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basic imagery interpretation report

1984 Vulnerability Testing Review Shagan River Test Area, USSR (S)

ATOMIC ENERGY FACILITIES

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JUNE 1985

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INSTALLATION OR ACTIVITY NAME					COUNTRY
1984 Vulnerability Testing Review Shagan River Test Area					UR
UTM COORDINATES	GEOGRAPHIC COORDINATES	CATEGORY	BE NO.	COMIREX NO.	NIETB NO.
NA	49-59-25N 078-55-48E	[redacted]			
MAP REFERENCE					
ACIC, USATC, Series 200, Sheet 0238-15HL, scale 1:200,000.					
LATEST IMAGERY USED		NEGATION DATE (If required)			
[redacted]		NA			

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ABSTRACT

1. This report is the sixth in a series of annual NPIC reports on the vulnerability testing program at the Shagan River Test Area in the USSR. It provides a thorough description and analysis of high explosive, vulnerability testing activity observed during 1984. Three ICBM silos in vulnerability area 89 were the primary test objects during this year; the 1984 test series may be the last multiple-silo vulnerability tests conducted and observed at Shagan River. NPIC has reported extensively on high-explosive activity at Shagan River since 1968 and has published an annual review on vulnerability testing since 1979. This report contains 37 figures and two tables. The date of the latest imagery used is [redacted] (S/WN) 25X1

INTRODUCTION

2. The Shagan River Test Area of the Semipalatinsk Nuclear Weapons Proving Ground (BE [redacted] is the primary locus for the Soviet vulnerability testing program. This program tests the vulnerability of strategic structures using HE* simulators to generate nuclear effects.[1-5] More than 80 vulnerability-related HE events have occurred at Shagan River since the program began in 1968. Many of the early HE tests did not appear to be directed at targets other than sensor arrays. These early tests were probably conducted to determine explosive characteristics and to perfect HE simulator designs. Later in the program, simulator designs were measured by instrumented generic test articles (single- or dual-walled cylinders buried vertically with their tops exposed). Test articles were used to calibrate test beds consisting of two or more HE simulators detonated simultaneously to create an environment which mimicked some of the effects of a nuclear weapons detonation. These simulated nuclear effects were usually ground shock (both direct and air-blast induced) and overpressure. Some evidence suggests that both EMP and thermal simulators have been used or attempted. (S/WN) 25X1

3. Concurrent with the early HE experiments and calibrations, six full-scale Soviet ICBM silos, a generic bunker, a deeply buried probable C3 structure, and several Soviet rocket force-related hardened antennas were built. These strategic structures were subjected to a multiple-target vulnerability test in 1974,[6] the first of 37 vulnerability tests of Soviet strategic structures to be conducted through 1984. During the last 10 years, vulnerability tests of strategic structures have included four multiple-silo tests, five deep UG probable C3 structure tests, and a series of nine tests involving various kinds of hardened antennas and cabling. In the same 10-year period, eight ICBM silos, two LCF silos, and at least eight hardened antennas were built and subjected to the effects generated by HE simulators. (S/WN)

4. The primary test objects during 1984 were three ICBM silos in vulnerability area 89: one each for the SS-17, SS-18, and SS-19 missile systems. Each of these silos had been subjected to an earlier vulnerability test, and each underwent repair and refurbishment during 1983 and 1984 prior to the tests. As is typical of Soviet testing of missile silo vulnerabilities, a calibration test in area 122, using a full-scale HE test bed surrounding a generic silo test article, preceded the tests of the ICBM silos. Other HE tests during 1984 included a test of the vulnerability of buried cables, connections, and junction boxes in vulnerability area 108 and the continuation of a series of small HE experiments started in 1983 around the location 116 instrumentation bunker (Figure 1). (S/WN)

*A list of acronyms and abbreviations is on page 46.

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5. This report provides a detailed imagery analysis of the 1984 Soviet vulnerability tests at Shagan River. Five tests and two experiments were conducted on at least five dates between June and September. [redacted] 25X1 25X1 Evidence of the two experiments was provided by overhead imagery alone (Table 1). A listing of all HE tests conducted at the Shagan River Test Area since 1968 is also provided (Table 2). This listing is intended to illustrate the direction and scope of the Soviet vulnerability testing program and includes additions and modifications to previously published listings. (S/WN)

Table 1.
1984 Vulnerability-Related Tests at Shagan River Test Area, USSR

Date	Alert No	Time (GMT)	Yield (Approx kt)	Imagery-Derived Coordinates	Remarks
[redacted]				49-57-28N 078-49-59E	Silo 156 calibration test in area 122
				50-03-15N 078-51-20E	Cabling & junction test in area 108
				49-57-44N 078-52-23E	Small HE experiments at location 116
				49-57-44N 078-52-23E	Small HE experiments at location 116
				49-58-02N 078-52-55E	Concurrent vulnerability tests at silo 10,
				49-57-57N 078-53-00E	silo 12,
				49-58-08N 078-52-52E	& silo 13 in area 89

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This table is classified SECRET/WNINTEL.

BASIC DESCRIPTION

Calibration Test Location 116

6. Location 116, outside the southwestern corner of vulnerability area 89, was the location of the 1980 calibration silo test. In June 1983, work was begun on a series of small HE experiments. This activity resulted in two groups of small craters: one group north of the 116 instrumentation bunker and the other group east of the bunker. These craters, most about 4 meters in diameter and a meter in depth, were first observed during June and July 1983. No seismic signals from these experiments were identified, and no further activity was observed in the area until 1984. (S/WN)

1984 HE Experiments

7. At least two small HE experiments, producing six separate craters, were conducted between [redacted] on the west side of the location 116 instrumentation bunker (Figure 2). On [redacted] people were seen north of 25X1 this instrumentation bunker in the vicinity of the 1983 craters. This activity was confirmed on [redacted] 25X1 when a new cable trench system, extend- 25X1 ing from the rear of the bunker, was observed. The trench terminated at three points along the west side of the bunker. When the site was next observed on [redacted] there were three new craters: 25X1 one near each of the three trench terminals. The craters were circular, roughly 4 meters in diameter, and 1 meter in depth. A stain extended 100 meters south of the craters before dissipating. (S/WN)

8. Little or no activity was observed around the new craters or the adjacent bunker until [redacted] 25X1 On that date, indications of minor ex- 25X1 cavations were near the northernmost and southernmost of the August craters. Imagery of [redacted] 25X1 revealed three more craters in the same 25X11

area. No further experiments were conducted at location 116 during the year. As with the 1983 experiment, no seismic signals were received from these experiments, probably due to the very small size of the detonations. The craters from both the 1983 and 1984 experiments are all nearly the same size, and many appear to have an additional hole in the bottom. Whether these holes were the result of some posttest activity or were caused by the explosive device was not discernible. (S/WN)

9. Additional study of other small cratering events around the Shagan River Test Area continues to support the analysis that the experiments at location 116 are part of the HE vulnerability program and are not related to seismic surveys or other known range activity. The use of an instrumentation bunker in an area associated with vulnerability testing; the lack of any survey activity in the immediate area; and the similarity between the growing pattern of craters at location 116 and older, abandoned HE test areas all support the analysis. (S/WN)

Calibration Test Area 122

10. Area 122 is on the southernmost scarp of the deflation basin, in the center of the Shagan River Test Area. Area 122 is about 3.5 km west of silo vulnerability area 89 and has been the primary area for HE calibration testing since the spring of 1981. Before that time, calibration testing was conducted in several locations including locations 5, 13, 51, 58, 116, and the HE cratering area north of area 89. Since calibration testing began here in 1981, seven HE tests have been conducted, including the one in 1984. (S/WN)

Silo 156 Calibration Test

11. The first observation of new construction activity in area 122 was on [redacted] when a crane shovel was seen excavating a new silo shaft. The silo excavation was the 156th drilled or mined excavation at Shagan River. By [redacted] while the excavation of silo 156 continued, more excavations had been started east of the shaft. On [redacted] five excavations were in an arc roughly 55 meters east of silo 156. The excavations were 20 meters apart and were identified as DI-HEST shaft locations being prepared for drillings. Prior to drilling DI-HEST shafts, which require a large drill rig, the Soviets install surface

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casings around the future shaft positions to prevent rig movement from collapsing the shafts. Surface casings used for Shagan River DI-HEST shafts typically have a diameter of [redacted] for the outer casings and [redacted] for the inner casings. They are at least 10 meters deep. Although the installations of the surface casings at silo 156 were observed infrequently, they appeared to be consistent with typical installations. (S/WN)

12. By [redacted] the DI-HEST surface casings were in the ground, ready for drilling, and two silo wall segments had been delivered to the site. On [redacted] three silo wall segments were present. Each silo wall segment was [redacted] high, with an outside diameter of [redacted] and an inside diameter of [redacted] Together, these three segments represent a "depth" of [redacted] ters, several meters deeper than any previous generic calibration silo. Calibration silo 16, used in 1981 and 1982, was at least 17 meters deep and may have been as much as 20 meters deep. Silo 156, a deeper calibration silo, is the most recent example of gradual evolution in Soviet testing practices and may allow internal instrumentation to obtain a more accurate recording of simulator forces. The actual ICBM silos that are eventually subjected to the simulator forces calibrated with these test articles vary between 25 and 40 meters in depth. Several cylindrical components were delivered to the silo 156 test site during January. These components had outside diameters of [redacted] meters and inside diameters of [redacted] They were originally assessed to be silo base and headwork pieces which would have made silo 156 over 30 meters deep. However, these components were evidently delivered to the wrong test site. They were later moved to silo 10 in area 89 and used to build a horizontal cylinder on the side of the silo headworks. (S/WN)

