was really the 4950th at Albuquerque, continued its ups and downs. In December 1959, General McCorkle of the Air Force Special Weapons Center in Albuquerque was still resisting the JCS decision to form a permanent Task Group 7.4 and suggested to General Canterbury of the Research and Development Command that the most appropriate move was simply to designate Headquarters 4950th as also Headquarters Task Group 7.4, continuing its AFSWP responsibilities. On January 13, 1960, General Duncan (JTF-7) agreed with this proposal, requesting specifically that the 4950th be responsible for exercising operational control over resident U.S. Air Force elements at Eniwetok Proving Ground during the periods between tests and that the responsiveness to the Task Force be determined by mutual agreement from time to time between the Commander of JTF-7 and the Commander of AFSWC. A charter was written to define this action, to become effective January 15, 1960. However, by June 20, 1960, the Headquarters of the 4950th had not yet received final notification on this move. In October of 1960, AFSWC was informed that Headquarters, U.S. Air Force, had not acted on the proposed charter and did not propose any further action until revised plans and concepts on overseas testing were established. As far as the author is aware, the permanent Task Group 7.4 was never activated.

Even without the specific charter of 7.4, the 4950th continued its vigorous support of the nuclear weapons program. However, Colonel Byrne's spirits probably dropped when he was informed in the last week of January that Willow would probably be cancelled. On April 12, 1960, McCorkle recommended to Schriever that the 4950th be relieved of its responsibility for maintaining a readiness to resume air support of nuclear testing within 12 months and, in fact, that they simply be deactivated. The 4950th Headquarters was reduced from 25 officers, 45 airmen, and 2 civilians in September of 1958 to 12 officers, 26 airmen, and 2 civilians in April 1960. By July 1960, the Commander, Keith Byrne, was sufficiently discouraged to recommend to AFSWC that the 4950th be disbanded and the 4926th be transferred to AFTAC. Headquarters was further reduced to 7 officers, 6 airmen, and 3 civilians on July 28, 1960.

Apparently, the 4926th Sampling Squadron was to be left alone. In mid-February of 1960, it was noted that of the six B-57D aircraft modified for high-altitude sampling, one had been destroyed in a crash, three were assigned to Air Defense

Command, and the other two were no longer in the active Air Force inventory. Because the B-57s were getting harder to maintain, the 4926th, in conjunction with the Laboratories, studied the question of a possible replacement. They concluded that the McDonnell F4H was the most suitable aircraft, with the A3J-1 the second choice. However, the 4926th Sampling Squadron managed to maintain its strength even though by mid-1960 they only had eight sampling configured aircraft. Their function continued to be valuable for several reasons, including sampling of the Rover and Pluto effluents in Nevada and their increasing assistance to the AFTAC. [redacted]

Ex.(b)(1)

The 4951st Support Squadron at Eniwetok was caught up in Operation Phasedown and was reduced in personnel and relieved of its job at Eniwetok. By July 1960, the air control function had been lost because of transfer of personnel. (The equipment was put in storage.)

Johnston Island

The test system backed out of Johnston Island in early 1959 on the basis that the Army intended to use the island after installing a Redstone or Jupiter launch capability there. This assumption proved to be incorrect. The Army intended to launch Jupiters (IRBMs) from Johnston Island as targets for the prototype Nike-Zeus system installed at Kwajalein. [redacted]

Ex.(b)(3)

During 1959, while negotiations were going on between the Army and the Air Force concerning the possible transfer of the island to the Army, plans were made to enlarge Johnston Island by 23 acres using fill dredged from the ocean bottom. A contract for that work was awarded July 9, 1959, with the completion scheduled for February 1, 1960. The coral fill construction program was completed in June of 1960, resulting in an addition of about 25 acres to the north side of the island. In December of 1959, the Secretary of Defense granted permission for the installation of a LORAN (long-range navigation) station on Sand Island with the provision that it operate on a noninterference basis with the proposed Nike-Zeus program. Since Sand Island was a Department of Interior bird refuge the occupants were required to observe bird refuge regulations. [redacted]

Ex.(b)(3)

Thus, the intercept exercise became of somewhat lower priority and was eventually cancelled, and the transfer to the Army that was to take place in December of 1959 did not take place. By August of 1960, Air Force retention of Johnston Island seemed assured and a program of rehabilitation of urgently required facilities and equipment was begun in early 1961. Such things as airfield pavement repair, emergency runway lighting, repair of the distillation system, and installation of new equipment were accomplished. Island population during this period of time was approximately 150 people. The launchers upon which the Willow planners had depended were never constructed.

WET/AFSWC, 1960

LRL began to phase out of the Marshmallow (Jericho) program the first of the year, and that effects shot became the responsibility of Field Command, DASA, on April 1, 1960, at which time it was intended that it be brought by October to a 12 months readiness and simply kept in that status from then on. Work continued on the

Vela Uniform high-explosive shots. Colonel Leo Kiley, who had become head of Weapons Effects Test on February 14, 1960, thought the future looked sufficiently discouraging that he recommended, on April 22, substantial reduction of his group. The number of personnel assigned to the Weapons Effects Test (WET) part of Field Command dropped from 113 in January to 97 at the end of June 1960.

Work began to increase for WET in the second half of 1960, largely as a result of increased Vela Uniform effort, in which they had the responsibility for measuring the close-in seismic signal and ground motion. Work continued on Marshmallow so that by the end of 1960, a 12 months readiness status was expected to be reached by May 1961. As the work load grew the number of personnel climbed back up to 104 people, and Jim Barton became the head of the Vela Uniform office in WET. FY 1961 Vela Uniform funding was 4.3 million dollars, of which 2.1 million had been committed halfway through the year. WET also became responsible for the conduct and control of the Vela Uniform high-explosive shots outside of the NTS. On August 21, 1960, Major General H.C. Donnelly (USAF) assumed command of Field Command, DASA, from Major General Louis T. Heath (USA).

The Air Force Special Weapons Center competency in high-altitude phenomenology began to grow appreciably in this period. Their efforts along this line had begun with the instrumented Jason sounding rockets used to measure the effects of the three Argus detonations in 1958. During the moratorium their efforts continued, using Javelin rockets and instrumented pods on Atlas ICBMs. Their Journeyman sounding rocket capability had been developed to a capability of taking space probes higher than 20,000 miles. In August of 1960, AFSWC suggested to Bradbury, following discussions between Herman Hoerlin of LASL and W.D. Henderson of AFSWC, that the two organizations co-operate in this field. Colonel Jones of AFSWC had supported for some time a contractual effort to describe the time and space history of bomb debris from high-altitude detonations and now proposed to analyze the previous assumptions to select that model which most nearly described the actual physical condition, and to predict the motion of bomb debris for explosions at different altitudes, locations, and yields. Bradbury replied to Colonel Jones that the LASL interest was to "look at the early time history of the expansion of a bomb plasma in space" and that LASL would address the physics of the early phase in detail fully before considering, if at all, the later times. However, he agreed to keep AFSWC informed of LASL's progress. By November, AFSWC was developing, specifically for Vela Hotel, a low-cost sounding rocket, which resulted in the solid propellant vehicle, Blue Scout Junior.

Vela Hotel, Early 1960

In early 1960 the AEC, NASA, and the Air Force (Air Research and Development Command-ARDC) were, at the request of ARPA, preparing a "Development and Funding Plan for High-Altitude Vela." Sandia and LASL, via the "Buzzer" committee, developed the AEC input to that plan. The plan, published by ARDC as "Project Vela Hotel, ARPA Order 102-60" was reviewed by the high-alitutde detection subgroup (Panofsky Panel) of the ARPA ad hoc group on the Detection of Nuclear Detonations (chaired by Richard Latter).

The plan, as submitted in April 1960, called for putting three satellites on station within four years at a total cost of a hundred million dollars. The LASL budget would be a million dollars per year and the Sandia budget five million dollars per year. Ex.(b)(1) [redacted] Detection of the various weapon outputs was considered wise as a help in identification in any case and in particular in case an evader tried to suppress the radiation from the bomb.

