XVIII-16-2

U. S. ARMY CORPS OF ENGINEERS
BALLISTIC MISSILE CONSTRUCTION OFFICE
LOS ANGELES, CALIFORNIA

CEBMCO

HISTORICAL SUMMARY REPORT OF MAJOR ICBM CONSTRUCTION

BOOK 2

LINCOLN AREA

ATLAS "F"

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ATLAS

OF

VOLUME TWO

AREA ENGINEER, LINCOLN
U. S. ARMY, CORPS OF ENGINEERS
BALLISTIC MISSILE CONSTRUCTION OFFICE
P. O. BOX 953
LINCOLN, NEBRASKA

31 March 1962

HISTORICAL SUMMARY REPORT OF MAJOR ICBM CONSTRUCTION

12 ATLAS "F" ICBM COMPLEXES

and

SUPPORT FACILITIES

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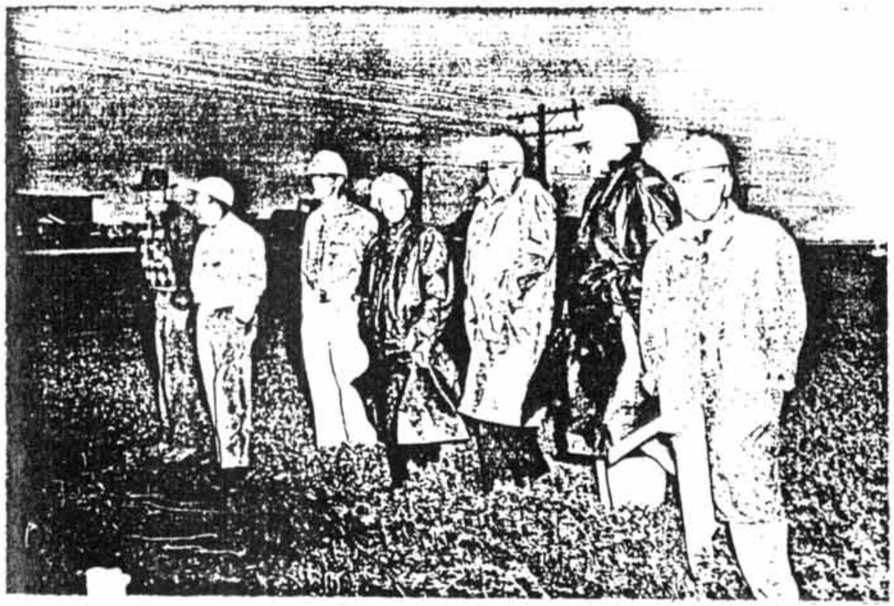
UNUSUAL FEAT[illegible] OF MISSILE FACILITY CONSTRUCTION

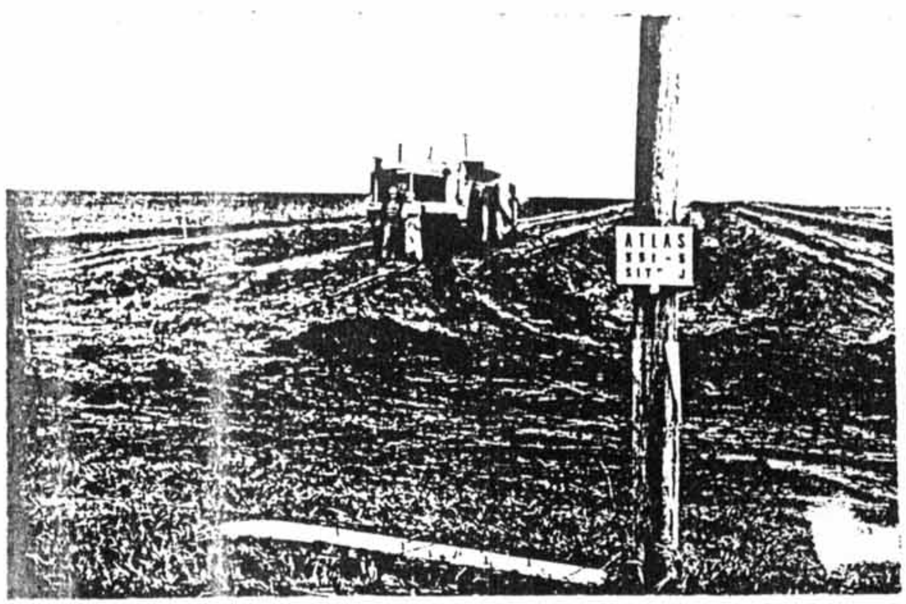
SUMMARY

The Alpha of the construction program of the Atlas "F" ICBM in Lincoln Area. Malcolm Shaller of Western Contracting Corporation and Lt. Colonel Lester J. Henderson at ground breaking ceremonies at Site 5 near Beatrice on Friday, 29 April 1960. #36360.

The Omega (well almost) when Colonel Henderson blocks the last of the more than 250 validation and test procedures that were completed at Site 10 on 6 November 61. #C-22.



29 April 1960. Party present at Ground Breaking, Site 5, Beatrice. Left to right: D. Sliger, WCC; C. W. Anderson, WCC; J. Tally, CE; F. D. Harlan, CE; A. L. Reed, CE; J. C. W. Carroll, CE; J. Fitzgerald, CE.



SITE 5, BEATRICE. View facing north from junction with Highway 136 shows preliminary earthwork on access road.

UNUSUAL FEATURE[illegible] MISSILE FACILITY CONSTRUCTION CONTRACTS

1. Unusually sho[illegible] [illegible]me allowed for construction of a large and complex facility.

a. With norm[illegible] [illegible]nstruction methods, whose tempo is adjusted to produce the most eco[illegible]ical schedule, the construction of an Atlas F facility woul[illegible] at least 24 months. The Lincoln Squadron was completed in 17 m[illegible]. The short time allowed required abnormally intense and comp[illegible]nsive attention to the setting up and maintenance of comple[illegible]edules; to assuring timely delivery of supplies and material[illegible] using extraordinary methods to prevent construction delays [illegible] overcome the effect of delays which could not be avoided; to r[illegible]ng the aggravated problem of mutual interference between vari[illegible]ades working simultaneously in close quarters; and to sec[illegible] adequate inspection to assure that the rapidly developing f[illegible]y met the needs for which it was designed.

b. The shor[illegible] formance times allowed for such a complex job, and the sequent[illegible]ature of the component parts of the job, required that rigid [illegible]ules be set up and maintained. In the launcher silo, excav[illegible] had to be completed before concreting could start; most of [illegible] concrete had to be placed and the excavation backfilled bef[illegible]e interior structural steel framework (crib steel) could start, [illegible]rib steel had to be placed before equipment installation could st[illegible] and practically all the equipment had to be installed and con[illegible]d before any one utility system could be checked and adjuste[illegible]th no appreciable slack time, a delay to almost any feature [illegible] work, arising from any cause whatsoever, had a direct delayi[illegible]fect on work scheduled to follow. To guard against such delays, exceedingly detailed and complex schedules had to be developed. The several circumstances of delay and change which ultimately developed here required an inordinate effort in attempting to keep schedules current.

c. Among the many serious problems encountered in materials delivery, securing timely fabrication and delivery of vessels for the propellant loading system (PLS) was particularly troublesome. In this regard Western Contracting Corporation deserves a pat on the back. The design of the PLS required use of 6 high pressure (4,000 - 6,000 psi) tanks and four cryogenic vessels (vacuum-insulated, low temperature liquid storage tanks) per site. Since the fabrication of such tanks is a relatively new art, and since such large numbers were required, Western secured the services of Chicago Bridge & Iron, A. O. Smith Corporation and Southwest Welding Company to supply their tanks. Production proved to be difficult and in some cases behind the required schedule. Because of the size and weight of all of the vessels, and the relative fragility of the cryogenics, transportation to the work site was slow, was subject to frequent delay by not being allowed to travel on Nebraska highways and frequently caused damage to the tanks. Placement of the tanks in the silo required demounting and remounting equipment and structural members already in place and the partial suspension of work of trades then at work.

d. Given a completion date that must be met, and given a shorter than normal construction period, the normal and inevitable delays which arise in any construction job could not be tolerated.

To aggravate the delay problem, the complexity and changing criteria inherent in this construction transformed situations which would not delay normal construction into circumstances which had a profound and critical effect on performance time. There being little slack time available, delays could be overcome only through the use of additional manpower and equipment. The short time available for completion of the projects made it necessary, particularly in the later stages of construction, to schedule simultaneous work by several trades inthe same work area. Since the work performed by one trade usually directly affected the rate or effectiveness of work by another, a delay to any one trade usually had a direct delaying effect on most other trades. For example, certain tests and checks necessary during the installation of the propellant loading system required the use of extremely high gas pressures, or the release of large volumes of nitrogen gas. Because of the hazard of explosion or asphyxiation and the extreme noise levels created, the work area had to be partially or entirely cleared while these checks were in progress. Delays in the conduct of these tests created additional delays for nearly all working trades. As a further example, neither certain parts of the crib steel, nor many mechanical and electrical connections, nor certain vital parts of the ventilation and air conditioning system could be installed until the forms for the concrete silo cap had been removed. Obviously, delays in cap placement had an immediate and direct effect in delaying nearly all other trades.

e. The diversity of the design features in the Atlas F launchers requred that use of specialized and qualified construction inspectors and engineers from every major branch of engineering. Some features of construction---PLS for example---were so new to the construction industry that personnel had to be specially trained or hired commercially to qualify as inspectors. Because of the distance separating the silos, and since the short time period required that similar operations be scheduled concurrently in each silo, no significant rotation of trained personnel between sites was possible.' Thus, unusually large numbers of inspectors and eingeers were required. Personnel procurement was difficult and slow, so that most jobs were operating shorthanded. The few people available had to work long hours under tight schedule s to provide the minimum acceptable coverage.

2. Unusually large geographic limits of the construction areas.

The Atlas F squadrons consist of twelve separate launcher facilities clustered around a central base. The individual launcher is separated from its base by from 22 to 60 miles; the individual sites are as much as 100 miles apart. Normally, a series of like structures can be built relatively economically through repetitive use of trained crews, use of central supply, use of central equipment pools, and simplified supervisory schemes. However, the wide separation between Atlas F work areas nullifies these advantages to a large extent.

a. Even though the sites are widely separated, trained crews can be used on successive sites, and have been so used effectively. However, the ineffective time of such crews is markedly affected. With a typical and inevitable delay of 2 hours at one location in a compact work area, the crew can readily be shifted to another location; ineffective time is short. With lost time between sites in the order of one to three hours, however, the possibility of shifting effort for short periods is eliminated; ineffective labor rates rise considerably.

b. The transportation time between the central supply point and the sites becomes a limiting factor in the operation of an economical centralized supply point. Daily resupply of small items (bolts, welding rod, nails, small tools) and daily servicing imposes so large a logistical burden in handling and transportation that it becomes necessary to set up substantially complete supply and servicing points at each site. Thus, total inventories of supplies and servicing equipment are considerably increased. As a necessary consequence, wastage factors, duplicated service manhours, and unproductive service equipment time are substantially increased.

c. The distance involved makes the transfer of construction equipment between sites an expensive and time consuming process. Instead of being driven between work areas, equipment must be loaded on trailers, transported, and unloaded. A normal operation requiring a half hour and costing fifty dollars becomes an all-day job costing five hundred dollars. Equipment cannot, then, readily be shifted from site to site to meet immediate demands and maintain a high productive rate, but must be kept idle to promote economy.

d. In a job involving several like features of work, it is possible and e[illegible]nomical to specialize supervisory personnel in certain component f[illegible]s of the work. Such specialization promotes better, ch[illegible] and quicker construction through the learning effect. [illegible]ravel time becomes an appreciable part of the work day, ho[illegible] the economy and effectiveness of this management device i[illegible]ailed. To obtain a given standard of supervision under su[illegible]nditions, more people must be comployed and trained, or tra[illegible]me must be reduced, or the number of trips must be reduced. I[illegible]event, either economy or effectiveness suffers.

3. <u>Abnormal co[illegible]ion of complex design and restricted working area.</u>

a. To buil[illegible]tlas F launcher is to build a 15-story steel framed struct[illegible]side a concrete-lined hole in the ground, and to install a co[illegible] array of mechanical and electrical equipment in an unusually res[illegible]d space.

b. A norma[illegible]truction job allows relatively easy access to the worki[illegible]as, and the working areas generally contain adequate ro[illegible]permit easy installation of equipment and connections. In th[illegible]s F silo, however, access to the work is severely limited an[illegible]ect to frequent and prolonged interruption. Furthermore, so muc[illegible]pment is crowded into such a small area that installation w[illegible] quite difficult, design interferences are inevitable, workmen [illegible]fere with each other seriously, and damage to completed work i[illegible]on.

(1) In normal construction, access to work areas can be obtained from several directions; men can enter the work areas readily and materials can be delivered into place in several ways. In this construction, however, the major part of the work must be accomplished with only one route of access - from the top of the hole. In later stages, personnel can gain access through the personnel tunnel connecting the silo and the Launch Control Center (LCC); however, it is not possible to use this route for the delivery of bulky or heavy items of supply or equipment. Thus, when placement of the cap and overhead doors blocks access from the top of the hole, only man-handled supplies can enter the work areas for a period of about three weeks. The installation of heavy equipment late in delivery must be delayed even further, and the prosecution of work in progress is slowed by the difficulty in procuring supplies.

(2) With the necessarily compact arrangement of the hundreds of motors, pumps, control panels, generators, compressors, tanks, and other items, workmen found it difficult to anchor and connect equipment. In several cases, it was physically impossible to work on one item if its neighbor were in place. Not only was the installation difficult, but also inevitable changes were difficult to accomplish. For example, making a simple change in one piece of equipment required that the adjoining piece be completely disconnected, demounted, and moved aside, purely to permit access. Thus, a ten-dollar, one-hour change is transformed into one taking two days and one hundred dollars to accomplish.

(3) Jobs that would normally be scheduled in sequence had to be scheduled concurrently to meet the overall completion date. In the crowded interior of the silo, it became common to see such instances as a plumber hanging water pipe, an electrician stringing cable, and a PLS workman placing his piping--all at the same time in a passageway where two men could barely squeeze past each other. Another of the many instances of enforced interference between workmen involved the placement and wiring of an electrical distribution cabinet located in a narrow passage - the only entrance to a major work area. The electrician wiring the cabinet repeatedly had to stop work and move aside to permit other workmen to pass.

(4) Since the missile system was being developed while the facility was being constructed, facility changes were numerous. In order to permit incorporation in the work as early as possible, the changes were processed rapidly with only the minimum essential engineering review. Under such circumstances, and when construction was done in an environment of closely-packed equipment, it was inevitable that relocation, rerouting, size increases, and additions would generate physical interferences with unchanged work. A relocated electrical panel had to be relocated again because a motor control box had previously been installed at the new location. A relocated pipe had to be relocated again because its path was interrupted by a new crib steel member. Such occurrences numbered in the hundreds.

(5) In the close confines of the silo, and with the numbers of people working together, damage to completed work was widespread and impossible to control adequately or prevent entirely. Workmen would use installed pipe as stepladders, thus breaking insulation, crushing thin-walled tubing, or bending hanger brackets. Workmen maneuvering bulky objects into place would break off valve handles, break the glass face plates of guages and cut electric cables. The damages were repaired without cost to the Government, of course, but the accumulated time loss was considerable.

4. <u>Incomplete Plans and Specifications.</u>

The urgency of the missile activation program required that facility construction contracts be awarded before design was complete. Our contract as awarded contained, essentially, only the initial design concept for the crib steel, with provisions for later issuance of definitive crib steel drawings. It was also known at the time of award that changes would be required to adapt the design to accommodate a number of items of centrally procured equipment, specifications for which were not then available. The contractors were forewarned as to the crib steel changes, and were instructed not to begin fabrication until the definitive drawings were received. However, late and incremental issue of the definitives caused substantial confusion and delay in the overall job.

a. The construction concept called for standardization of certain critical items of equipment. This equipment was procured by a series of single-supplier contracts let just before the earliest launcher contract was awarded. Since the specifications and dimensions for this equipment was not known until all of the shop drawings had been submitted by the supply contractors, and since it was not possible to prod revised drawings until after award of the last launcher contract, it was necessary to base the design on assumed data. It had been determine itially that only minor changes would be necessary; however, th sign changes necessary became so numerous that the change packa inally issued affected every system in the silo to a marked exten The change eased extensive engineering study by the contract required reorder of much of their materials, and made necessary ex ive re-work.

b. There w a number of inaccuracies, contradictions and omissions contained i r contract. These, although individually not so spectacular a t mentioned above, had a cumulative effect of several days of d

5. Stringent S ication Requirements.

The needs of e missile system dictated construction to tolerances of dimensio cleanliness, and operation which are far more precise than th ormally encountered in heavy construction. The difficulty in obta ng required standards required disproportionate supervisory attention, eated numerous delays, and generated a substantial number of con ctor claims for large amounts of money.

a. A major ficulty was the near surgical cleanliness required in the PLS erience was limited in this new field of providing a system for e storage and rapid transfer of large volumes of missile fuel, in ol g gases under extreme pressure and liquids at very low temperatur s. abricators had little experience and were required to learn on the job. Inspectors had no experience and had to undergo special training and continue learning on the job. United Testing Laboratory engineers were hired on a Man-Day Contract. The extreme precautions necessary to prevent contamination of the systems during installation, to check the systems for cleanliness and proper operation, and to prevent personal injury during the course of installation and testing caused major interference with other work. Delays in resolving discrepancies in the often inadequate specifications frequently caused delay in the prosecution of the work.

b. The required crib steel tolerances were difficult and time consuming to meet. The mill tolerances specified for fabrication proved to be incompatible with the precise final assembly tolerances specified. In many cases, it was determined only after members had been placed in position in the hole that the accidental variations in member tolerance were such that structure tolerance could not be achieved - the offending members had to be corrected or replaced before erection could proceed. In an extreme case, and despite the contractor's intensive effort to control the progressive steps in erection, it took two weeks of effort after completion of erection to adjust and rework the crib to meet the structure tolerance.

c. The close tolerances required for steel inserts imbedded in concrete were completely foreign to most contractors' experience. Preparation for concrete pours was time consuming, and involved special effort in verifying the precise placement of the inserts in the forms. Slight displacements caused by the pouring operations, normally inconsequential, were critical in this construction. Extraordinary care in concrete placement was required, increasing time and effort expanded.

d. The sight tube - a 12-inch steel tube about 150 feet long, slanting upward through the earth from a point midway on the silo wall to the surface, and aligned as to permit precise observations of Polaris from the silo interior-presented another tolerance problem. Despite careful attention to the backfill operations, a number of instances arose in which settlement bent the tube to such an extent that the contractor had to re-excavate, realign the tube, and backfill again.

6. <u>Abnormal Combination of Safety Hazards.</u>

The Atlas F launcher design presented a combination of construction hazards which, while not entirely unique in themselves, in combination presented a serious safety problem. The extraordinary measures necessary to protect life and health interfered materially with the prosecution of the construction.

a. The PLS was a prime source of concern. The high pressures used generated the possibility of explosion and required suspension of work while testing was in progress. One death was directly attributable to work on a pressurized system. In the test of certain PLS vessels, large volumes of nitrogen gas were released on confined areas. Despite constant emphasis on the need for care in this regard, one death occurred due to a fall following partial asphyxiation.

b. The hazard in crib steel erection is directly comparable to the hazard involved in structural steel work anywhere. Innumerable lost time accidents were experienced during this phase of work.

c. A concentration of workers dispersed vertically aggravated the danger of falling objects. Several serious accidents and one death occurred from this cause.

d. The need to energize partially finished and incompletely protected electric circuits generated, in the close working quarters, another aggravated hazard that could not be completely offset.

7. Abnormal Surveillance.

The division of the missile activation program into two major sequential contractual operations created the need for close attention to the progress of the facility construction contractor by the follow-on installation and checkout contractor. The facility construction program was interfered with to a degree by the additional surveillance effort. Some delays were caused. An unassessable amount of ill-feeling was generated, undoubtedly generating further inefficiency and delay.

a. Physical interference resulted from the continual presence, in a limited area, of double and even triple the normal number of visitors, inspectors, and overseers.

b. Administrative delays and occasional physical delays resulted from the sometimes mistaken allegations by the follow-on contractor of construction deficiencies or omissions.

c. Tests and verifications necessary to determine the compatibility of the facility construction with the missile and its control elements were time consuming. The resolution of discrepancies, often involving modifications to the facility contract, caused an abnormally protracted period of construction clean-up.

8. Labor Difficulties.

A large number of skilled workmen were required on short notice for short periods. This requirement coincided with a generally higher demand from other construction activity. The competition for labor created local shortages in required skills, accelerated the turn-over of personnel, and generated a situation favorable for strikes and slow-downs.

a. At all sites, it was quite difficult for the contractors to obtain the required skills in the numbers required. Had the originally contemplated contract schedules been followed, the number required would have been less and easier to find. With the complex changed work and changed contractual conditions, which occurred at all sites, there was a substantial increase in the amount of concurrent work required to meet fixed schedules, and a consequent increase in the manloading required.

b. Competition for labor was intense in this area - both from construction activity away from the site as well as from the follow-on construction and installation activity on the site. The abnormally quick turn-ov[illegible] of personnel complicated considerably the contractors' procurement [illegible]d training problems. A real loss in labor productivity was occasio[illegible] through the inability to use workers on successive jobs and thus [illegible]ain the advantage of learning.

c. The strike [illegible]d slowdown problem greatly affected us. Lincoln had 1,801 man-d[illegible] lost due to strikes.

9. Scheduling -- [illegible] Area was particularly careful to require that the contractor sch[illegible]le early completion of the initial construction operations. [illegible]s series of actions, although it often forced the contractor into une[illegible]nomical operations, did much to assure enough time for accomplishment [illegible]f the complex work which followed. It further had the effect of reduc[illegible] the peak activity level, and of distributing the work more nearly un[illegible]ormly across the total contract time. Thus,

Problems of congestion were somewhat reduced.

10. Allowing Time -- In the early stages of construction, it was essential to insist on adherence to the original contract schedule, despite delays from whatever cause, to insure against unforeseen delays late in constructic ... ing unacceptable slippage of completion dates. This action forced th ... ntractor to accelerate his efforts to overcome delays. When ... ame evident that the construction would be completed acceptabl ... , ... Government could afford to allow additional contract time to co ... ate for excusable delays or for added work. This action did mu ... egularize the contractor's planning and scheduling and to decreas ... ost of the construction.

11. Expediti ... rials Production and Delivery

a. Clos ... ontinuing contact was maintained with suppliers of every ... hich was initially considered to be critical or which was deter ... o be critical during the course of construction.

b. Wher ... sary, direct and immediate action was taken to improve or forecas ... s by suggesting changes in plant operations, directing changes ... very procedures, or modifying specification requirements.

c. Cont ... supplying the missile effort were given the highest national p ... in obtaining raw materials.

d. Supp ... ho were delayed through excusable causes were authorized to acce ... their efforts.

e. Spec ... nsportation assistance was given in emergency situations.

12. Accelerating Critical Construction and Production.

a. Where it became apparent that a feature of construction or an item in production was critical to the uninterrupted progress of the rest of the work, and where there was an excusable delay, the Government authorized additional expense to overcome the delay and regain schedule.

b. Where delays occurred in critical features for inexcusable reasons, the Government exercised its contractual option to direct the contractor to increase his efforr to overcome the delay.

c. The combination of these two actions served to maintain the urgent tempo of the early phases of construction. In the later stages of construction, its having become evident that the remaining work would be completed within the need dates, such actions were rare.

13. Making Maximum Use of Learning.

With the formation of CEBMCO in Fall, 1960, all of the missile construction sites were brought under single management. This action facilitated the transfer of information between bases, including information as to construction difficulties being experienced at the early sites which could be expected to occur at downstream sites. Information of this nature was disseminated in a variety of ways: Area Engineers were gathered together periodically; a list of such construction problems and their solutions were prepared, kept current, and distributed; visits were frequent in connection with particular problems, not only from CEBMCO to the Areas, but also from Area to Area; daily telephone contact was maintained from CEBMCO to the Areas and between Areas.

14. Giving Special Assistance to the Contractor.

a. The urgency of the program required that notice to proceed with changes be given immediately, particularly before price agreement had been reached. The difficulties in reaching agreement as to equitable prices caused long times to elapse between accomplishment of work and price agreement and subsequent payment. Since the changes became quite expensive, all contractors and subcontractors had large sums invested in the program. To alleviate this financial burden, interim payments of millions of dollars were made the contractors prior to final settlement.

b. As a further vehicle to relieve the financial burden on contractors, contractor claims were processed as expeditiously as possible. Where it was determined that the contractor had incurred allowable costs, negotiations were entered into promptly and agreed settlements paid.

c. Government personnel, with special knowledge of similar, earlier construction, were often able to suggest to the contractors methods and techniques which saved time and money.

15. Cost and Time Impact

a. The principal problems which the Area Engineer, his staff and the contractor have encountered in evaluating fairly the costs of changes in the Lincoln Squadron derives from the compression of time. The contractor and our past experience in estimating costs of work was based on the availability of sufficient time to plan the job properly and to accomplish the work using normal hours of work per day and days of work per week. Our experience tables and factors proved to be useless in determining a basis for fair and reasonable settlements of our missile base change orders, because when we compressed the time element we encountered many factors which greatly reduced the efficiency of contractor operations. Obviously, in a history of this type it is impossible to discuss all of these factors. These comments are intended only to point to a few of the major factors and to present a few examples.

b. Compression of time referred to above resulted from various actions on the part of Government agencies ranging from directed acceleration to indirect or constructive acceleration which resulted from our refusal to permit time extensions when we directed work changes.

c. It should be recognized by everyone concerned that construction costs are the concurrency concept of "buying time" are bound to be much higher than under our conventional construction procedures. This is true because when many activities are being performed simultaneously, an error or omission in one of the activities affects much more severely the other activities. The most serious--and costly--effect under these conditions is to destroy the ability to plan adequately any job and to substitute a get-it-done-the-best-way-you-can approach. When planning cannot be accomplished adequately, the results are confusion, false starts and stops, rework, and wastage of materials, equipment hours and manhouse--in other words, an extremely inefficient, and therefore costly operation. In the early stages of the Lincoln Squadron neither the contractor nor the Government agencies recognized the magnitude of these inefficiencies and the increased costs. Therefore, all of us, including the architect-engineer, used past experience tables to estimate the cost of changes work. The contractors didn't become alarmed about the situation until they saw their costs running wild. Even as their costs were skyrocketing our contractor, who was considered tops in the business, was unable to understand what was happening to them. They were afraid that they might not be able to convince the Contracting Officer of the reasonableness of their proposals. Changes which would have cost only a few thousand dollars if they had been included at the start of or early in the program cost millions when they caused a delay to a pacing operation. (As an example see paragraph 17. c.) Therefore, we were required to laboriously determine these factors on an individual basis.

16. The stage for this accelerated program was set by two actions:

a. The contract provisions which stated that it was extremely important that the contract completion dates be met and which provided authority for the Contracting Officer to "buy time".

b. A meeting held by Secretary of Defense Gates in Washington on 29 July 1960 at which the urgency for completing the program on schedule was stressed to all the contractors. As a result of this meeting, our contractor, being an intensely patriotic organization, took actions which they would have refused to take under normal circumstances. After the stage was set, various Governmental agencies kept the pressure on the contractors to buy time by adding personnel and equipment and by working generally around the clock. Until mid 1961, the Government theme--and, therefore, the atmosphere under which the Lincoln Squadron was accomplished--was "Time is of the essence; costs are of no consequence; meet the scheduled dates!"