13. Work at the silo 156 test site continued throughout February and March. Late in March, a large drilling rig was delivered to the test site, and drilling of the DI-HEST shafts began (Figure 3). Drilling continued until at least [redacted] When completed, the DI-HEST array consisted of five, 1-meter shafts spaced 20 meters apart. The center shaft was 54 meters from silo 156. The pair of shafts nearest the center shaft was 56 meters from the silo, and the outer pair of shafts was 63 meters away from silo 156. By [redacted] one of the three silo wall segments had been installed. All three silo wall segments had been installed in the silo shaft by [redacted] Three probable silo closure components remained on the component platform where the wall segments had previously been. These components were installed on top of the wall segments, and the concrete had been poured by [redacted] 25X1
[redacted] Thus, the silo construction portion of the project (Figure 4) was completed. (S/WN) 25X1

14. Construction of the HEST and BLEST simulators began on [redacted] when the first arch of the HEST simulator was erected (Figure 5). The footing blocks for the HEST structure were laid in trenches which placed the base of the simulator [redacted] below the top of the calibration silo. HEST footing blocks are usually laid at the same height as the top of the silo. In 1980, footing blocks were laid in trenches at silo 6, a type IIID silo for the SS-11 ICBM. At silo 6, the footing blocks were [redacted] below the silo door; thus, the volume of the HEST structure was significantly decreased. This testing anomaly and the use of fewer HE emplacement shafts (five instead of seven or eight) in the rosette DI-HEST were assessed to be means of lessening the overpressure and ground shock generated by the HE simulators. Reduced overpressure and ground shock appeared to be necessary because silo 6 was an older, less hardened missile silo. If this analysis is correct, the HEST simulator over silo 156 was being calibrated to generate less overpressure than a typically constructed HEST simulator. Whatever the purpose, the HEST structure later built over silo 13 (type IIIH) was like the one over silo 156. (S/WN)

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15. The arch-roofed portion of the HEST structure had been completed by [redacted] although neither end wall was in place. The HEST structure was built from the standard prefabricated materials and was [redacted] 14 meters across the base, and 7 meters high from the footing block level to the peak of the arch. Because the footing blocks were [redacted] below grade and the ground was backfilled around them, the peak of the arch was [redacted] above the ground or above the top of the silo. This modification decreased the [redacted] internal volume of a standard HEST structure by 360 cubic meters or about 27 percent. The internal volume of the HEST structure over silo 156 was [redacted] On [redacted] the ground around the HEST structure was being leveled in preparation for the BLEST bed. Stacks of HE containers for the BLEST bed had been present since at least [redacted] They appeared to be the light-toned, [redacted] ter-diameter containers used in Shagan River BLEST beds since 1981. These containers have a

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volume of [redacted] Before the HE was laid out, an instrumentation cable trench, which extended from the silo to the instrumentation bunker, was backfilled. The instrumentation bunker was not new but was one originally built for the silo 16 calibration tests in 1981 and 1982. (S/WN)

16. When the silo 156 test site was next observed on [redacted] two thirds of the BLEST bed had been laid, and workers were laying out the rest of the HE containers (Figure 6). Like the BLEST bed configuration used in 1983, the silo 156 BLEST bed consisted of [redacted] rows of 12 HE containers. The spacing between the rows varied as in the previous year; however, the rows were much closer together and were greater in number. The outer nine rows of containers were spaced 1 meter apart, center to center, and formed a [redacted] meter outer bed. Imagery of sufficient interpretability to distinguish the inner BLEST bed spacings at silo 156 was not collected; however, three different bed spacings were on either side of the HEST structure, as well as in front of and to the rear of the structure. The inner BLEST bed spacings at silo 156 were probably the same as spacings at silos 10, 12, and 13 because silo 156 was used to calibrate the simulators used at these silos in the September test. Therefore, the silo 156 BLEST bed was probably over 70 meters long and contained more than 400 cubic meters of HE containers. (S/WN)

17. By [redacted] the HEST and BLEST simulators were partially covered by overburden. Towed scrapers and bulldozers were being maneuvered from the burrow pits to the overburden pile and back again, while a bailer was removing the water/drilling mud from the DI-HEST shafts. The overburden pile was almost complete on [redacted] and workers were connecting the BLEST bed timing/firing lines. Lightning arrestors had been erected around the HEST/BLEST overburden and along the line of the DI-HEST array. Overcast monoscopic imagery of [redacted] revealed that the overburden pile had been groomed into its final pretest configuration and that most of the equipment and personnel had been removed from the test site. The necessary pretest imagery was not obtained, so an accurate assessment of the HEST/BLEST overburden volume was impossible. The pile appeared normal for the emplaced simulators and probably contained from 15 to 20 thousand cubic meters of earth. (S/WN)

18. The silo 156 calibration test occurred at [redacted] A seismic yield of [redacted] The test results, observed on [redacted] included a large dark stain extending 1,800 meters south-southwest, a large DI-HEST crater, and a berm from the HEST/BLEST overburden (Figure 7). The DI-HEST crater measured 125 by 47 meters lip to lip with an average depth of [redacted] below normal terrain. The depth varied between 4 and 8 meters, and the height of the rim above the terrain varied between 3 and 5 meters. Two axis profiles of the DI-HEST crater (Figure 8) convey the true post-test appearance of the test site area. The berm around the silo from the HEST/BLEST overburden was 84 by 49 meters and merged with the near lip of the DI-HEST crater, 34 meters from the top of the silo. Reentry into the instrumentation bunker had occurred by [redacted] and a trailer was parked near the entrance. (S/WN)

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20. If bags of HE material small enough to fit into the flanges [redacted] were held in place with metal bands or with wood riveted to the concrete, more than 100 cubic meters of HE material could be installed in the flanges 25X1

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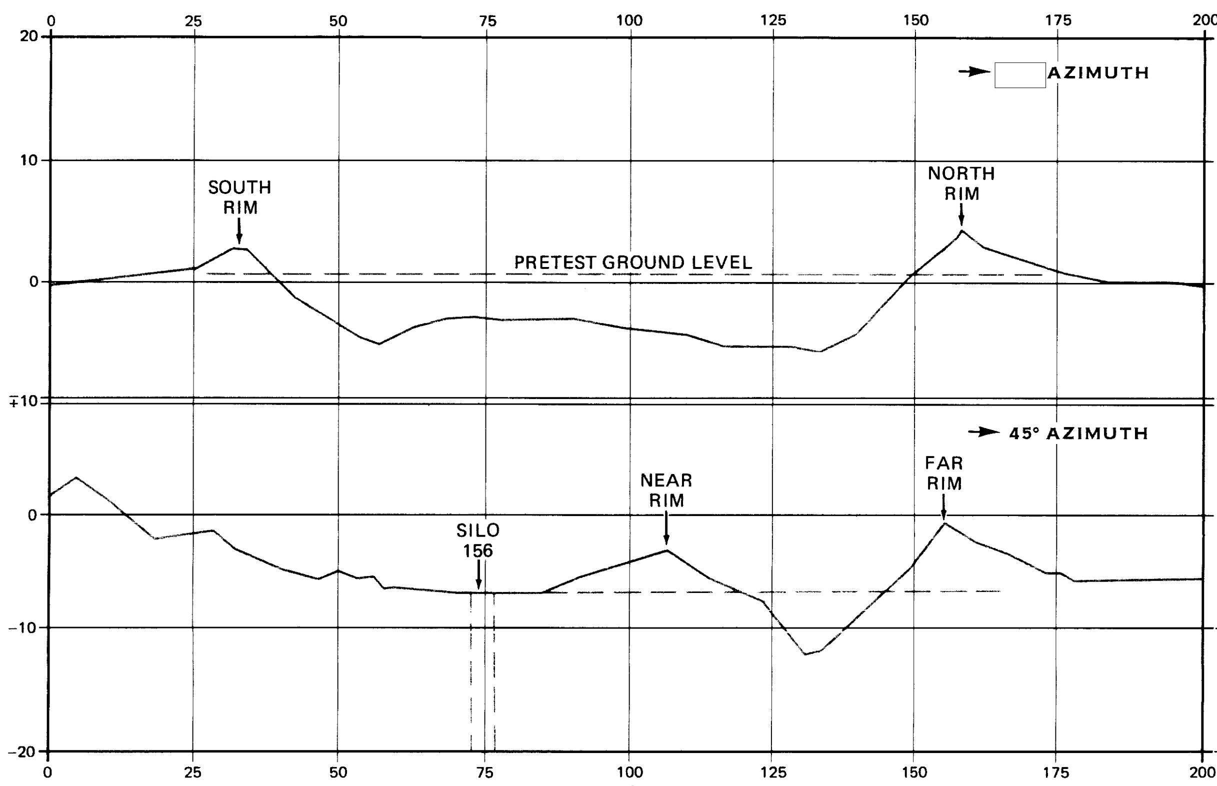

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FIGURE 8. CRATER PROFILES AT SILO 156

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of the explosive structure (Figure 9). While this HE arrangement is only one possibility, it is based on the flange configuration and on the fact that the arch pieces completely disintegrate in the HEST explosion, probably because the HE is placed close to the inside of the arches. This HE arrangement is provided as a starting point for discussion or for modeling and tests to determine how an arch-roofed HEST structure provides a valid overpressure simulation. (S/WN)