In order to complete and test the design of the satellite components a large number of small rocket flights would be necessary to furnish test beds for prototype instrumentation. Indeed, some such flights had already taken place from Canaveral and the Tonopah test range, and more were planned from these launch sites and others, including Point Arguello, Wallops Island, and Fort Churchill. Missiles included Atlas, Journeyman B, and others.

The ARPA subpanel recommended that the proposed plan be followed, but requested investigation of the possibility of an interim capability that could be carried out in 18 months, but probably with reduced sensitivity from that planned later.

In response to that request LASL and Sandia produced a "Proposal for Interim Capability in Outer Space, ICOS" on June 10. The proposal was for a one satellite capability, with sensitivity reduced a factor of ten below that previously suggested, using only presently proven components and techniques, and to be deployed in 18 months.

The ARPA subpanel reviewed this proposal in mid-June 1960 and recommended that the high-altitude detection program be expanded, that a capability be deployed as soon as possible, and that the Atlas/Agena B be used as the lift vehicle. They then endorsed the technical approach proposed in the two studies mentioned above.

Vela Sierra, Early 1960

In a February 9, 1960, message to Hertford, Bradbury, and Molnar, Starbird discussed an upcoming meeting of the "Principals" in the next 10 days to discuss the future of the detection system, the research and development programs, and the division of responsibility. Starbird saw the area of high-altitude detection by ground stations as being entirely LASL's (within the AEC Laboratory structure) responsibility, with the direct optical and fluorescence systems as part of the first step. LASL, with DMA concurrence, arranged that EG&G build the LASL-designed fluorescence system prototype and told EG&G that they might be asked later to build the direct optical system. During March, EG&G was funded. Target dates for the fluorescence system were established as follows: approval of the proposed system design on June 1; prototype delivery to LASL on August 1; lightning discrimination tests completed at LASL by September 15; auroral background tests in October and November; and system evaluation completed by January 15, 1961. Furthermore, a prototype of the direct optical system, to observe visible light from the expanding bomb debris, was to follow the fluorescence system by two months.

Discussions between Carl Walske at Geneva, and Don Westervelt* of LASL, in late May and early June, brought out the possible value of pinpointing the direction of a clandestine detonation as an aid to the fluorescence system. Walske felt that no one detection system would give the U.S. enough information to challenge the Russians with an accusation of violation, and that corroboration by another method was vital.

Plowshare, 1960

Proponents continued to develop plans for the various Plowshare prospects during 1960, but the hope of conducting actual detonations during the moratorium did not come to fruition, and the program had budget problems because of the growing needs of the Vela Uniform program. Some of the specific actions are related below.

*Westervelt was the focal point for the atmospheric fluorescence system design.

Gnome

Project Gnome was discussed in several meetings of the Commission and the Plowshare Advisory Committee during January and February 1960. The January 12 Commission meeting, attended by ALOO environmental hazard experts, included discussions of potential contamination of the aquifer and possible triggering of earthquakes. The recommendation of the Plowshare Advisory Committee was accepted by the Commission at its January 22 meeting, and led to the decision to proceed with site preparation and construction which would be disclosed publicly at the time bid proposals were requested. In their February 4 meeting, the Commission summarized the objectives of Gnome as heat production for power generation, investigation of the feasibility of recovering beneficial bomb radioactive isotopes, and extending knowledge about characteristics of an underground explosion in a medium (natural salt) having physical properties in marked contrast to the only medium (volcanic tuff) for which such information was presently available.

Indicative of LRL efforts to pursue Plowshare projects, Brown noted in his status report of July 15, 1960, that Gnome was the only nuclear experiment for which construction authorization then existed and that funding reductions had caused discontinuation of high-explosive studies and reduction in the level of certain feasibility studies. Livermore was determined "to make Gnome as successful an experiment as possible, believing that a single successful Plowshare demonstration may very well affect decisions on the budget and authorization."

By June 9, 1960, the Gnome plan had been expanded to include basic physics measurements as well as the earlier planned experiments on heat and isotope production and underground nuclear explosion phenomenology. Basic physics experiments included four neutron experiments that could not be done in the laboratory, three of which utilized moderated neutrons to study fission and capture reactions and resonance parameters for certain heavy nuclei, and the fourth using fast neutrons to study direct interactions in inelastic scattering off carbon.

Noting the stagnation of the overall Plowshare program as a result of negative public reactions, the Plowshare Advisory Committee, at their meeting of October 19 and 20, 1960, strongly urged that the LRL plan for Gnome be executed as soon as possible.

The AEC's 1960 annual report noted that full preparation, excluding device emplacement, was authorized on March 16 and the prime contract was awarded on June 9.

Oilsands

The Oilsands project (to recover oil from tar sands in the Athabasca region of Alberta) was discussed in the January 22 Commission meeting, which was attended by Gerry Johnson, Philip Farley, and representatives of the Richfield Oil Company. Richfield representatives expressed their opinion that an economical return from initial tests would be more likely if the yield of the nuclear device were 100 kt instead of the planned 9 kt. They also stated it was their belief that the Canadian government was waiting for the U.S. to go ahead with Gnome before granting approval for the Oilsands experiment.

A related LRL effort (Pinot) conducted in Rifle, Colorado in August 1960 was a small-scale, high-explosive experiment intended to measure the migration of gaseous products along bedding planes in oil shale.

Chariot-Ditchdigger-Panama Canal

During 1960 the fates of the Chariot, Ditchdigger, and trans-isthmus projects

were tightly bound by the problem of fallout from cratering detonations. Chariot, the harbor project near Cape Thompson, Alaska, was to be carried out as soon as possible, depending upon bioenvironmental studies. While the purpose of the experiment was to produce a harbor, the fallout and cratering data obtained would be used to guide planning for the proposed new trans-isthmus canal. However, it was clear that the canal would have to be done with clean explosives, producing as little fission as possible. The main candidate for that explosive was the "Ditchdigger" device. That device, however, would not be available for use in the Chariot experiment, which would use a normal fission bomb.

On January 17, 1960, a Mr. Rutledge, the only Plowshare Advisory Committee member who had not previously been associated with any atomic energy work, wrote a letter to Spofford English stating:

> To my mind, the future of the whole Plowshare program is endangered if Chariot is permitted to go ahead without having a Ditchdigger in progress and without being able to tell the public that Chariot is entirely experimental and that it is the last time that conventional atomic bombs will be used for such a purpose.

The Committee itself had recommended at the January 14-15 meeting that:

> . . .each Plowshare detonation be highly instrumented; the Ditchdigger program be initiated as soon as possible in order to demonstrate Ditchdigger principles by the time the Chariot detonations are carried out; the bioenvironmental survey work for Project Chariot be continued at the present level but not further expanded.

The Commission reviewed this recommendation at their January 22, 1960, meeting and concluded that the AEC could proceed with Chariot only after resolving problems with the White House, Congress, State Department, and other federal agencies, but that it would be all right to go ahead with the ecological survey as long as there was no other shot preparation. They approved the survey and developmental studies of Ditchdigger (at LRL). However, at their February 4 meeting they expressed their feeling that a Ditchdigger experiment, wherein the tunnel and instrumentation configuration could be open for inspection, would not be possible in the near future.

On March 2, addressing the Chariot project, the Commission reiterated its decision to continue to authorize the bioenvironmental surveys, but approved a target date for the firing in spring of 1962 which obviated the need for any construction work in the summer of 1960. Furthermore, they requested that recommendations be furnished to them by October of 1960 as to whether to proceed then with planning for the experiment in the spring of 1962. Approximately 72 people were involved in Alaska in the work on this project through 1960.