17. Certain specific items which caused greatly increased costs under the speeded-up "concurrency concept":

a. Insufficient subsurface investigation -- Apparently as a result of a desire to get construction work started quickly the architect-engineers and consultants were rushed in their explorations and analyses of subsurface programs. As a result, soil borings were insufficient at practically all sites, and water pumping tests were generally inadequate. Later studies of the records have revealed that, under these hurried circumstances, a considerable amount of information which was available to the Government was not included in the bid documents and that there were mechanical and administrative errors which resulted in the contract drawings providing incorrect portrayals of underground conditions. In the early stages of construction our contractor claimed they were encountering numerous changed conditions. In most instances the Government refused to recognize that changed conditions existed and directed the contractors to stay on schedule. After further study of the records and of additional information submitted by the contractor, we have had to recognize that the contractor did in fact encounter changed conditions. In those instances, our Government estimates have had to be increased to include the fair costs for overcoming the changed conditions.

b. <u>The large number of design changes</u> -- It had been expected that there would be numerous changes to the design; however, it is very doubtful that anyone expected the changes would be so frequent or so drastic. Until the end of 1960, changes came so rapidly that it was almost impossible to keep track of them much less to estimate the cost and effect of each of them. The most serious problems introduced by design changes resulted from errors, omissions and interferences which existed in the revisions. The point here is not to be unduly critical of the design architect-engineer or the design agency; neither is there a desire to give undue weight to this factor. To the contrary, it should be recognized that errors are to be expected in plans and specifications for any complex construction project, even under the most favorable planning conditions. Due to the stress on speed in the Atlas F program, these deficiencies were much more numerous than they would have been under a normal program. (Therefore, this is an added cost factor to be recognized in the concurrency concept.) To indicate the extent of some of the changes, the silo crib had modifications which changed more than 97% of the structural steel items. They increased the number of field bolts by 55%, the weight of the structure by 38%, and the number of special connections per site from 184 to 1506. A large modification which was issued in September 1960 and is referred to as "the big mod" or "Mod 17" drastically changed structural steel, mechanical, electrical, and heating and ventilating systems. Although this modification played havoc with the contractors schedules as a result of the changes it made, our greatest problems with it were in overcoming the errors, omissions and interferences which it introduced, with resultant delays at all echelons while these problems were being resolved. Our contractor asked for clarification on 60 items in this modification in the first go-around. He ultimately asked over 175 questions concerning it. Some of the questions he raised were not resolved until February 1961, the majority of the pipe and duct hangers were modified. These changes were necessary because the hangers as designed did not fit the piping and ductwork as changed by "the big mod". Prior to issuance of the changes, many man and equipment hours were lost because the prefabricated piping would not fit the hangers. As a result, a misfit problem would idle a crew of five or six men while one man field-fabricated a hanger. If it was expected that the period of idleness would be of long duration, the men would be shifted to another item of work. However, time would be lost in this shift. As an additional result of rushed design, changes were issued on top of changes with the result that some items were changed as many as or 6 times. The numerous and rushed redesigns of the crib steel resul d in dimensional errors of such a magnitude that the crib could not ithout rework be erected in the field to meet the extremely tight tol ances which had been specified for it. As a result, much ironwork time was lost or fruitlessly expended in attempting to fit up n compatible members and in making field revisions to the steel nbers on a "cut-and-fit" basis. Validation of the resultant field ut-and-fit" crib was extremely difficult and erratic; it accoun for an unforeseeable and high added cost.

c. Need to e identical structures throughout the program -- On a normal constructi job interferences between systems would have been overcome by rerou g conduit, piping or duct work without appreciable effect on work. In the missile program it was necessary to refer a problem of s nature to a central agency in order to be sure that a field fix ld not conflict later with other portions of the program. As a res , crews frequently had to sit and wait for a decision while the foreman or superintendent climbed out of the silo, made a telephone call, and waited for a decision. Since these conditions were encountered during different stages of construction at different sites, it was impossible for an estimator using normal procedures to evaluate the air cost of a change of interferences. The normal factors of cost per unit of work--such as, per foot of weld or per ton of steel erected--have no application in this situation. The additional costs resulting from the crib steel change had a tremendous impace as a result of varying states of fabrication, delivery or erection of materials and equipment at the time the changes hit the contractor. It was necessary for both the contractor and the Government to determine the status of thousands of items, many of which had to be scrapped at a total loss. It was obviously impossible to estimate the cost of a crib steel change until it was determined which members had been fabricated, which ones had been transported to the site, which ones had been installed and had to be removed at additional cost, which ones were reusable with rework, and which ones had to be totally scrapped and transported from the site at an additional cost as well as the costs to sort through the steel and segregate the members into the various categories, the costs for field rework of some of the items and the costs of round trip transportation and rework of some of the items at nearby steel plants. One contractor was directed to accomplish re-fabrication of many crib steel items on an accelerated basis. In order to meet the time requirement, his steel supplier had to sub the changed work to [illegible] fabricators instead of only the one which had done the original work. As would be expected, the increased problems of administration and supervision as well as the handling of smaller lots by each sub resulted in much higher costs than would be normal. Furthermore, a considerable amount of this steel had to be shipped and reshipped between points as far apart as Houston, Texas, and Chicago, Illinois, so the shipping costs increased crazily. Some people are inclined to think of our project as one job. Actually, it was 12 projects in 12 widely scattered areas. When a problem arose which caused a crew at one silo to become idle, it was frequently impossible for the contractor to put the crew to work at another silo. Even when he could, there was a considerable additional cost involved due to the time required to stop work at one silo, gather up and load gear, transport the men to the new site and set up for work there. The time that the work would be done might be dependent on the delivery of certain materials. The difference in cost as to whether a certain scaffold would be available or the accessibility of the work would be dependent on the progress of other work introduced items for which the estimator could only enter his best guess. Later investigations into the conditions which existed and information provided by the contractor's negotiators frequently required upward revision of the estimates. If scaffolding had been removed prior to installing the new work, the costs increased either because the scaffolding had to be moved again into the restricted areas involved, reerected, torn down and removed or ladders had to be used to avoid interfering with other trades, with resultant less efficient work by the journeymen and the added cost of a non-productive man at the foot of the ladder. Another example involved the Government estimate for relocating one pipe hanger, removing one pipe hanger and adding one pipe hanger at each silo. It was not known by the estimator until negotiations were started--

and the information was verified by Government personnel--that pipe insulation had already been placed and that it had to be removed and replaced due to the changes.

d. Time compression prevented assembly line production-- Costs increased above those no ally expected because the contractor wasn't able to obtain the inc ed efficiencies which result from employees doing a job repetitive As changes were directed or changed conditions were encount d which caused crews to have to remain longer at a silo, the ractor had to add additional crews and equipment and in order to m the time requirement.

e. Reduced iciencies -- As work was added for accomplishment within a given ti frame, contractors were required to accelerate construction by using or more of the following:

(1) I ased number of crews.

(2) I ased crew size.

(3) I ased hours per shift.

(4) I ased number of shifts.

(5) I ased work days per week.

(6) I ased quantity of equipment assigned to project.

(7) ased number of items of work being performed simultaneously at ea te.

The result of each o se operations was generally decreased efficiency due to su ctors as hiring less efficient journeymen, paying additional p wages, increasing supervision problems, increasing interfer between members of different crafts and lower production during h of darkness. The net result, of course, was a greater cost for a given unit of production. Such cost increases would have resulted on the best planned and supervised projects and are over and above the added costs resulting from crews waiting idly for decisions. For example, when a 7-day week is worked and the men get money in their pocket as a result of high overtime wages, they take "days off" without advance warning. Normally, they take these "days off" on the regular pay days of the week and work over the week-end at overtime rates. An additional cost was involved on our jobs because it was necessary to increase crew sizes in order to maintain normal production crew units on those days when some of the workers took their "days off". An item difficult to evaluate from an efficiency standpoint was the morale effect on a conscientious worker when he was stopped halfway through an intricate installation with the demoralizing order to tear it out and do it another way; nevertheless, it is certain that the effect became appreciable after workmen had to tear out their work and reinstall it several times.

f. Access to the structures and limited available space caused interferences between trades -- Efficiency of work was reduced with resultant increased costs as more workmen were employed in the restricted spaces available in our structures. Access to the work was limited and storage space was practically non-existent. The job had to be fed by equipment down the center or by handcarry down the entry tunnel through restricted spaces and down the spiral stairway. During the time the silo cap and doors were being formed, poured and cured, the entry tunnel was the only access. This situation is in contrast to the normal multi-story construction job where materials may be fed to the workmen by cranes from all sides of the structure and where elevators are available to transport tools, supplies and small materials. Space was so limited in the silos that movement of large items blocked workers on all systems. After the control cabinets were installed on silo level 3, all material introduced into the silo or removed from it which wasn't handled by crane through the silo door required hand-carrying through a 30-inch space. The interference to workmen working on these cabinets as materials and tools were carried past them and the delay to other workers attempting to move past this bottleneck--and other similar ones--were impossible of exact determination. As a result of these interferences and limited access factors, changes which were directed on one system had an effect (called impace by some) on allof the work being done in the silo, some of which was unchanged work and some of which was work changed by other modifications. It has been extremely difficult to evaluate the fair and reasonable cost for overcoming this effect of the many changes.

g. <u>Acceleration of changed work required acceleration of unchanged work</u> -- The changed work was so extensive and so intermingled with the unchanged work that it was necessary for the contractor to accelerate all of the work. It was totally impossible for him to accelerate only the changed work. A delay in one feature of work affected all follow-on work. Under the requirement for accomplishing more work in a given period of time, a delay in an early phase of the program resulted in less time being available for follow-on trades to accomplish their work. This has been referred to as the "ripple effect" whereby each trade, in turn, had to accelerate its work with the attendant reduction in efficiencies. For example, when changes in the mechanical piping system required a longer time for accomplishment, the pipe coverers and painters were left with less time to do their work and each, in turn, had to accelerate. There is no known estimating procedure which would permit one to estimate the cost per foot of pipe installed or per hanger installed or per makeup of a pipe connection under these conditions of wastage of materials, manhours, and equipment hours. Yet, throughout most of the project the funding program was based on control estimates which were based on past cost experience on normal construction projects.

h. Increased equipment cost -- Since equipment serves labor, we have encountered the same problems in evaluating fairly equipment costs as we have encountered in evaluating fairly labor costs for accomplishing changed work. When labor efficiencies drop thereby requiring longer hours to accomplish a given amount of work, equipment usage efficiencies drop proportionately.

i. Effect of acceleration on other projects and programs -- Across the entire missile base construction program acceleration at one project had its effect on other projects. Acceleration at the Lincoln Squadron affected the I&C contractor as well as other Atlas F bases in the same general geographical area. The effect was that workers migrated to the jobs which worked long premium hours, and it was necessary in some instances for contractors to increase their premium hours in order to retain an adequate labor force and to avoid additional costs resulting from high turnover of personnel. Of course, the same problems applied at all missile sites. A contractor could not accelerate only one or a few of his silos. If he had tried to do so, he would have created a serious morale problem in his labor force and would have caused a migration of workers to the accelerated silos.

18. Although an attempt has been made above to comment on individual factors, it should be apparent by this time that it is impossible to isolate any one of these factors and to evaluate it apart from the others. The fact which we have had to contend with is the old truism, "Haste makes waste" for everyone--the designer, the construction agency and the contractor. Most of the actions taken to "buy back time" resulted in decreased efficiency of operation. The interplay between these factors caused costs to pyramid to such a degree that our best experience proved almost useless for estimating the fair value of directed changes. Many thousands of manhours have been required to evaluate the fair costs for accomplishing the work under the construction conditions which existed -- to include the status of work at the time the directed changes were issued.

CONTRACTOR'S PLAN OF OPERATION AND PROBLEMS ENCOUNTERED

1. CONTRACTOR' PLAN OF OPERATIONS

a. The con actor originally planned to conduct open cut operations simultan usly at six sites, preparatory to shafting operations which we to be done at four sites simultaneously assuming a nine hol squadron. Upon increasing the number of sites to 12, his pl included shafting at six sites simultaneously. A single shift 6-da operation was contemplated for all operations with the shift leng being generally 8 hours but varying for some crafts dependent up working agreements with Unions concerned or with practices in t industry. Exceptions to the single shift operation were that wo shifts were planned on open cut excavation, three shifts on sha mining, and a continuous three shift operation on concrete pours i olving slip forming.

b. The con acto originally proposed to open the sites on a sequence of 5, , 1, , 2, 3, 8, 7 and 9. This sequence was based upon anti pate excavation problems. Before this sequence was approved by the ntr ting Officer, he was directed to change the sequence to 1,2, , 4 5, 6, 7, 8, and 9 because of operational considerations esta she by the Air Force. The contractor strongly objected to this nu ic sequence, citing delays which would be encountered. The A For concept was later reversed. On 16 September 1960, co ractor requested that the sequence be changed to 3, 9, 6, 2, 1, 5, 4, 11, 10, 12, 7 and 8 because of delays encountered in shafting operations at certain sites. This was approved by the Contracting Officer on 4 November 1960 and remained in effect until 9 January 1961 when the contractor requested, shortly before the deadline provided in SC-65 of the contract, that the sequence be changed to 3, 9, 1, 6, 2, 5, 4, 11, 12, 10, 7 and 8 due to the fact that ten of the twelve sites had finished the excavation and were in various stages of concrete and steel erection and a firm sequence could then be established. This sequence remained in effect and has been the order in which the sites have been completed and turned over to the Air Force.

2. MAJOR PROBLEMS AND DELAYS EXPERIENCED DURING CONSTRUCTION

a. Shafting Operations: Contractor experienced delays in shafting excavation at eight of the twelve sites. At four of these, the delays were extensive and expensive, and involved two sites, 4 and 5, in which the delays were largely caused by inability of the contractor to successfully excavate through the strata of fine sand using the prescribed ring beams and lagging design. At two other sites, 7 and [illegible], the problem was essentially one of inability to control the inflow of water into the excavation. The design at these two sites called for driving a circular cut-off wall of sheet piling into clay strata underlying deep sand aquifer. The contractor never completely established such a cut-off at either site and was hampered by the inflow of water from these areas as well as from water bearing strata at lower levels throughout the course of the excavation phase. At all four sites the situation was characterized by long periods of no downward progress in the excavation because of failures to a varying degree of ring beams and lagging (or liner plate) or of sheet piling which at times threatened the imminent collapse of the entire structure.

b. Crib Steel Delivery: Before and during the fabrication of crib steel numerous modifications were issued which resulted in the contractor's supplier, Continental Emsco, Houston, Texas, falling behind in his scheduled deliveries. As a result, Contracting Officer exerted pressure which resulted in approximately one-half of the crib steel being sub-contracted by Continental Emsco to other fabricators in the Chicago area. This involved additional cost, but did result in improvement in delivery schedules over that considered feasible by Continental Emsco (who also were supplying crib steel to the Altus, Oklahoma, Atlas F Squadron). The crib steel arrived at the job site generally in time to be utilized in normal sequence. Installation and validation of the crib was time consuming and expensive due to numerous discrepancies in the design which affected assembly and rigid validation procedures established jointly between the Air Force and the Area Office, in order to insure compliance with provisions of the specifications pertaining to erection tolerances.

c. Pressure and Cryogenic Vessels: Due to a variety of reasons, delivery scheduled for the cryogenic vessels being furnished by Chicago Bridge and Iron, Chicago, Illinois, and by Southwest Welding, Los Angeles, California, indicated arrival later than originally called for in the Purchase Orders. The Contracting

Officer issued GC-5 instructions to the contractor in order to improve his delivery schedule of the cryogenic vessels. The contractor responded as the delivery schedules were considerably improved. Because of continued delays in the excavation program and of the subsequent delays in shaft concreting and crib steel erection, the vessels were on site when needed for placing in the silo.

d. Major Concrete Pours: The contractor often experienced delays in major concrete pours such as base slab, slip forming of the silo walls, and silo cap pours. The slip forming contractor, Hansen Kashner, Fresno, California, was selected on the basis of favorable recommendations of the firm's work at Vandenberg Air Force Base, from both contractor and Government sources. However, the contractor failed accomplish the desired results and was defaulted by the prim ontractor with less than 1/3 of the slip forming operations co eted. The prime contractor then took over and completed the wor ith his own forces. Difficulties in achieving validation embedded items, uncertain concrete supply including the defaul of a supplier, Crouse Ready Mix, who was furnishing concrete wo sites, and winter operations all contributed to high concreting c .

e. Backfill rations: Although Western Contracting Corporation had hist of extensive experience in earthwork operations in this r n and had an excellent reputation in this field, they experien great difficulties in placing backfill around the silo and LCC. The costs were high and schedules were not met. A marginal tability of the available materials was one factor, the construc sequence which called for placing the backfill in a comparatively small quantity at different periods in order to provide access, contributed to a generally inefficient system of backfilling. The placing of backfill under winter conditions was a large contributory factor as will be covered in more detail later. In general the resultant of winter operations was mobilization of equipment and manpower with a high percentage of standby time and attendant inefficiencies in order to take advantage of the one or two days a week in which weather conditions were suitable for backfill operations.

f. Winter Operations: In September, 1960, when it was apparent that his schedule was being disrupted by delays in the excavation phase, the contractor proposed that if he were to continue his operations on a pace which would enable him to complete the silos on the original schedule, namely the first site to be completed on 28 March 1961 and one site per week thereafter, that he be authorized to undertake certain actions which would permit him to accomplish acceptable work during winter conditions. This involved such things as importing frost free backfill material, installing drying equipment to reduce moisture content of backfill, winterizing concrete plants, and continuing the work of such crafts as Ironworkers, Carpenters, etc., during winter months with a resultant loss of efficiency. He estimated that the cost of such procedures would be approximately 10 million dollars. The contracting Officer adopted the position that although the schedule in the contract must be met, that the delays which the contractor had experienced to that point were largely the result of his own improper actions and that any costs resulting from continuing to work under winter conditions

a. Supervisory Personnel: Affecting to some degree each of the categories presented above has been criticism by the Contracting Officer of the contractor's supervision and management. This has been reflected in the correspondence mentioned in the previous section, in the Interim Contractor Performance Ratings prepared by the Area Engineer, by the daily logs of Inspectors and Resident Engineers, etc. These all pointed out contractor's failures to staff with adequate numbers or quality his central project office in Lincoln, his organization at each of the twelve sites, or the establishment of an intermediate echelon between the sites and the project office. They noted the centralized authority (which could also be noted in the case of the Corps personnel) and lack of delegation to individuals at the site and frequent failures of personnel at site level to react quickly to changing conditions or to coordinate the work of several crafts working simultaneously. The contractor's position in reply to the criticism was based on the interpretation of his original plan of operations which contemplated a sequential operation rather than concurrent operations at all sites, his inability to attract adequate numbers of supervisory personnel in spite of numerous efforts to do so, the Union requirements to furnish foreman level supervisors rather than selection of such individuals by prime contractor, the desire for standarized construction at each of the twelve sites which dictated a strong central control, and the various disruptions to planning orderly job progress which resulted from the numerous and frequent changes to the work directed by the Government.

b. Responsiveness: Contrary to criticism of his management of the work in the field, contractor is to be commended on his desire to complete the job, his willingness to expend large sums of money without definite reassurance of reimbursement, the care in the selection of his subcontractors and suppliers and the efficient manner in which materials and equipment were delivered to the job site.

5. IMPORTANCE OF MODIFICATIONS

A total of 107 modifications and 108 field orders were issued under this contract and have been reduced to 177 separate written notices to proceed. One modification and/or field order encompasses from one to many changed items of work. These changes were of great magnitude and affected the major portion of the crib steel, mechanical, electrical and related items in the silo making much of the operation essentially new work. Changes affected 324 of the original 476 pages of the specifications and included 1,244 new drawings compared to the original 355 drawings. These changes affected about 80 percent of the structural steel, increased the number of field bolts by 5[illegible] percent, increased the weight of the silo crib by approximately [illegible] percent and increased the number of special connections from [illegible]4 to 1,506 per site. They further modified 94 percent of the mechanical piping work, increased the numbers of spools by 190 percent and modified numerous manufactured items, for example, one piece of electrical control equipment was changed eight times, the last being only three weeks prior to the contract installation date.

CRIB STEEL CHANGES

The following presents a condensed and detailed explanation of the major changes of design affecting the silo crib steel and the associated Supplemental Design drawings.

The design drawings were completed and the district issue was made on 13 January 1960. At that time, it was known that the Weapons System GSE had not been fully developed, especially in the Launcher Platform area. The construction scheduling was such that facility design could not wait, and the philosophy of concurrency was adopted. Therefore, the facility contract was awarded on 15 April 1960 with full prior knowledge, by all parties, that certain changes in the structural design would be inevitable.

Six major changes have been made to the crib steel as follows:

1. First Design Change - Addendum

A major overall resizing of the floor members was made, and certain members in the drive base and tension equalizer areas were marked "HOLD." This was an Addendum of the original contract, and the Contractor's bid reflected this change. This status will be referred to as the Basic Crib whenever the affect of later changes are evaluated.

2. Addition of L/P Downlock - C. O. # 157 - Mod. 3

Minor floor member changes, addition of the Launch Platform downlock frame and the completion of the suspension bracket design were made on Change Order No. 157. The addition of the downlock frame was a change in the class or type of work; however, the heavy, welded box members were evaluated separately from the Basic Crib. The only direct change to the Basic Crib was the addition of holes in the columns to receive the downlock. All this material was included in the original issue of the Supplemental Design drawings.

3. Missile Enclosure Bracing - C. O. # 168 - Mod. 4

A general rework of the crib top, changes to some floor members and the addition of rod bracing in the missile enclosure framing constituted Change Order No. 168. The addition of this bracing increased the erection time, but had little affect on fabrication, since these rods and fasteners are usually purchased items from a specialty manufacturer. Pin plates for the connections of these rods were added to 22 members of the Basic Crib. All this material was included in the original issue of the Supplemental Design drawings.

4. Exterior Truss - C. O. # 181 - Mod.6

Levels 4 and 5 of the crib were reworked as a result of problems discovered in a computer analysis of the structure, resulting in Change Order No. 181.

From experience with the fabricators preliminary shop drawings at OSTF-2, the vertical truss and the three-dimensional joint connections were found to be difficult for the detailer to correctly interpret. By rearranging the floor system on the design change, the number of special or difficult connections was reduced 50 percent. By using 1-inch bolts, the size and complexity of these connections was further reduced. All material and design was included in the original issue of the Supplemental Design drawings.

5. Suspension Bracket

As the result of a change to the shock strut hangers, first required at OSTF-2, a redesign of the crib suspension bracket was made, allowing a large reduction of steel tonnage. This design change was included in the original issue of the Supplemental Design drawings.

6. Otis Elevator

After a ruling on the Otis Elevator contract by the Kansas City Corps District Office, the elevator support steel, guides, and miscellaneous framing were added. Minor changes were made at this time to Levels 5 and 6 to support the diesel-generator. This was issued as a Change Order and added to the Supplemental Design drawings on the 25 July 1960 revision.

Early in the program, the Air Force realized the problems inherent in allowing each contractor to make shop drawings for the structural steel. Much of the problem would be in the time lost by the fabricator's preparation of the shop drawings and the time delay in checking the details. All the drawings would have had to be checked against the design for structural adequacy; as well as clearance with piping, H.V. and A.C., electrical conduit, equipment, GSE and other items not fully developed. To alleviate the problem and to expedite steel fabrication, it was decided to furnish the contractor a standard set of shop details or Supplemental Design drawings. The specifications (Section 22-06) were changed accordingly, notifying the contractor of the Supplemental Design drawings to be furnished, and also relieving him of the responsibility for error in the detailing of this steel.

The LCC crib and floor plate detail drawings were prepared and issued as part of the design drawings for that portion of the work. This was done as part of the original contract. The contractor was notified that the silo-crib Supplemental Design drawings would be furnished at a later date, and no fabrication could be started until the drawings were issued.

With the accelerated schedule at Vandenberg AFB, OSTF-2, it was planned to reissue the Kaiser Steel shop drawings for the other bases. Subsequent to the third design change, Change Order No. 168, Bechtel undertook the task of furnishing the Supplemental Design drawings. The Kaiser Steel shop drawings were reworked before the reissue because the crib at OSTF-2 is not identical with the crib of the operational bases, and a certain amount of rework and alteration of the drawings was required. The Supplemental Design drawings were issued in two packages, one 11 May 1960, and the other on 13 May 1960. Subsequent to these issues, certain drawings were revised to correct items carried over from OSTF-2 in error; discovered by a C of E back-check review, and reissued on 25 May 1960. The revised set was then sent out as the original ussue for Lincoln AFB (dated 26 May 1960).

After making the first issue, Bechtel was directed to have the Supplemental Design drawings checked by an outside agency. American Bridge Division of U. S. Steel undertook this check on 16 May 1960, and completing their work about 10 June 1960. The drawings were checked for adequacy, completeness, correctness, general good shop practice and ease of erection. After this check, 146 drawings were revised. Minor girt changes and detail, dimension and connection revisions were made to avoid fabrication and erection delays. These revised drawings were issued 28 June 1960.

When Kaiser Steel began to fabricate the crib for Schilling AFB many additional errors were reported. American Bridge Division at Orange, Texas, also reported many of the same errors. When the Supplemental Design drawings were revised to include the addition of the Otis elevator framing and the diesel-generator change, the correction of these discrepancies was incorporated in the package. This issue of 110 drawings was made on 25 July 1960.

As previously stated, all of the design changes were included in the original issue of the Supplemental Design drawings. This was done as a matter of expediency, since all these changes had been authorized but their issue on the contract drawings was scheduled for a later date. In general, this was true of all issues of the Supplemental Design drawings until the 8 September 1960 issue; after which time the Supplemental Design and the contract drawings accurately reflect each other. All subsequent issues of the Supplemental Design drawings were issued to reflect the previously issued contract drawings and, where required, to correct any errors or discrepancies reported by the fabricators through official channels. A total of 348 sheets were reissued and over 250 changes initiated at field level during erection of the crib, to correct the design deficiencies.

Notwithstanding the vigilance with which the structural design drawings were continually reviewed and corrected through field change order conferences for apparent discrepancies, there still remained a number of members and systems with small dimensional errors which materially effected the final validation of the crib by the Using Agency. A study of such beams and systems is attached for the record.

ERECTION OF CRIB STEEL

RESUME OF DAY-TO-DAY ACTIVITIES IN
THE ERECTION OF CRIB STEEL AT
SITE 7, NEAR YORK, NEBRASKA

16 January 1961, Western Contracting Corporation ironworkers started to assemble crib steel falsework in storage area. Falsework arrived on site at 2000 hours 14 January 1961. Contractor erection superintendent informed me on 16 January that erection will be carried out by two nine hour shifts. Day shift had 14 ironworkers and nite shift had 3 ironworkers.

17 January: Continued to assemble falsework and began lowering same into the silo. Assembling crib steel sections in storage area.

18 January: At 0500 hours water and sand washed through the collimater blockout into the silo bottom. Erection of crib steel will be delayed until bottom of the silo is cleaned out. Validation of crib falsework was delayed. Cause of washout---contractor was excavating for site tube at the collimator blockout and supports gave way.

19 January: Continued cleaning up and mucking out silo bottom. No crib steel erection.

20 January:- 21 January: Continued mucking out the silo bottom. No crib steel erection.

22 January: No activity.

23 January: Removed crib steel falsework from silo bottom to clean it up. Reset crib falsework on pedestals. Day shift--14 iron workers, night shift--3 ironworkers. Talked with erection superintendent this date; told him that if we were to increase production more men are needed on the night shift.

24 January: Ironworkers continued installing temporary crib falsework on both day and night shifts. 14 ironworkers on day shift, 3 ironworkers on night shift.

25 January: Continued installing falsework. Western survey party began checking falsework. 14 ironworkers on day shift. 3 ironworkers on night shift. Western survey party and Convair completed checking falsework on night shift.

26 January: Ironworkers started erection of crib steel installed 8 columns for levels 8 and 7. Day shift--12 men. Night shift--14 ironworkers; installing beams level #8.

27 January: Ironworkers installing column connection beams levels 8 and 7 on both shifts. Day shift--16 iron workers, 3 foremen. Night shift--16 ironworkers, 3 foremen.

28 January: Continued installing crib steel beams and bracing levels 8 and 7. Began bolting connections. Day shift--15 men, 3 foremen. Night shift--18 men, 3 foremen. Also installed blast door in silo vestibule and placed bridge across silo top.

29 January: No activity.

30 January: Ironworkers installing crib steel structural members, and permanent ladder between levels 7 and 8. Began plumbing columns between levels 8 and 7. Day shift--21 men, 3 foremen, night shift--16 men, 3 foremen.

31 January: Ironworkers plumbing collumns level 7 and 8, and erecting cross members. Day shift--19 men, 3 foremen. Night shift--18 men, 3 foremen.

1 February: Plumbing crib columns and torquing bolts on level #8. Day shift--19 men, 3 foremen. Night shift--12 men, 3 foremen.

2 February: Torquing bolts on level 7, assembling columns above ground to be placed above level #7. Plumbing columns and drilling holes in silo concrete for temporary crib bracing. Day shift--17 men, 3 foremen. Night shift--14 men, three foremen.

3 February: Plumbing and leveling steel on level 8 and torquing bolts level 8. Began assembling guy derrick for PLS vessel installation. Western survey party checking steel. Day shift--22 men, 3 foremen. Night shift--11 men, 3 foremen. Survey party 4 men.

4 February: Torquing bolts levels 8 and 7B and assembling guy derrick. Convair optics team and C of E site engineer validated level #8 for orientation and elevation. Day shift--23 men, 6 foremen. Night shift--10 men, 3 foremen.

5 February: No activity.

6 February: Torquing bolts levels 7A and 7B. Assembling guy derrick. Day shift--13 men, 4 foremen. Night shift--11 men, 3 foremen.

7 February: Ironworkers torquing bolts levels 7, 7A, and 7B. Contractor survey team checking elevations and orientation. Convair optics team validated levels 7, 7A and 7B. Began erecting steel levels 4, 5 and 6. Day shift--17 men, 4 foremen. Night shift--11 men, 3 foremen.

8 February: Started setting PLS vessels this date. (Day shift operation only.) Ironworkers erecting crib steel levels 4, 5, and 6. Day shift--11 men, 2 foremen. Night shift--12 men, 3 foremen.

9 February: Continued installing PLS vessels on day shift. Bolting crib steel levels 4, 5, and 6. Day shift--17 men, 3 foremen. Night shift--10 men, 3 foremen.

10 February: Continued setting PLS vessels on day shift. Installing beams and bolting same, levels 6 and 5. Day shift--16 men, 3 foremen. Night shift--10 men, 3 foremen.

11 February: Completed setting PLS vessels at 0930 hours this date. Ironworkers installing cross beams levels 6, 5 and 4, and bolting same. Day shift--15 men, 3 foremen. Night shift--12 men, 3 foremen.

12 February: No activity.

13 February: Began setting columns from pile #1. Torquing bolts at level 7 on cross members installed after PLS vessel were set. Torquing bolts level 6. Day shift--14 men, 4 foremen. Night shift--11 men, 3 foremen.

14 February: Installing rods and structural members levels 4, 5 and 6. Began setting columns levels 3, 2 and 1. Day shift--14 men, 3 foremen. Night shift--11 men, 3 foremen.

15 February: Bolting up connections levels 4, 5 and 6. Welding box girders. Day shift--15 men, 3 foremen. Night shift--11 men, 3 foremen.