Vulnerability Area 108

21. Vulnerability area 108, a 1.4- by 1.0-km area, is 7 km north of the deflation basin. The area is secured by three fences and is used for testing the vulnerability of strategic structures other than ICBM silos. Most of the structures tested at this area have been C3 related, including both deployed and experimental versions of hardened communications antennas. Two tests conducted in 1980 were probably related to the development of a viable horizontal rail-mobile missile shelter. This program has either been delayed or cancelled because a full-scale, probable shelter built in area 108 has never been tested. In the two years since this probable shelter was completed, both the shelter and its HE simulator have suffered apparent structural damage from flooding. Ten vulnerability tests have been conducted at area 108 since 1979, including one test in 1984. The 1984 test was actually conducted outside the northwestern fenceline of the area, evidently because there is little or no room left within the fence for construction of either test objects or HE simulators. Subsequent C3 vulnerability tests may require an additional fenceline expansion or a move to an entirely new area on the range. (S/WN)

Cabling and Junction Vulnerability Test

22. The Shagan River vulnerability testing program is evidently intended to uncover weak or vulnerable points in Soviet strategic deterrent facil-

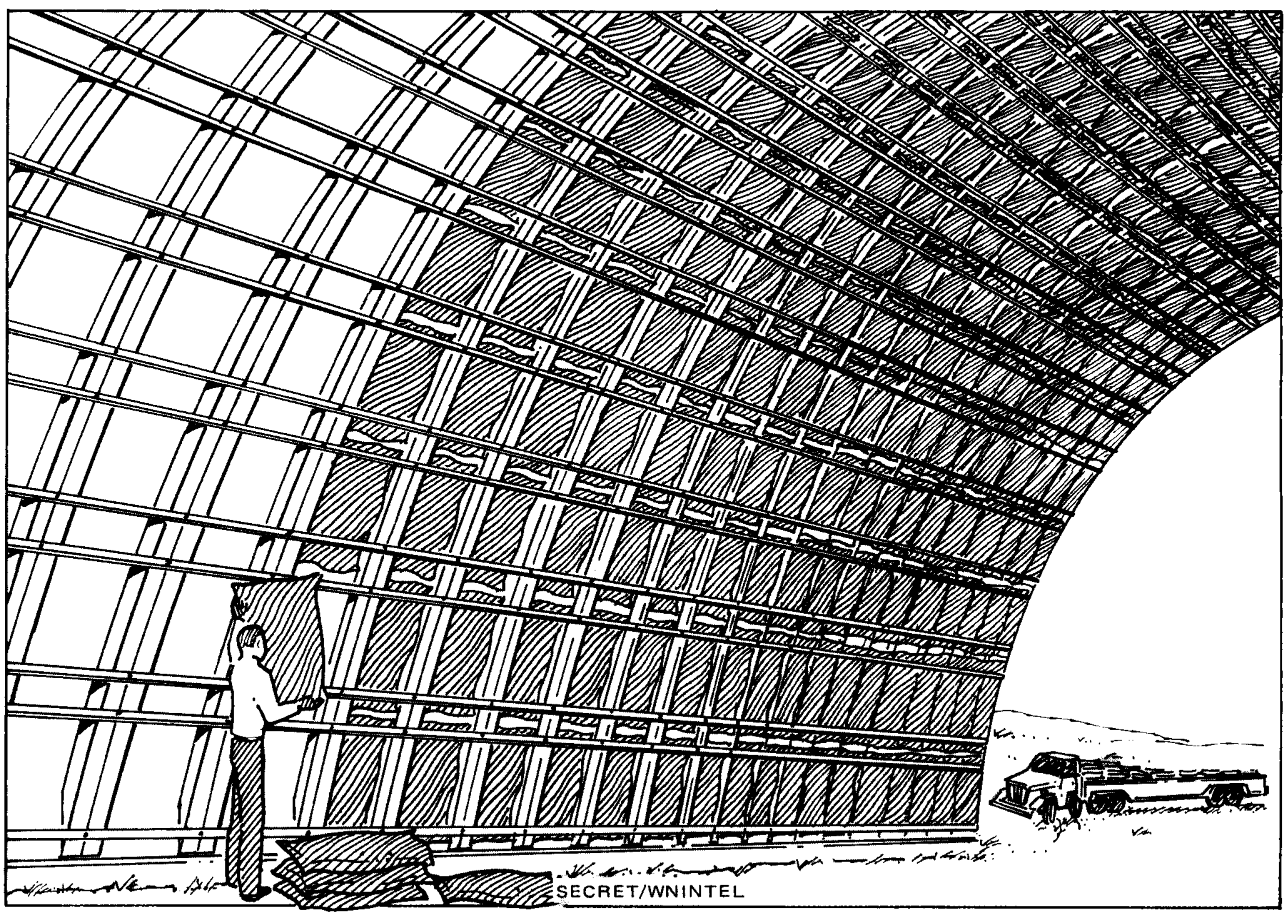

FIGURE 9. POSSIBLE HE PLACEMENT IN HEST SIMULATOR

ities. This investigation has taken at least fifteen years thus far. It has included testing the vulnerabilities of National Command bunkers buried hundreds of meters beneath the ground and hardened concrete and steel missile and command silos. The buried antennas and cables by which these facilities communicate have also been subjected to vulnerability tests. The part of the vulnerability program conducted in vulnerability area 108 has concentrated on the vulnerabilities of the connecting or communications links. Since 1980, the vulnerability of several hardened antennas has been tested. In 1984, the second aspect of the connecting links between command authority and weapons systems, that is underground cabling, was tested. (S/WN)

23. **Test Bed Preparations: April–June 1984.** In late April 1984, a roughly triangular trench system was excavated just outside the northwestern fenceline of area 108. The two sides of the triangle were approximately 120 meters long and met at a right angle, while the base was approximately 155 meters long. The trenches were [redacted] deep and [redacted] wide. By early May, the sides had been expanded into a system of parallel trenches, cross trenches, and alcoves. Additional trenches split the middle of the triangle and connected the expanded north and west sides to the center of the base where an instrumentation bunker was under construction (Figure 10). Work on the HE simulators also began in May, and their orientation evinced that the test objects would be centered in the expanded north and west sections with the major focus on the alcoves in each of these test beds. The rest of the trench pattern connected the test beds to the instrumentation bunker. (S/WN)

24. The north test bed was approximately half the size of the west test bed. It was 42 by 12 meters, with three alcoves spaced 10 meters apart. The west test bed was 70 by 25 meters, with three alcoves spaced 20 meters apart. In addition to being larger, the west test bed had twice the number of cross and parallel trenches. On [redacted] cable lines were visible in the bottom of the trenches leading into and away from the north test bed. Within the test bed, the cables were laid throughout the cross and parallel trenches and led to the center point in each alcove. A tent, [redacted] was in the easternmost alcove. Cable lines entered each end of the tent. Coverages during May and June revealed that the tent(s) was (were) moved from alcove to alcove, presumably covering preparations/attachment of the test objects to the cable lines. Observation of the alcoves after the tent(s) had moved revealed only very small conduits or junction boxes. (S/WN)

25. By [redacted] the northern test bed trenches had been backfilled, and the western test bed was being prepared. A tent was in the southern alcove, and cables were present in all parallel and cross trenches of the test bed. On [redacted] the tent had been moved to the central alcove. The exposed southern alcove contained a small conduit/junction box and a light-toned, inline splice (Figure 11). Other inline splices were visible in the test bed but not in other sections of the trenches. At each end of the test bed was a 2- by 2-meter junction box. Part of the cables from the test bed entered the junction boxes, but most of the cables bypassed them and were laid directly to the instrumentation bunker. The instrumentation bunker was incomplete, and several coils of cable were lying in the trench next to the unfinished bunker (Figure 12). On [redacted] the western test bed was being backfilled. Earth was in approximately half of the expanded trench system. A small object, presumably the junction box previously observed, was visible in the exposed southern alcove. The western test bed was completely backfilled by [redacted] although the instrumentation bunker was still incomplete and exposed. Finally, during observations of these preparations, it seemed possible that a test more complex than cables and junction boxes was being prepared. The spacing of the alcoves was the strongest indication of greater complexity, and a search for similar spacing in a strategic systems deployment pattern was made. No known system fit the matrix, and a cable and junction box vulnerability test remained the likely alternative. (S/WN)

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26. **HE Simulator Construction: May–July 1984.** *DI-HEST ARRAYS.* Work on the DI-HEST arrays had begun by [redacted] On that day, casing sections were on site, and equipment was working on the north test bed array. The casing sections each measured 11 meters in length and [redacted] in diameter. These casings were emplaced by means other than the usual drill rigs. On [redacted] the unique equipment used was observed on the

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were built with the alcove row on the front edge of the north test bed and on the rear edge of the west test bed. The westernmost part of the west test bed consisted of an additional alcove containing a cable and two in-line splices. These objects were subjected to greater ground shock and motion than the test objects on the alcove rows. (S/WN)

27. *BLEST BEDS.* Construction of the BLEST beds began as soon as the test beds were backfilled. The north test bed was backfilled between [redacted] The earth-moving operation appeared to be continuous, with no interruption between the backfilling and the building up of the lower earth mound over the test bed. The lower mound covered the entire north test bed. It was 121 meters long, [redacted] and 3 meters high. The mound was frustum-shaped, like a truncated pyramid, with a volume of 17,243 cubic meters. On top of the mound, a large bed of closely spaced HE containers was laid down. There were eight rows of the standard [redacted] meter-diameter HE containers. The rows were at least 90 meters long, with the individual containers spaced [redacted] apart center-to-center. This spacing and row length translate into 129 containers per row or 1,032 containers in the BLEST bed. The volume of an HE container is [redacted] meters, which means an HE container volume for the north BLEST bed of 357 cubic meters. Since the complete BLEST bed was not observed without overburden, the rows could have been longer, and therefore, the total container volume could have been larger. Overburden was then placed over the lower mound and the BLEST bed. The entire earthen pile was 110 meters long, [redacted] wide, and 6 meters high with a volume of more than 25,600 cubic meters. A similar, but larger BLEST bed was built over the west test bed at the end of June. The lower mound over the west test bed was 126 meters long, 70 meters wide and 2 meters high. The volume was 15,225 cubic meters. The west BLEST bed, which was laid out on top of the mound, was 10 rows of containers wide, two rows wider than the north BLEST bed. The west BLEST bed was 39 meters wide and at least [redacted] with 125 containers in each row. At least 40 more HE containers were stacked at the end of the orderly rows, and the ground had been prepared for HE placement. Use of all the prepared area would have made the bed [redacted] long and able to accommodate 138 containers in each row, for a total of 1,380 HE containers and a volume of 477 cubic meters. Once the BLEST HE containers were laid down, they were covered with earthen overburden (Figure 14). When this work was complete on [redacted] the earthen pile was [redacted] 25X1
54 meters wide, and 6 meters high, with a volume of more than 29,700 cubic meters. (S/WN)