Teller briefed the President and his cabinet on April 29 and followed up with a letter to Eisenhower concerning the trans-isthmus canal. He stated that this was the most ambitious of the Plowshare projects in view, and that it appeared to Livermore that its technical feasibility was assured. He then presented to the President two preparatory steps which would lead up to the development of a trans-isthmian canal in an orderly way. The first of these was the development of nuclear explosives such as envisaged in the Livermore Ditchdigger proposal. He pointed out that combining reduced fission designs with deep burial of the explosive would reduce radioactivity released to the atmosphere by a factor of 1,000. Use of the Ditchdigger concept would considerably decrease the number of persons having to be evacuated for safety reasons. Thus, emotional objections would be greatly decreased although, as Teller pointed out, "None of these people need worry about radioactivity at all." The second developmental step would be a trial run on a reasonably large scale. Teller felt that this should be in the U.S. in an area with little population and that the harbor project in northern Alaska (Chariot) would be suitable preparation.

Not everyone was as optimistic. Following the Plowshare Advisory Committee meeting of May 25 and 26, another one of its members, Willard Bascom, came out against Project Chariot, noting that since future ditches would be dug by another method, the Project would demonstrate very little. He recommended immediate abandonment of the project and transfer of the funds to something of greater promise.

By November of 1960 the plan for Project Chariot had been modified a couple of times. The present version would create a channel to the ocean and a turning basin by detonating one 200-kiloton and four 20-kiloton nuclear devices. All that had been accomplished to date, other than one small (256-pound high explosive) detonation, were studies on the environmental effects of the program execution. Such studies were to continue until final recommendations for proceeding with the project, expected about March 1961. No funding was presently programmed for the project beyond that date. Based on possible firing dates for 1962 or 1963, the overall project could cost $12,000,000 or $13,000,000, of which $2,500,000 had been spent to date.

On December 2, the Commission considered the Plowshare budget and future authorizations in light of a recommendation from the Bureau of the Budget for a $7,500,000 reduction for FY 1962. The Commission felt that they could accept $6,500,000 of this reduction, given its restoration in the event of a test resumption. However, they felt that $1,000,000 was required to permit proceeding with the necessary Chariot related high-explosive experiments. Starbird felt that the total $7,500,000 reduction would require eliminating the Ditchdigger and Chariot projects. The Commission agreed to request an additional $500,000 from the Bureau of the Budget to keep the project going.

High-Explosive Cratering Experiments

During 1960, Sandia carried out, at the NTS, a major portion of the Plowshare high-explosive cratering experiments designed to establish scaling laws in different rock and soil media. Project Buckboard, carried out in the summer of 1960, involved a number of high-explosive shots (from 1,000 to 40,000 pounds) in holes of various diameters and depths in basalt. Project Toboggan, also conducted in the summer on Yucca Lake, consisted of linear cratering experiments with high explosives (up to 8,500 pounds) in alluvium. Project Scooter, a 500-ton high-explosive detonation in a sphere 125 feet below ground at Yucca Flat, was attempted and misfired on July 14. (Rumor had it that sugar detonators instead of the real thing had been installed.) Representatives of the contractors, as well as both Sandia and Livermore, briefed the Commission on August 30, 1960, on details of reentry of Project Scooter. The shot was successfully carried out in October of 1960.

Vela Uniform, 1960

The Black Box Problem

During 1960, Black Box devices were discussed in connection with seismic detection, as well as with Plowshare. The discussions related to detection started from the U.S. idea to furnish devices for Vela Uniform experiments in such a manner as to convince the Russians that we were not conducting weapons tests, and at the same time satisfy the U.S. law that precludes disclosure of device design to foreign nations.

The need for such an idea arose from the uncertainty in the seismic detection threshold of the Conference of Experts Geneva network which had been introduced because of the results of the analysis of the Hardtack Phase II data and the introduction of the Latter big hole theory in late 1958 and early 1959. On February 11,

1960, as part of the new U.S. proposal for a treaty banning detonations in the atmosphere and underground above the seismic threshold of 4.75, Ambassador Wadsworth commented that the United States had already "embarked on a major experimental program aimed at the discovery and development of improved means of seismic detection and identification." Among the methods and techniques used in this program, there might be nuclear explosions, if they were required, and as part of the U.S. proposal, he invited the U.K. and the Soviet Union to join the United States in instituting a program of joint research. On February 16, Tsarapkin commented that such a research program could begin immediately after signing of the treaty, and added that nuclear devices would not be required in the program, that chemical exposives would be sufficient. Repeating the U.S. suggestion on March 29, in reporting on their meeting at Camp David, President Eisenhower and Prime Minister Macmillan stated that they had agreed to "invite the Soviet government to join at once with their two governments in making arrangements for a coordinated research program and putting it into operation." On April 9, in proposing a conference on the technical aspects of the proposed research program, to be called the Seismic Research Program Advisory Group, Ambassador Wadsworth again discussed the type of "coordinated research program" that the United States felt should be carried out. On May 3, in accepting the new Western position, the U.S.S.R. agreed that as part of the planned research, there might be a "strictly limited number of joint underground nuclear explosions." During the discussions of the Seismic Research Program Advisory Group which began on May 11, the Russian delegate, Mr. Riznichenko, commented on May 14, "It seems obvious to us that at the present time, a certain number of coordinated nuclear explosions of definite magnitude or energy will have to be carried out by us." This led the US momentarily to believe that some of the experimental explosions might be in the U.S.S.R. However, at the next meeting on May 16, Riznichenko announced that there would be no nuclear explosions in the U.S.S.R. and that the references in the Soviet paper were to nuclear explosions envisaged in the American program. Futhermore, at the diplomatic conference on May 27, Tsarapkin stated that the Soviet Union had never believed it was necessary to carry out underground tests for research purposes, and since it was the United States that insisted on the explosions, they should be carried out by the United States on its own territory. He also demanded that Soviet scientists participate fully in carrying out underground explosions on the territory of the Western powers, and asked what safeguards would be used to make sure the underground nuclear explosions were not used to improve weapons. Ambassador Wadsworth, in his reply six days later, stated:

> First, the party shall detonate only nuclear devices of proven design in its experiments. Secondly, the devices used in these experiments shall be taken from a special depository of previously deposited devices established by the party within its territory. We consider that such prior deposits should take place within the shortest possible time and thus propose specifically August 15 of this year as the time limit. The devices suitably packaged shall be under the constant surveillance of representatives of the other parties, or, if preferable, of an international group. The devices may not be altered and devices once withdrawn from the depository may not be redeposited. A device removed from the depository in order to be detonated shall remain under surveillance until detonated. Third, the representatives of the other parties or of the international group responsible for surveillance shall be permitted to observe all aspects of the detonation and its instrumentation except for the interior of the package. Fourth, no diagnostic instrumentation will be used in the near vicinity of the device except for specific yield measurements. Such yield measurements as are made under this provision will, of course, be under the surveillance of the other parties or the international group as the case may be and all the information thus obtained will be available to them.

Ambassador Wadsworth commented that these safeguards had been adapted from those which the United States had previously proposed in connection with the peaceful

nuclear detonations. On January 30, 1959, Wadsworth had proposed that nuclear devices to be used for peaceful uses explosions would be placed in a depository on or before the date of entry into force of the treaty and would be kept under surveillance from then on until used. Interior inspection of the device would not be permitted. This was the so-called "Black Box" proposal. Tsarapkin, on February 23, 1959, had rejected this "Peaceful Uses Black Box" proposal, charging that it would permit the stockpiling of new nuclear weapons and their testing, and introduced an article proposing (a) prior submission to the original parties with complete description and the blueprints of the construction of the device to be exploded, and (b) inspection of the internal and external construction of the device.

On June 15, 1960, Tsarapkin rejected Wadsworth's "Vela Uniform Black Box" proposal as a "fictitious" safeguard, repeating that Soviet scientists must participate in any underground explosion program and that there must be effective control to ensure that such explosions were not used for nuclear weapons development. He insisted on the following conditions:

a. A full description and blueprints of the structure of the device to be exploded must be made available beforehand to the other participants in the program and they must be allowed to inspect the internal and external structure of the device.
b. The representatives of all participants in this program must be present at the place of assembly and explosion of the device.
c. The instruments and measurements apparatus shall be installed by all the participants in the program.
d. All data obtained as a result of the explosion shall be made available to all participants in the program.