16 February: Ironworkers bolting up on levels 4, 5 and 6. Attempting to orient level 5. Installed spiral staircase levels 7 to 3. Day shift--15 men, 3 foremen. Night shift--11 men, 3 foremen.

17 February: Bolting up level 4. Western survey party helping orient level 4. Day shift--20 men, 4 foremen. Night shift--no activity due to snow.

18 February: No activity due to snow. Left job at 1000 hours. Night shift no activity.

19 February: No activity.

20 February: Bolting up level 4. Welding temporary bracing to maintain orientation. Tack welding handrail on spiral staircase. 26 men, 5 foremen working.

21 February: Ironworkers bolting up and installing grating level 7. 29 ironworkers and 5 foremen working.

22 February: Bolting up levels 4 and 5, torquing bolts level 6 and installing grating level 7. 29 ironworkers and 6 foremen working.

23 February: Bolting up levels 4 and 5, torquing bolts level 6 and installing grating level 8. 29 ironworkers, 6 foremen working.

24 February: Installing grating level 8, torquing bolts level 6 and bolting up level 4. 33 ironworkers, 7 foremen working.

25 February: Bolting up levels 4 and 5. Torquing column splices below level 6. Western survey crew and Convair optics team checked level 6 for elevation and orientation and reported it within specifications. 34 ironworkers, 6 foremen and 3 in survey party working.

26 February: No activity.

27 February: Ironworkers torquing bolts level 5, welding lower shock support brackets on the Y axis, assembling grating level 6.

28 February: Torquing bolts levels 5 and 6, installing grating level 8. Western survey party and Convair optics team checked and validated level 5 for elevation and orientation. 36 ironworkers, 7 foremen working.

1 March: Torquing bolts level 4. Installing intermediate beams level 4 installing grating levels 6 and 8. 24 ironworkers, 7 foremen, 3 in survey party working.

2 March: Bolting up level 4, installing grating and checker plate levels 6 and 8. Survey party checking orientation of level 4. 28 ironworkers, 7 foremen and 3 surveyors working.

3 March: Bolting and torquing levels 3, 4 and 5, installing grating level 8 and floor plates level 4. 25 ironworkers, 7 foremen, 3 surveyors working. Convair optics team validated level 4.

4 March: Bolting up levels 4, 5 and 6. Began setting iron level 3. Torquing bolts levels 6 and 5. Welding grating level 8. Convair optics team validated level 3 for orientation and elevation. 28 ironworkers, 7 foremen, 3 surveyors working.

5 March: No activity.

6 March: Bolting up levels 3 and 4. Torquing level 5. Welding crib steel to suspension brackets. 27 ironworkers, 8 foremen, 3 surveyors.

7 March: Torquing bolts levels 4 and 5, installing grating level 6, welding crib to suspension brackets. 29 ironworkers, 7 foremen, 3 surveyors.

8 March: Ironworkers torquing bolts level 3. Installing grating levels 3, 4, 5 and 6. Welding crib to suspension brackets. 25 ironworkers, 7 foremen and 3 surveyors working.

9 March: Plumbing crib suspension system, installing grating levels 4 and 5, welding checker plate level 8. Welding plates on shock hangers. Began installing lifting jacks. 29 ironworkers, 8 foremen, 3 surveyors.

10 March: Plumbing crib suspension system, installing grating levels 4 and 5. Cutting temporary supports for columns loose. 30 ironworkers, 9 foremen, 3 surveyors.

11 March: Preparing to jack silo crib, installing grating and checker plate levels 3, 4, and 5. The base of the vertical crib lock on the - Y axis was found to be out of square at the bottom requiring wedges to be installed to provide proper bearing surface. Delay of approximately 1 day. 29 ironworkers, 8 foremen, 3 surveyors.

12 March: No activity.

13 March: Ironworkers jacking and hanging silo crib. The jacking operations were started at 1030. The crib was hung and validated for orientation and elevation at 1540 hours. Welded braces from columns to silo wall at levels 4 and 8. 15 ironworkers, 4 foremen, 3 surveyors working.

14 March: Ironworkers removing jacks and temporary crib falsework. Installing checker plate levels 3 and 4. 17 ironworkers, 4 foremen, 3 surveyors working.

15 March: Removing temporary crib falsework, installing floor grating levels 3, 4 and 5. Installing detail steel levels 4 to 7. 17 ironworkers, 4 foremen, 3 surveyors working.

16 March: Crib falsework removed. Removed temporary bracing from columns, installing floor grating levels 3 to 8. 18 ironworkers, 4 foremen, 3 surveyors working.

17 March: Installing raised platform level 3 and crib steel levels 1 and 2. Preparing to install counterweights. 17 ironworkers, 5 foremen, 3 surveyors working.

18 March: Installing crib steel level 1, bolting steel levels 1 and 2. 19 ironworkers, 5 foremen, 3 surveyors working.

19 March: No activity.

20 March: Installing crib steel levels 1 and 2. Western survey party and Convair optics team began checking levels 1 and 2 for elevation and orientation. 19 ironworkers, 5 foremen, 3 surveyors working.

21 March: Torquing bolts levels 1 and 2, installing detail steel all levels. 21 ironworkers, 5 foremen working.

22 March: Torquing bolts level 1, installing floor plate levels 3 and 4 and grating level 8 and temporary counterweight support. Convair optics team validated level 2 for elevation and orientation. 20 ironworkers, 5 foremen working.

23 March: Torquing bolts levels 1 and 2, installing detail steel and counterweights. 16 ironworkers, four foremen, 3 in survey party working.

24 March: Torquing bolts level 1 setting spiral stairway, installing checker plate level 8. Convair optics team validated level 1 for elevation and orientation. 15 ironworkers, 4 foremen, 3 surveyors working.

25 March to 24 April 1961: Installing detail stool, floor plate and grating. Adjusting diagonal brace rods, setting drive base and completing spiral stairway.

CONCRETE SILO CAP

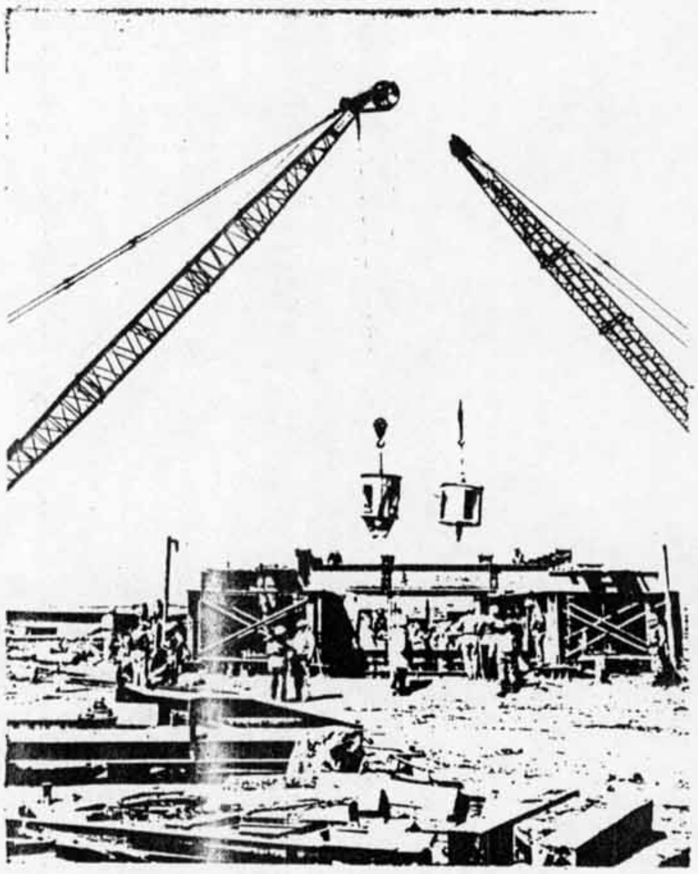
The caps were poured over the open center of the silo on a floating form system designed with a heavy beam supported deck suspended from four built-up girders resting on the 18-inch concrete collar of the wall structure, all as diagramed on the "Overhead Girder Plan" and the "Deck Beam Plan", attached.

A stress analysis of the system indicated a maximum defection of approximately 1-inch along the major girders as resulting from the superimposed load of the wet concrete on the floating deck. Therefore, the hanger rods were adjusted accordingly to induce a slight camber in the deck which would resolve to a neutral chord under full dead load of the cap.

The concrete was placed pyramidally with two cranes handling 2-yard buckets starting at the center of gravity and working outward in a balanced load. This helped stabilize the suspended form system by producing the maximum deflection prior to the critical stage in the initial set of the green concrete. This construction programming and control greatly reduced the loss of bond resulting from movement of the green concrete along the steel reinforcement and the development of a shear zone at the point of rotation between the floating deck and the solid shoulder of the silo wall.

The rate and distribution of concrete placement and the deflections on the form system are shown graphically in the attached series of prints. (Annex S)

The 9'-0" thick mass of concrete was poured with a 6 1/2 sack design mix using Type II cement and was well insulated from atmospheric cooling by the 18-inch collar around the perimeter, a polyethylene sheet and sand cover over thetop and the 2-inch wood planking under the floating section. The heat of hydration was checked and recorded with a complex of thermocouples buried in the concrete. A representative time-temperature graph is filed in attached illustrations.



Two cranes each handling 2-cubic yards in placing concrete.

BACKFILL PROBLEMS

The problem of backfill was one of considerable concern to the Corps. Because of the Corps' extensive experience in earthwork, it was of special consideration and especially so because of the time of year in which a substantial portion of this work was to be accomplished.

The matter was given special attention by the Area Engineer. Special meetings were held on this particular subject. A symposium was held on 10 April of 1961 when some 40 members of the Area organization were in attendance.

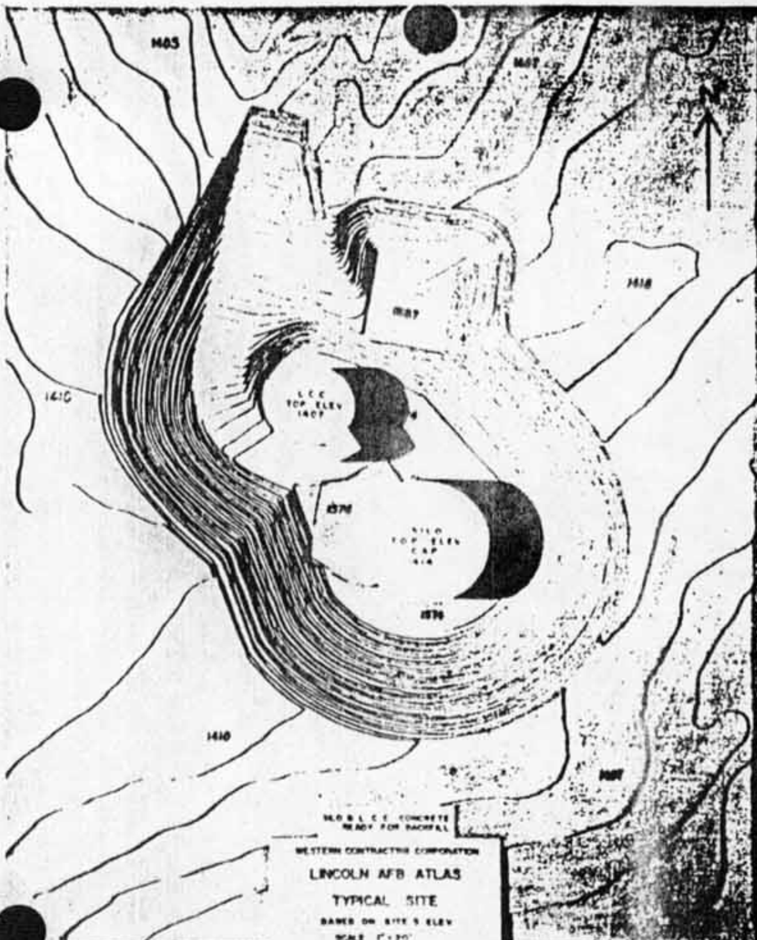
The subject matter of this meeting is contained in Annex G.

Because of the concern at the various Squadron Areas, an OCE Soils Team visited the various areas. It was at the Lincoln Area on 12 and 13 June 1961. The results of their studies, conclusions, and recommendations are contained in a section of the report which will be found in Annex I.

METHOD OF BACKFILLING

A method for backfill operation was proposed by the Western Contracting Corporation. Their proposal was based upon a plywood model of a typical site which they photographed to show the various phases or stages.

The following three pages show the initial condition with nine stages of progress. The final one shows the desired configuration.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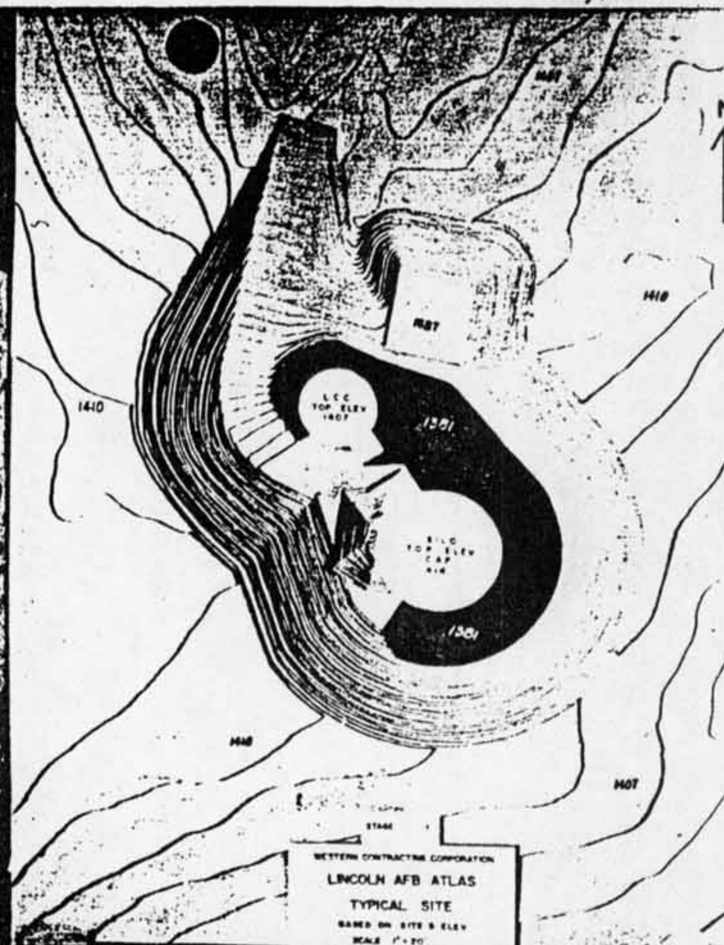
LINCOLN AFB ATLAS
TYPICAL SITE
BASED ON SITE 5 ELEV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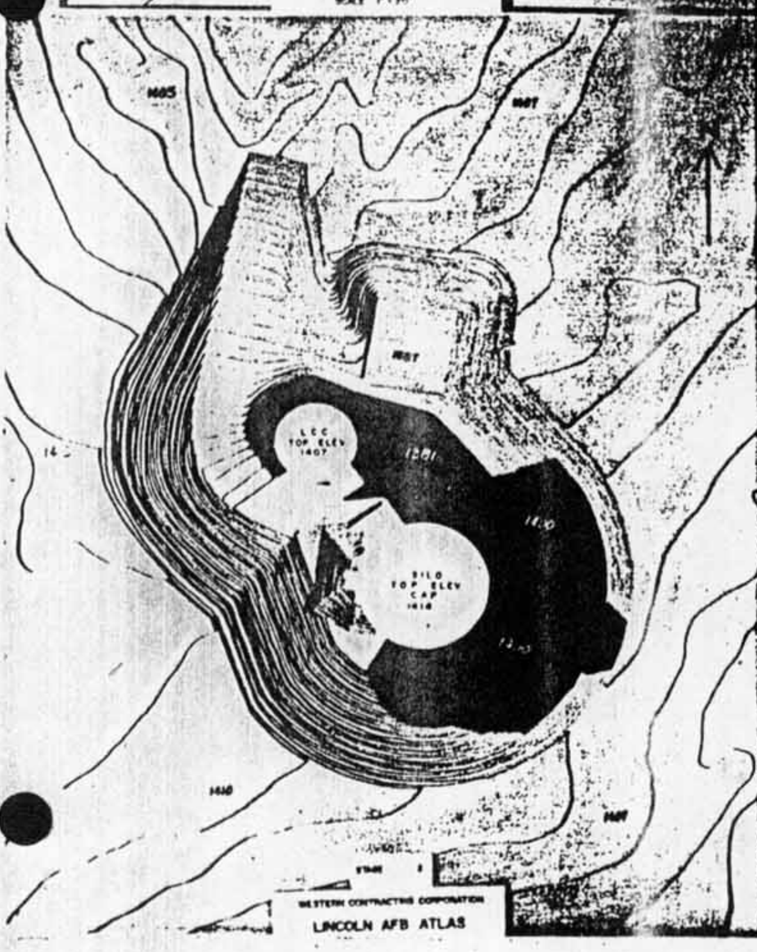
BASED ON SITE 5 ELEV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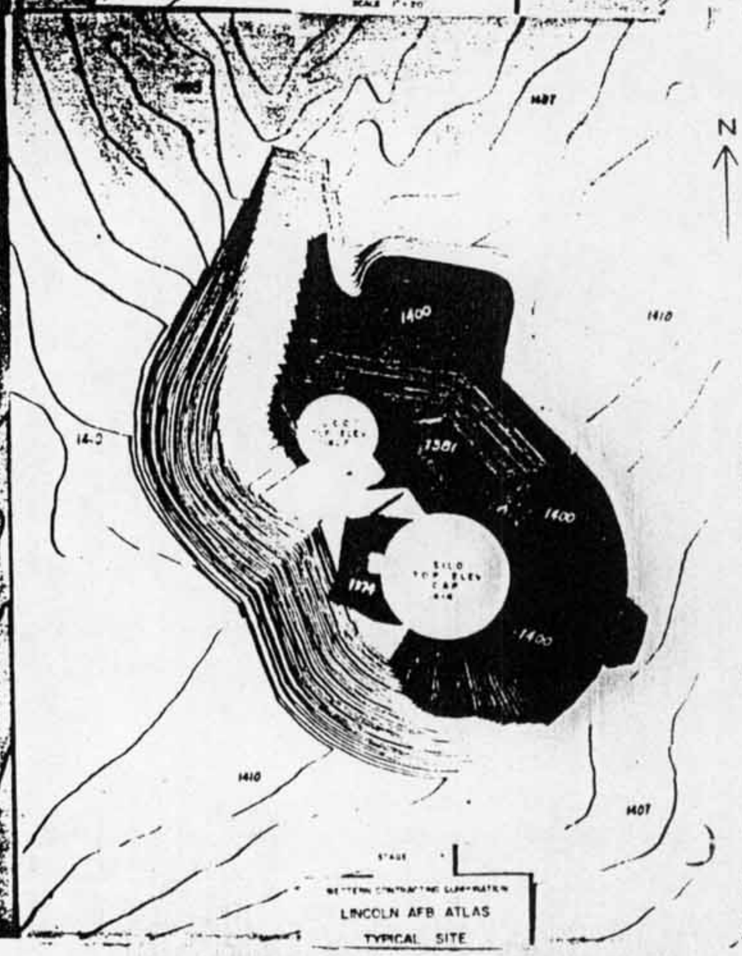
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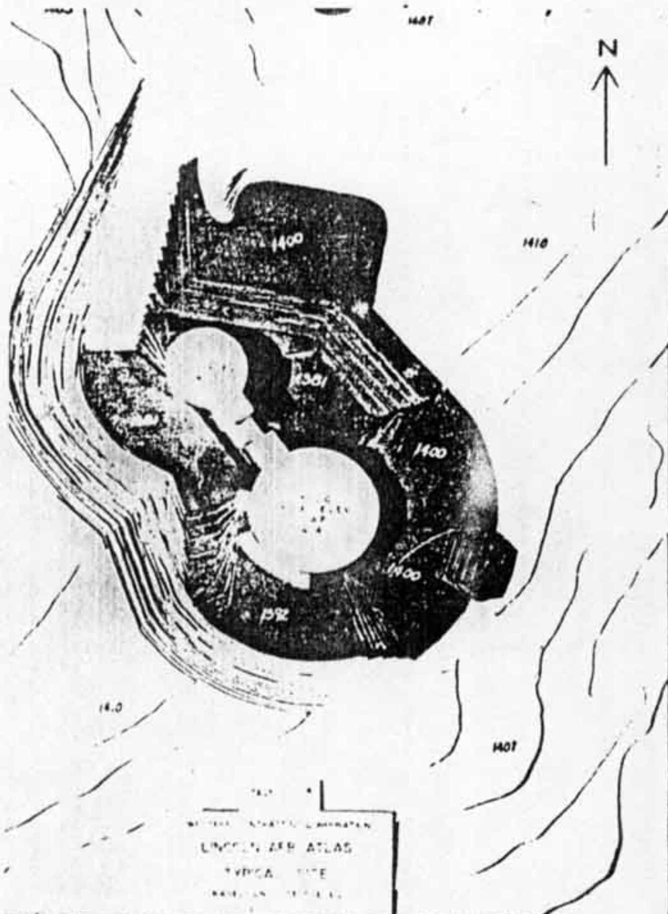
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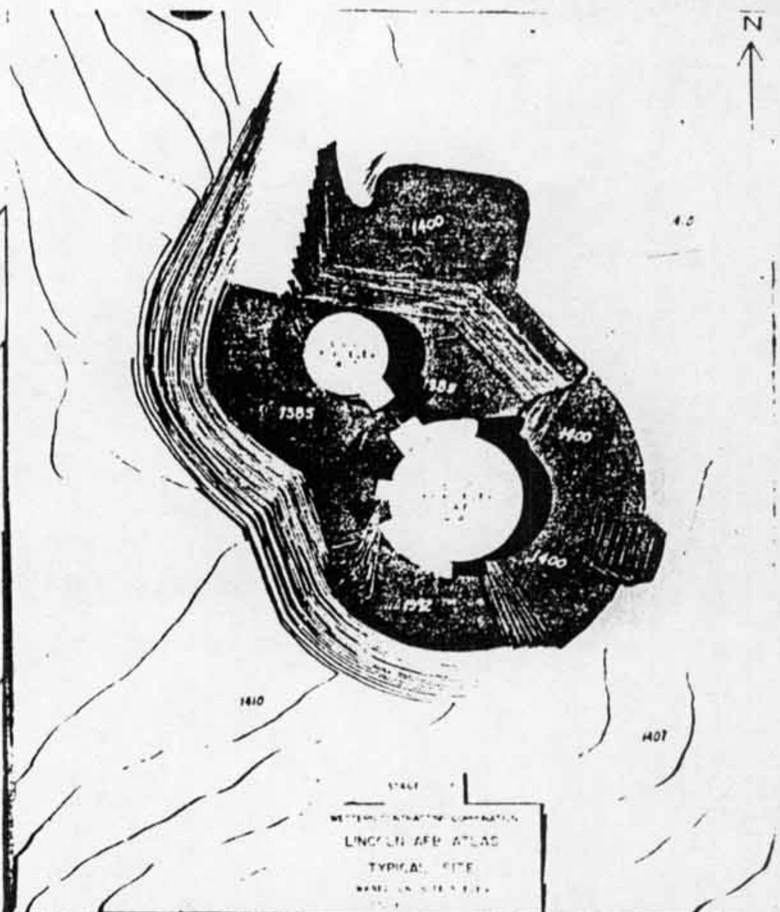
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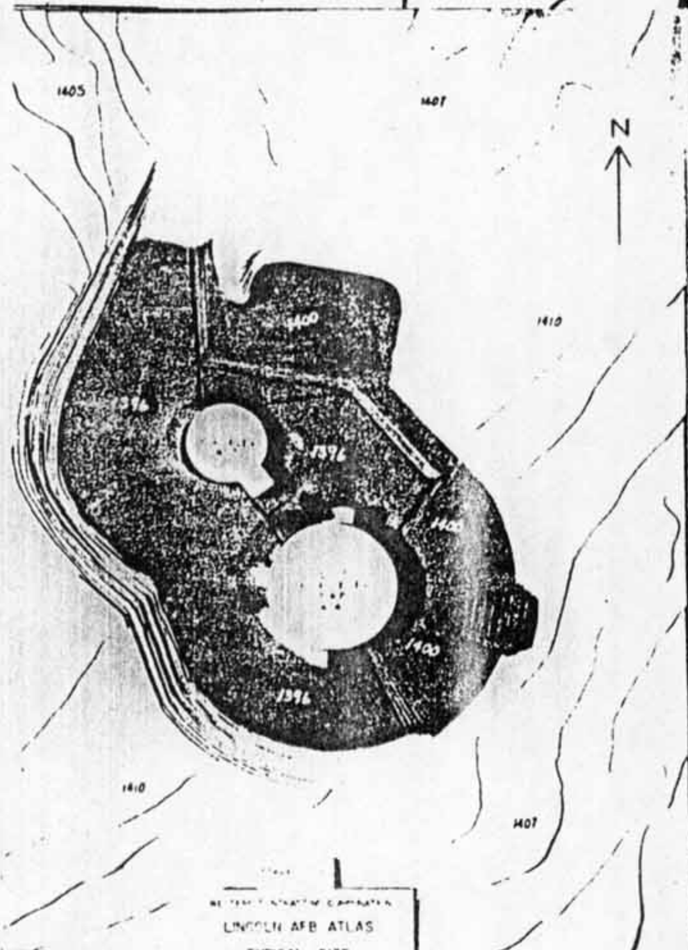
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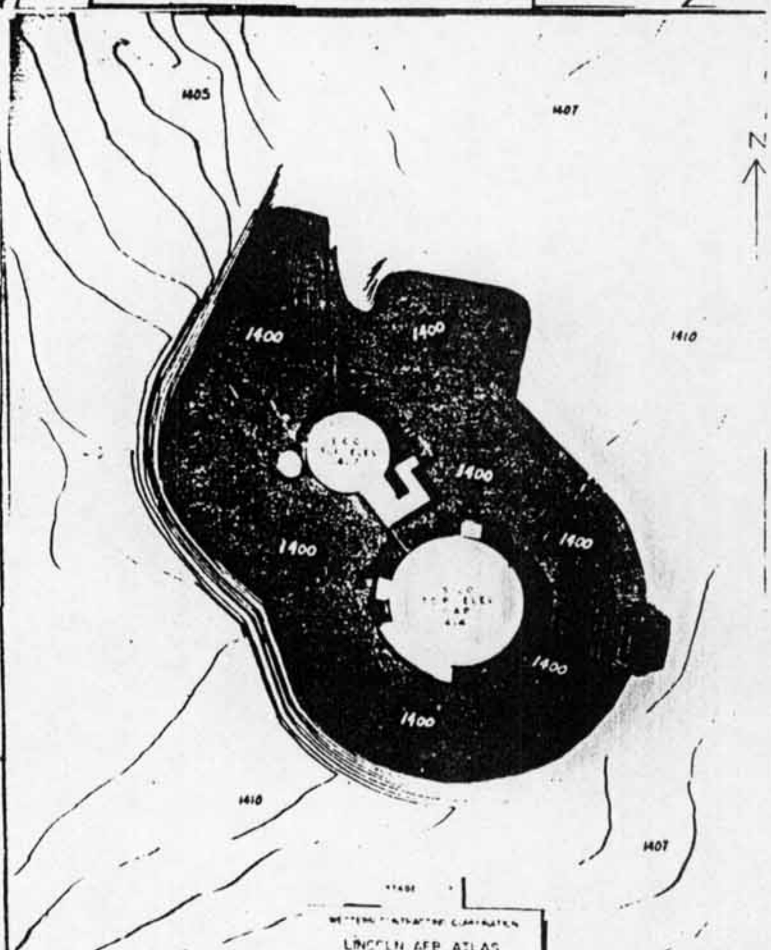
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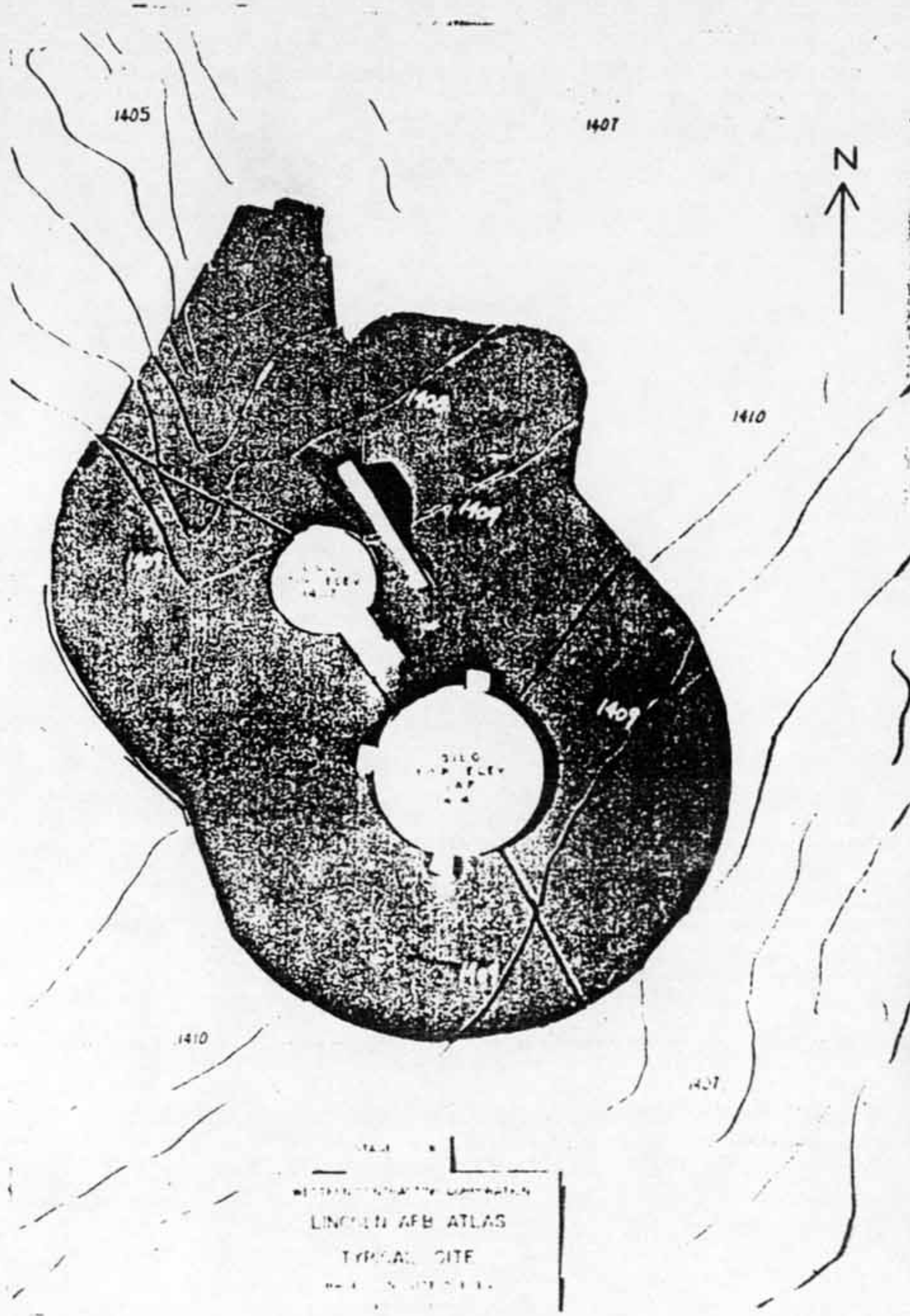
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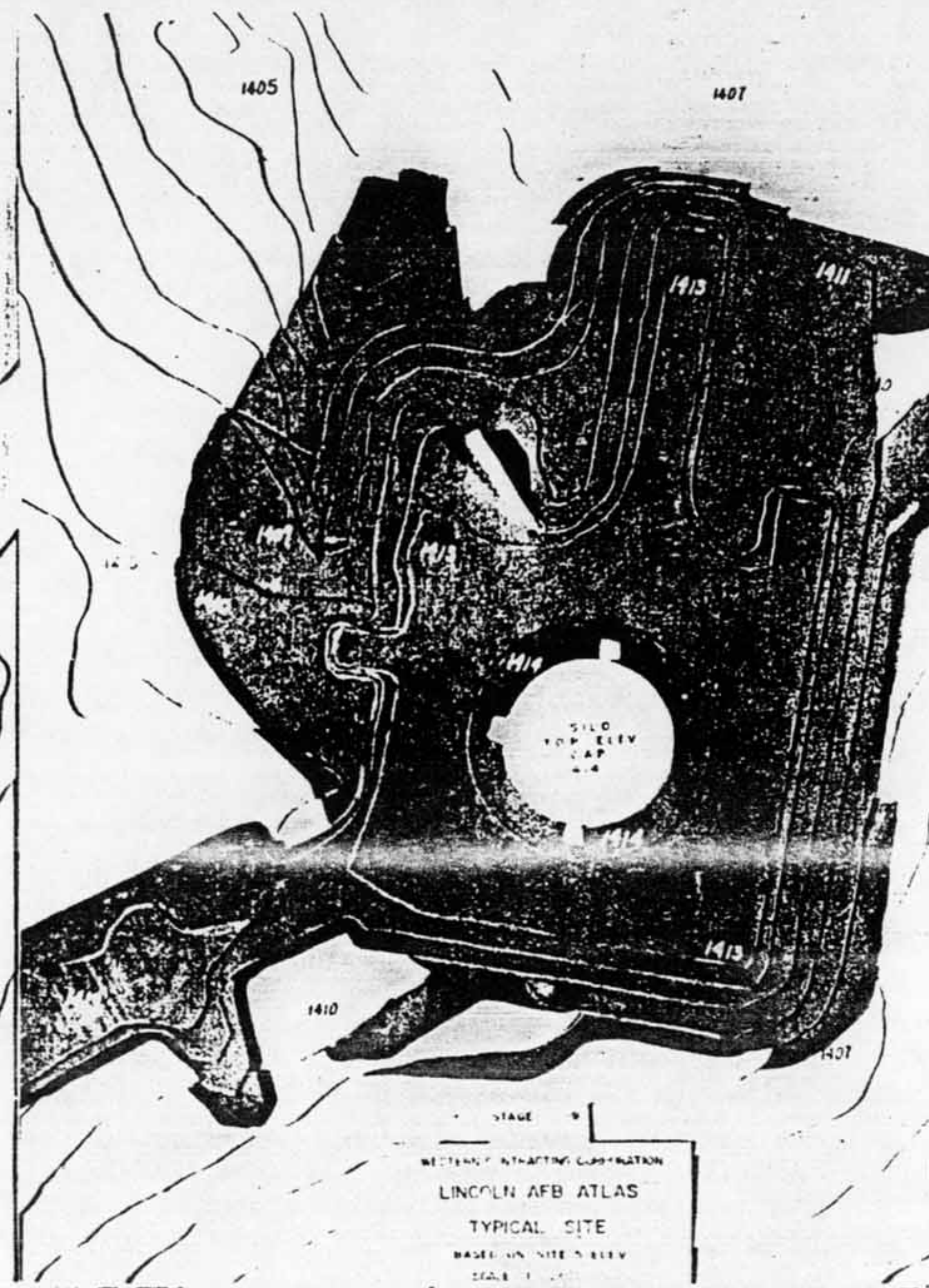
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WESTERN CONTRACTING CORPORATION
LINCOLN AFB ATLAS
TYPICAL SITE
BASED ON SITE 5 ELEV