28. *HESS STRUCTURES.* A HESS was built at each test bed. Each HESS consisted of three screen structures built in an arc in front of each test bed. Construction began early in May, and the bases of the HESS structures were complete by [redacted] Each HESS structure base was 12 meters long, 5 meters wide, and [redacted] The bases were built of prefabricated concrete pieces and were simply a flat base supported on five parallel walls, each 3 meters from the adjacent wall. The center of each HESS base was 110 meters from the center alcove of its associated test bed. At the north test bed, the three HESS structures were separated by 50 degrees of arc, while at the west test bed they were separated by [redacted] of arc. By [redacted] uprights to support the screen enclosures atop the HESS bases were being erected. The uprights had been erected by [redacted] and the screen enclosures had been completed by [redacted] The screen enclosure for each HESS structure was 12 by 2 by [redacted] when the overburden over the BLEST beds was being groomed, all six HESS enclosures were full of HE material. Each screen enclosure held 132 cubic meters or 396 cubic meters of HE material in each HESS (Figure 15). (S/WN)

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29. **Test and Posttest.** The last pretest observation of the cable and junction test site was on [redacted] The first clear posttest imagery of the test site was obtained on [redacted] The DI-HEST arrays had created two large craters with a lot of rocky throw out. The north DI-HEST crater was 117 by 53 by 11 meters deep, and the west DI-HEST crater was 112 by 59 by 11 meters deep. The average rim height for both craters was [redacted] Each of the HESS structures created slightly oblong craters 30 by 26 by 6 meters with [redacted] high rims. By [redacted] reentry was underway at both test beds. Earth was being removed from the top of the north test bed (Figure 16). The cuts back into the test beds were 4 meters below the test-altered grade level and did not appear to have reached test bed level. (S/WN)

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Silo Vulnerability Area 89

30. Silo vulnerability area 89 is a 1- by 1.5-km area situated on the southwestern scarp of the deflation basin at the center of the Shagan River Test Area. The area is surrounded by three security fences which are lighted and patrolled (Figure 17). An all-weather road extends east of area 89, past vulnerability areas 23 and 108, and exits the northwestern corner of the test area. Construction of ICBM silos began in area 89 in July 1978. Five silo corings were dug and faced with silo-lining blocks along a 650-meter-radius arc between the northwestern and southeastern corners of the area. Only four of these silos have been completed: three ICBM silos (types IIIF, IIIG, and IIIH) and a type 3 LCF launch control silo. The silos were completed in 1980, and vulnerability testing began in 1981. Since then, seven silo tests, using HE simulators to generate ground shock and overpressure, have been conducted. Three of these tests occurred in 1984. (S/WN)

Repairs, Refurbishments, and Modifications: January–August 1984

31. During the four-month period after the vulnerability tests at silos 10 (type IIIF) and 12 (type IIIG) in September 1982, there were clear indications that the silos had been damaged by the tests. An extensive effort to repair the damage took more than 18 months. During that time, activity in the first year appeared to be the evaluation and repair of damage in the core areas of the two silos. By winter 1983, it was apparent that major components would be removed from each silo. The silo doors and their associated mechanisms were removed. Preparations for removing the doors took place from January through March, and the refurbishment from April through August. Because part of the refurbishment process probably necessitated pouring concrete, a portable batch plant had been set up in area 89 by and remained there until the end of August. Meanwhile, HE simulators for the 1984 tests at silos 10, 12, and 13 were being prepared. (S/WN)

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32. **Silo 10 (Type IIIF).** The gantry crane at silo 10 had been assembled and erected on its rails by the end of January. During much of February, no major changes were discernible. The door was open at the end of the month. By [redacted] it was at least 50 degrees past the typical vertical position and was supported by the gantry crane. For the door to reach this position, part of the activator mechanism was probably disconnected. The door itself was completely disconnected and lying on the apron on [redacted] With the door off, an excavation next to the west side of the silo was begun. The excavation was complete in early April and measured 17 by 15 by 7 meters. On [redacted] components for a horizontal cylinder arrived at silo 10. These components, which had a [redacted] outer diameter and a [redacted] inner diameter, were [redacted] high. They had been at calibration area 122 next to calibration silo 156 (see paragraph 12). The assembled cylinder was in the excavation and attached to the silo headworks 3 meters below ground level by [redacted] The assembled horizontal cylinder was [redacted] in diameter and 9 meters long. (S/WN)

33. The horizontal cylinder was probably pargeted by the first of May, as its appearance changed from dark and smooth to light and rough. When the excavation was backfilled in early June, a pipe with a 1-meter diameter was attached to a hole near the center top of the cylinder. This pipe extended aboveground a few meters west of the silo. During May, while the horizontal cylinder was being completed, work was also underway both on the silo door and in the silo. The silo door was lying top down on the apron, usually with a light-toned cover over the plug area. This cover was also seen off the plug area several times and was an indication of activity at the door. On [redacted] several small components were laid out next to the eastern gantry crane rail. The components were probably pieces of the hinge and door actuator mechanisms and included the two hydraulic actuators (Figure 18A). The following day, a chute, probably for pouring concrete, was next to the hinge area of the headworks. (S/WN)

34. On [redacted] the cover was off the silo door, and some of the material making up the bottom of the plug had been removed (Figure 18B). A crane was over the door, and apparently discarded components littered the area on the east side of the door and crane. During the next two weeks, more of the plug area was removed. By the end of June, the bottom of the door had probably been completely disassembled. When next observed on [redacted] the silo door was lying top up. By [redacted] the top plate of the silo door had been removed and light-toned blocks, possibly radiation absorbent material like paraffin, were being removed from or placed into the structure. Major structural beams of the door were clearly visible, and what appeared to be the concrete apron was visible between the beams (Figure 18C). On [redacted] much of the door had been reassembled. The top of the door appeared complete except for the top plate and any full material that was placed around the structural members which support the top plate (Figure 18D). The top plate of the door was installed by [redacted] Reassembly of the bottom side of the door must have occurred earlier because the door remained top up on the apron until 19 August when it was back on its hinges. (S/WN)

25X1 25X1 25X1 25X1 25X1 25X1 25X1

35. **Silo 12 (Type IIIG).** By the beginning of January 1984, some of the activity which had occurred at silo 10 in the summer had already been completed at silo 12. A horizontal cylinder, very similar to the one installed at silo 10, was installed at silo 12 in October and November 1983. However, this excavation was still open at the end of January 1984, and a trench extended from it three quarters of the way around the silo headworks. The excavation and trench were filled in at the end of March, concurrent with the arrival of a gantry crane and its erection at the silo. On [redacted] the silo door was open, and dark marks or voids were on the bottom of the plug. The silo was not seen open again until [redacted] when the door was off and lying top down on the apron. (S/WN)

25X1 25X1 25X1 25X1

36. Work on the silo door was visible on [redacted] when the middle of the light-toned plug fill or the cover over the fill had been removed. By [redacted] the light-toned material had been separated into quadrants. One quadrant was missing; another was lying flat on the plug, and the other two were raised into the air. A cruciform component was on the apron beside the door (Figure 19A). It had either been removed from or was to be installed in the door. The next clear imagery, on [redacted] revealed that the door had been turned over and that the spoke plate with the spokes attached had been removed from the rest of the door (Figure 19B). The radial spokes were attached to at least three circular reinforcing rings, and the door

25X1 25X1 25X1 25X1 25X1 25X1

[redacted] 25X1

[redacted] 25X1

body was visibly offset beneath the spoke plate. The spoke plate had been reattached to the body of the silo door by [redacted] and the fill between the spokes had been replaced in all wedges except one. (S/WN)

37. By [redacted] the silo door had been turned over once again and was top down. The bottom plate was off, and light-toned blocks of material were being removed from the door body (Figure 19C). The next day all the light-toned material, which could be to absorb radiation, was out of the door, and the primary structural beams aligned with the base of the door hinge were visible. On [redacted] 25X1 [redacted] even more of the internal door structure was 25X1 visible, and on [redacted] hoop-shaped components 25X1 from the door were hanging over a support structure next to the silo door. On [redacted] the silo 25X1 door was evidently being reassembled. A crane 25X1 was over the door, and light-toned blocks were once again in the door body (Figure 19D). The

[redacted] 25X1

[redacted] 25X1

reassembly continued throughout the rest of June and was probably complete by [redacted] Throughout the silo door disassembly and reassembly, work was underway at the silo. A small lifting mechanism was adjacent to the hinge, and the movement of objects and vehicles around the silo seemed to center in this area. On [redacted] the door pocket, which had been covered for two months, was exposed and appeared clean and refurbished. On [redacted] [redacted] the silo door was closed atop the silo. The top of the door appeared dark with radial spokes faintly visible. (S/WN) 25X1 25X1

38. **Silo 13 (Type IIIH).** Silo 13, which was last subjected to a vulnerability test in 1981, did not undergo extensive refitting like silos 10 and 12. The door was not removed, and there was a limited amount of activity within the silo coring. However, a horizontal cylinder like the ones at silos 10 25X1 25X1

and 12 was attached to the headworks, and the equipment room was renovated and evidently reconnected to the silo through the cylinder. Work on the horizontal cylinder and equipment room was completed during April and May. In early May, before the cylinder was backfilled on the west side of the silo, an excavation was started on the east side. This excavation extended several meters below grade and was open until the first of June (Figure 20). On [redacted] the excavations east and west of the silo were filled in. Two square access ports to the equipment room were covered, and a 1-meter-diameter pipe from the top of the horizontal cylinder extended aboveground near the silo. The renovation was evidently complete; the silo door was closed, and work on the HEST simulator began. (S/WN)

39. **Imagery Analyst's Comments.** The disassembly and reassembly of the silo 10 and silo 12 doors required considerable time and effort, yet no imagery data suggested the doors were damaged. Any severe deformations of the silo doors would probably have been noticed, either because of a change in appearance or because the damage would have forced a change in door function. However, both silo doors appeared unchanged by the 1982 test, and they were opened and closed frequently during the 18-month period between the test and the door removals. Minor deformations could have remained undetected, allowed the doors to function, yet threatened the survival of the doors in a second test. Therefore, minor deformations could be interpreted as the cause for the reconstruction, although there is at least one other possibility.