After due consideration by the United States, Ambassador Wadsworth suggested on July 12 that the three powers pool a number of nuclear devices of militarily outdated design. All three parties could then examine the internal design of the devices which would be kept under joint technical surveillance until detonated. Thus, the U.S. was asking the Soviet Union to supply some of the nuclear devices, even if the explosions were to take place in the United States. He also stated that if the Soviet Union agreed to this pooling proposal, the President was prepared to seek Congressional authorization in August to permit internal examination of U.S. nuclear devices to be used in the seismic research program. On August 2, Tsarapkin noted this move as a favorable sign and stated that the United States and United Kingdom could set up a pool of such devices if they wished, but the Soviet Union refused to be involved as a supplier of nuclear weapons to the United States for research that it considered unnecessary. He reiterated the Soviet Union demand for conditions such that:

> When the United States carries out nuclear explosions for purposes of research, no loophole will be left, either directly or indirectly, for improving existing types of nuclear weapons or for testing new types.

All of this had not taken place without active participation by the weapons laboratories and testing community and without some effect on their budget. On February 24, 1960, Kistiakowsky, the President's Scientific Advisor, had written to the Chairman of the Atomic Energy Commission:

> The President has asked me to inform you and Secretary Gates that he considers a vigorous and continuing research and development program on the detection of underground and high-altitude explosions to be a matter of high priority and that he hopes the DOD and AEC will find it possible to finance this program for FY 1961 within their existing budgets. I am forwarding a copy of this letter to Secretary Herter.

The February 11 invitation for a joint program obviously triggered off appreciable discussion in the Laboratories and the AEC on how such a joint program should be carried out and what the problems would be. It was recognized early on, as a result of the Plowshare discussions the previous year, that device considerations would be a serious problem. The announcement on April 9 of the intent to hold a conference on underground detection in early May increased the pace of the discussions. It had become clear early on that we would not propose to use our most modern devices in a situation in which the Russians could legally obtain the diagnostic information on those devices, even if they were not privy to the internal designs, because the diagnostics in themselves, especially radiochemistry or reaction time, could reveal some of those design features, for example, boosting. Thus, the thoughts clearly centered around old devices from which not much could be learned. By late April 1960, the concept of putting away a stockpile of devices for use in the then planned seismic detection program was already being discussed seriously and the search was on for an old device which could be stockpiled in sufficient yield variation to satisfy the requirements of the program. Starbird, on April 26, made the point to the Laboratories that it was not necessary to state that either the weapons are obsolete or that all versions had been previously tested, but we should be able to state that they were standard, older-type weapons. The Mark VI, 39 inch diameter, and the Mark VII, 27 inch diameter, were discussed, with the Mark VII being more desirable because of the requirement to lower the device in its container down a 36-inch hole*. Such careful wording would, in his opinion, allow prompt production and stockpiling of the devices in whatever yield was desired, even though the yield might not be a stockpile number. Livermore was already procuring containers for the device. On the same date, Starbird asked the Laboratories for advice on how the devices might best be stockpiled, possible methods of emplacement, etc., and requested that the Labs work together in preparing answers. He proposed that the stockpile be at Ex.(b)(3) Since the Mark VII was a Los Alamos device, Los Alamos was asked to comment on the accuracy of the yield prediction for variations not previously tested. Jane Hall, on April 26, stated that the predicted yield for untested versions of the Mark VII should be good to plus or minus 10%. She added that the uncertainty of yield determination using radiochemical methods for underground shots would be 15% or 20%. At the same time Starbird furnished to the Laboratories a list of the possible energy releases required for the proposed Vela underground shots. On April 27, ALOO recommended against storing the devices at Ex.(b)(3) since it was a normal stockpile site, suggesting instead, military ordnance depots such as Wingate, New Mexico, etc.

On April 28, 1960, Starbird recommended a U.S. position to the Commission. Part of that recommendation was that no diagnostic instrumentation be allowed but acquisition of radiochemical samples would be allowed. If these provisions were acceptable to the Soviets he would prefer the Mark VII as the explosive. The devices would be placed in Black Boxes and no internal inspection allowed. If none of this was acceptable to the Russians, then a proposal in which we actually allow inspection of some of the older devices could be made as long as there was a quid pro quo from the Russian side. At the same meeting, Colonel Sherrill stated for Loper a different position, that of simply going ahead with the Vela underground program unilaterally, offering the Russians the freedom to monitor it if they liked, and simply stating that we were not doing it for weapons development.

Teller was not enthused about the Black Box proposal, feeling that if the Russians did the same thing, they would cheat and make them into weapons tests, so he, too, proposed that we go ahead unilaterally with our own Vela program.

*The Black Box had to be watertight and capable of standing fairly large hydrostatic pressure since some of the possible seismic improvement shots involved emplacement below the water table in uncased holes.

The Commission, on May 3, agreed with General Starbird that the storage of some 25 devices seemed reasonable.

The Principals approved the Black Box concept as the U.S. position at Geneva on May 10.

On May 17, Starbird instructed Hertford of ALOO to prepare to stockpile some 25 devices Ex.(b)(3) in order to be prepared for at least 12 different shots. The devices should be designed to fit into a 36-inch diameter hole, and the Black Boxes should be in storage by August 1, 1960.

On May 18, the Commission approved (subject to the condition that the Russians accepted the whole Black Box proposal) declassification of the debris of the Mark VII devices used in the seismic improvement program or in Project Plowshare. However, at the same time, they noted that obtaining samples of Russian debris would not serve as a basis to determine whether or not the Russians might be carrying on a weapons test program in connection with the seismic improvement program or Plowshare program.

In parallel with these actions came the debate on the question of how to determine the actual yield of the detonations. There were several possibilities, all of which were discussed at one time or another. Radiochemical analysis of samples obtained by core drilling into the detonation region would give a good measurement of yield if the amount of active material in the device were known. Radiochemistry could also be used to compare two devices that were stated to be the same. To assist in the radiochemical determination of yield, it was also suggested that the other countries could put tracers next to the nuclear explosive to help determine the fraction of the bomb materials that might be collected in a given sample. The measurement of alpha (reaction history) on a single-stage unboosted device could be used to determine that the device operated as previously predicted, but would not give the yield directly. Measurement of time of arrival of the shock near the detonation would, in principle, give the yield independent of any details of the design of the device, but there was no appreciable experience underground with the technique. It was expected that the uncertainty of the measurement would be about 50%. One could, in principle, determine the yield from a measurement of the radiation temperature reached in a bottle surrounding the device. However, this was also an untried method and its accuracy was unknown. It was fairly clear, however, that the technique could be used to compare two similar shots. Livermore favored still another method, that of the measurement of the time of transit of radiation through a polyethylene block next to the bomb, and began construction of a polyethylene box that would allow application of that technique.

On May 25, 1960, Bradbury told Starbird that LASL felt the best method for determining yield was through a simple measurement of peak alpha which could be made by Sandia or EG&G.

> **The LASL strongly recommends that such a measurement be included and openly identified as completely uninterpretable without a knowledge of the bomb being observed. It actually yields far less information than do the radiochemical samples. It is LASL's opinion that such a measurement could be regarded as an obvious and elementary method of yield determination necessary to the program to avoid ambiguous results in case of weapon malbehavior for some reason. The LASL recommends against attempts to determine yield by radiochemical methods.**

He went on to state that LASL would expect to be the agency primarily responsible for theoretical predictions and yield determination for those bombs for which LASL provided the active material capsules.

At this point, on May 27, Tsarapkin made his safeguard statement at Geneva and on June 2, Wadsworth answered with the Black Box proposal.