SECTION VIII - 7

Silo Floors

7. General

a. Site 6

b. Site 7

(1) General

(2) Graph of Piezometer Readings

(3) Placement of Floor

c. Site 8

LAUNCHING SILO FOUNDATION SCHEDULE

SITE	TYPE NO.	CONTRACT DRAWING
1	1	AFBMD-1-S-2.3
2	3	AFBMD-1-S-19
3	3	AFBMD-1-S-19
4	3	AFBMD-1-S-19
5	1	AFBMD-1-S-2.3
6	1	SK-2635-S-2
7	6	SK-551-E-69-0
8	5	AFBMD-1-S-43
9	4	AFBMD-1-S-19
10	1	AFBMD-1-S-2.3
11	1	AFBMD-1-S-2.3
12	1	AFBMD-1-S-2.3

Type 1 - 6" concrete floor w/30" sand filter underdrain

Type 2 - Not used

Type 3 - 4'-0" concrete slab

Type 4 - 7'-6" concrete slab

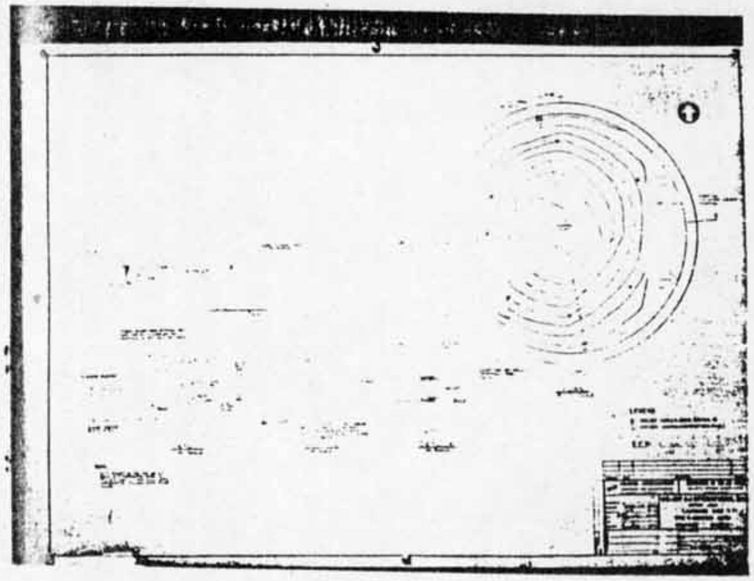
Type 5 - 5'-6" concrete slab

Type 6 - 6'-0" concrete slab

FOUNDATION SITE 6

The excavation for the launching silo at Site 6 bottomed out in a sandstone formation seamed with carbonaceous shale. A Type 1 foundation and 6" concrete floor slab with 30" sand filter sub-drain were constructed in place as the silo base.

The exploratory drilling logs did not indicate a water-bearing strata of fine sand approximately 20-feet thick underlying the floor slab at a depth of 23.0-26.0 feet. The hydrostatic pressure in this strata was sufficient to cause a shear failure in the limestone-shale overburden and dome the 6" floor slab approximately 11-inches at the sump in the center.



The Corps of Engineers drilled seven gravel-packed relief wells thru this strata for surface drainage into the sump. These wells flow at approximately 0.5 - 2.0 g.p.m. and have dropped the piezometer readings to approximately 0.75 - 1.75 p.s.i. at floor level.

The total flow from the relief wells and reduced hydrostatic head on the strata were considered live-with conditions and, therefore, a collecting system was designed to drain the water from around the perimeter of the floor slab back into the sump.

The special design of such system is illustrated above and the installation is being accomplished under the I & C phase.

FOUNDATION SITE 7

The excavation for the launching silo at Site 7 bottomed out in the Kansan Till Formation of moist sandy clay pocketed with silt and sand lenses. The original design specified a Type 1 foundation with a 6" concrete floor slab and sand underdrain system to a center sump.

There was a foundation failure at this site and the silo progressively settled approximately 4-inches with a corresponding doming of the floor slab approximately 7-inches.

There was, also, considerable water in the sand pockets and silt lenses thru the Kansan Till Formation which were recharged from the overlying Grand Island sands and discharged at rates of 200 - 250 g.p.m. over and thru the underdrain system to the sump. The design criteria for the Type 1 Foundation was based on construction economy with a maximum flow to the sump of 100 g.p.m.

Therefore, remedial action was indicated to preserve the integrity of the silo and reduce the inflow within economic limits. This was accomplished in two steps.

The Corps of Engineers grouted the water-bearing silt and sand pockets immediately adjacent to the silo walls with a cement-Bentonite slurry which materially reduced the inflow to approximately 50 g.p.m.

Also, a 6'-0" reinforced concrete structural slab was designed to key into the silo wall and distribute the foundation load. This slab was poured during concurrent operations by GD/A and required careful programming of time and space. A copy of the design is inclosed for the record.

A series of piezometer tubes were installed thru the water-bearing horizons underlying the new structural slab. A graph showing the gradual increase in the hydrostatic pressure or uplift against the bottom of the slab is also attached for the record.

FLOOR SLAB REPLACEMENT AT SITE 7

CONTRACT DA-7682

Sides Construction Company, Omaha, Nebraska - Prime Contractor

New York Plumbing and Heating Company, Omaha, Nebraska - Sub-contractor, Mechanical and Dewatering

Industrial Electrical Works, Omaha, Nebraska - Electrical Sub-contractor

1. At 1700 on 4 December 1961, silo dewatering responsibility was assumed by the Sides Construction Company through New York Plumbing and Heating, a sub-contractor.

2. On 5 December 1961, a meeting was held on the site to establish a working relationship and understanding between Sides Construction Company, Convair's (GD/A) site supervision, and Corps of Engineers Site Engineer. Personnel present included Mr. Burrel Sides and Mr. Bill Simpson of Sides Construction Company; Mr. Carpenter, GD/A Complex Supervisor; and Joe Hallahan, Corps of Engineers Site Engineer. Safety standards required and enforced by GD/A and Corps of Engineers were spelled out. Work area requirements for Sides Construction were discussed and cooperation between contractors established.

3. 5 and 6 December 1961, Contractor assembled equipment, work trailers and shelters, provided access from silo cap to silo floor and placed protective covering as needed.

4. Started cutting keyway in silo wall at 1300 on 6 December 1961. Re-steel was removed as exposed.

5. 8 December 1961, installed vacuum pump for dewatering operations. Drill equipment for well points arrived.

6. 9 December 1961, first well point for dewatering was sunk.

7. 10 December 1961, very cold. Temperature below freezing in silo (27° F Level 5 - silo). Replaced cover on silo to retain heat and prevent water lines and diesel jackets from freezing (in that they were not drained). Progress on keyway cutting slowed down due to air lines to jack hammers freezing.

8. 11 and 12 December 1961, inclement weather cold and blowing snow. Six laborers left site because of weather on 11 December 1961. All hands left site at midnight on 12 December. At 1200 on 11 December 1961, informed Sides Construction Superintendent, Bill Simpson, of change in keyway construction to slope 1 on 12 from 831'9" to 831'8", run 12" deep to 827'8" and slope to existing concrete floor slab to 826'3" (RI-1) (Mod. 1).

9. 12 December 1961. Started fabricating dewatering header.

10. 16 December 1961. Otis Elevator Company modified bottom of elevator shaft. Elevator out of commission from 0800 to 1900.

11. 16 December 1961, all well points in place.

12. 18 December 1961, completed four piezometers, one each quad. Installed compound gauge on each piezometer.

13. 18 December 1961, completed tying well points to vacuum dewatering pump suction header. Tested dewatering pump.

14. 19 December 1961, started dewatering at 1045 from 42 well points with 6" vacuum pumps.

15. 20 December 1961, completed counterweight blockout excavation. During excavation for counterweight blockout, found and removed three lengths 6" pipe approximately 4' long that apparently were used for draining original counterweight footing area.

16. 19 December 1961, started removing 7'6" section of existing floor slab west of counterweight and excavated to elevation 826'-0" to permit modification of resteel (RI-3) (Mod. 2). Increases effective depth of beams adjacent to counterweight blockout and adjust stirrups for maximum shear.

17. 21 December 1961. Dewatering pump down from 0500 to 1330. There was a leak in discharge line and vacuum pump packing gland had to be repacked.

18. 21 December 1961, keyway substantially complete. Started final dressing of keyway.

NOTE: Experienced difficulty maintaining steady flow of water during dewatering operation to date. Pump draws down to approximately 3 feet below existing slab, loses suction, water table rises 23" and pump picks up suction. Efforts to balance flow from well points ineffective. Instructed contractor to regulate flow and drawdown to maintain steady water table, which was done.

19. 21 December 1961. Re-steel arrived for counterweight blockout.

NOTE: 1800, 21 December 1961. Operating engineer tried to repack dewatering pump discharge valve while under pressure. Packing blew out and sprayed water throughout work area. Dewatering shut down about 45 minutes while packing replaced.

20. 21 December 1961. On about this date, auxiliary gasoline engine powered vacuum pump installed and connected up.

21. 22 December 1961, completed dressing keyway.

22. 22 December 1961. At 0100 main dewatering pump broke down. Down till 1340. Unable to get auxiliary pump into operation.

23. 22 December 1961. Ironworkers at rebar for counterweight footing and slab. Re-steel grounded. Time on re-steel 1400 to 2300. Carpenters completed forming counterweight blockout 2100 (economy forms) steel bonded together by tackwelding.

24. 23 December 1961. 0900 to 1800. Poured counterweight slab - 28 yards concrete. Started curing.

25. 26 December 1961. Removed existing silo sump pumps.

26. 26 December 1961. Completed breaking up existing floor slab to eliminate voids and poured three yards grout on broken up floor. Cleaned out and filled existing silo sump with filter material.

27. 27 December 1961. Started placing bottom mat of new floor slab resteel.

28. 28 December 1961. Only two ironworkers placing rebar for bottom mat. Working one 8-hour shift. Contractor says not enough rebar on site to justify additional or bonger shifts. His supplier told him no rebar would be delivered till 2 January 1962. Lt. Colonel Henderson informed Mr. Sides (Contractor) that more rebar to be on site 29 January 1962.

29. 29 December 1961. Installed automotive type valve stems on piezometers and made piezometers air-tight to permit more accurate piezometer readings.

30. 30 December 1961. Completed setting, tying, and blocking up bottom mat of new floor steel.

31. 30 December 1961. Started placing 17 foot #18 bars for bottom mat of the 3 top mats.

32. 30 December 1961. Auxiliary dewatering pump tested.

33. 30 December 1961. All work knocked off this date at 1200 except for dewatering. Insufficient resteel on site.

34. 30 December 1961 to 2 January 1962. No activity except dewatering around the clock.

35, 2 January 1962. Completed bonding of #8 bars in bottom mat by tackwelding.

36. 2 January 1962. 7 day break on cylinders for counterweight slab were 2800#, 3170#, 3260#, 3230#.

37. 2 January 1962. Contractor knocked off at 2000 because of insufficient supply of #18 steel for three top mats on site.

38.3 January 1962. Rebar for 3 top mats arrived at 0330. Unloaded at 0800.

39. Started butt welding second layer of 3 top mats of #18 bar.

NOTE: Contractor was informed that welders must be certified. Also instructed to preheat 18 bar and after welding to wrap weld with asbestos for slower cooling. Contractor concurred.

40. Also agreed to tackweld every bar on X and Y axes to insure complete bonding.

41. 3 January 1962. Contractor informed that materials used in floor slab mix design will be tested per specifications.

42. 4 January 1962. Main dewatering pump broke down at 0230. Started auxiliary pump. Water table at approximately 825'0 - 826.09 with auxiliary pump. Facility elevator out of commission 0000 - 0200.

43. 5 January 1962. Started tackwelding second mat of top three.

44. 5 January 1962. Main dewatering pump repaired at midnight. New shaft and impeller installed to replace old assembly with broken shaft. Secured auxiliary pump and started main pump.

45. 5 January 1962. Additional #18 steel arrived at 1730 for top mat. Was due at 0200 this date.

NOTE: Project Manager, Simpson (Sides Construction), informed Corps of Engineers site engineer that foundry supplying resteel shut down because of severe weather. They were within two hours of completing this steel order.

46. 6 January 1962. Second mat of top three re-bars, tack welding and but welding complete. Started butt welding top mat.

47. 6 January 1962. Pumpcrete equipment arrived.

48. 6 January 1962. Last load of resteel due to leave Kansas City this date. Held up by bad weather. To leave Kansas City on 8 January 1962.

49. 7 January 1962. Started fabricating "A" frame to raise rebar mats into position. Started installing pumpcrete equipment.

50. 7 January 1962. No work 1600 to 2400 6 January 1962 and 0000 - 0800 7 January because of lack of resteel.

51. 8 January 1962. At1000 received load of stirrups and unloaded. 2220 last load steel arrived - unloaded 2400.

52. 8 January 1962. Concrete cylinder break for fourteen day test on counterweight slab - 4000#, 4290#, 3860#, 4450#.

53. 9 January 1962. Started tack welding cross-bars top mat.

54. 10 January 1962. Completed butt welds top mat.

55. 10 January 1962. Setting forms counterweight pit. (Economy forms)

56. 11 January 1962. Completed tack welding top mat cross bars at 1200.

57. 11 January 1962. "A" frames and hoisting equipment in place and raised top mat of resteel to position. Also started raising the second mat.

58. 11 January 1962. Second mat raised into position and started to place stirrups.

59. 13 January 1962. Completed grounding rebar of floor slab. Completed placing stirrups. Completed installing and testing pumpcrete equipment. Completed forming and bracing counterweight pit.

POUR

1. 13 January 1962. Grout arrived 1800, First load concrete at 1815. Rejected nine cubic yards concrete at 1915 - excessive time lapse - concrete preset. Placed 48 yards 1800 - 2400. The 6" pipe to silo was plugging. Started using buggies at 2000 until 6" pipe could be altered to discharge concrete through lower section.

2. 14 January 1962. 0000-0800, placed 120 yards concrete total as of 0800. Concrete placement slowed because of elbow in bottom of 6" pipe plugging. 0800 - 1600, 200 cubic yards in place at 1600. Using buggies to place concrete in counterweight, sump and dewatering area. 1600 - 2400, 314 yards at 2400.

3. 15 January 1962. Completed placing concrete at 0530. 392 cubic yards concrete silo floor. Finished, wood floated and placed curing cover.

4. 16 January 1962. Started dismantling pumpcrete equipment.

5. 17 January 1962. Dismantling complete.

6. 17 January 1962. Forms removed from counterweight blockout. Some honeycomb found. Finisher finished. Cleanup started.

7. 18 January 1962. New sump pump installation started and piping. Electrician started electrical.

8. 22 January 1962. Removed curing cover silo floor slab.

NOTE: Two fitters arrived at 1300 but couldn't start work till 1500 because Convair had elevator tied up and fitters couldn't get equipment to bottom of silo.

9. 26 January 1962. Hydrostatically tested new sump pump discharge line from sump pumps to 4" riser including hose at 150 psi for 30 minutes Daturday. Meggered control and line leads to new sump pumps Saturday.

10. 29 January 1962. Electrical and mechanical installation substantially complete except for testing. Tests attempted but broke 2" gate valve on vacuum breaker. No replacement. Electrical wiring deficiencies found and being corrected. Test postponed to 30 January 1962.

11. 30 January 1962. Replaced 2" gate valve but could not conduct test on pumps because I & C phase contractor had counterweight pit full of timber and debris. Wiring deficiencies corrected. Preliminary inspection conducted by John Clema of Corps, Contractor representative (Sides), Base Engineering and SATAF. Contractor instructed to continue dewatering on 24 hour basis until further notice.

12. 31 January 1962. Sides Construction planned to test silo pumps this date but unable to because I & C Contractor lowering counterweights into pit.

13. 1 February 1962. Conducted final inspection. Corps of Engineers, SATAF, GD/A and Sides Construction representatives present. Silo sump pumps tested and validated. Six hour delay caused because I & C phase contractor had damaged conduit and wiring going to new sump pump alternator while working on counterweights, 31 January 1962. I & C phase contractor completed repair at 1400 this date. After validation complete, silo sump pumps, Sides Construction was instructed to stop dewatering (temporary) at 1900. At 2000 a GD/A inspector reported a small stream of water flowing into counterweight sump. Found water entering at construction joint at bottom of counterweight pit near center of north corner fillet. Assumed this leakage to be due to counterweights being lowered on oak cribbing on counterweight support slab causing separation at construction joint. Piezometers indicated a rapid rise after temporary dewatering pumps shut down. At 2100 water backed up through an open valve in the temporary pump system. Valve was closed by maintenance personnel. Mr. Poynder, the night GD/A

supervisor called Sides Construction operating engineer back to site to resume dewatering. He was worried about the lagging under the counterweights swelling as they soaked up water and causing movement of the counterweights. Dewatering continued until 1140 on 2 February 1962.

14. 2 February 1962. Contractor (Sides) and New York Plumbing) removed temporary gasoline driven dewatering pump. Agreement was made to leave main pump in place until it was determined that it no longer would be needed.

15. 5 February 1962. Removed main dewatering pump. Contractor removed temporary equipment and facilities from site.

16. 10 February 1962. Cleanup and restoration of all levels and equipment disturbed by Sides Construction Company complete. Last punch list item corrected.

17. Completion.

a. Contract specification item No. SC-1a(1) covering the placing of concrete, removal of concreting equipment and all work and clean up level 8 was scheduled for completion on 22 January 1962. It was substantially completed on 15 January 1962.

b. Contract specification item No. SC-1a(2) covering the installation and testing of electrical and mechanical equipment was scheduled for completion on 15 February 1962. It was substantially completed on 29 January 1962.

c. Contract specification item No. SC-1a(3) calling for final completion including water control operations and final clean up of premises was scheduled for completion on 22 February 1962. It was substantially completed on 29 January 1962.

18. GENERAL COMMENTS: In spite of the congested areas, many problems encountered and delays in steel shipment this Contractor, generally, did an excellent job, was extremely cooperative and completed the job ahead of schedule.

FOUNDATION SITE 8

The launching silo at Site 8 was bottomed out in a quick material of a fine sandy silt lens in the Aftonian Formation. This was obviously a changed condition from the exploratory drilling logs shown on the original contract plans.

The contractor was directed to use steel liner plates against the vertical face of the cut in lieu of the wood lagging specified and to drive an additional ring of well points around the cutting shoe to remove th

interstitial wate

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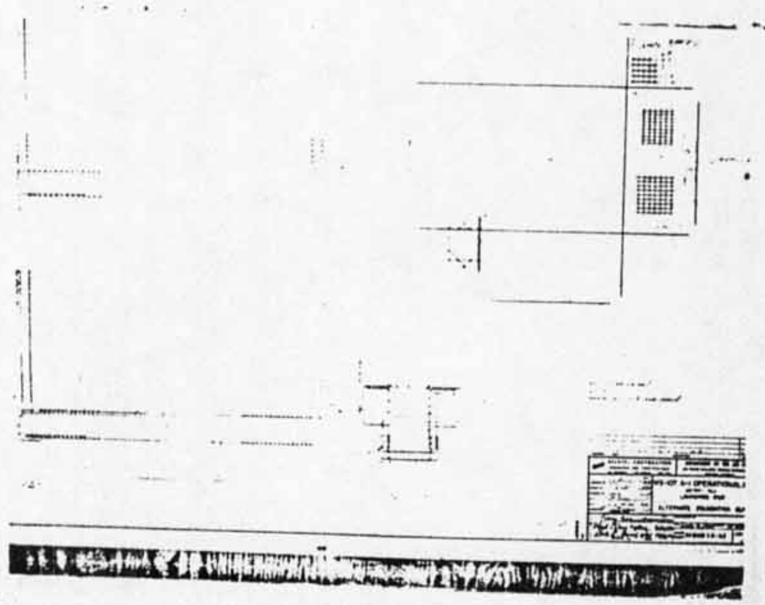
of the material.



It took appro

imately thirty day

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by the contractor

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of this hole. The

cost and loss of time on this pacing item was a substantiated claim against the Government. It was, therefore, important to the economy of the project and in the best interest of all parties concerned to minimize such costs and delays compatible with sound engineering design and construction.

The foundation was originally detailed with a Type 4, 7'-6" reinforced concrete slab structurally designed for a full hydrostatic head of 181'-6". The existing hydrostatic head was recorded as approximately 119'-0" and, therefore, a special silo foundation slab of 5'-6" reinforced concrete was designed and poured for Site 8 only. A copy of this design, known as Type 5, is illustrated above.

VALIDATION AND TESTING OF
SYSTEMS AND EQUIPMENT

1. General:

a. Validations were often conducted before electrical connections were checked out completely and before piping systems were made completely tight. This was usually necessary to properly utilize test crews, and to meet scheduled completion dates.

b. As a result, deficiencies cropped up that would normally have been corrected before final testing.

c. Most of the deficiencies were corrected as the tests progressed. When this caused undue delay, test crews often moved to another validation. Test crews were proficient enough to handle most problems and help was available when needed.

d. This procedure often wasted man-hours but just as often saved time by eliminating the necessity of rescheduling tests, refilling systems, etc. Quite often it took longer to set up a test than it did to run it. And quite often a deficiency corrected in one system expedited the validation of other systems - especially in those that were interconnected.

2. Diesel generator and switchgear validation consisted of the following:

a. Checked and recorded crank shaft alignment.

b. Checked and recorded generator air gap.

c. Visually inspected complete plant and components.

d. Recorded insulation resistances (meggered).

e. Checked operation of circuit breakers - local control and remote control.

f. Checked out main and control circuits.

g. Checked phase rotation.

h. Checked operation Diesel Engine controls - local, from 480 volt switchgear and from Power Remote Control Panel.

i. Checked operation of meters, indicating instruments and ground detection equipment including protective relays.

j. Checked safety devices and alarms.'

k. Made and charted steady state frequency tests, 25% to 110% load.

l. Made and charted steady state voltage tests, 0 to 110% load.

m. Made and recorded (chart) steady state voltage drift tests.

n. Made and recorded (chart) speed regulation tests.

o. Made frequency transient and response tests and recorded results (chart).

p. Made voltage regulator tests and recorded results (chart).

q. Checked out and demonstrated parallel operation 2-hour test at loads to 550 kw.

r. Demonstrated remote control operation from the Launch Control Center.

s. Demonstrated sustained operation with 18 hour continuous operation tests with loads ranging from 25% to 125% load; logged readings of temperatures, pressures and electrical readings and secured recordings of electrical conditions.

t. Checked fuel consumption various load conditions.

u. In conjunction with diesel generator tests, the following systems associated with the diesel engines were also tested: condenser water, cooling water, lube oil, fuel supply, exhaust and ventilation and exhaust air systems.

v. Some slight modifications on the engines: baffles in the air intakes were installed to reduce cavitation. Some hour meters were replaced; gauge cocks moved out of enclosed engine panels in order to be accessible, modified fuel injection delivery valves and changed fuel injection timing from 7.5 degrees to 10 degrees BTDC.

3. The test crew consisted of two White Engine and two General Electric Company field engineers who worked 12-hour shifts. One Corps of Engineers Engineering Technician was assigned to the crew on a full time basis and utilized site Corps of Engineers personnel to assist on around-the-clock tests. Western Contracting Corporation employed one operating engineer and one pipefitter for each shift and Power Engineer (electrical sub-contractor) supplied an electrician each shift and a test foreman who was in charge of transporting and setting up test equipment. Other men and trades utilized as conditions dictaged. GD/A QC was present for all tests so that field tests were actually a final validation also.

4. A fan cooled resistor bank was used to load the generators. The bank was arranged to provide 25%, 50%, 75%, 100% and 110% loads for the generators - 550 KW total. This load bank was a custom-built unit and served the requirements admirably. This method appeared to be much more satisfactory and essentially trouble-free during the tests at all sites.