40. Reconstruction may have been necessary to complete the analytical phase of the vulnerability test program. The purpose of vulnerability testing is to discover how a structure reacts to stress, to find where its point of failure is, and to pinpoint the mode of that failure. Failure modes in complex structures like silo doors—given the interaction of steel beams, plates, and fill materials—are unavoidably complex. A truly scientific vulnerability testing program would completely examine these complex structural responses—including disassembly of the most complex portion of the silo structure—the door, and its associated opening systems. The disassembly and reassembly of the silo 10 and 12 doors may be another example of the Soviet's thoroughness in their vulnerability testing program. (S/WN)

Silo Vulnerability Tests and Preparations

41. On [redacted] the Soviets conducted concurrent vulnerability tests at three ICBM silos within area 89. The silos—designated silo 10 (type IIIF), silo 12 (type IIIG), and silo 13 (type IIIH)—were subjected to ground shock and overpressure from HEST, BLEST, and DI-HEST simulators and to unknown effects from HESS simulators. Preparations for these tests required that the silos be made ready for testing (see previous sections) and that the HE simulators be built. Simulator construction began in December 1983, when surface casings for the DI-HEST array at silo 12 were installed. The final preparations were observed on [redacted] when the HEST/BLEST overburdens were being groomed two days before the tests. While most simulator construction at the silos was relatively concurrent, preparation of silo 13 was slightly faster because significantly less was to be done to the silo itself. Construction of the HEST/BLEST simulators was begun earlier at silo 13 than at the other silos. The HE simulator "sets" over and around each silo were relatively the same; they differed in size and volume, but not in kind. The observed preparations of each simulator are described in the following paragraphs. All important simulator measurements are included on Figures 21, 24, 26, 32, 33. (S/WN)

25X1 25X1 25X1

42. **DI-HEST Arrays.** Construction of arcuate DI-HEST arrays at each of the three silos was the beginning of simulator work in the test area. The installation of surface casing began at silos 12, 10, and 13 in December, January, and February, respectively. The outer casing measured [redacted] in diameter, and the inner casing measured [redacted] meters in diameter. The depth of the surface casing was at least 11 meters, which was the length the inner casing measured before installation. The installation took about a month at each silo. The position of the surface casings indicated that there would be a five-shaft array at silo 10 and at silo 12, but only a four-shaft array at silo 13. The arrays were each more than 50 meters from their respective silos and built along arcs which did not use the silo as a center point (Figure 21). (S/WN)

25X1 25X1

43. A large drill rig was moved into the silo 12 test site in the middle of March, and drilling of the DI-HEST shafts began. The drill rig remained at silo 12 until at least [redacted] This onsite time of 97 days would have allowed more than 19 days to drill a shaft. Because the shafts were mined to the 25X1

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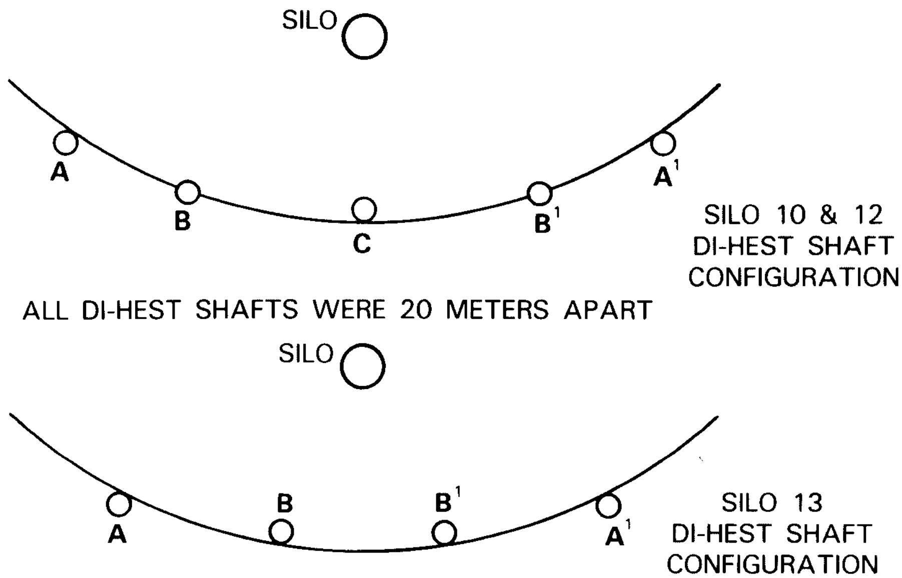
[redacted] 25X1



SHAFTS	SILO 10	SILO 12	SILO 13
A	[redacted]		
A'			
B			
B'			
C			

25X1

Distances and azimuths are from the silo to the shaft.

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FIGURE 21. HE SHAFT SPACINGS AND AZIMUTHS AT DI-HEST SIMULATOR

11-meter level (for the installation of the surface casing) and were certainly less than 40 meters deep, drilling must have been extremely sporadic. A large drill rig was not observed in operation at the silo 10 DI-HEST array. Cloud cover during several periods could have masked its presence, or some other means might have been used to drill the shafts. The silo 10 DI-HEST array was certainly built, was exploded correctly, and consisted of five shafts spaced like the array at silo 12 (Figure 22). (S/WN)

44. The large drill rig was first seen at the silo 13 test bed on [redacted] and it remained there until at least [redacted] This onsite span of more than 58 days allowed 14.5 days for each of the four shafts to be drilled, an extraordinarily long time for drilling shallow shafts 1 meter in diameter. The use of a four-shaft instead of a five-shaft DI-HEST array at silo 13 was the first indication that the silo 13 test bed was probably being designed to generate less energy than the test beds over and around silos 10 and 12. The array had one less shaft for HE material and was further away from the silo (Figure 23). (S/WN)

45. **HEST Structures.** Work on the arch-roofed HEST structures began at silo 13, where prefabricated pieces of the structure were first seen on [redacted] HEST structures were made from the same type of components at all three silos, and their characteristics were similar (Figure 24). The only difference was that the silo 13 HEST footing blocks were installed in [redacted] trenches on either side of the silo (Figure 23); thus, the height of the HEST structure was reduced, and the internal volume decreased by 360 cubic meters. This difference in installation was the second indication that the silo 13 test bed would produce a milder environment than the test beds at silos 10

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25X1
25X1

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 25X1

[redacted] 25X1

and 12. The calibration silo 156 test in June had a similar reduced-volume HEST structure, and the technique was originally used at silo 6 (type IIID) in 1980. Other than the reduced volume at silo 13, all other aspects of the arch-roofed HEST structures were normal. Arch pieces had arrived at silos 10 and 12 by mid-June, when the HEST structure was nearly complete over silo 13 (Figure 25). However, the completed back wall and accessway of the silo 13 HEST structure, as seen in late June, must have restricted access to something because they were disassembled in July and not rebuilt until August. Construction on the HEST structure over silo 12 began on [redacted] and was completed by [redacted] The silo 10 door was replaced by [redacted] and construction on the silo 10 HEST structure began. Most of the arched sections were up by [redacted] and the simulation structure was completely finished (and about to be covered) on [redacted] (S/WN)

46. **BLEST Beds.** The BLEST beds constructed for the 1984 silo vulnerability tests remain a partial enigma. [redacted] 25X1 A review of the available imagery did indicate that the three BLEST beds at silos in area 89 and the BLEST bed at calibration silo 156 were all similar. While the overall and bed subdivision sizes were resolved, and it was clear that rows in the inner beds were more closely spaced than either middle or front beds, no data on exact row spacing or actual container count was obtained. However, based on the past Soviet propensity for symmetrical BLEST arrangements and on the fact that the inner and middle BLEST beds measured consistently wider than the outer beds, a probable BLEST HE loading solution could be determined (Figure 26). The row spacing of the outer beds (1 [redacted] 25X1

[redacted] 25X1

DIMENSIONS	SILO 10	SILO 12	SILO 13
LENGTH EXTERNAL/INTERNAL	[redacted]		
DIAMETER EXTERNAL/INTERNAL			
HEIGHT EXTERNAL/INTERNAL			
EXTERNAL VOLUME			
INTERNAL VOLUME			
FLANGE VOLUME			