Meanwhile, on May 23, Starbird had authorized expenditures of $200,000 for production of the required capsules and noted ongoing negotiations with the Department of Defense to withdraw the necessary weapons from stockpile. Procurement and construction of the Black Boxes was to be a Sandia job. [redacted] Ex.(b)(3) The schedule was still to have devices at the storage location not later than August 1. The tentative firing dates for the first two shots of the Vela Uniform program were September 1 and October 15, 1960. Ex.(b)(3) [redacted] By June 1, the storage of devices was known as the Whirlaway Program. On June 3, 1960, Sandia estimated for Starbird a Sandia cost for this program of $133,000 for FY 1960, $1,000,000 for FY 1961, etc. By June 8, Bradbury had thought a little further on the yield question and suggested to Starbird that LASL be responsible for giving the expected yield, but that Livermore be responsible for whatever yield measurements were made, and for issuing the experimental value of the yield. He further stated:

> This proposal is made for a variety of reasons, one of which appears to be that there are already too many cooks stirring this broth with conflicting opinions and advice, another is that logically the organization which states the a priori expected might be accused of bias in experimental measurements thereof, and a third is that with practical certainty, differing values of the experimentally observed yield will be obtained by different organizations, both domestic and foreign, and there is no need to add a third party to the argument.

However, he does state that LASL would desire to have some of the radiochemical debris for their own study and analysis and be involved in any plans for hydrodynamic measurements. In a June 9 letter to Starbird, Bradbury was a little more frank.

> It is my own opinion that the inclusion of tracers (supplied by the U.S.S.R.) and indeed, the whole radiochemical measurement and distribution of samples is a mistake and will open up a Pandora's Box of bitter argument.

He pointed out that the Russians could easily doctor the tracers and, thus, make the samples look larger and the bomb yield look smaller. They could also select the right samples to give the results they wish and accuse the U.S. of doing the same thing and, hence, engender a yield argument between the two nations. He remained of the opinion that the measurement of alpha was the only way to get a quick, accurate, internal estimate of the experimental yield. He went on:

> I am reminded more and more of the Hardtack proposal for a "clean" bomb demonstration for the Russians. This eventually fell through for the same sort of reasons which will haunt Project Whirlaway: one cannot objectively and unassailably demonstrate good faith within the framework of the legal restrictions of the Atomic Energy Act! If this were my job, I would take these "nominal" bombs, shoot them off, measure the seismic disturbance at the distance of interest, and do nothing else! Everything else we do is (or can be construed to be) learning something about bombs or their effects unrelated to Whirlaway.

He ended the letter by saying that these were his "last remarks on this unpleasant subject."

On June 10, Harold Brown of Livermore stated that Livermore was quite willing to accept the responsibility of making yield measurements on Whirlaway. They would be happy to provide samples of the debris to LASL and stated:

> LRL fully expects to view the LASL calculated yield values as the correct ones and the "experimental" value which we issue will be for the purpose of satisfying the international coordination requirements.

The feeling that the Russians might not accept the Black Box concept apparently grew in Washington in the first week of June and on June 9, Starbird informed the

Laboratories:

> High-level decision made here today that we give consideration on an urgent basis to the feasibility of using older gun-type devices for the seismic improvement program. This, of course, to enable opening of devices for U.S.S.R. inspection.

He requested information on this possibility by June 13. The Laboratories replied on June 13, with Harold Brown (Livermore) commenting that this seemed largely a LASL job, but also noting:

> I assume we are talking about declassification here and not about opening only for U.S.S.R. inspection; I would like again to call attention to the extreme damage which could be done to our alliances by giving information to the Soviets which is not made available to our allies . . . . I am only pointing out that declassification conflicts with the mistaken idea that nth power nuclear weapons capabilities are inhibited largely by keeping weapons notions secret.

Bradbury (LASL) noted that providing these designs was considerably more effort than that which was involved with using the Mark VII but:

> We think this proposed program is much more sensible if the devices are open for inspection and if alpha is measured. If this program is decided upon, we would propose to design the devices and make any necessary assembly tests here, work with Sandia on the packaging, arming, and firing, and be responsible for the determination of alpha.

Sandia noted that the costs would be somewhat higher and added that all of the warheads previously agreed upon had been received at Ex.(b)(3) and were currently being modified. All nuclear Black Box and fusing system hardware had been ordered.

On June 15, Tsarapkin rejected the Black Box concept and insisted upon a system in which device details were revealed. However, the U.S. system continued to coast for a while. On June 16, Starbird, at the request of the U.S. delegation at Geneva, requested that the Laboratories provide step-by-step procedures, assuming the Black Box concept, including the operations and inspections that would be permitted to the Russians. Part of Bradbury's reply was:

> Comments on the remainder of the proposals are better obtained from those who will have to carry them out. As an example, it is not imagined that radiochemistry is likely to be done at LASL under Soviet surveillance, a situation for which we find ourselves duly grateful. Nor would we care to comment on the embarrassment to the U.S. which might ensue consequent to the presentation or later withdrawal of this proposal. Surely there must now be many experts in Washington on how the U.S. can be embarrassed.

Livermore continued to press for the polyethylene block method of measuring yield and on June 28, recommended that the present Sandia-designed Whirlaway package under construction be redesigned or that the Livermore Black Box design, which was a variation of their Plowshare design, be used.

At the June 20 Commission meeting, Starbird continued to argue for the Black Box concept and suggested that the AEC request that this concept be pursued further at Geneva. The Commission, however, leaned more toward picking a device whose inner workings could be revealed to the Soviets. The Chairman (McCone) stated that the U.S. would not transmit blueprints of the devices to the Soviets, but would only allow visual inspection. Furthermore, the U.S. would make it clear that cooperation in this endeavor would cease immediately if information on the devices was transmitted to other powers.

In response to the AEC proposal to the JCAE that we reveal the internal details of the devices to the U.K. and U.S.S.R. only (which would require changing the atomic energy law), the JCAE advised on June 24 and 27 that such a proposal would not pass Congress unless it contained a definite reciprocal feature. In late June and early July the U.S. decided on a tentative position of a three nation nuclear device pool, with the devices to be open for inspection by the participating nations. The U.S. intended to state at Geneva that Soviet rejection of this position would result in strong pressure to proceed unilaterally in its own research program using the Black Box safeguard concept. The British objected to the ultimatum feature and it was deleted.

On June 23, a meeting of technical representatives of the Laboratories concluded that the integral polyethylene method was the best yield measurement, but that modification of the existent Whirlaway Black Boxes would take too long. However, on the same date, Starbird commented that we should stick to one version of the Black Box, and that the target date for stockpiling had now been moved to August 15 (ARPA had recommended a delay to November 1). On the 24th, Starbird reiterated his desire to continue the Whirlaway Black Box program while the question of using a declassified Mark XI was investigated. LASL commented that they could build a Mark XI for any of the yields desired in the program. On July 11, Starbird authorized $536,000 for Project Whirlaway Black Box fabrication and on July 12, the United States made its proposal at Geneva that all three nations contribute old devices to such a stockpile with the device details to be revealed. By now, the first shot of the program had been delayed to October 1. In July, Livermore was fabricating its own Black Box for a Mark VII, incorporating a polyethylene yield measurement, although the Mark VII in the Sandia Whirlaway box was also still a possibility, as was the Mark XI. By August 1, Starbird had decided not to ship the Whirlaway boxes to the agreed upon storage point, Army Ordnance Depot, Wingate, New Mexico, but rather to store them at [redacted] From here on, the question of Black Box use dribbles out into history with the concept still being applied to Lollipop for some time.

Ex.(b)(3)

Other Aspects Of Vela Uniform

In spite of the Black Box problem, Vela Uniform, commonly called the seismic improvement program in the AEC, grew rapidly during 1960. As has been mentioned, ARPA was assigned the responsibiity for Vela at the beginning of September 1959 and in conjunction with the AFTAC, the Atomic Energy Commission, Livermore, Rand, and others had moved rapidly toward solidifying a program that would satisfy the recommendations of the Berkner Panel. A great deal of work had been done in the second half of 1959 by these agencies to solidify that program. By the beginning of 1960, Project Concerto, the tamped nuclear shots in Nevada, was fairly well defined. In addition, Lollipop, the nuclear shot in Nevada granite, was defined, and Project Ripple, nuclear shots off the Test Site, was fairly clear conceptually. Construction work had been going on for some time on Lollipop and on Cottontail, which was the high-explosive 5-kt shot to be fired in tuff at NTS, and the process of site selection had started for the off-site shots.