5. The test crew spent an average of seven days on a site. This could have been reduced to four days through better coordination and preparation by the Contractor.

6. In most cases, the site was not ready for diesel generator tests when the crew arrived. A common problem was lack of condenser water on the site. It was usually necessary to haul water for the cooling tower in a [illegible] truck and to have a tank truck standing by for make-up water. When things went wrong, it was often a problem to keep the tests going. The following is an excerpt from the Corps of Engineers test diary that describes an incident that actually occurred on one site during engine tests:

"Cooling tower messed up. Tank truck delivering make-up water broke axle and had to be towed into position. Pump on truck failed. Had to change to gravity flow (from truck to tower) which was inadequate. (Water) level on tower too low and strainers clogged. Had to dump pond water from fire truck and take water out of tank truck into fire truck from which it was pumped into cooling tower before new pump engine arrived for tank truck. We managed to get thing cleared up before engine temperatures became too high."

7. The condenser water strainers clogged because the cooling towers were new and the redwood used in them was still flaking. During the summer months, moths and June Bugs created a problem. Cooling tower strainers were coarse enough to allow these insects to be drawn into the system. Temporary fine mesh screens were installed to lick this problem. The test team was made of excellent personnel who did the job right and well.

8. Delays were caused because of other work going on; silo caps being poured; PLS tests being conducted; welding and oxy-acetylene cutting was going on.

9. Mechanical and electrical deficiencies also contributed to delays. Piping systems were often in the process of being completed or tested when the test crew arrived. Electric control wiring was still being pulled. Generator areas were cluttered with gang boxes, hose, scaffolding, and other equipment which had to be removed.

10. On some sites we found engine controls damaged, fittings broken off by workmen walking on engines, fire damage from welding or burning in the vicinity.

11. When replacement parts were needed, it was sometimes necessary to canabalize the switchgear or engine on another site to be able to proceed with tests without delay. However, replacement parts were secured in ample time so there was no holdup on the downstream sites because of this.

12. On one site, a valve was removed from a 3" line tied into the silo sump pump discharge riser. Contractor personnel started the silo sump pump and pumped water through the riser and 3" line and

drenched the main switchgear a few hours before the diesel test crew arrived on site. It was necessary to clean and dry out the switchgear. Such unfortunate accidents were rare but they did happen.

13. A good many other frustrating things happened that interfered with Diesel Generator validations, but the job got done and everyone connected with the project was satisfied with the results. It was recognized that under such an accelerated concurrent construction program problems were to be faced and our people were there to see that they were solved expeditiously.

14. Utility Air Validation:

Leaks developed and were repaired, back pressure regulators were in backwards and were reversed, relief valves and pressure regulators were found to be improperly adjusted and were set for correct pressures. When the system was later given a final proof pressure test, little or no leakage was found. Pressure switches were adjusted and tested in one operation.

15. Utility Water Validations:

a. Leak checks on this system conducted prior to validation and leaks were not a problem. Some wiring deficiencies were found and corrected. Pressure switches were adjusted and tested in one operation.

b. Common Problems:

Check valves in P-80 and P-81 slammed hard and sometimes tripped pressure switches. Solved by insolating pressure switches.

16. Facility Electrical Power:

Wiring deficiencies found and corrected.

17. Emergency Lighting System:

Replaced several batteries - wouldn't come up to charge. Failed intensity tests. Damaged lamps were replaced. Considerable time was lost because of improperly calibrated relays; however, a new source was found by Contractor and flown in and replacements made.

18. Gas Detectors:

Mine Safety Appliance Company representatives calibrated detection equipment. Problems-snifter heads damaged - dirty; defective components in detection cabinets - replaced by Mine Safety Appliance; damper motor for VD-21 unable to open VD-21 after SF-22 started - replaced with larger motor; wiring deficiencies - corrected. The representatives from this company were well acquanited with their equipment and did a thorough and conscientious job.

19. Blast Doors:

Problems: Limit switch adjustments necessary; wiring deficiencies, corrected; some grinding required for proper sealing of doors.

20. Emergency Water System:

Problems: Wiring deficiencies in valve motor circuits were corrected; valve operating mechanism reversed - corrected; control wiring deficiencies were corrected; pump rotation was in some cases wrong so motor connections had to be reversed.

21. General Plumbing and Pumps:

Fire hose system - no problems.

22. LCC Sewage Pumps and Sanitary System:

Proble[illegible] Liaphragm operated switch failed - reworked by manufacturer; [illegible]t leaks in connections between diaphragm and column and swi[illegible] column were problem - Teflon tape finally used to stop leaks; [illegible]rature of water also seemed to affect operation. Also, wiring d[illegible]cies - corrected.

23. Silo S[illegible]mps:

Proble[illegible] [illegible]ping silo sump clean during construction and pumps protecte[illegible] chemicals, solvents, etc. Float switch rods handing up on [illegible]se, wiring deficiencies - corrected.

24. LCC Do[illegible] Water System:

No pro[illegible]

25. RP-1 D[illegible]g Pump:

No pro[illegible]

26. Air Con[illegible]ing System:

Proble[illegible]ring deficiencies - corrected; fan motor rotation wrong - revers[illegible]rmostats adjusted and tested one operation; liquid control [illegible] - adjusted; VD-40 striking X-bracing - corrected by moving supp[illegible] SF-41 away from X-bracing; broken mercoid switches VD-40 - replac[illegible]struction damage); firestat wired wrong - rewired; pressure switc[illegible]usted and tested in one operation; cooling tower thermost[illegible]ng deficiencies - corrected; water chiller oil pressure failu[illegible]ch timer - required adjustment.

27. Heating [illegible]entilation:

Proble[illegible]ntrol wiring deficiencies - corrected; LCV and TCV adjustment[illegible] volume dampers adjustments required and made; firestat and d[illegible]t wiring wrong - rewired.

28. Air Washer System:

Problems: P-20 and P-21 unable to maintain pressure - losing suction - air bound; operation unsatisfactory. Liquid control valves leaking through - valves designed to operate at 30 psi and header pressure 45 psi plus; leakage through spray nozzles flooding flex ducts; leakage at water collector flanges; water backing up through 3" emergency discharge line; from four inch silo sump discharge riser (no check valve); wiring deficiencies corrected.

29. Automatic Gate Operator:

Electrically operated latch required adjustment in some cases.

30. Fire Detection and Suppression:

Wiring deficiencies - corrected.

31. Personnel Warning and Alarm System:

Wiring deficiencies - corrected.

32. Facility Remote Control Panel:

Wiring deficiencies - corrected.

33. 48 Volt DC System:

No problems except a defective relay in one case.

34. Television Validation:

No problems. Television representative from the factory supervised the installation and made the adjustments required.

35. LCC Air Cylinder Spring Supports:

Level switches wired wrong - corrected; other wiring deficiencies - corrected; cylinder pressures not within specified limits - low because floor not carrying design load at time of test.

36. Facility Elevator:

Manufacturers representative on hand for tests - electrical deficiencies corrected as found. The Otis Elevator people performed their own operational test and checkout before our Validation Team was called to validate on our procedures. In some cases the manufacturers test requirements were greater than our own.

PROPELLANT LOADING SYSTEM

CONTRACT DA-5761

WELDING OF PIPE AND CLEANING

There was considerable discussion on the subject of producing structurally sound piping which would meet the cleanliness requirements of the specifications.

The initial welding and cleaning by acid pickling performed by the Contractor produced severe corrosion in the heat effected zone of the pipe, greatly reducing its physical properties. This phenomenon is not strange to the welding industry associated with oxygen piping and effective means of minimizing it have been developed. Proper welding procedure and technique are the most important criteria. Carbide precipitation occurs in the unstabilized stainless steel used on this contract when heated during welding. The extent of the precipitation is dependent on the length of time the steel remains in the "critical" temperature range and on the carbon content of the steel. This precipitation can be minimized but not completely avoided. However, the physical properties of the steel pipe under discussion were not materially altered by the weld itself. The internal condition of the pipe at the weld was such that excessive acid pickling was required to remove the severe oxides and/or nitrides which formed during welding. The excessive pickling caused severe corrosion in the heat effected zone which physically removed the precipitated chromium carbides thereby materially reducing the structural soundness of the pipe. Elimination of the severe oxides and nitrides during welding, will in turn eliminate the need for excessive pickling to produce a product suitable for use with oxygen that is structurally sound, providing the weld is <u>good</u>.

The question then is whether the contract specifications were adequate to provide the quality desired. The specifications read "welding shall be in accordance with the procedures and material specified in the ASME Code and the ASA Code B31.1 for pressure piping. Inert gas backing welding process shall be used for welding of all pipe joints for at least the first pass." It is not known exactly what interpretation of this paragraph was made by the responsible procuring agency (Ft. Worth District, CE); however, the gas-shielded tungsten arc welding process was used for at least the first pass with an internal nitrogen gas purge (backing). This is fine; however, it is not understood why nitrogen backing was used instead of an <u>inert</u> gas. This practice served to aggravate the problem of maintaining a clean weld prior to pickling. "Shielding" serves to exclude oxygen and nitrogen of the air, thus eliminating the formation of oxides and nitrides ---- "(under 'ARC WELDING' page 13-30 of Marks' Mechanical Engineers' Handbook, Sixth Edition)". It is obvious that nitrogen will not serve this purpose. Reference paragraph 2a of Chapter VII, CEBMCO Ballistic Missile and Space Facility Design and Construction Handbook, "A 100% purge of the weld area with argon will produce the minimum amount of scale". Linde Company, Division of Union Carbide Corporation, states "Argon is recommended as a backing gas for pipe welding, since it is the most effective in preventing oxidation of the back side of the weld.-----Nitrogen has been used as a gas backing for the welding of stainless steel pipe, and carbon dioxide has been tried. If nitrogen or carbon dioxide are used as a gas backing in welding, the back side of the weld may be adversely affected due to chemical reactions of these gases with the weld puddle." At best, the specifications were vague. They required welding in accordance with the ASME Code and an inert gas backing. The ASME Code does not specify procedures. The fabricator's procedures are code qualified by passing prescribed tests on specimens. This was done <u>prior</u> to acid pickling. It would seem that perhaps the simplest way to assure desired quality would be to specify that the fabricators welding procedure be qualified <u>following</u> acid pickling. This would force the fabricator to develop welding techniques and procedures and pickling methods that would result in the desired end product.

Due to the difficulties encountered in obtaining sound piping, Ft. Worth District authorized an alternate cleaning method in lieu of acid pickling as prescribed by the Contract specifications. This consisted of degreasing prior to welding with Oakite 33, weld using nitrogen backup and "clean" by immersion in Oakite 99. Oakite is not an acid and it does not remove weld scale. As a result, the inaccessible welds (those that could not be reached for mechanical cleaning) had, and still have, a coating of weld scale. This was evidenced by the fact that even some of the accessible welds (which were mechanically cleaned with a stiff nylon brush) on piping received in the field showed presence of weld scale. Particles of weld scale in excess of 150 microns in size could be dislodged from the internal surfaces of the pipe by tapping on the external surface. Also much of the piping contained a large amount of lint, indicating that possibly the final rinse water used at the cleaning plant was not kept clean. In short, the cleanliness of the propellant loading system piping as received at the job site was far from being suitable for use in the system. As much as 90% of the piping at some sites had to have contamination removed prior to installation into the system. Methods used were tapping and jarring of pipe, nylon cloth or brush, trichlorethylene wash and blowing with nitrogen gas. A great amount of time was spent and progress was noticeably affected. However, it is felt that the effort was worthwhile as an average of no more than five blowdowns were required during system testing to meet acceptable standards. Reports from some other Atlas F projects indicated a higher average than this.

It is not known whether the condition of the piping as installed and tested will ever be detrimental to the system. Apparently the missile contractor, General Dynamics/Astronautics, and the Air Force have no fears as they did not question the integrity of the systems on this contract.

VESSEL CLEANLINESS

The vessels installed under subject contract were as clean or cleaner than experienced on any previous project of this nature. The three fabricators involved performed a commendable job, producing a quality product with timely delivery. At no time were other phases of the project delayed due to vessel delivery. The prime contractor, Western, was very wise in his choice of fabricators and in choosing more than one to furnish the cryogenic vessels.

The major problem concerning vessels revolved about the specifications of Contract DA-5761 which read "the Contractor shall check to his satisfaction that the facility vessels and interconnecting piping and components are clean, and free of foreign material." This statement "opened the door" for the piping Contractor to refuse to connect to the vessels supplied by the facility contractor on the basis that they were not clean. It is a simple matter to find a particle or so in excess of 150 microns in size (maximum allowed by specifications) immediately inside a vessel nozzle as such may be introduced at the time the blind flange is removed although they are readily removable. The Contractor on DA-5761 took full advantage of the situation, resulting in a modification to the contract to provide blowdown testing of some of the vessels prior to connection into they system at a considerable cost to the Government in time and money.

EXCELLENT UNDERSTANDING BETWEEN AIR FORCE (SATAF) AND CORPS OF ENGINEERS

The local SATAF exercised sound judgment and a realistic approach to problems encountered. Of prime importance was a "Memorandum of Understanding" regarding cleanliness, prepared jointly by Lincoln SATAF and Corps of Engineers. This document relaxed the specification requirements of most of the system regarding cleanliness during installation and testing. There is no doubt that this action had a marked effect on timely completion of the PLS. It served as a great aid to the Corps of Engineers, Lincoln Area, in making the most of what we had to work with. In connection with this agreement, the Corps documented the field cleanliness inspection data on each component, spool by spool, etc., and submitted this information to the local SATAF to give them a complete cleanliness history of the entire system. It is believed that this is the only time such has been done on a project of this nature. Unequivocal acceptance of the completed systems by SATAF was in large part contributable to the above. In addition SATAF surveillance personnel were allowed 100% access and signed the inspection documents along with the Corps of Engineers representative.

CORPS OF ENGINEERS INSPECTION

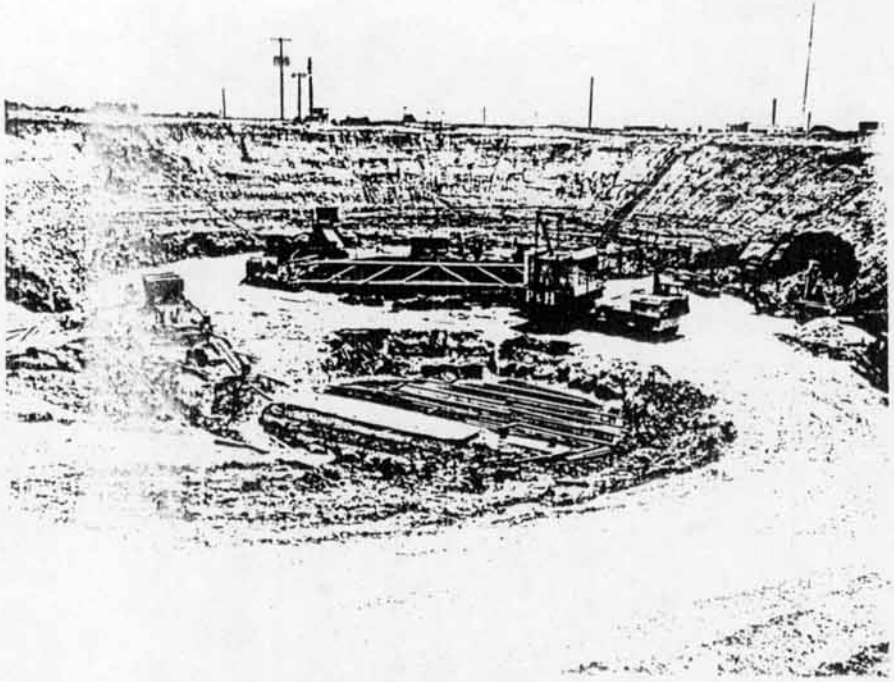
Quality control coverage by the Corps was achieved by assigning one qualified man at each of the twelve sites with sole responsibility for PLS. The minimum qualification for these men was previous PLS experience with above average performance. The Corps of Engineers did not have enough of such men to supply twelve to this project; only four were obtained. The additional eight men were supplied under a separate "Service Contract" with United Testing Laboratories. This office was fortunate in having the services of that Contract phase into this project direct from a previous project. Only the top individuals were selected based on our prior experience with these men.

The "lead" PLS men at each site was supplemented by Corps of Engineers inspectors on the site covering other work during peak work load. The system was very satisfactory and resulted in a smooth running project where many various parties are involved. Adequate coverage was achieved with a minimum of personnel on a phase of the project requiring almost 100% inspection.

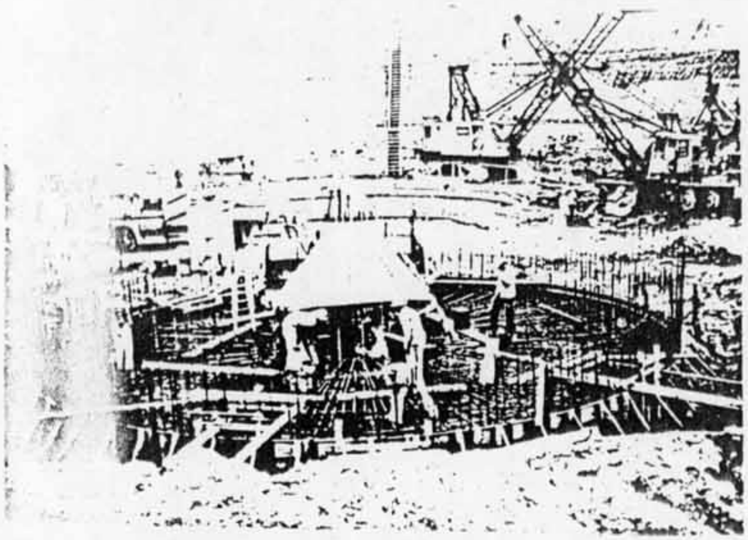
SECTION 10

Construction Photographs

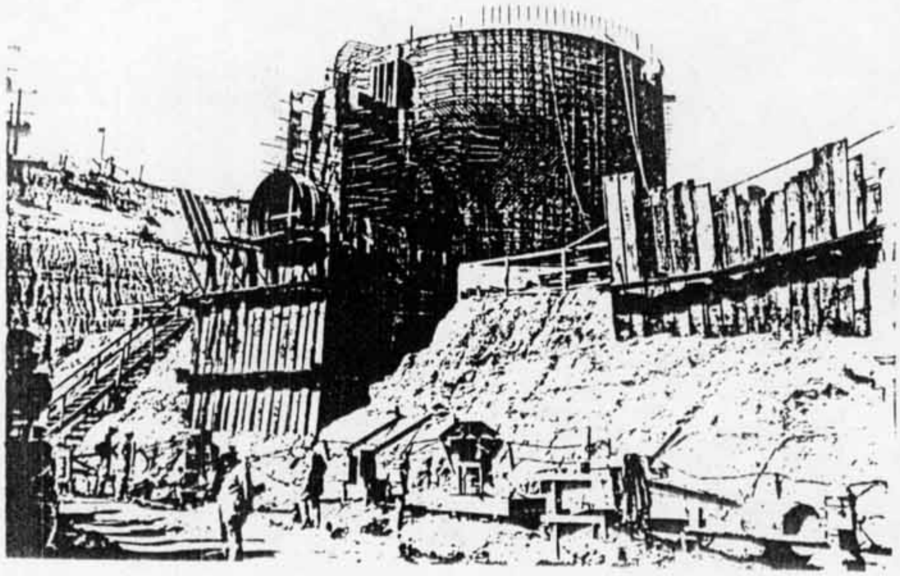
1. Launch Control Center
2. Silo Wall Concrete
3. Structural Steel
   a. Crib Suspension
   b. Launch Platform Drive Base
4. Silo
   a. Excavating
   b. Silo Electrical
   c. Silo Mechanical
   d. PLS
   e. Silo Cap
5. Exterior Complex
6. Missile Assembly Building
7. Liquid Oxygen Plant
8. Grounding and Bonding



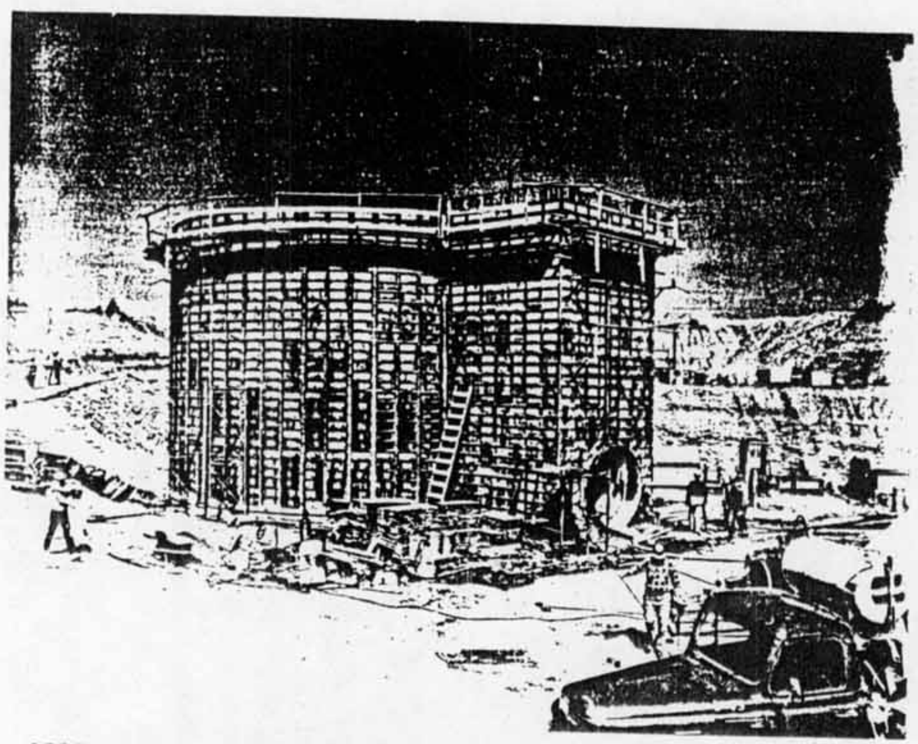
SITE [illegible] View facing southeast shows temporary covering over lean concrete pad for LCC floor.



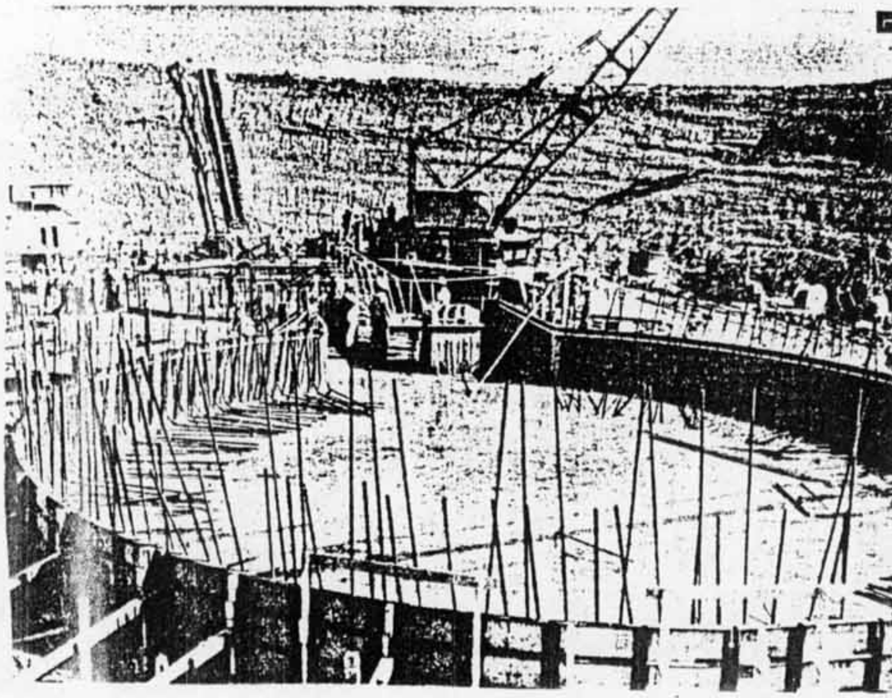
C-4. [illegible] B. BEATRICE, NEBRASKA. View facing south[illegible] shows wall dowels reinforcing steel for [illegible] floor. Note the metal form used to form the [illegible] of cone which was the base of the LCC center support pillar.



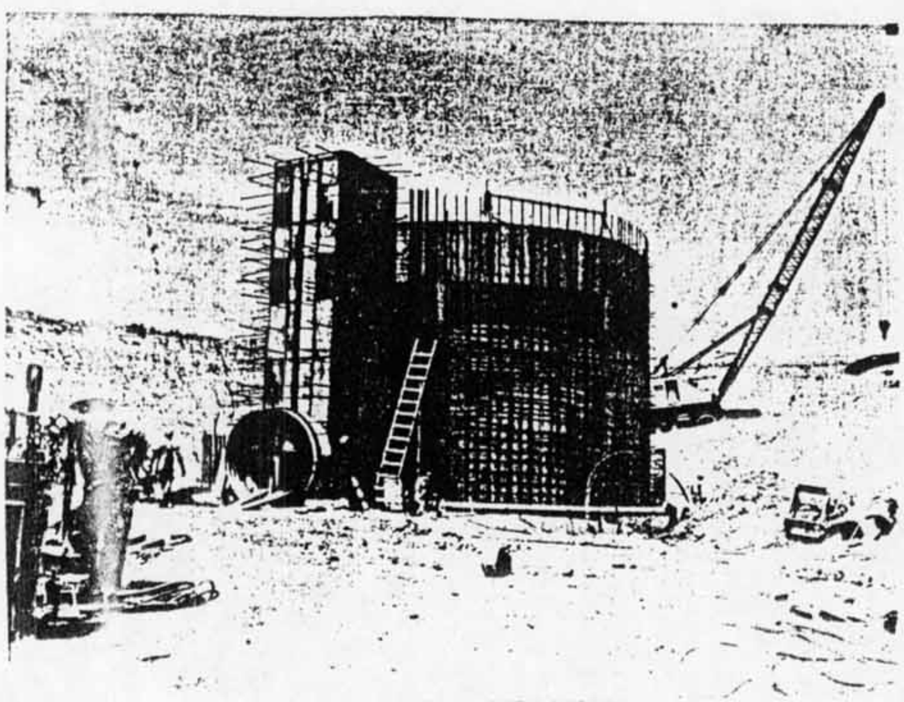
#41090. SITE 8. SEWARD, NEBRASKA. 5 Oct 60. View facing northwest shows retaining sheet piling and a considerable amount of reinforcing steel as installed in LCC walls.



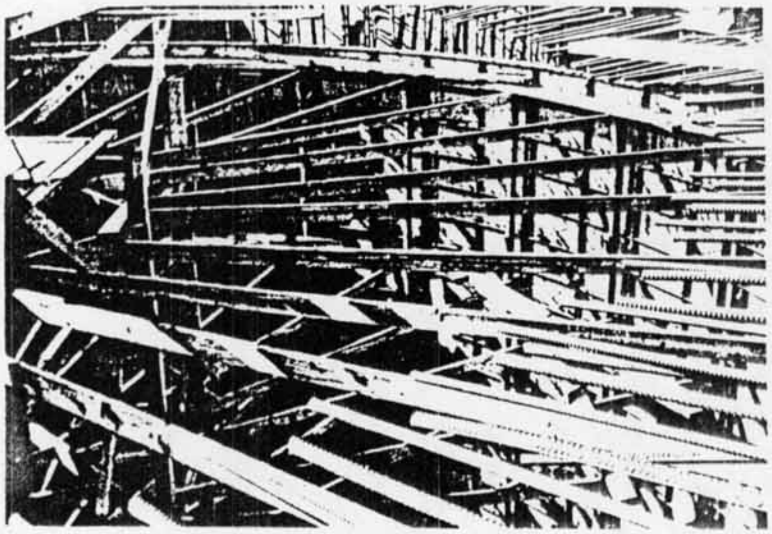
#40872. SITE 6. WILBER, NEBRASKA. 3 Oct 60. View, facing northeast shows LCC wall forming to roof line. Note the safety guard rail installed at top.



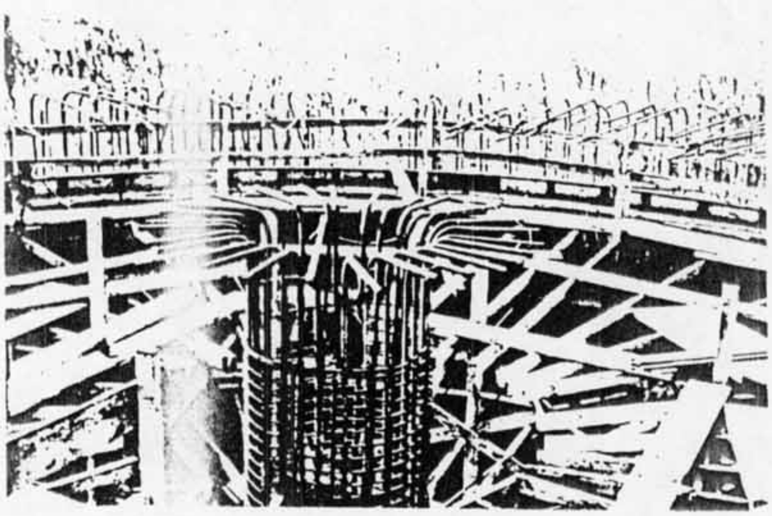
SITE 2. View looking south showing partial forming and re-steel for sides of launch control center.