25X1

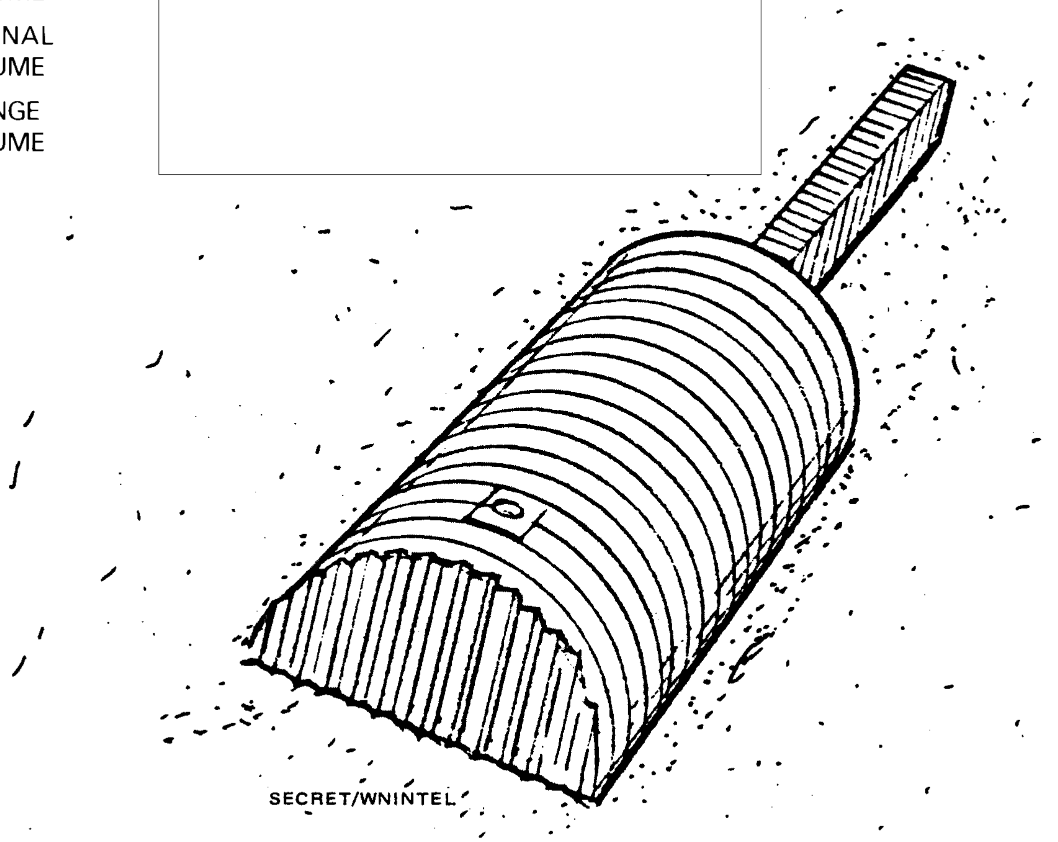

FIGURE 24. DIMENSIONS OF HEST SIMULATOR

[redacted] there were 18 and 27 rows in the middle and inner beds, respectively, the spaces between these tightly packed rows would not have been seen on the acquired imagery. While the correctness of the totals in the table cannot be confirmed, there is no doubt that the number of HE containers in the 1984 BLEST beds was at least twice that observed in the 1982 BLEST beds. The BLEST HE container volumes would, therefore, be more than 400 cubic meters. (S/WN) 25X1

47. The first evidence of BLEST bed construction was seen at silo 13 on [redacted] when stacks of HE containers were present. The bed was not started until after the arched portion of the HEST structure had been completed in early July. The BLEST beds around silo 13 were complete by [redacted] Figure 27) and buried beneath overburden 25X1 25X1 25X1

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[redacted] 25X1

[redacted] 25X1

by [redacted] The BLEST bed construction at silo 12 had begun by [redacted] and had been completed by [redacted] Only the north side of the silo 10 BLEST beds was observed, as the work was done between [redacted] and had been partially covered by overburden (Figure 28). (S/WN)

48. **HEST/BLEST Overburden.** Movement of overburden over the HEST and BLEST simulators began at silo 13 between [redacted] and was essentially complete by [redacted] The HEST and BLEST simulators at silo 13 were completely covered by [redacted] and the pile was roughly a pyramid by [redacted] when the overburden was being put over the HEST and BLEST simulators at both silos 10 and 12. The overburden over all three silos had been shaped into rough pyramids by [redacted] (Figure 29). The final grooming of the overburden did not take place until after

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25X1

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the BLEST bed timing/firing lines were connected. This process was underway at silo 10 on [redacted] (Figure 30). By [redacted] the BLEST timing/firing lines were attached at all three silos, and the final grooming of the overburden was nearly complete. The overburden appeared to be in the stacked frustum typical of HEST/BLEST overburden at the Shagan River Test Area. Other evidence of the late stage of preparations included debris from the HE loading operation outside the HEST accessways and the HE loaded into the screen structures (Figure 31). The sizes of the overburden frustum and the volume, less the HEST structures beneath them, are included (Figure 32). (S/WN)

25X1
25X1

49. **HESS Structures.** HESS structures have been used at five different test sites since they were first used at a calibration test in 1982. HESS structures were present at two 1984 test sites: the multiple ICBM silo test in area 89 and the cable/junc-

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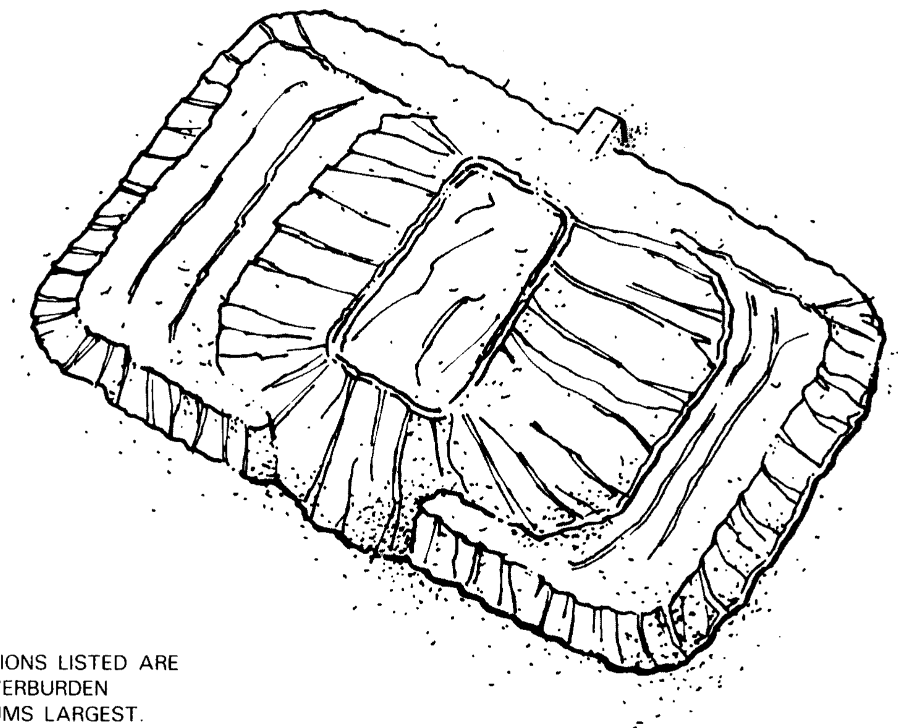
tion test in area 108. While at least three different hypotheses exist for the purpose of the HESS, none have been proven. The three hypotheses are: an [redacted] pressure simulator. Whatever its purpose, the HESS apparently functions within the design parameters, as it is still being used. [redacted]

[redacted]

50. Work on the HESS bases began at silos 12 and 13 in late March and a few weeks later at silo 10. All HESS bases were complete by [redacted] 25X1 and work on them ceased until August. The uprights, which form the boundaries of the screen enclosure atop the bases, were first erected at silo 13 and were erect at all three silos by [redacted] 25X1 Three HESS structures were associated with each silo. Each set of structures was positioned with the DI-HEST array between them and the silo—with a structure in the center, to the left, and to the right of the array (Figure 33). The translucent material that is hung between the uprights to confine the HE was in place by [redacted] and the HE was 25X1 partially loaded into the screen enclosures. A mea-

25X1 25X1 25X1



DIMENSIONS LISTED ARE
THE OVERBURDEN
FRUSTUMS LARGEST.