The question now seemed to be one of how much enthusiasm the United States was really going to put into this program, how hard it would be pressed, what kind of funding would be attached to it, etc. At the January 11, 1960, Commission meeting, Mr. Graham commented on the importance of the development of a weapon test detection system and stated that in order to test the accuracy of the system, it would be necessary to conduct some underground tests. The Commission, at that meeting, noted that authorization to acquire property and mineral rights for Tatum Salt Dome would

be covered by the FY 1961 weapons contingency project. On February 24, 1960, as previously noted, the President's Scientific Advisor, Kistiakowsky, informed the Chairman of the Commission of the President's conclusion "that he considers a vigorous and continuing research and development program on the detection of underground and high-altitude explosions to be a matter of high priority" and that he hoped the AEC would find it possible to finance the program for FY 1961 with their existing budget. The February 11, 1960, proposal at Geneva that we agree to a treaty that would ban shots in the atmosphere, but allow them underground while investigating the seismic detection question, obviously put more pressure on the system to prepare for such shots.

During the early part of the year, Livermore planned for Operation Hobo, a set of high-explosive decoupling studies in Tunnel U-12e, and in April they conducted four shots, three of them being 500 pounds of high explosives at depths of 100 feet, 200 feet, and 1,000 feet and the fourth being 1,500 pounds of high explosive at 1,000 feet. These shots were to establish a basis for comparison of decoupled signals in the Nevada tuff with the signals from later shots to be fired in salt.

During the first few months of 1960, the DOD started planning the Groundhog series of high-explosive shots off the NTS.

In spite of overall AEC budget difficulties, Starbird took the bull by the horns in mid-May by transferring most of the remaining test readiness construction money for FY 1960 to the seismic detection program and reassigning most of the underground weapon test sites being prepared in Nevada to the Vela Uniform program.

At the May 1960 General Advisory Committee meeting, Spofford English listed the projected cost of the seismic improvement program of high-explosive and nuclear shots as $2,310,000 in FY 1960 and $13,490,000 in FY 1961.

By mid-May, agreement on the division of responsibility between AEC and ARPA had been reached. The AEC agreed to be responsible for all nuclear shots and the 5-kt high-explosive shot in Nevada, but a large amount of the instrumentation and the interpretation of the diagnostic information would be in the hands of ARPA. Jim Reeves of ALOO was designated manager for the AEC portion of the program. ARPA retained its Advisory Committee (the ad hoc group for detection of nuclear detonations) chaired by Richard Latter, and having as members Frank Press, Kenneth Watson, Allan Donovan, Jack Oliver, Walter Munk, Hugo Bernioff, John Tukey, Roland Herbst, and Conrad Longmire. The program at that time was essentially the previously mentioned Concerto program plus Lollipop. The first shot would be the 5-kt shot in granite in Area 15, NTS (Lollipop). The second shot would be the 5-kt nuclear shot in tuff in Tunnel U-12b (Orchid) and the third shot would be the 5-kt high-explosive detonation in tuff, also in Tunnel U-12b (Cottontail, later called Linen). Others would be a 1/4-kt test (Coffee Pot), a 1.2-kt test (Crystal), and a 40 to 50-kt test (Stingray), all to be in U-12e. The seismic decoupling shots would be done at the Hockley mine in Hockley, Texas.

Work now moved forward to define the program and responsibilities in greater detail. LASL had no desire to be connected with the program at all, but did agree to furnish devices and appropriate diagnostics as mentioned elsewhere. Livermore concluded that they did not want to be responsible for any shots on NTS except Lollipop (possibly partly because the devices, in general, were LASL devices). Thus, the responsibility for the on-site shots other than Lollipop (called as a class Concerto) was given to Sandia. The DOD responsibility was placed in DASA with WET being responsible for the field effort.

By early June 1960, the field organization was beginning to shape up and Lollipop was predicted to be ready for firing by October 15. However, in late June, ARPA recommended a delay until November 1 for Lollipop in order to permit the installation of the maximum number of instrumentation stations. Jim Reeves began dealing directly

with the ARPA director, Brig. General A. W. Betts, since ARPA's approval was required for specific site locations. On July 5, Reeves suggested specific sites for five of the shots as e.03a, e.03b, e.08, b.09, and b.07. Tunneling had already started in tunnel b.07, but the other locations had to be considered tentative as there were as yet no firm criteria.

At the July 1, 1960, meeting of the Commission, the Chairman noted that Secretary of Defense Gates favored August 15 for the first shot in a unilateral seismic improvement program. Mr. Kistiakowsky, then Chairman of the Scientific Advisory Committee, had expressed the opinion that this date would be too early and would result in strenuous objections by U.S. seismologists. Howard Brown (AEC Staff) said it would not be feasible to proceed with a meaningful seismic improvement program until the necessary data-gathering instruments could be in place, which would not be before September 15 to October 1.

At the midyear review on July 15, 1960, Harold Brown (Livermore) stated:

> Livermore plans to take no primary responsibility except for the Lollipop shot in granite which may take place later in September 1960, and the decoupling shot which can be carried out sometime in 1961 depending on the size of the salt cavities which may be eventually decided upon. For these experiments LRL plans to take responsibility for staging shots and for coordinating close-in measurements only, immediate and distant measurements being the responsibility of others. For other shots, LRL will serve only in an advisory capacity, concerning ourselves primarily with the theory of coupling of energy from the explosion into the seismic waves. ARPA has overall supervision of the program. If no adequate program of nuclear explosions for measurement of decoupling is authorized, it will be desirable to carry out further chemical explosions at Winfield with gaseous explosives.

By late July 1960, the Lollipop proposed shot date had been changed to October 1, with field exercises to rehearse for the Livermore device configuration about August 10 and for the Whirlaway devices configuration about August 20. No decision had yet been made on which device was to be used, Ex.(b)(3)

Thus, on August 9, 1960, Jim Reeves issued a comprehensive planning directive for the AEC portion of the Vela Uniform program. He identified Concerto as those shots, both nuclear and nonnuclear, to be done at NTS, and Ripple as nuclear shots at sites other than the Nevada Test Site. DASA would conduct a separate series of high-explosive shots at locations other than the NTS. The AEC responsibilities were:

a. Fund and accomplish all nuclear shots regardless of location and all high-explosive shots located at the NTS.

b. Obtain close-in measurements necessary to establish cavity behavior and to study the transmission of signals to the immediately surrounding earth on decoupled shots.

c. Make all yield measurements and conduct any postshot drilling required to obtain radioactive samples for this purpose.

d. Designate an AEC project manager with the appropriate responsibilities, which include providing the explosives, site studies, safety, positioning, arming and firing, construction support, etc.

Among other things, DASA was to prepare the consolidated DOD plans, supervise DOD activities at the shot sites, arrange for DOD support, implement DOD directed on-site measurements and designate a DOD associate project manager who would coordinate DOD programs with the AEC, establish DOD readiness for off-site preparations, etc. Jim Reeves was designated project manager and Colonel Leo A. Kiley as associate project

manager. Other appointments for Concerto were Bill Allaire as deputy project manager for AEC matters, E. L. Gomel (Sandia Corporation) as coordinator of operations; and John Williamson of REECo as coordinator of base support. The Lawrence Radiation Laboratory was to appoint a technical group leader for Lollipop, whereas Sandia would appoint a technical group director for AEC measurements on the rest of the Concerto shots. DASA would appoint a technical group director for the DOD-directed experiments of Concerto at NTS except Lollipop. A tentative organization for Project Ripple was also given and was very similar to the Concerto organization, except that Lawrence Radiation Laboratory was to appoint the technical director for the programs for which AEC was responsible. The coordinators for Concerto were to be stationed at NTS, whereas the coordinators for Ripple would be headquartered at Sandia Base, New Mexico, and should report for duty no later than September 9, 1960.