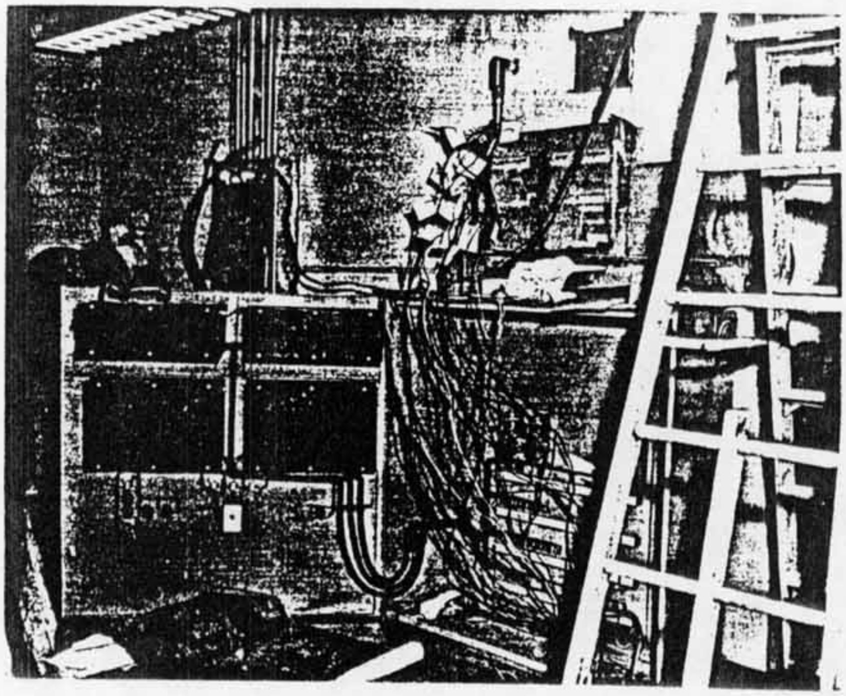
SITE 4. Southeast elevation of launch control center. Showing inside pan forms and tying steel on vestibule and walls.



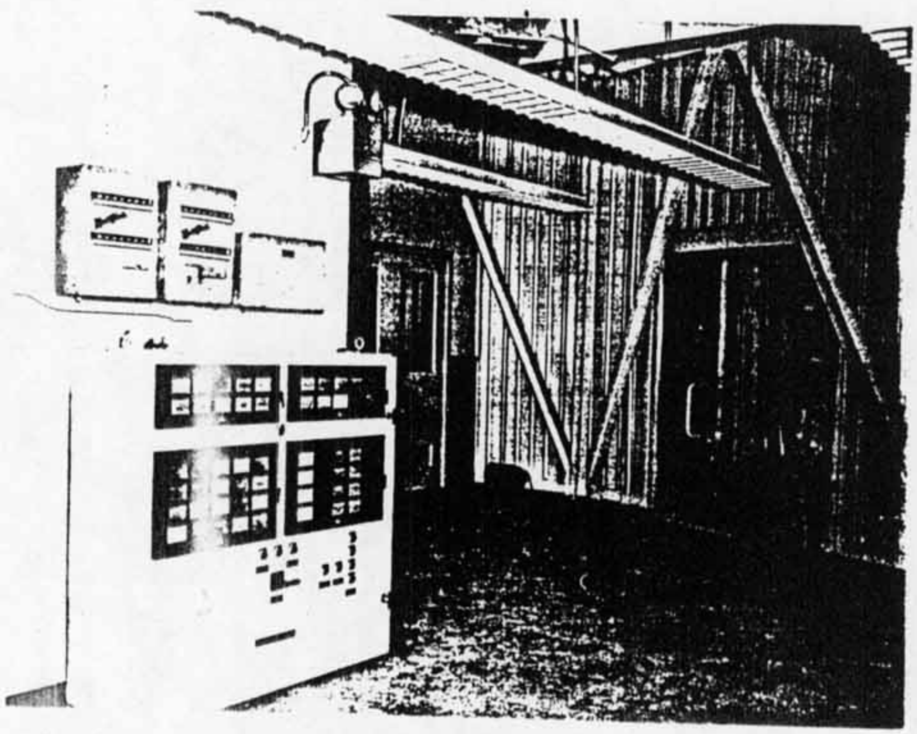
C-5. View shows large amount of 2" x 4" bracing for LCC walls, reinforcing steel for center pillar and ties to wall steel for roof.



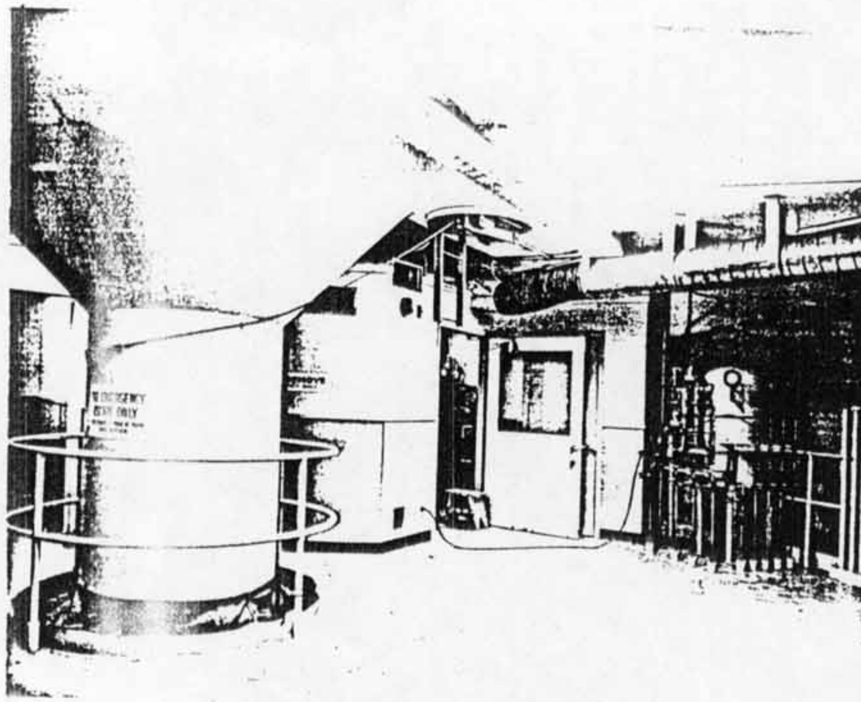
C-6. Vi[illegible] shows additional bracing at lower levels f[illegible] LCC wall forms.



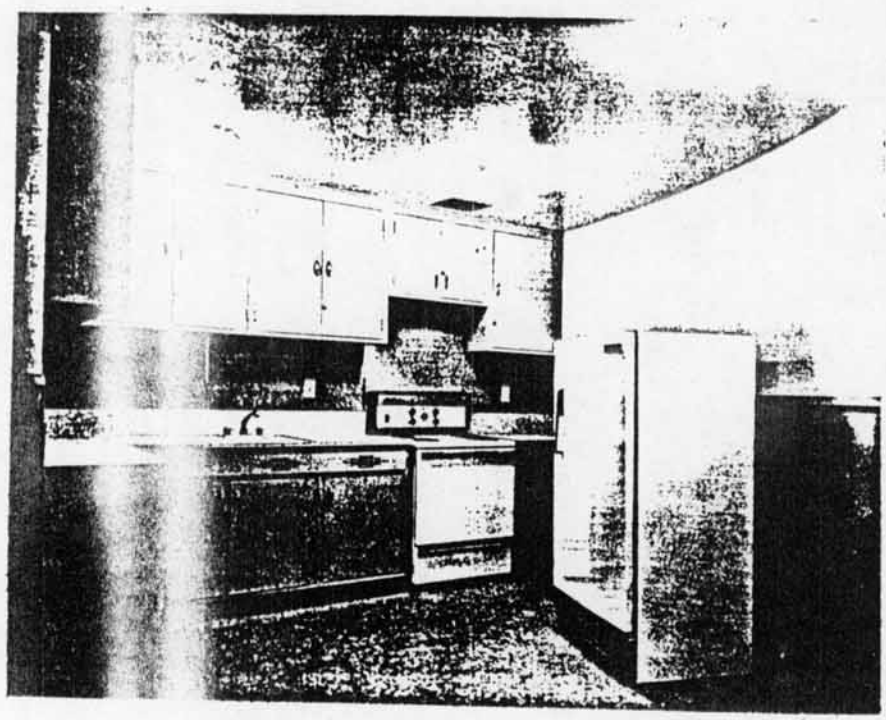
[illegible]. SITE 1. EAGLE, NEBRASKA. 1 Mar 61. Photo during construction shows rear view of Facility Remote Control Panel on second level LCC.



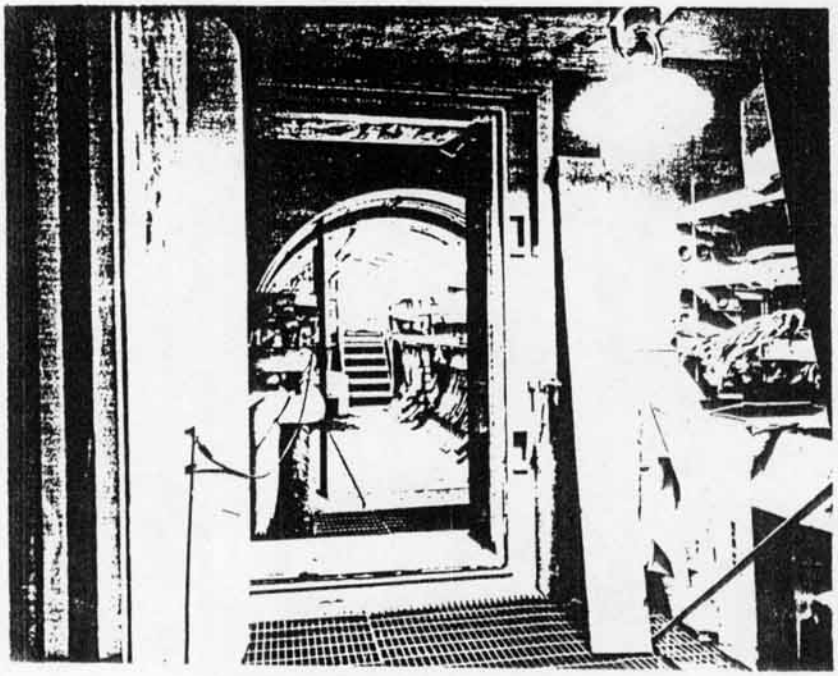
A44001. [illegible] 3, TECUMSEH, NEBRASKA. [illegible] Mar 61. Completion [illegible]hoto shows south portion of Launch Control Room on se[illegible]nd level LCC Fire Control Panels and Battery Box are lo[illegible]ted directly above. A battery powered Emergency [illegible]ghting Unit is mounted above the Fire Control Panels.



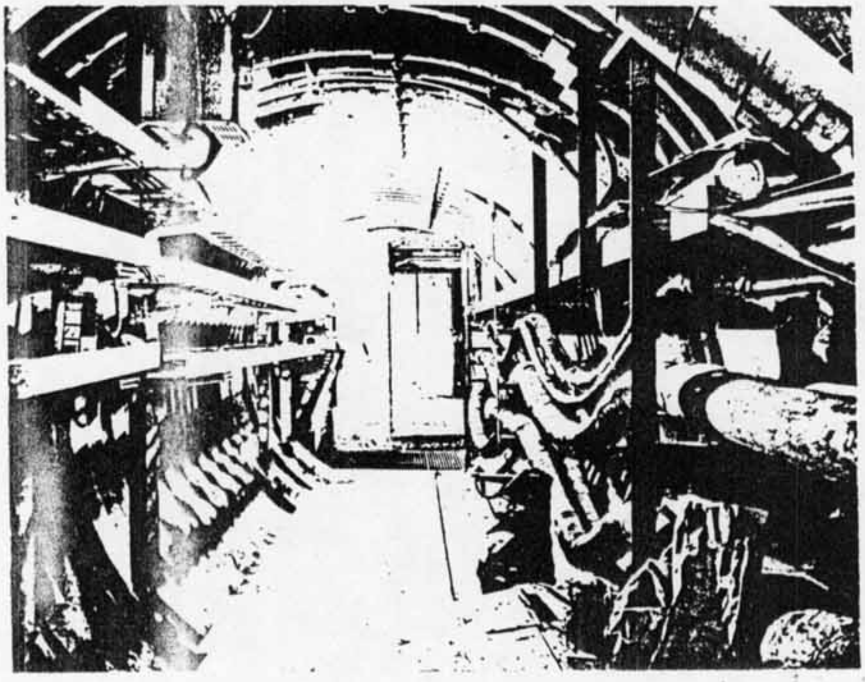
View f[illegible] north in Ready Room on 1st level LCC.
G/A Photo [illegible]52576.



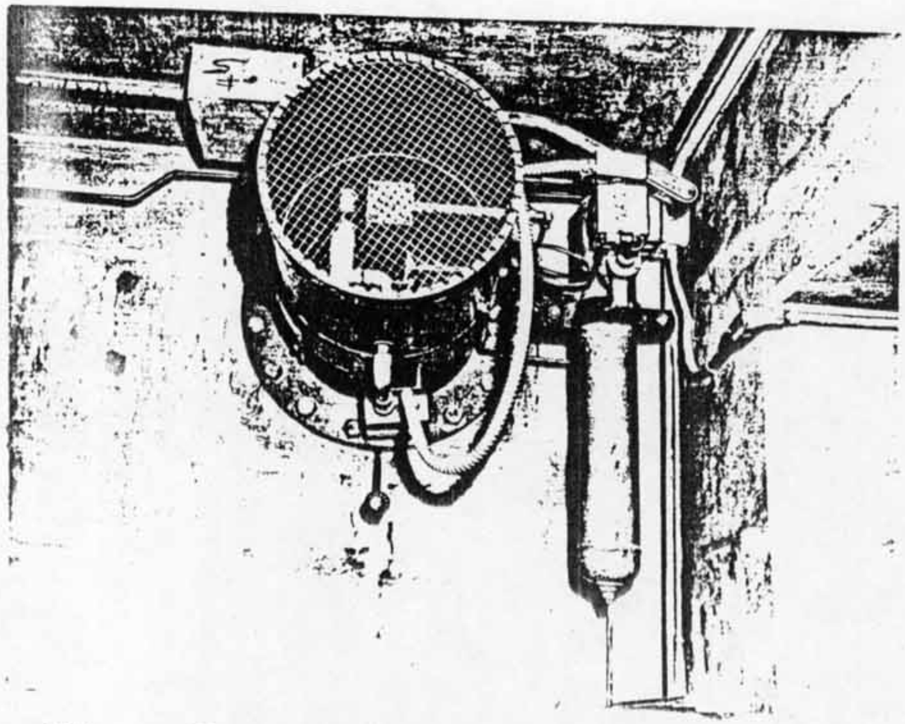
View of [illegible] and facilities, 1st level LCC. G/A
Photo [illegible].



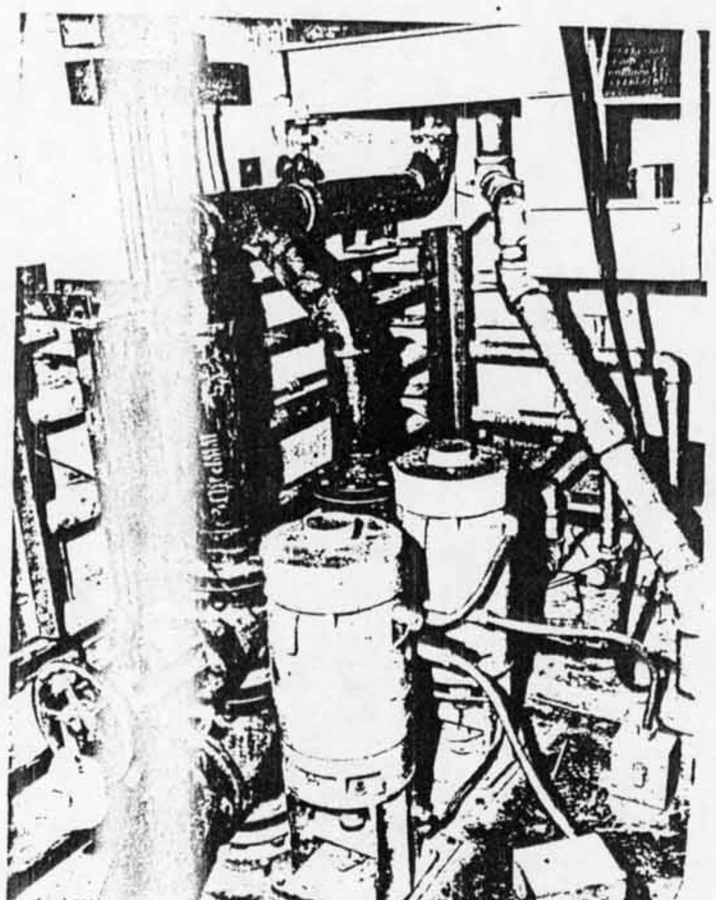
View facing LCC
LCC - Silo Utility Tunnel
GD/A Photo No. 52356



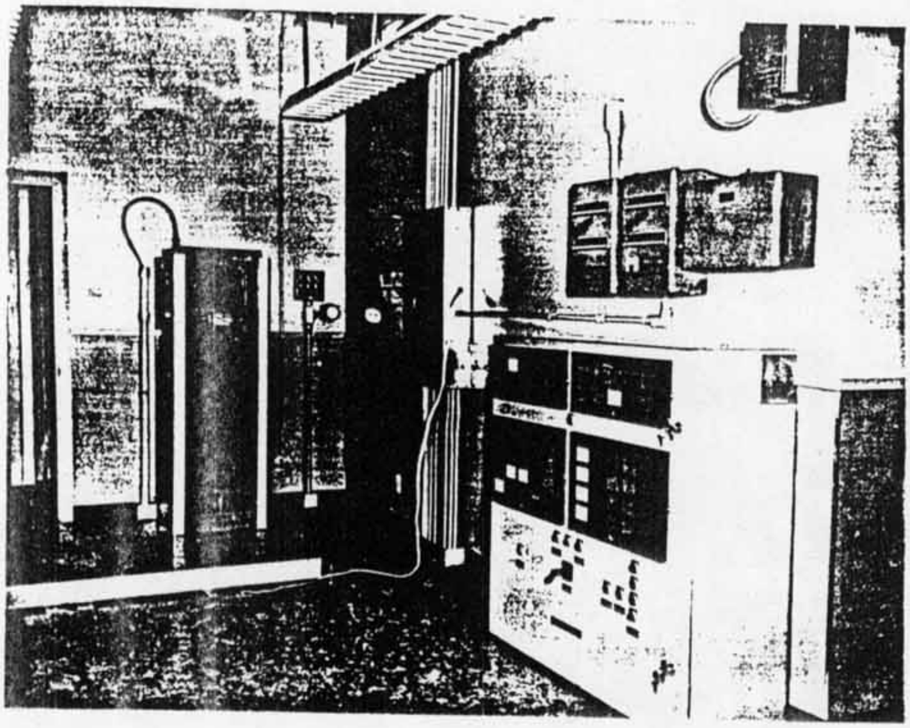
View facing Silo
GD/A Photo No. 52357



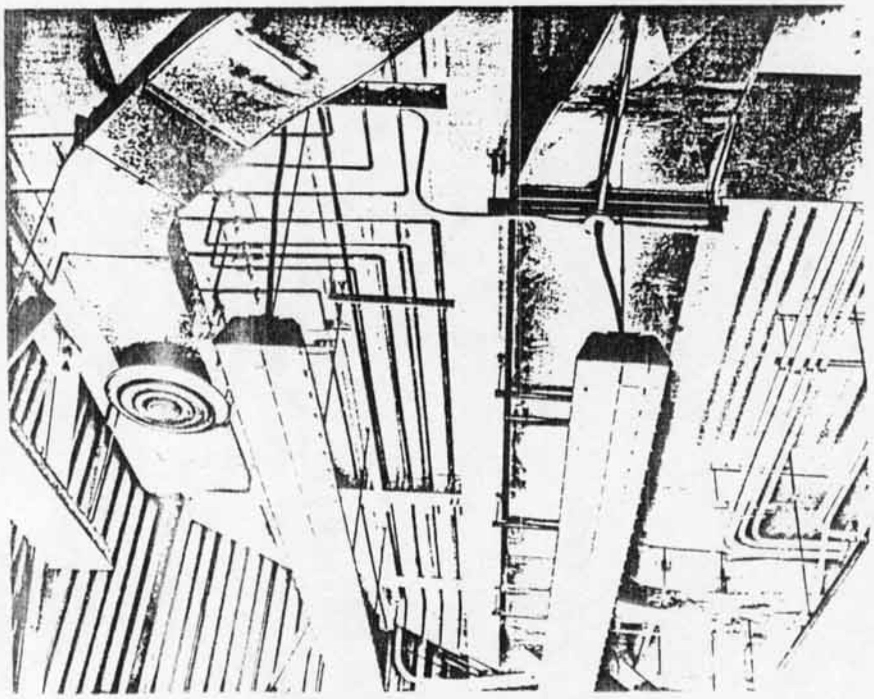
#443[illegible] [illegible] SITE 5. BEATRICE, NEBRASKA. 3 Apr 61. Detail [illegible] view shows typical installation of 16" blast [illegible] ure (Exhaust) in LCC Stairwell.



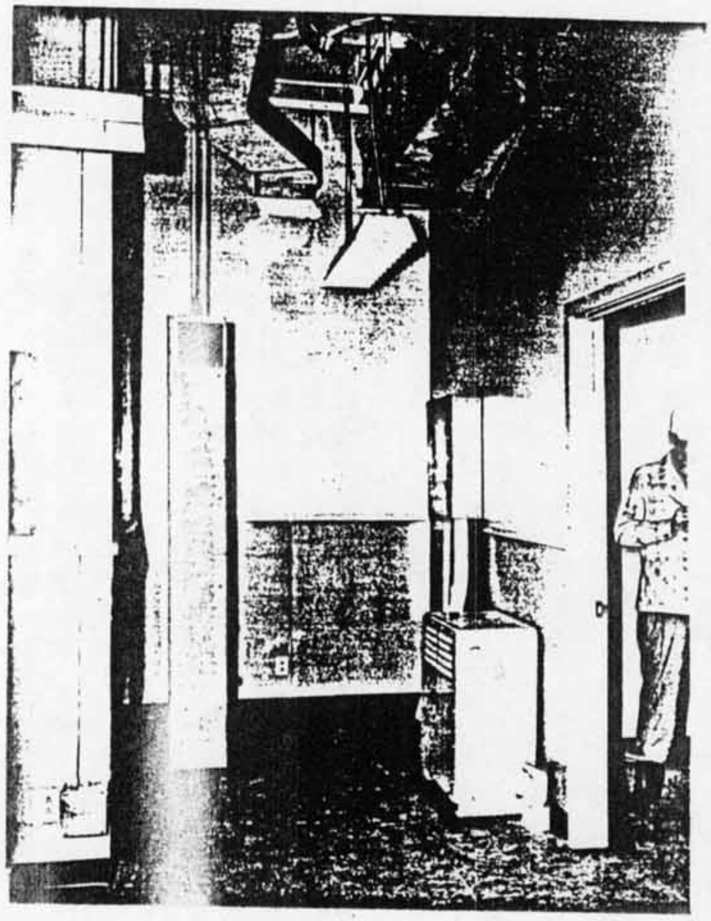
#44574. SITE 4 CORTLAND, NEBRASKA. 3Apr61 View facing LCC from Utility Tunnel shows LCC Sewage pumps and associated piping.



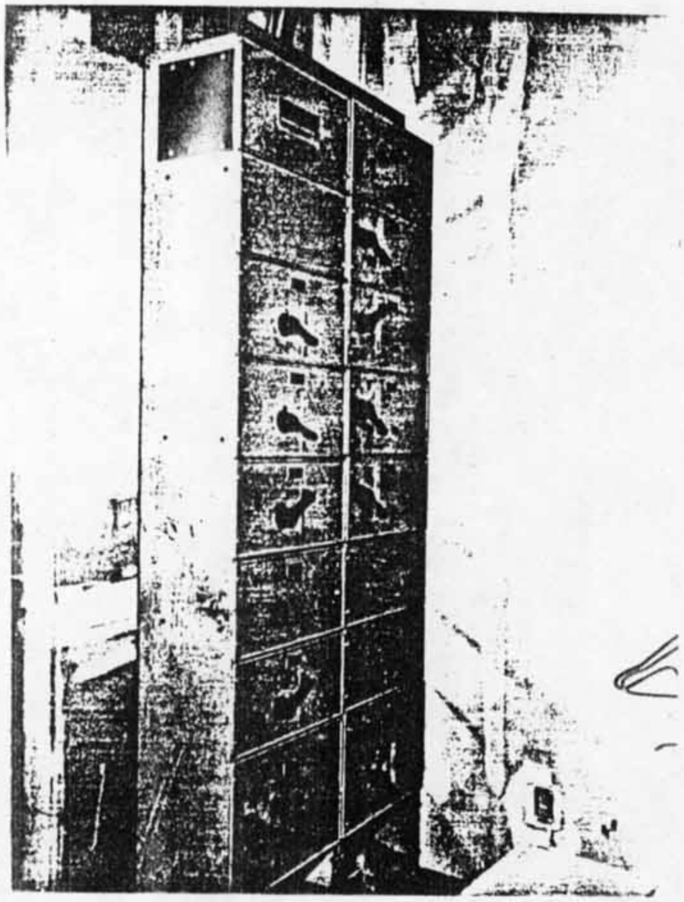
#44596. SITE 3. 20 Mar 61. Shows TV Monitor on left, Entrapment Area and Gate Control switches in corner, Lighting Panel "A", Facility Remote Control Panel and directly above Fire Control Panels and one battery box.



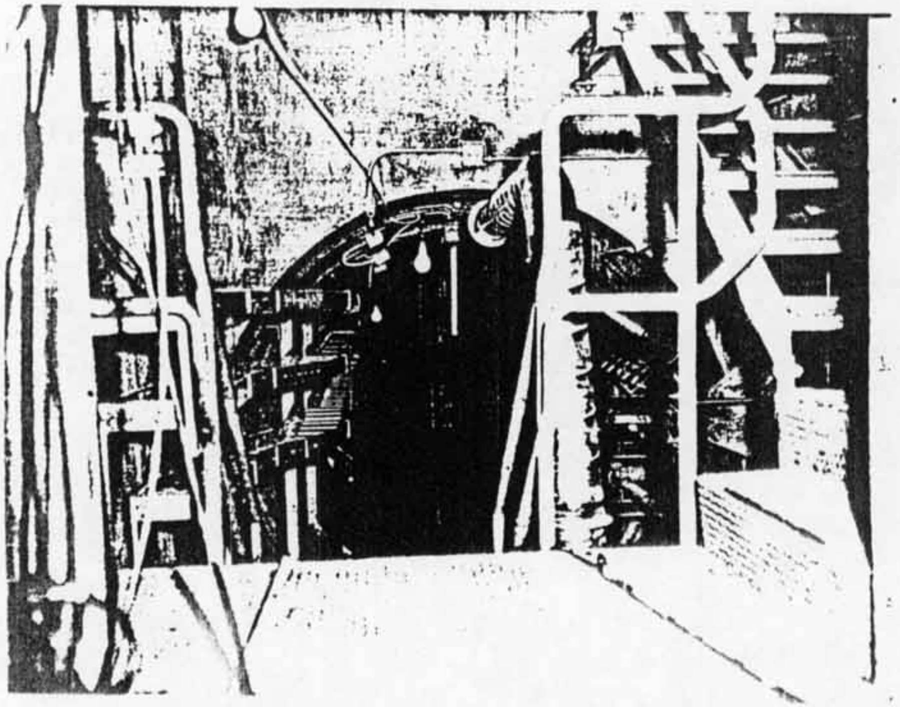
LCC. Photo facing south shows typical overhead lighting fixtures, ductwork and diffusing head in communications room, LCC. Copper lines at upper left are service air lines to Blast Closures and Air Cylinder Spring Supports.



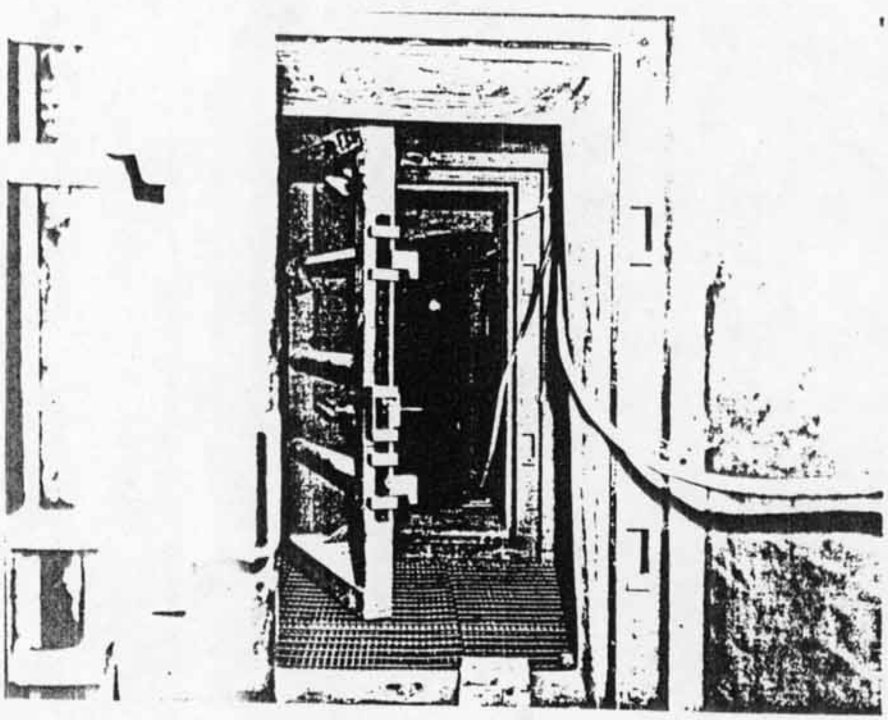
#44084. SIT[illegible], TECUMSEH, NEBRASK[illegible]. 2 Mar 61. Completion p[illegible]to shows from left to right in rear of communica[illegible]ons room the 480 Volt Control Panel, Lighting Dis[illegible]ibution Panel "[illegible]", Lighting Distribution Trans[illegible]mer. Door to battery room is at right edge [illegible] photo.