O.B. PILE	SILO 10	SILO 12	SILO 13
BLEST OVERBURDEN	[redacted]		
HEST OVERBURDEN			
TOTAL OVERBURDEN			

25X1

FIGURE 32. DIMENSIONS AND VOLUMES OF HEST/BLEST OVERBURDEN

[redacted] 25X1

surement on [redacted] indicated that HE containers were stacked 4 meters high, which equalled 96 cubic meters of HE containers per structure (288 cubic meters of HE containers in the HESS at each silo). If the HE containers were later stacked to the top [redacted] of the screen enclosures, each structure would hold 132 cubic meters or 396 cubic meters of HE containers per HESS. (S/WN)

Test and Posttest

51. The last pretest observation of the three silo test sites was on [redacted] The first posttest imagery was obtained on [redacted] at 0742 GMT, about one and a half hours after the detonation. Three huge craters from the detonations of the DI-HEST arrays dominated the appearance of the test site. Each crater was more than 100 meters long and more than 50 meters wide. They varied in depth from 6 to 10 meters below ground level (Figure 34). A dark stain from the explosions surrounded the entire test site but did not appear to extend further in any one direction, probably because of calm wind conditions at test time. Reentry had not occurred at the silos, although buses and other vehicles were at both silos 10 and 13 and new vehicle tracks were near silo 12. Actual reentry into the silos occurred in October. The silo 13 door was opened, and the other

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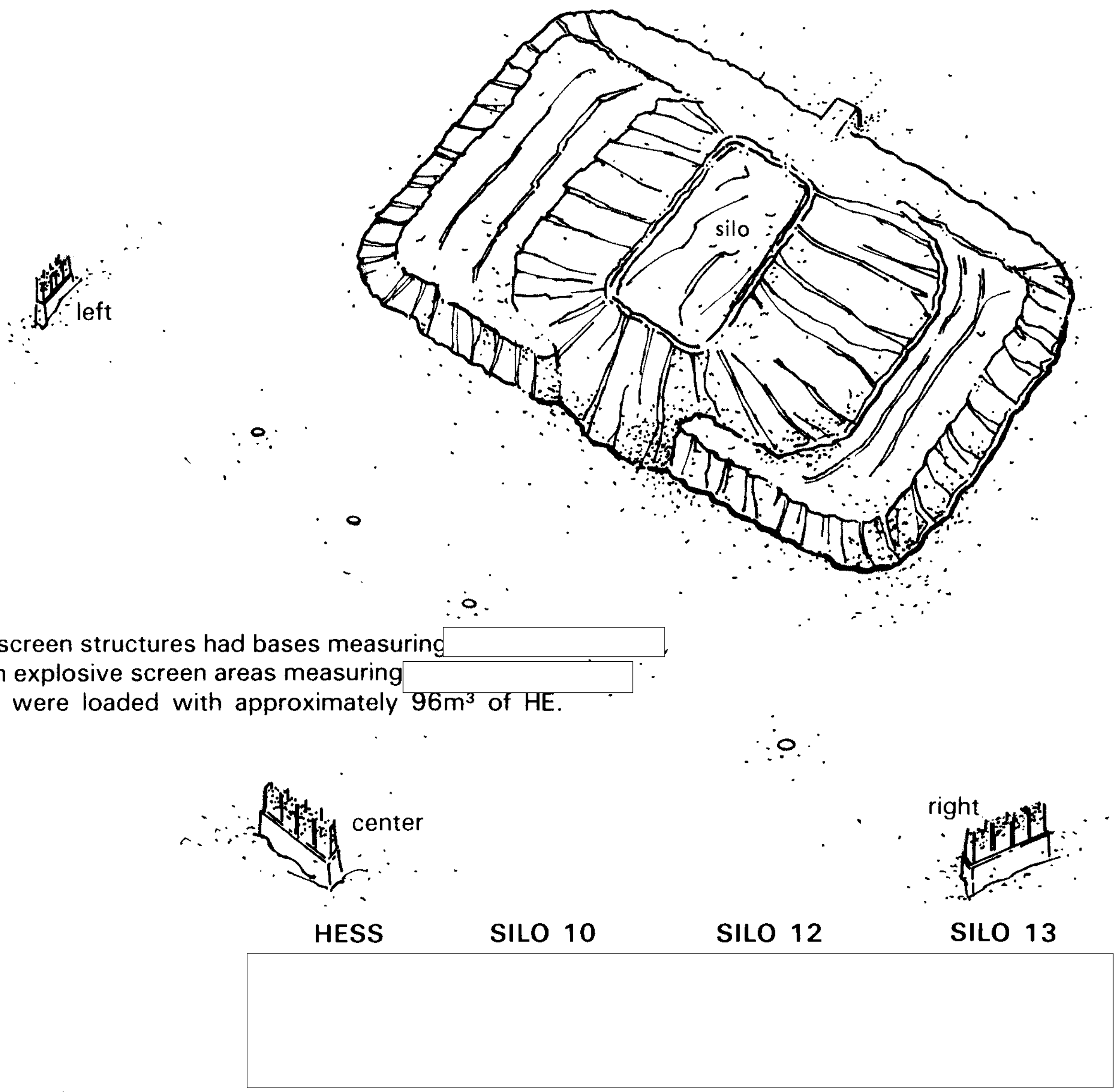

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FIGURE 33. DIMENSIONS OF HESS

25X1

two silo doors, although not seen open, appeared undamaged. Activity during reentry seemed to concentrate on excavating back into the horizontal cylinders, probably to recover instrumentation data. (S/WN)

52. In order to show the differences in the shapes of the DI-HEST craters, two axis plots of each crater are included in this report (Figures 35 through 37). A striking difference is apparent in the axis plots through the silos at silos 10 and 12 when compared with the plot on the same axis at silo 13. A distinct scarp with a drop of three or more meters exists some 20 meters from both silos 10 and 12, and the near rims of the craters are at least 2 meters below ground level. These features are not present at silo 13 where the near rim of the crater is 4 meters above ground level. Some of the observed differences in the craters could be the results of the different DI-HEST array configurations, but most are probably because the silo 10 and silo 12 DI-HEST arrays were placed in fill material. The craters from the 1984 vulnerability test are in the same place as the craters created by the

(Continued p. 46)

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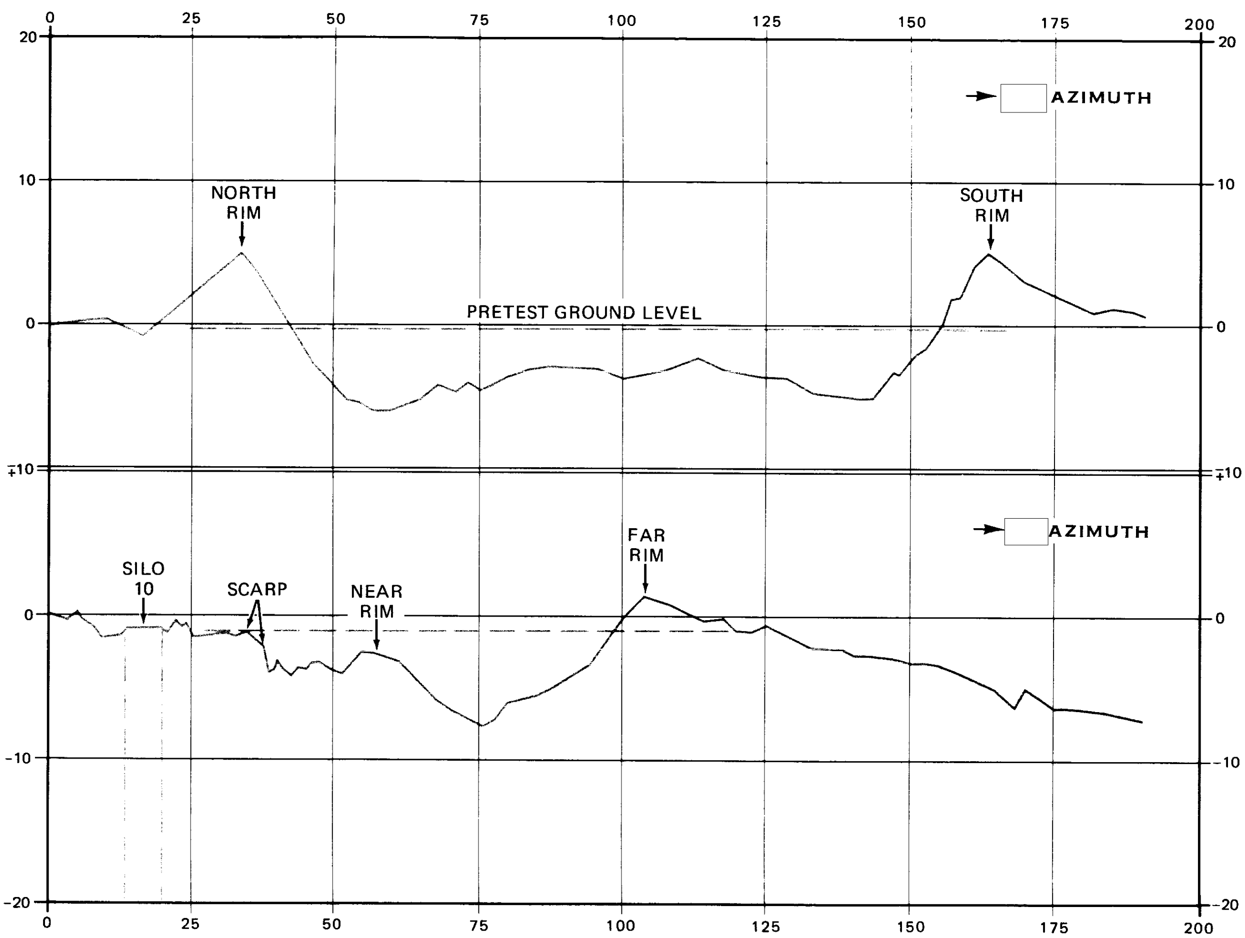

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FIGURE 35. CRATER PROFILES AT SILO 10