Reeves established a site evaluation panel with membership from the AEC, the DOD, the technical contractors (LASL is notable by its absence), and the supporting contractors (EG&G is notable by its absence). He noted three sites as being presently identified as compatible with the Ripple shot schedule, namely the Hockley Mine in Hockley, Texas, about 31 miles northwest of Houston, Texas; the Bruinsburg Salt Dome, Mississippi, midway between Vicksburg and Natchez; and the Tatum Salt Dome, Mississippi, 33 miles southwest of Hattiesburg, Mississippi. Contractor responsibilities were further outlined, with EG&G being responsible for timing and firing of all explosives, REECo being responsible for on-site radiological safety, etc. H&N was to prepare engineering and construction plans and cost estimates and, tentatively, REECo would be responsible for logistical site support and CPFF construction not feasible for lump-sum award. The necessity for further operating agreements, for example, on financial management in fiscal controls, was noted.

Project Concerto ready dates were given as follows: Lollipop, October 1, 1960; Orchid, May 1961; Cottontail, July 1961; Stingray, August 1961; Crystal, September 1961; Porpoise, open; and Coffee Pot, May 1962. Project Ripple was a series of seven nuclear shots to be fired at an unknown depth in salt as shown in Table VII.

In the third week of August, Fred Reines, the discoverer of the neutrino, and Bill Ogle designed a Vela test detection system based on the observation of neutrinos from a nuclear detonation. Neutrinos, having a very small cross section for interaction with other material, pass easily through the entire earth, but unfortunately, because of that small cross section, they are only detected by very large and expensive detectors. It was estimated that a national system consisting of one detector, probably in the Grand Canyon, which would observe a 1-kt detonation anywhere on earth, would cost approximately a trillion dollars, not including the electronics.

TABLE VII
RIPPLE
August 9, 1960

Event	Yield (kt)	Readiness Date	Remarks
Harvest	Ex.(b)(1)	10/61	Ex.(b)(1)
Hayride		10/61	
Hermit		10/61	
Gaucho		12/62	
Geisha		12/62	
Gypsy		12/62	
To Be Announced		07/72	

On August 25, the Lollipop readiness date was slipped from October 1 to November 15. On September 15, Chief DASA defined Groundhog and the assignment of responsibilities for the rest of the community. Groundhog would be conducted entirely by the Department of Defense and would include five 30-ton H.E. shots at a depth of 100 feet and five 100-ton H.E. shots at a depth of 200 feet, with readiness dates ranging from February 1962 to July 1963.

In September of 1960, H. M. Fulley of the Institute for Defense Analyses published a report suggesting that motion of the bomb plasma in the underground cavity produced by a nuclear detonation might generate changes in the electromagnetic field at remote points and, hence, might provide another possible method of detection of underground explosions. This suggestion was not received with favor.

On October 5, Don Shuster of Sandia informed Reeves of the proposed schedule for Cottontail, the 5-kt H.E. detonation. Deliveries would be completed by May of 1961, loading the cavity would start in April of 1961, and a detonation date of June 1, 1961, was planned.

The subject of Lollipop arose early in October and was discussed by Harold Brown and Spofford English at the October 28 Commission meeting. Consideration of containment had raised the question of whether or not the hard granite, contrary to what was expected in tuff or alluvium, would crack, allowing the escape of radioactive gases to the atmosphere. Brown pointed out that the current plan was to fire about December 15 (they must have delayed final installation in order to have this meeting), but various experts in the program were recommending that the shot be fired at a depth of 1,500 feet instead of 950 feet. It was intended that the press and foreign visitors be present at the firing site. Starbird noted that the presence of a plume which might contain radioactivity could result in adverse publicity for the AEC, suggesting, perhaps, that the AEC was unable to confine the radioactivity. Starbird outlined a proposed new schedule that would do Orchid about December 15 and delay Lollipop until a new site could be built. A new shaft for Lollipop would, of course, leave the old shaft available for a future experiment. Starbird noted that if some shot wasn't fired by early January, the seismologists might want to delay the entire schedule until the following spring because of winter background seismic noises. The Commission approved the proposed change in schedule, emphasizing that the first shot should not be delayed beyond January unless absolutely necessary.

On October 4 and 5 of 1960, ARPA sponsored a technical symposium on Vela at the Pentagon in Washington. The attendees, some 300 in number, included representatives from the Department of Defense, other government agencies, industrial companies, universities, and scientific organizations. Among others, talks were given on Vela Uniform in general by Gen. Betts, detection by Carl Romney, worldwide standard seismic network by L. M. Murphey, the explosion series by Theodore George (who did not mention Groundhog), source measurements by Chuck Violet of Livermore, decoupling by Al Latter, and results of Project Cowboy by Glen Werth.

By late October, some of the names had changed. Concerto had become Project Shade and Ripple had become Dribble and was now definitely planned for Tatum Dome, Mississippi. The previously unspecified shot to be fired in an active seismic area had now been given the name Shoal. Dribble had been changed to six nuclear shots (vice the previous eight) to be fired at a depth of 2,500 feet. LASL was trying to dream up an acceptable direct sampling technique for a 5-kt nuclear explosion underground.

By fall 1960 the AEC had received an FY 1961 supplemental appropriation of $32,500,000 for Vela. The Department of Defense had committed $7,460,000 in FY 1960 and had programmed $33,340,000 to be spent in FY 1961. A great portion of the DOD money was to be spent through universities and private contractors.

By October 28, 1960, the AEC, DMA, and DASA had authorized final construction

for the Orchid event (5 kt in tuff, tamped) to meet a readiness date of December 15, 1960, a very tight schedule.

Some comments on the procedures for firing an underground shot in a tunnel will, perhaps, aid in understanding the continued delays. After "field construction," the phase during which the construction contractor prepared the site for laboratory occupation, there was a period of a month or two months or even longer, during which the equipment for whatever experiments were to be performed was installed and tested. In certain circumstances, the equipment installation phase could overlap the field construction period. After the technical installation was finished and checked out, the device itself could be brought in, last-minute checks run, and then stemming could proceed. The process of stemming could take from a week to as much as a month or so. Because digging back to recover the device was a large and obnoxious job, very few people in the system wanted to bury it without having received firing authorization. A very few times during a later period of underground testing, devices were emplaced before authority to fire was received, and the results were, on occasion, embarrassing. Thus, while the field organization could bring a site up to something like six-week or one-month readiness, it, in general, could not go past that point without receiving authority to fire. Such authority, in this period of time, was continually delayed and, of course, always delayed as late as possible. Thus, we see, time after time, shot preparation progressing to within a month or two of the planned firing date before delays began because permission to fire had not been received. In the Vela Uniform program during this period, there was, of course, further confusion on which device was to be fired, Ex.(b)(3) or something else. Since device selection affected the zero room geometry, the firing circuitry, etc., additional delays were introduced. Lastly, since the field organizations were there to carry out experiments, any delay might be seen as an opportunity to change or improve some part of the experimental setup. These changes could lead to the expenditure of further effort and time.

During the summer and fall of 1960, several high-explosive detonations for the Plowshare program were fired in Nevada. While not strictly part of the Vela Uniform program, some of these did add to the data base for Vela Uniform. Scooter, a half kiloton of high explosive buried 125 feet deep, was fired in October of 1960.

In late October, the location of Orchid was changed from U-12b.09 to U-12e.04. Other changes were made during this period as a result of continued effort by ALOO and LRL to site the proposed detonations so as to get the most out of the overall underground complex. Some of the initial site choices had been such that firing the planned shots would limit the use of already constructed zero points.

Several things in late 1960 reduced the likelihood of firing Vela Uniform shots in the near future. The Eisenhower administration was reluctant to act after the election of John F. Kennedy as President of the U.S. in November of 1960. The problem of which device to use, Whirlaway Ex.(b)(3) had not been settled. The Geneva Conference was to recess on December 5, so there was little time to achieve U.S.S.R. agreement to Vela Uniform shots, and Tsarapkin had made it clear that he objected to the decoupling shot program.

Thus, on November 16, Starbird advised that the first shot of Project Shade would now be Orchid, to be fired on April 15, 1961, with Lollipop following on about June 15 at the new depth of 1,500 feet. The Lollipop hole would be drilled to 36-inch i.d. to accommodate the Sandia Whirlaway box.