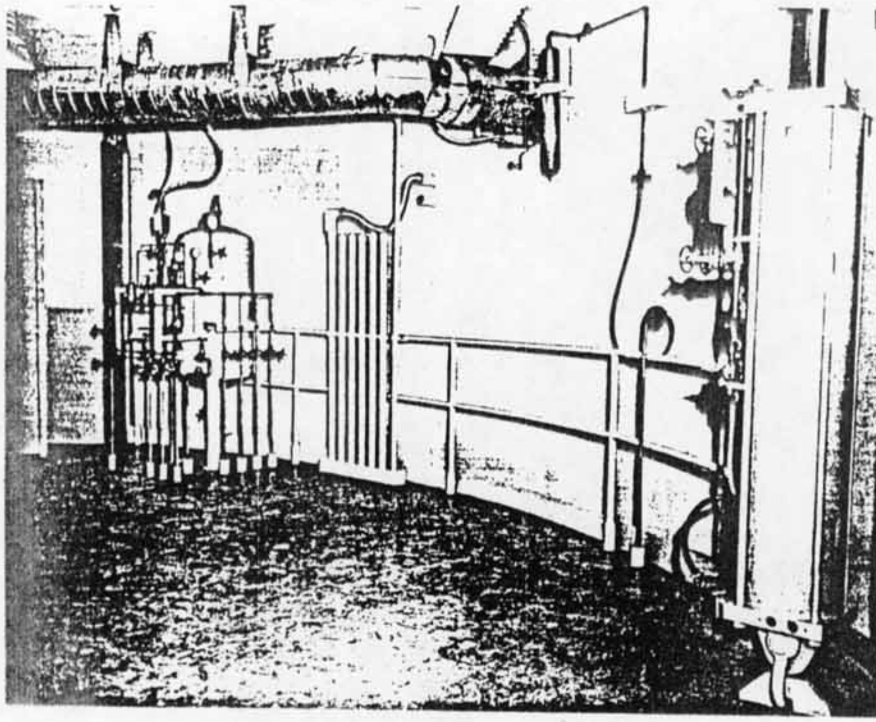
[illegible]. SITE 11. AVOCA, NEBRASKA. 1 Mar 61.
View shows partial installation of 480 Volt Control Panel in rear of communications room on second level LCC. Panel controls feeders for Lighting Transformer, Sewage Pumps, Water Wells and Water Treating Plant.



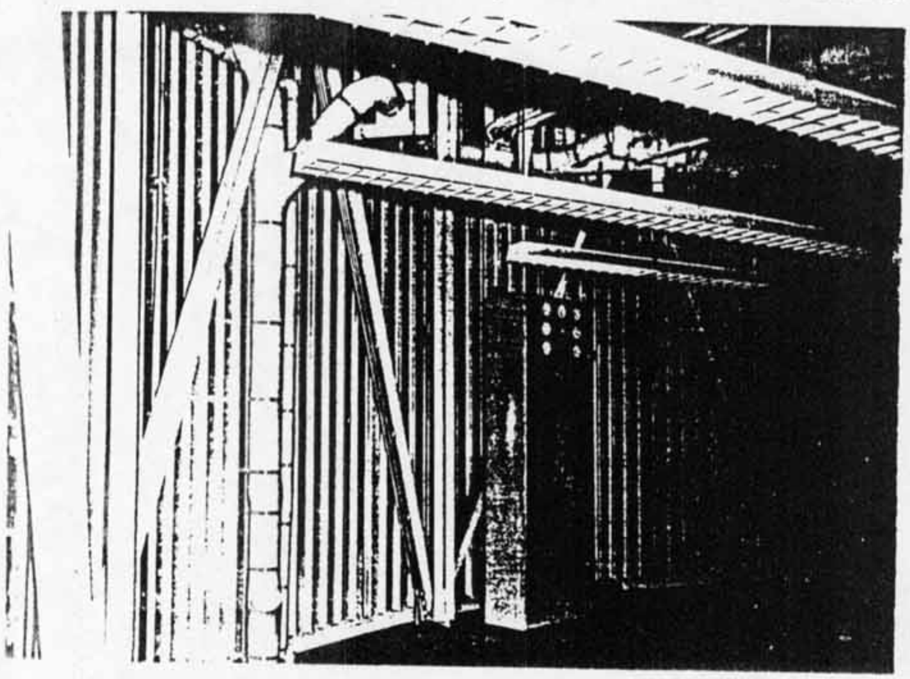
#44[illegible]. SITE [illegible]. TECUMSEH, NEBRASKA. 1 Feb 61. View of interior of utility tunnel from LCC Stairwell facing silo. Shows temporary supports used during backfilling operations.



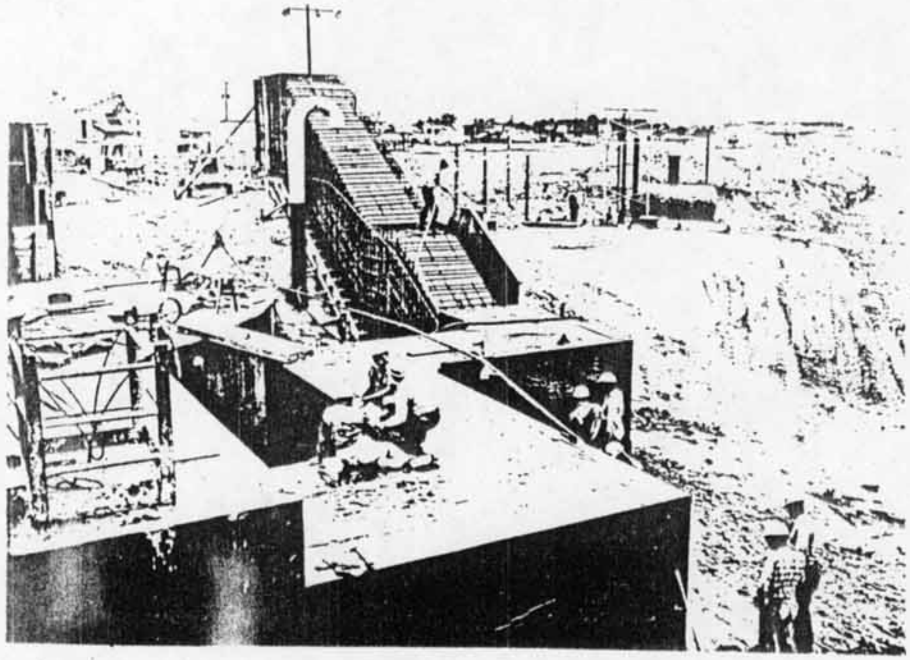
#44027. SITE [illegible], NEBRASKA CITY, NEBRASKA. 2 Mar 61 View from interior of silo, facing LCC showing silo vestibule and blast doors.



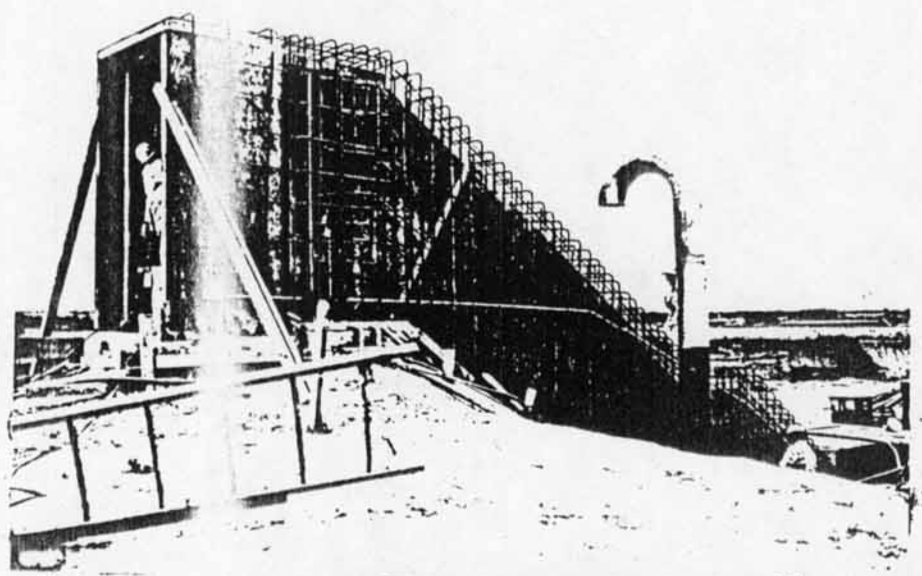
544072. SITE 3. TECUMSEH, NEBRASKA. 2 Mar 61. View of ready room on level 1 of LCC shows left to right, Air Receiver Tank for air supply to Blast Closures and Air Cylinder Spring Supports; Electrical Conduit Bank and Air Cylinder Spring Support on right. Overhead duct carries exhaust air from the LCC through Blast Closure to surface.



544078. SITE 3. TECUMSEH, NEBRASKA. 2 Mar 61. View facing north in Launch Control Room shows Power Remote Control Panel used for remote control of Diesel Generating Units.



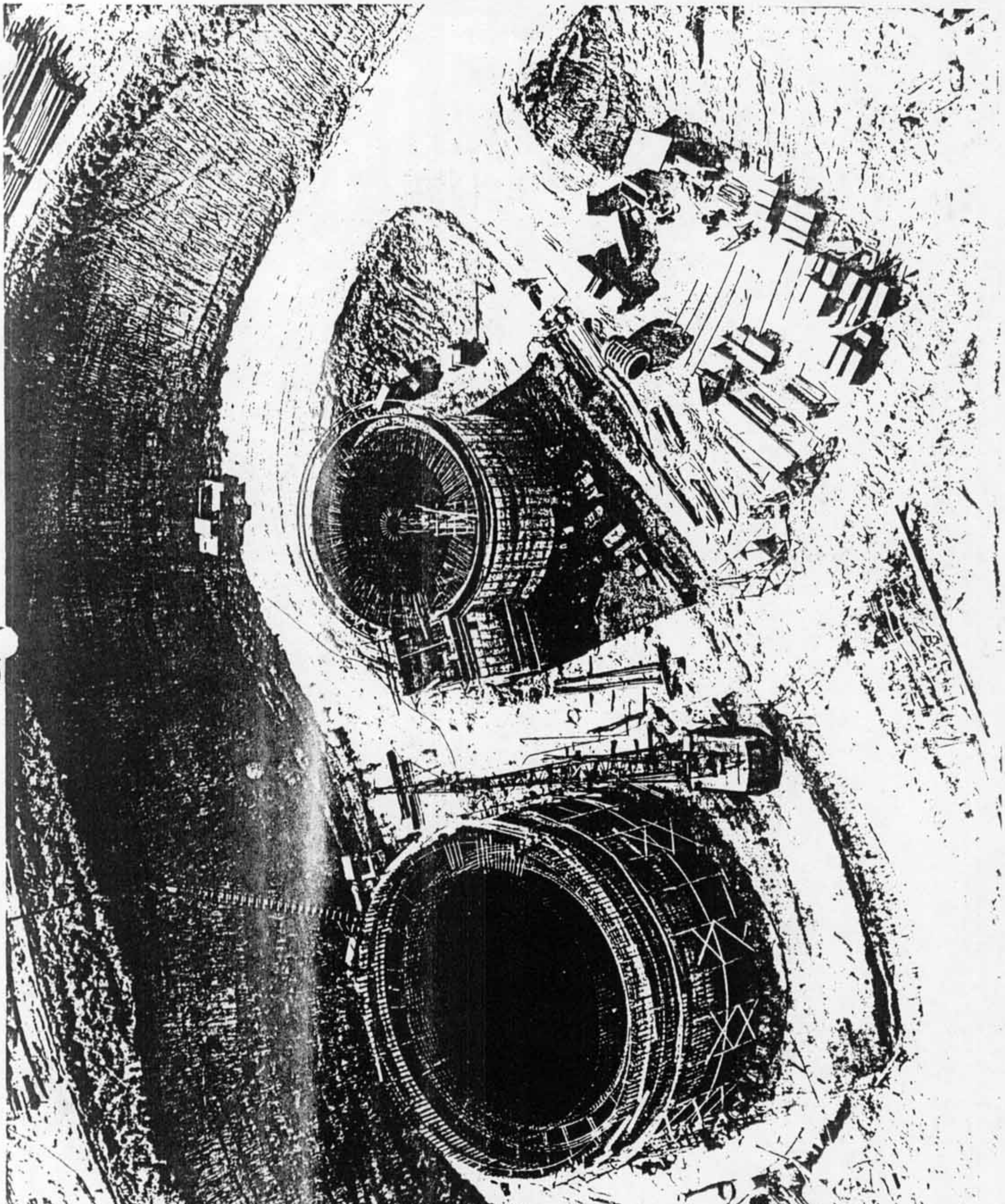
SITE 8. [illegible]. View north shows general view of LCC entrance tunnel with reinforcing steel exposed at upper end. Raw water storage tank and piping for water treatment plant at right. #4547[illegible]. 13 June 61.



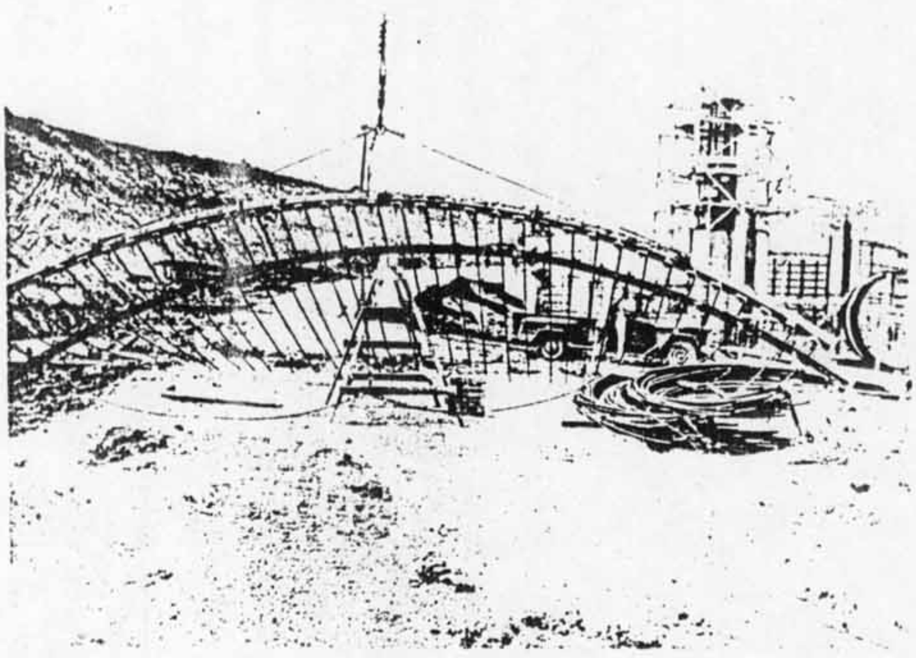
SITE 8. [illegible]. Closeup shows reinforcing steel arrangement for LCC entrance tunnel. #45478. 13 June 61.

GENERAL AERIAL VIEW NORTH

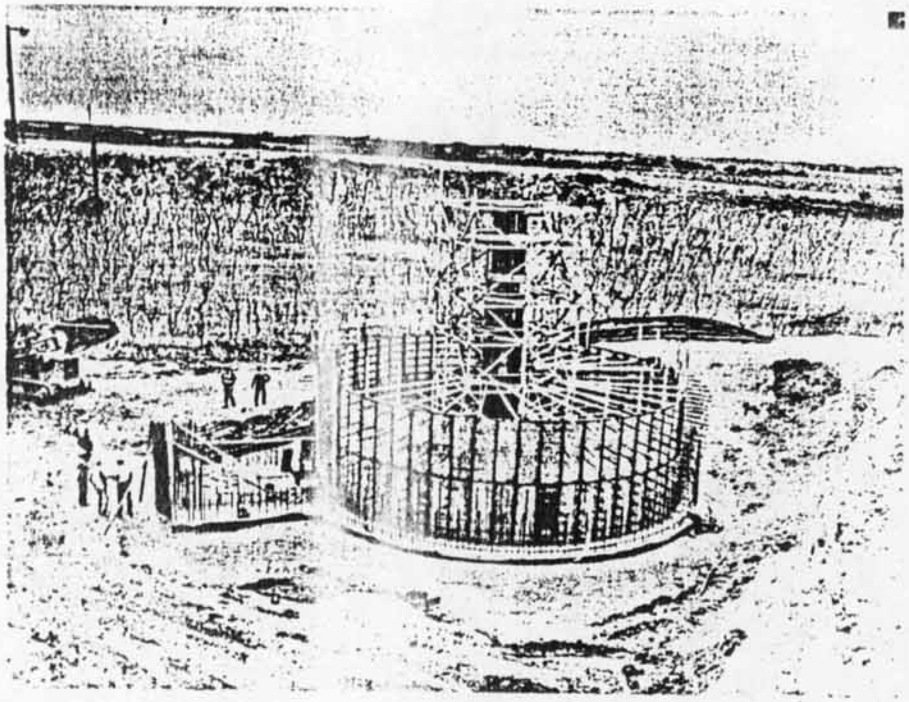
View shows working area backfilled to elev. 960. Wall forms for LCC being removed and stored upper right. "Barrel" form in place for silo wall pour to elev. 991, placing of reinforcing steel in progress. Slipform deck visible in silo at elev. 945. Small cylindrical form above LCC is for LCC escape hatch. Crib steel storage at far left. Large pump visible at lower right lifts water from silo discharge sump to waste at top of open excavation. C of E #1-41316. 11 Oct 60.



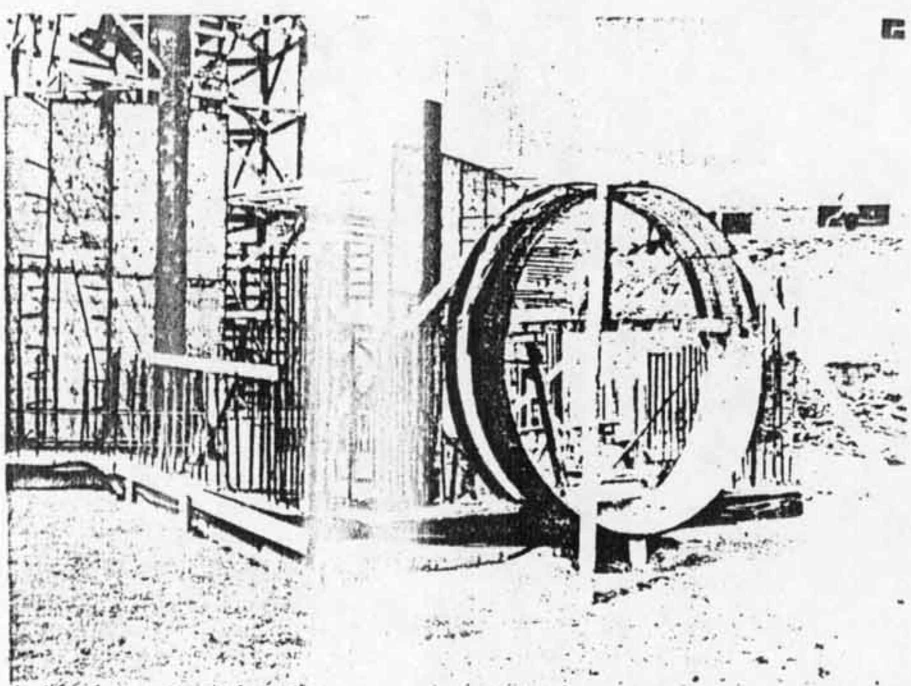
Site 3. Bending operation of re-bar steel in preparation for placement in missile silo.



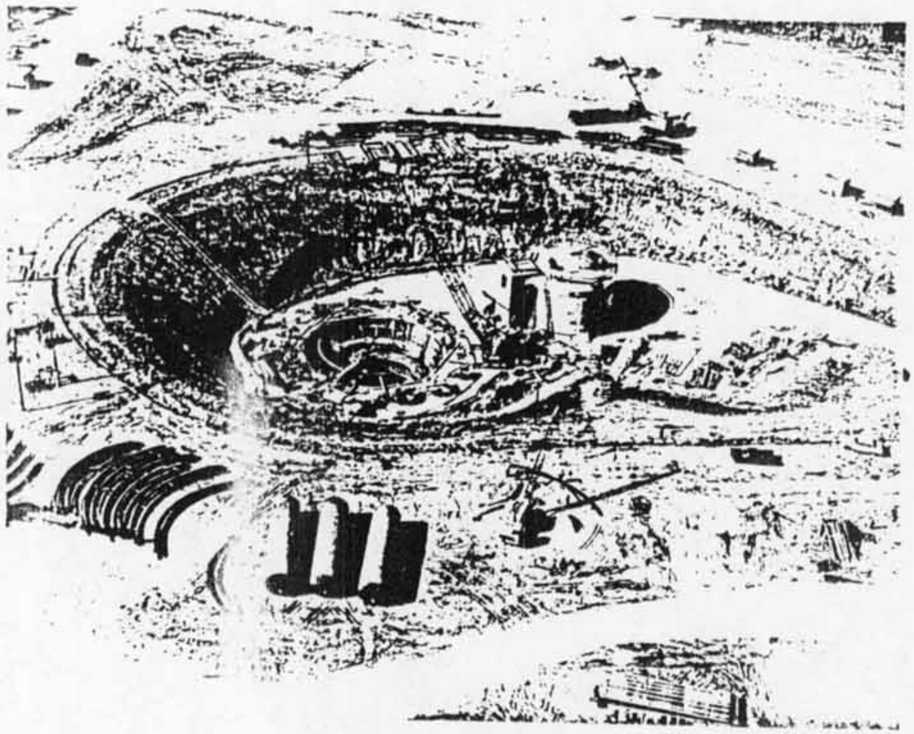
Site 3. Detail view of jig for placement of vertical re-steel in sides of missile silo. Steel in jig ready to be lowered into place.



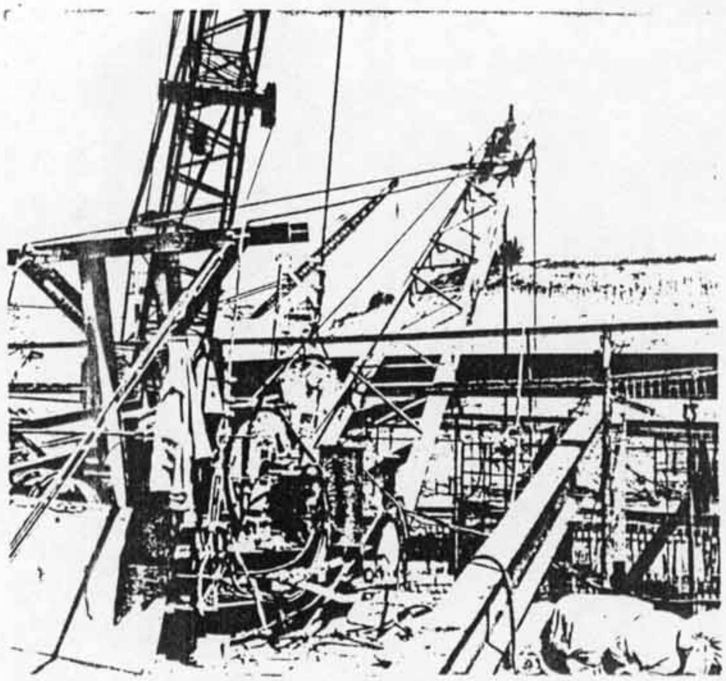
Site 3. View looking west showing inside forming and partial re-steel for sides of launch control center. Also shown is forming and re-steel for center column.



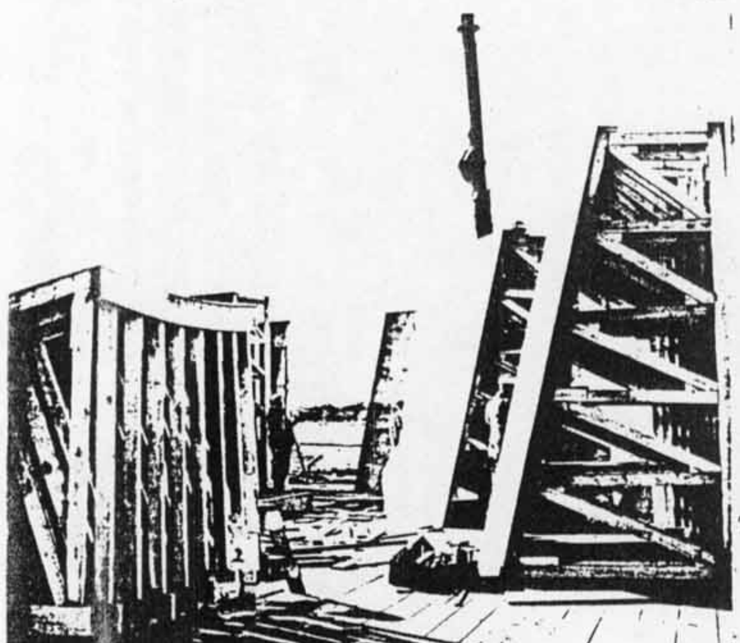
Site 3. Looking north view shows stool, ring and partial re-steel for utility tunnel entrance of launch control center.



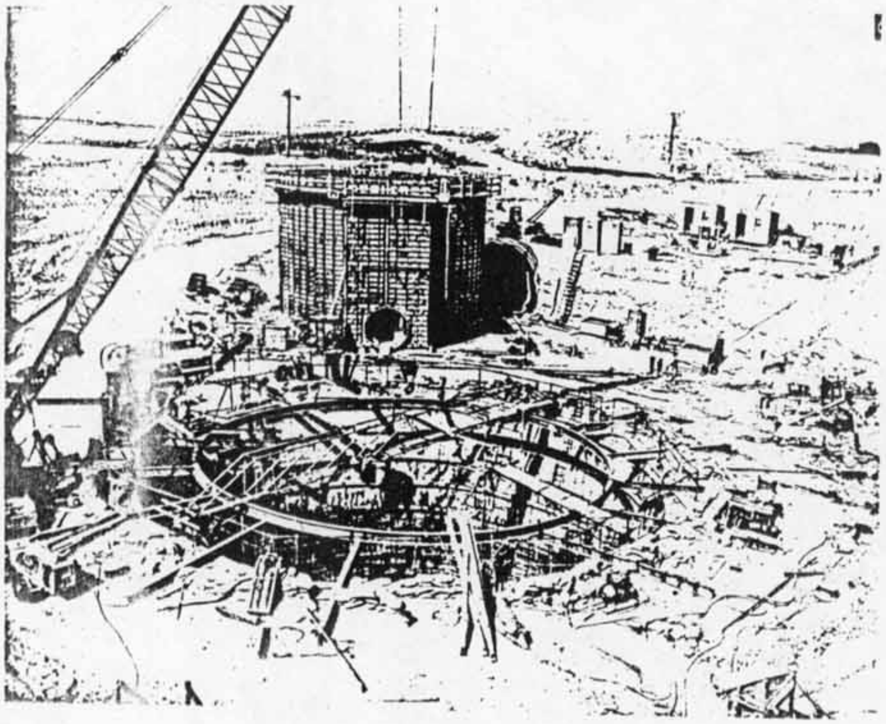
41199. Aerial view of complex shows forms removed from LCC. A series of small excavations is in progress around perimeter of silo and are about 15' from top ring beam. These are for the concrete "hold down" supports under the cantilever beams which will support the circular beam from which the slipform jacking rods are suspended. Approximately one third of the circular beam is in place.



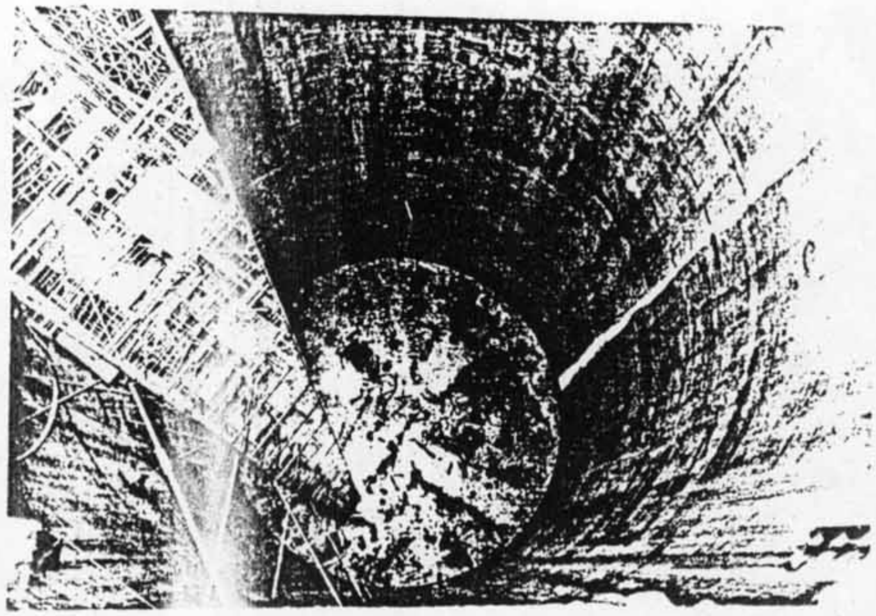
View of hoist used in slipforming operation.
C/A [illegible].