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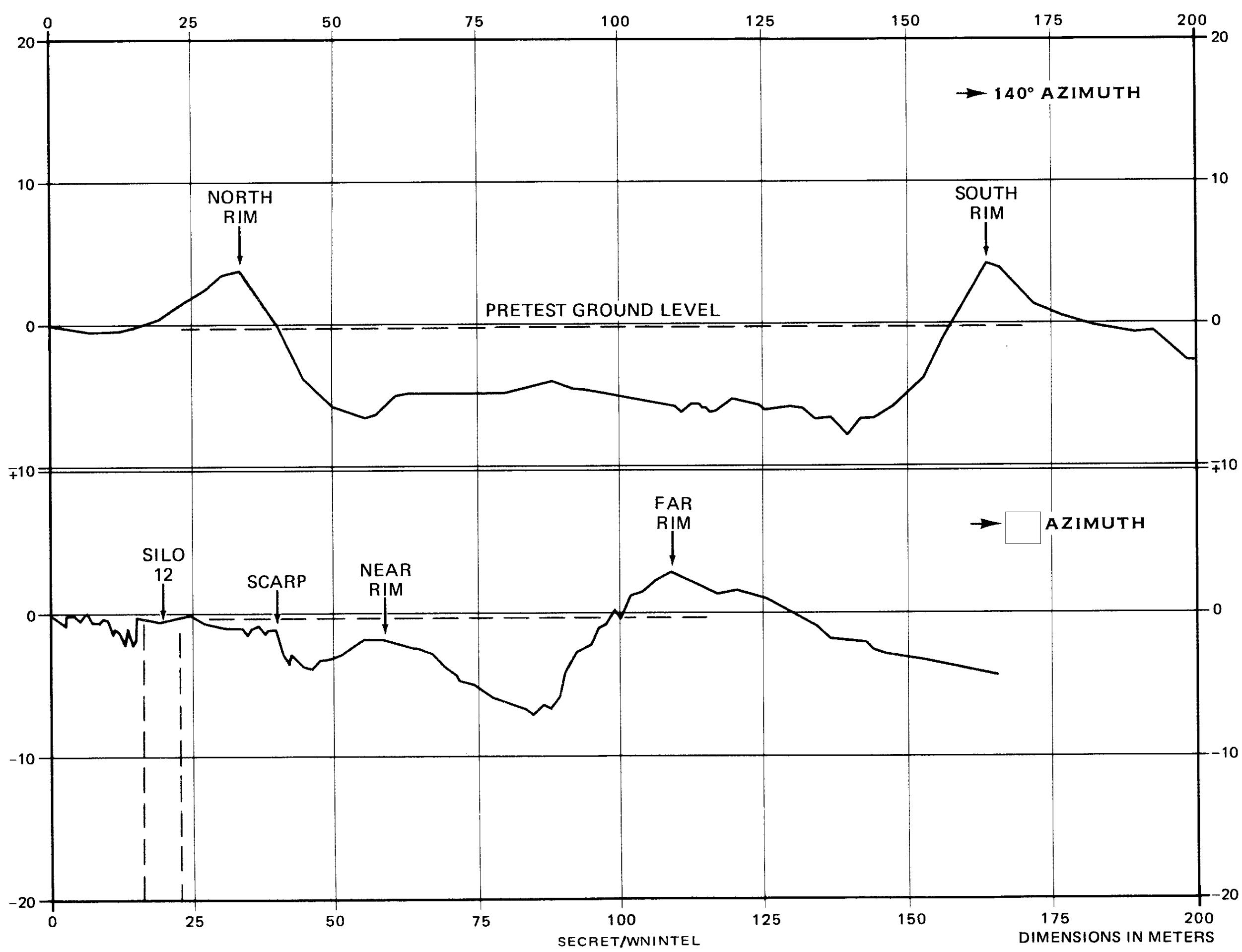

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FIGURE 36. CRATER PROFILES AT SILO 12

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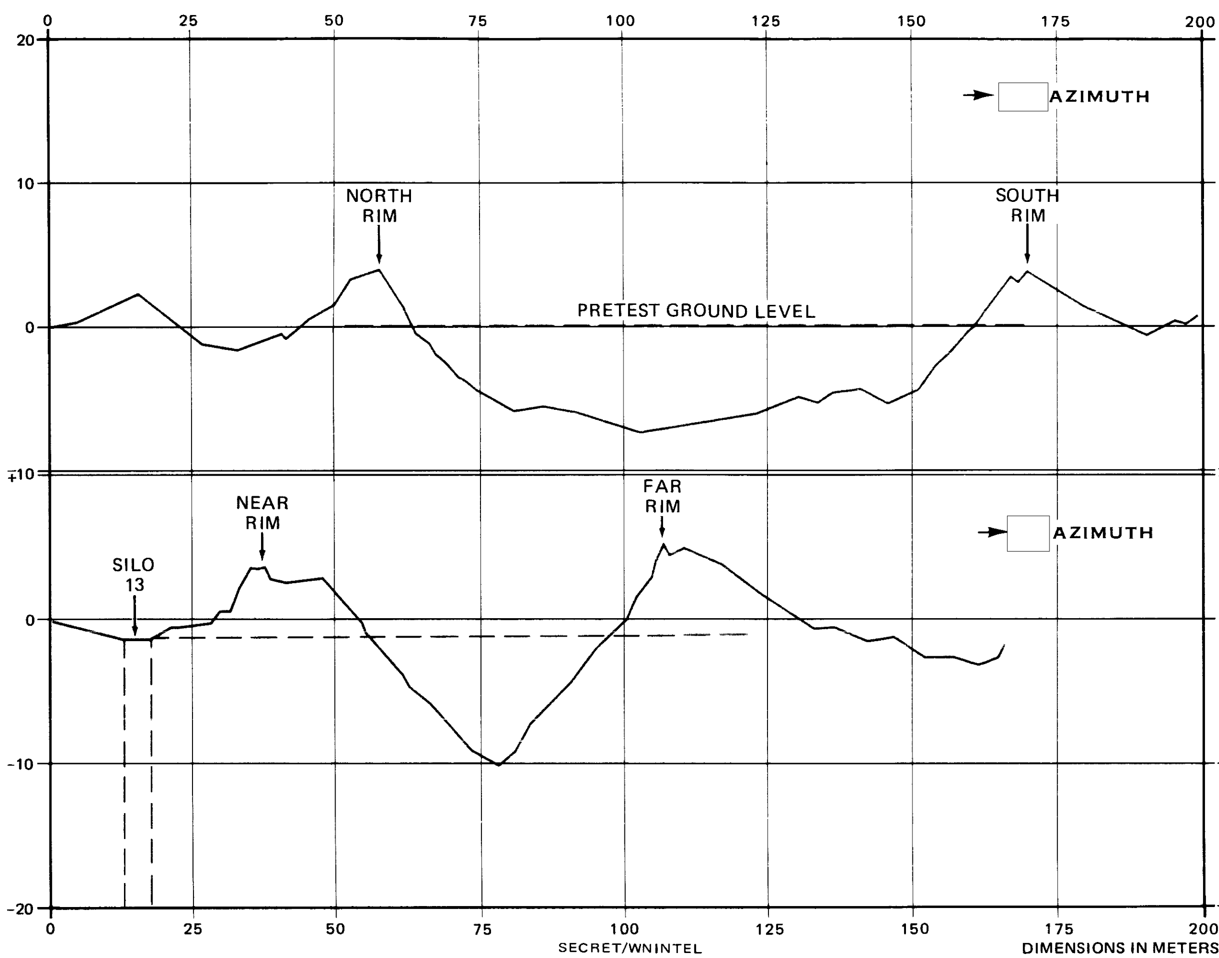

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FIGURE 37. CRATER PROFILES AT SILO 13

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1982 vulnerability tests at these silos. The 1982 craters were nearly 100 meters long, 70 meters wide, and 8 meters deep and were backfilled for the drilling of the 1984 DI-HEST arrays. A much smaller and shallower crater (41 meters in diameter and [redacted] was at silo 13 from the 1981 vulnerability test at that silo. The scarps and the appearance of the material that makes up the near rim areas of the craters at silo 10 and 12 suggest that the crater rims are actually the scarps and that fill material occupies a considerable portion of the two craters. Formulating test levels at the silos by using the crater volumes of these two craters should be done with caution. (S/WN) 25X1

CONCLUSION

53. At present, all ICBM silos in the test area, except silo 11, have been subjected to at least two vulnerability tests and have probably been abandoned. Silo 11, a type III LCF launch control silo, could be subjected to a test in 1985. Evidence suggesting refurbishment of this silo has been present since 1983. The opportunity to observe the construction and testing of a new or modified structure exists at the silo 14 coring. When reconstruction of the silo doors had been completed at silos 10 and 12 in August 1984, the rail gantry cranes were moved from those silos to silo 14. At the end of 1984, the crane pieces remained on the ground at silo 14. Their presence indicated major construction and future testing, probably in 1985 and beyond. The other major vulnerability test area is area 108 where C3-related vulnerability tests have been conducted. Little or no room is left in area 108 for the construction of new test beds. Because of the apparently highly structured nature of the test program at Shagan River and because most available space in the vulnerability test areas has been used, vulnerability testing may come to an end after the silo 11 and 14 tests. A complete listing of vulnerability tests at the Shagan River Test Area—with associated alert numbers, dates, locations, coordinates, types of simulators used, crater sizes, and remarks—is included in this report (Table 2). This listing updates previous versions and includes 1984 test data and revisions of earlier test data. (S/WN)

LIST OF ACRONYMS AND ABBREVIATIONS

AFTAC	Air Force Technical Application Center
BLEST	berm loaded explosive simulation technique
C3	command, control, and communications
DABS	dynamic air blast simulation
DI-HEST	direct induced high-explosive simulation technique
EMP	electro-magnetic pulse
GMT	Greenwich Mean Time
HE	high explosive
HESS	high-explosive screen simulator
HEST	high-explosive simulation technique
ICBM	intercontinental ballistic missile
km	kilometer
kt	kiloton
LCF	launch control facility
SRF	Soviet Rocket Force
tgt	target
UG	underground
USAEDS	United States Atomic Energy Detection System

This list is UNCLASSIFIED.

[redacted] 25X1

REFERENCES

IMAGERY

All applicable satellite imagery acquired through [redacted] was used in the preparation of this report. (S/WN) 25X1

MAPS OR CHARTS

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*Extracted information is classified SECRET [redacted] 25X1
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REQUIREMENT

COMIREX O29
Project 5450080

Comments and queries regarding this report are welcome. They may be directed to [redacted] Soviet Air Navy Nuclear Division, Imagery Exploitation Group, NPIC, [redacted] 25X1 25X1