A November 20 memo from DASA to DDR&E defined the Groundhog series in a little more detail. It was listed as a series of 30-ton and 100-ton high-explosive detonations at depths of 100 and 200 feet to be conducted in the summer of 1961 at an unspecified site.

A number of chemical explosions of up to 100 tons are required to investigate relative coupling in various media, to investigate the effect of increasing depth of burial in one or more media, to provide additional comparisons of chemical versus nuclear explosions, and to provide a direct comparison with small earthquakes in a seismic region.

Table VIII details Shade and Dribble.

TABLE VIII

SHADE AND DRIBBLE
November 20, 1960

Name	Yield (kt)	Medium	Depth (ft)	Site	Firing Date
Lollipop	5.0	Granite	1900	NTS	06/15/61
Orchid	5.0	Tuff	900	NTS	04/15/61
Linen	5.0 (HE)	Tuff	900	NTS	09/15/61
Stingray	25-50	Tuff	2000	NTS	11/01/61
Crystal	1.0	Tuff	900	NTS	08/01/61
Record[a]	0.1	Salt	Decoupled		10/61
Hayride[a]	0.5	Salt	Overdriven		10/61
Hermit[a]	0.1	Salt	Tamped		10/61
Muslin	0.25	Tuff	900	NTS	05/62
Shoal[a]	5.0			Calif.	07/62
Gaucho[a]	5.0	Salt	Decoupled		12/62
Greenbean[a]	25.0	Salt	Overdriven		12/62
Tipsy[a]	5.0	Salt	Tamped		12/62
Porpoise	5.0	Tuff	5-10,000	NTS	

[a]Dribble

At the December 2, 1960, Commission meeting, it was noted that the Bureau of the Budget had suggested a reduction of $10,000,000 for the Vela Program in FY 1962. "The AEC staff deemed it appropriate to appeal this recommended reduction. General Starbird said if such a reduction was permitted, the deep shots and the decoupling shots recommended by technicians and (the) seismic improvement program would be delayed considerably." The Commission agreed to appeal the $10,000,000 reduction.

On the last day of the year the status of tunnel construction for Shade was as shown in Table IX. All shots were to be fully tamped, and all were to be fired in tuff with the exception of Lollipop, which would be in granite.

TABLE IX
SHADE STATUS
December 31, 1960

Name	Yield (kt)	Status
Orchid	5.0	Construction complete
Crystal	1.0	Construction complete
Lollipop	5.0	60% of exploratory holes complete
Linen (previously Cottontail)	5.0 (HE)	Extended shaft and sphere, 67% complete
Stingray	25-50	No site selection.
Porpoise	5.0 (deep)	No site selection.
Muslin	0.25	Tunnel advancement complete for U-12e.03 but it is noted that the event may be canceled.

NTS Readiness Effort Shifts to Seismic Detection, Mid-1960

In early May 1960, the Nevada program was the only viable readiness field program available to the AEC. The LRL had a quick readiness program of four shots for which the construction had been approved and was going forward, and the LASL had been given authority to deepen some holes and drill others to provide for more zero points. However, at this time, the readiness effort began to degrade rapidly. As mentioned before, on February 24, the President's Science Advisor had informed the Chairman of the Commission that the President considered a vigorous and continuing research and development program on the detection of underground and high-altitude explosions to be a matter of high priority. During the intervening time, the U.S. had informed Russia of its proposed Vela Uniform program and was about to join the agreed-upon discussions of the Seismic Research Program Advisory Group to be held on May 11, 1960. Eisenhower had publicly announced the Vela underground program on May 7. On May 9 Colonel O'Brien of DMA and Allaire of ALOO agreed that Reynolds Electric and H&N should start "shifting gears" from the present program to the detection program. In addition, they agreed to cancel the bid on the construction of LASL holes and the other Area 3 items directly associated with those holes. They further agreed that ALOO should check with LASL to see if the alpha trailers were still desired for other possible uses. On May 13, ALOO sent to O'Brien the estimated savings based on immediately stopping all weapons program construction. The total savings for FY 1960 could be $1,625,000. On May 18, a Starbird message to the field stated:

> It appears now that the Succotash activities and expenditures for NTS construction and procurement should be stopped immediately except for completion of digging for the U-12e.07 drift and vertical shaft. (If there is any other Succotash effort that may contribute directly to the seismic program it should be made known to me.) I would plan, therefore, to direct shortly that the necessary action be taken to terminate such activity and that the funds concerned be diverted to cover the initial funds of the seismic improvement program. I request that ALOO advise me at the earliest practical time as to the savings that can be accomplished in FY 1960, thereby, and the amount required for FY 1960 seismic improvement activities.

Succotash was the Livermore weapons test readiness effort. The LASL effort, as noted, had already been stopped. The field reacted quickly. On May 19, Harold Brown

of Livermore told Starbird:

> The proposed program, including the 50 kt in e.07 and the 1.2 kt in e.03, wipes out three of four sites of the readiness program. In addition, the HE shot will very probably make the B tunnel unavailable for a period of six months to a year . . . .In case the international situation were to lead at some future time to a decision to resume underground testing, there would then be a delay of 3 to 6 months beyond the 40- to 50-day readiness which we had previously planned. We consider this very undesirable . . . . Two possible sites in the E tunnel for the 50-kt and the 1.2-kt shots should be obtained by additional tunneling funded from the seismic improvement program, as would be the case for experiments and locations other than at NTS . . . . We will, in the near future, make up a proposal for additional work to put NTS into the same state of readiness capability which we have previously proposed; the details of such a proposal will obviously have to await firm and final arrangements for the seismic program.

It is interesting to note that in the Commission meeting of May 18, which Starbird attended, the subject of this shift did not come up. However, Mr. Graham did say that the Commission was committed to proceed with the seismic improvement program and it was remarked that in view of the failure of the Paris Summit Conference, Congress might not approve funds for the test detection program.

At this point in time (mid-May 1960), the site for Ex.(b)(3) shot (U-12b.09) was just short of construction completion and a month short of scientific construction completion. The site for the [redacted] was about two months short of construction completion and the site for Chiffon Ex.(b)(3) U-12e.03) was roughly two months from completion.

From this point on, the effort devoted to test readiness began to drop off appreciably. However, some work continued. Livermore and EG&G completed on May 23 their Project Tattoo, which was the field environmental test of a new underground prompt diagnostic telemetry system in which the data was partly reduced inside the tunnel and then transmitted over hardwire to remote instrumentation stations. The test used simulated gamma and neutron signals similar to those that might be received from a nuclear device.

During July and August 1960, the USGS groundwater investigation of Yucca and Frenchman Flats continued with the drilling of new water wells. Some seven wells were being drilled from 900 to 1,850 feet deep, the six deepest wells being in Yucca Flat and a 900-foot well in Frenchman Flats. The rate of drilling was such as to produce two new wells per month.

In spite of the shift to Vela, Livermore continued work on test readiness. After a tour of NTS on July 12 with members of LRL and ALOO, Starbird requested that Livermore send in a new plan for Succotash (test readiness) based on the assumption that the Vela Uniform program would use the existing tunnels. He asked that the plan be sent in as early as practical, but stressed that this did not imply a strong possibility of getting money for added weapon test readiness. Harold Brown replied in mid-August with a detailed plan to get into a state of 30 to 60 day readiness the same four shots as previously decided upon. Costs would be approximately $900,000 on the basis of a 40-hour workweek. Internal planning on the physics design for the measurements to be made was essentially complete at this time.

In mid-November 1960, Reeves (ALOO) expressed his concern to Starbird on the growing U.S. inability to resume weapons testing in a short time. He requested guidance from DMA in order that he could prepare a plan for future weapons test capability. The development of such a plan following DMA guidelines would then permit DMA to authorize such portions of the plan as might be feasible considering budget restrictions and political implications. There was no immediate response.

Thus, the field expenditures for weapons test readiness, and most of what few sites were available were switched to Vela Uniform in mid-1960.