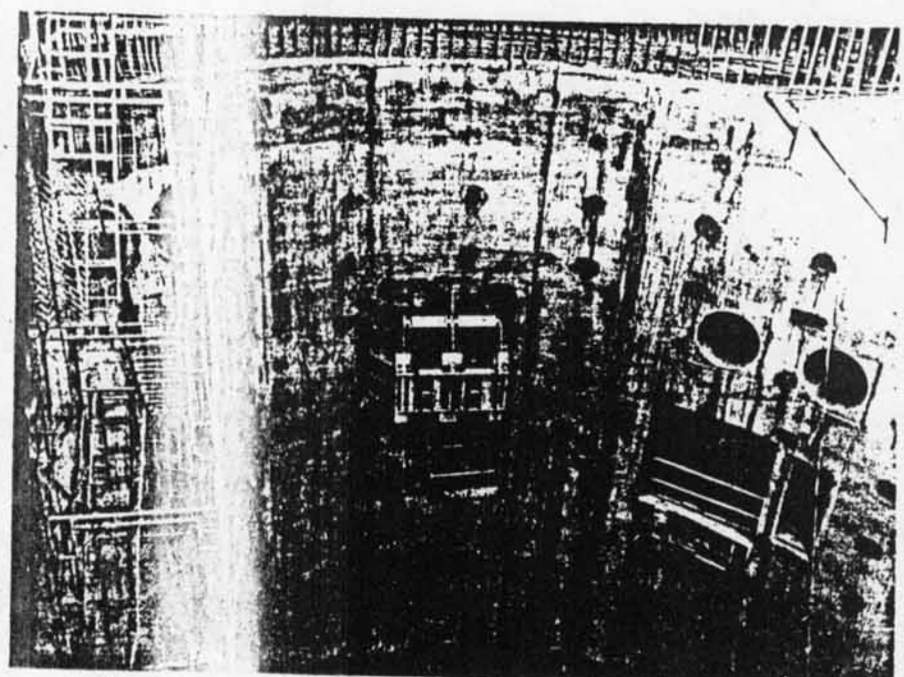
Sections of transition portion of "barrel form" at
Cortland, Nebraska. Carpenter shop. C/A #51013.



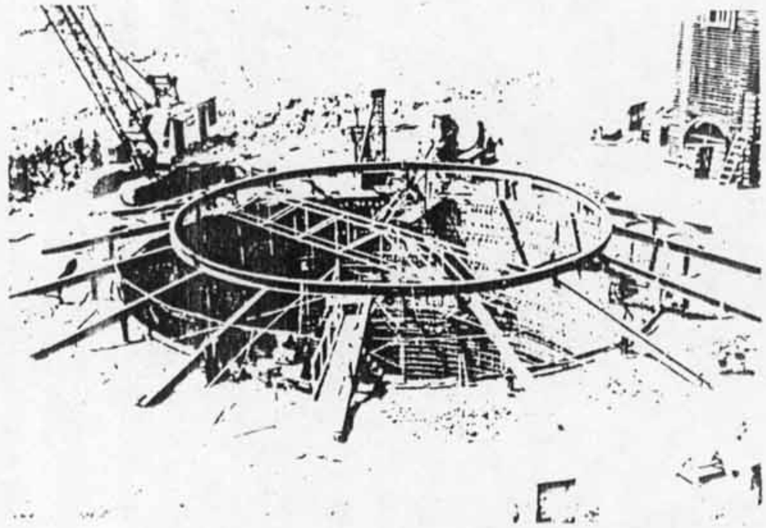
#40857. SITE 6, WILSON. 3 Oct 60. View facing northwest shows installation of surface facilities for the slipform pour of silo walls, first lift. Winch and short boom at left control the "mudbucket" to hopper on slipform deck. A second "mudbucket" handled by the crane is shown at end of trough near center of silo. Circular beam and cantilever supports will carry the weight of slipform and related equipment. The bridge over silo was attached only to collar beam and was installed at this time for the sole purpose of supporting the 1/16" piano wire that was used for control of centerline during pour.



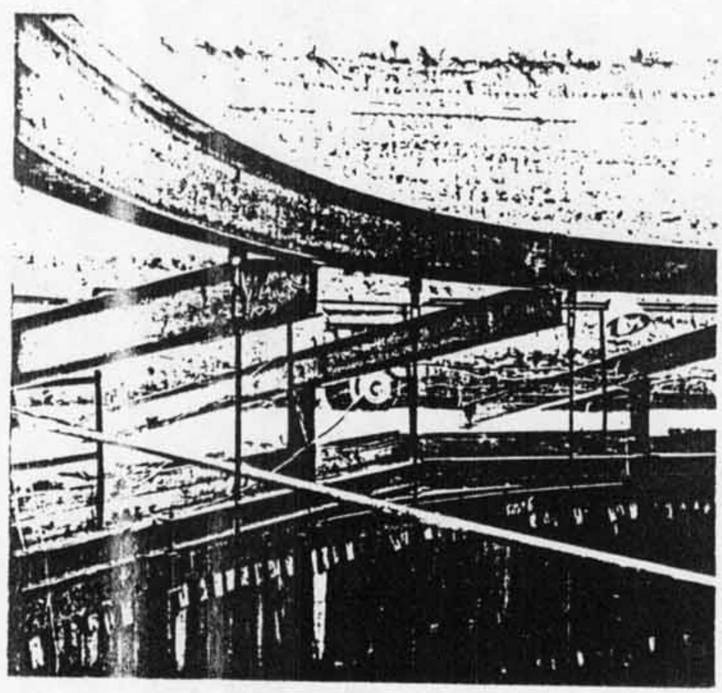
View into [illegible] shows completed pour of lower silo area after removal [illegible] slipform. Collimator insert plate at right, pipe [illegible]er insert plates top center. Temporary access stai[illegible] at left. #41794.



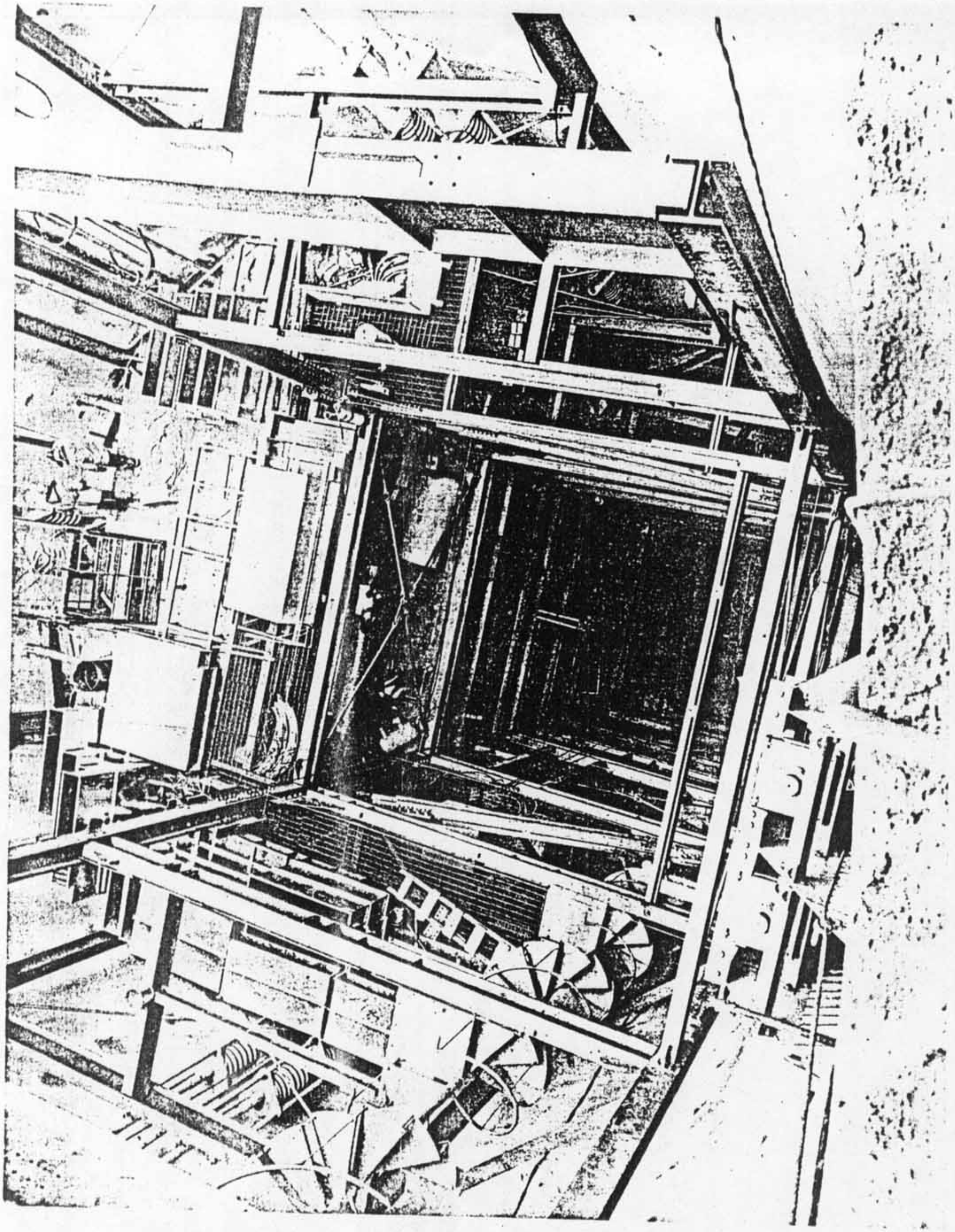
SITE 7. Y[illegible] 3 Jan 61. View facing west showing concrete "upper" st[illegible] from elev. 945 to 991. 46" [illegible] air intake sleeves on [illegible] 46" air exhaust sleeves on right above silo vestibule [illegible] conduit blockouts. #42563.



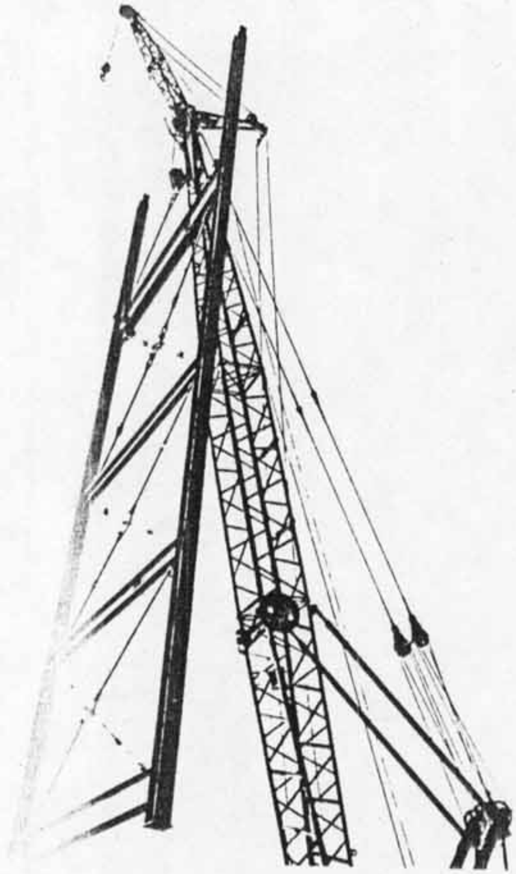
SITE 5. [illegible]. View facing northwest shows surface facilities for slipforming. At this site the bridge for centerline control was installed under the circular [illegible] [illegible].



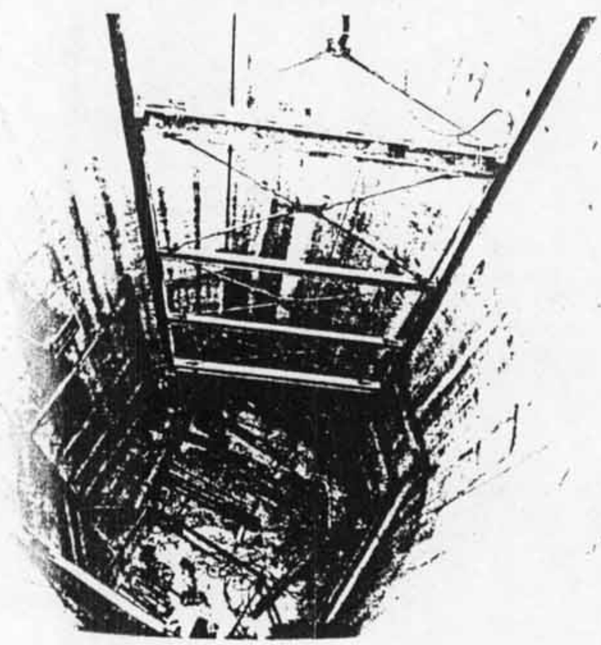
[illegible] view of cantilever beams, circular beam and jacking rods. [illegible]



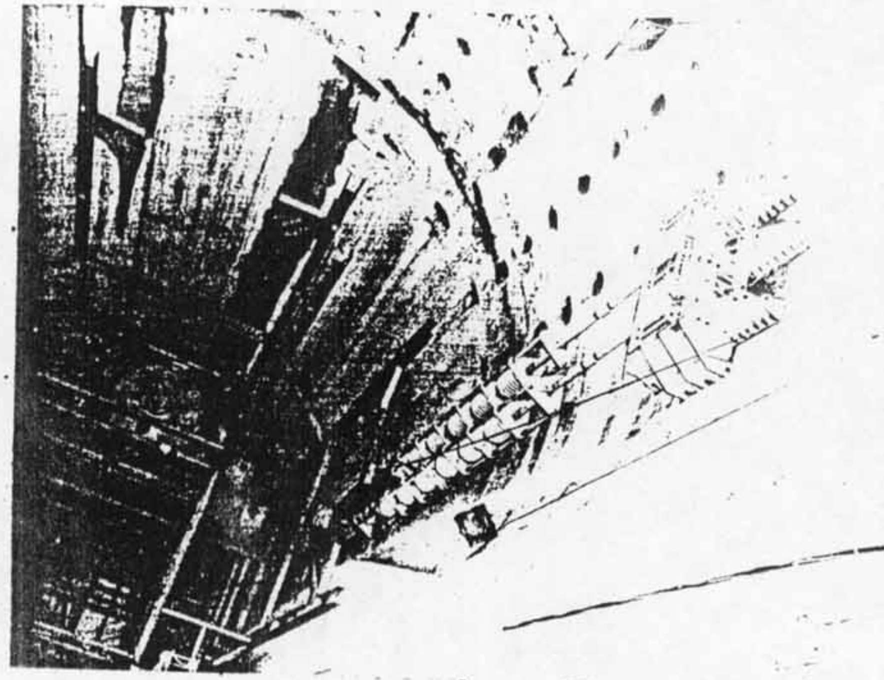
View to bottom of silo showing crib steel and grating essentially complete through Level 3.



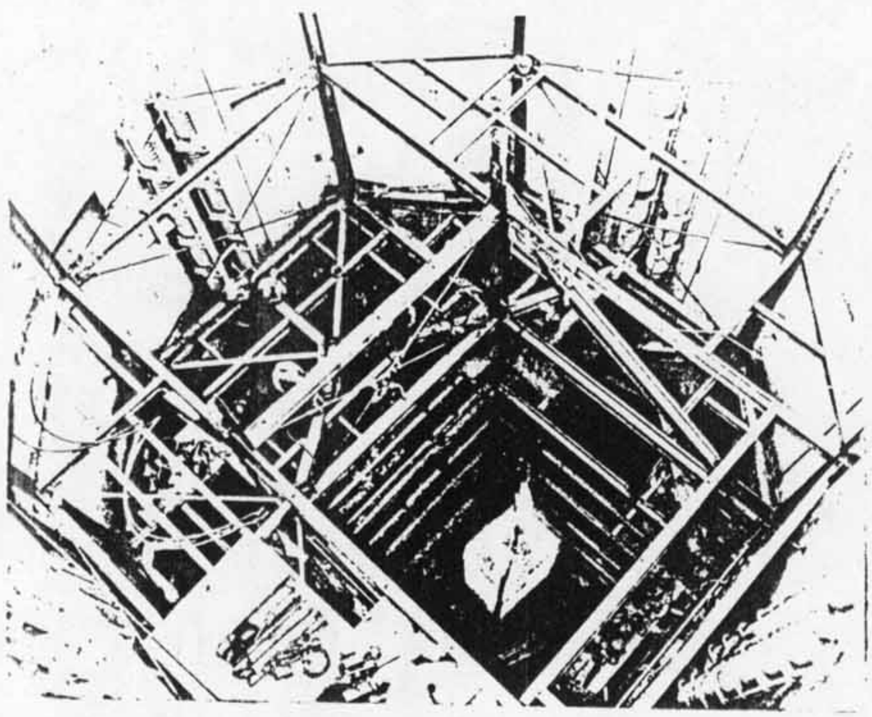
SITE 9, BRAINARD. Preassembled section of steel crib being hoisted for lowering into silo. #41849. 3 Nov 60.



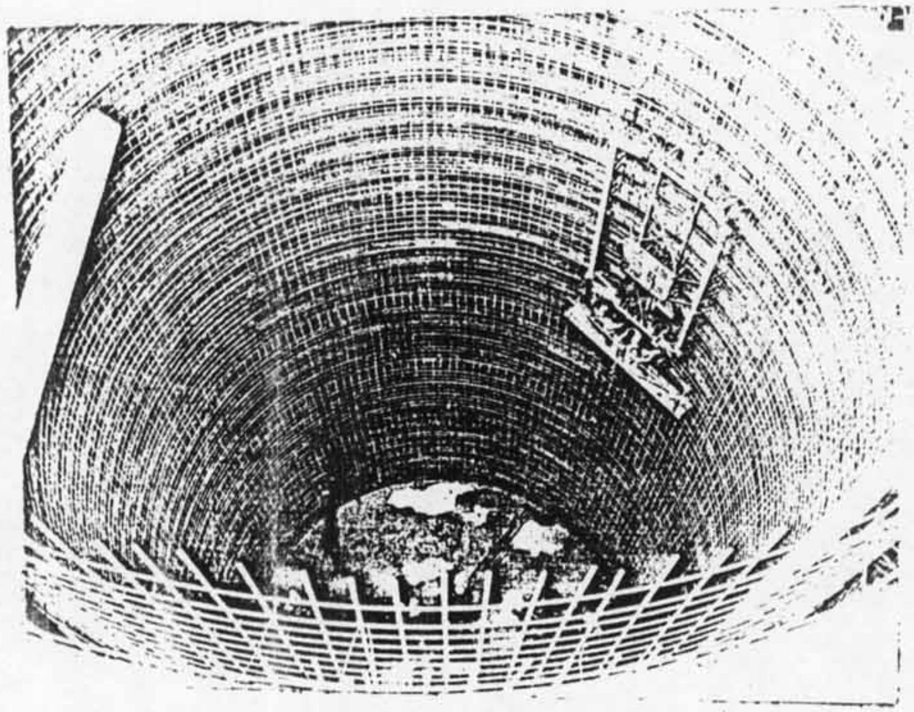
[illegible] shows same section being lowered to level 8 in silo. [illegible] tube blockout is visible at left center above [illegible] and ladder. #41851. 3 Nov 60.



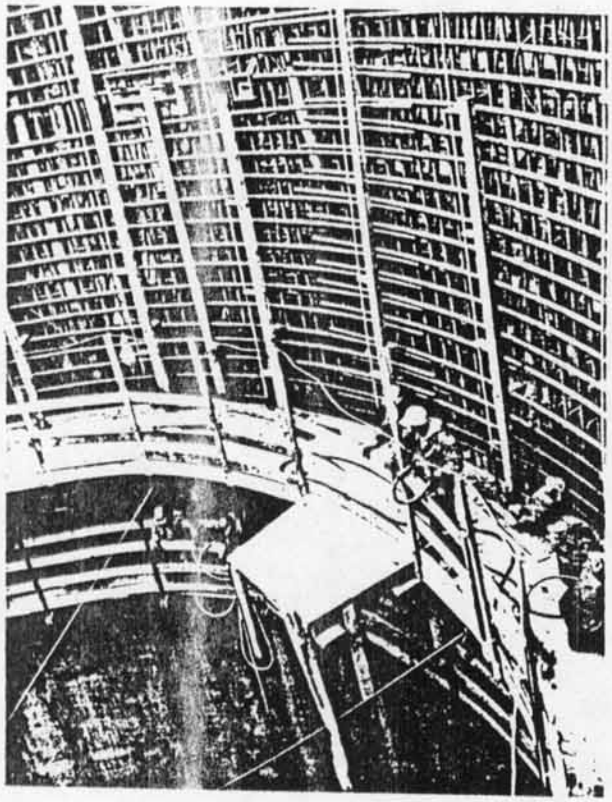
SITE 6. WILBER. View into silo shows shock hanger bracket and struts installed on +X. FLS vessels placed on level 8. #42363. 7 Dec 60.



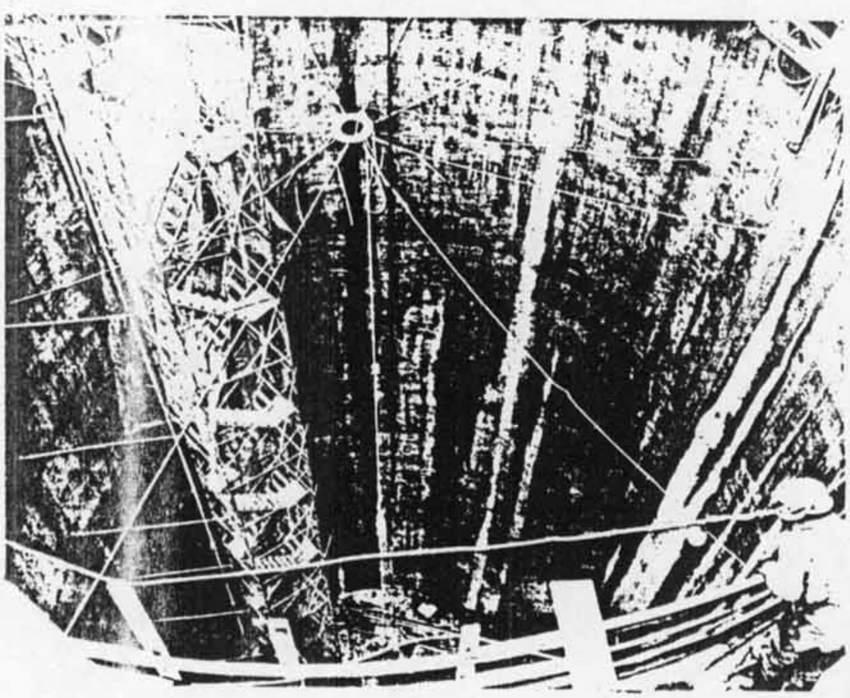
SITE 7, YORK. General view shows crib steel to level 3. #43796. 1 Mar 61.



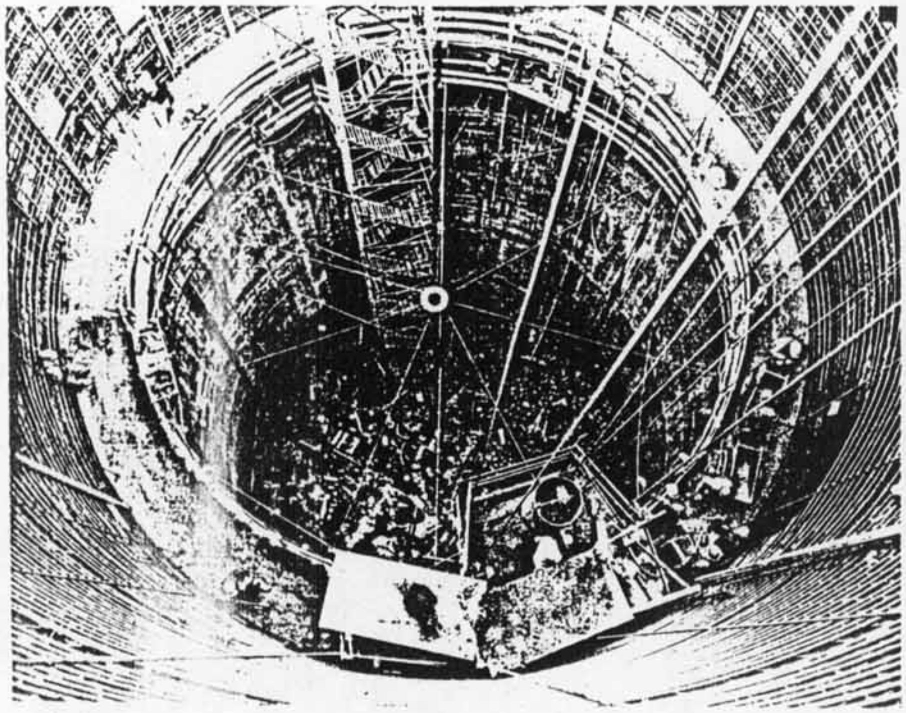
SITE 9. BRAINARD. 7 Sept. 60. View into silo shows reinforcing steel prior to erection of the slipform. Work is in progress at the base of the collimator insert plate. The centerline of collimator is located 5 5/8" west of the centerline of the silo (X-X Axis.) #40216.



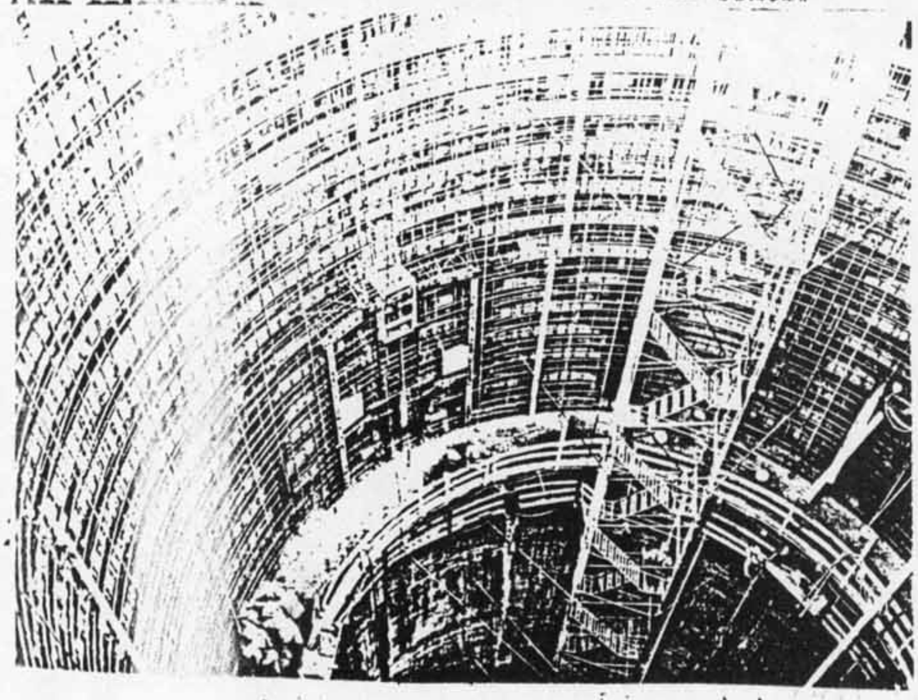
#41037. SITE 6, WILBER. 2 Nov 60. View facing southwest shows slipform deck at datum elevation 945. Small platform in foreground was used to transfer finishing materials and tools to the lower deck.



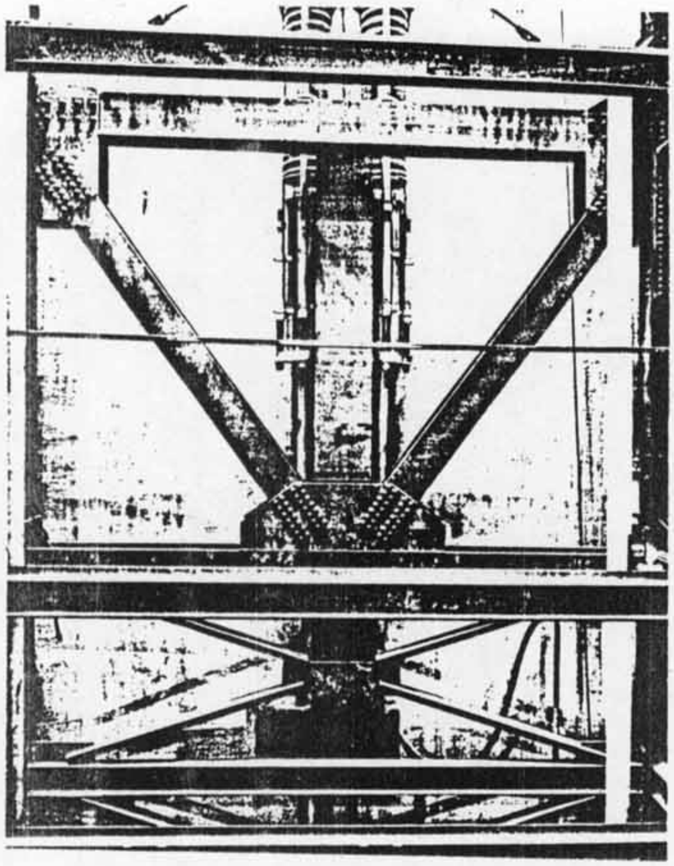
#41035. SITE 6, WILBER. View into silo from elevation 965 shows slipform at elev. 945 which was the top of the first lift. Water on silo walls was supplied for curing purposes through perforated plastic lawn irrigation tubing placed around the slipform perimeter.



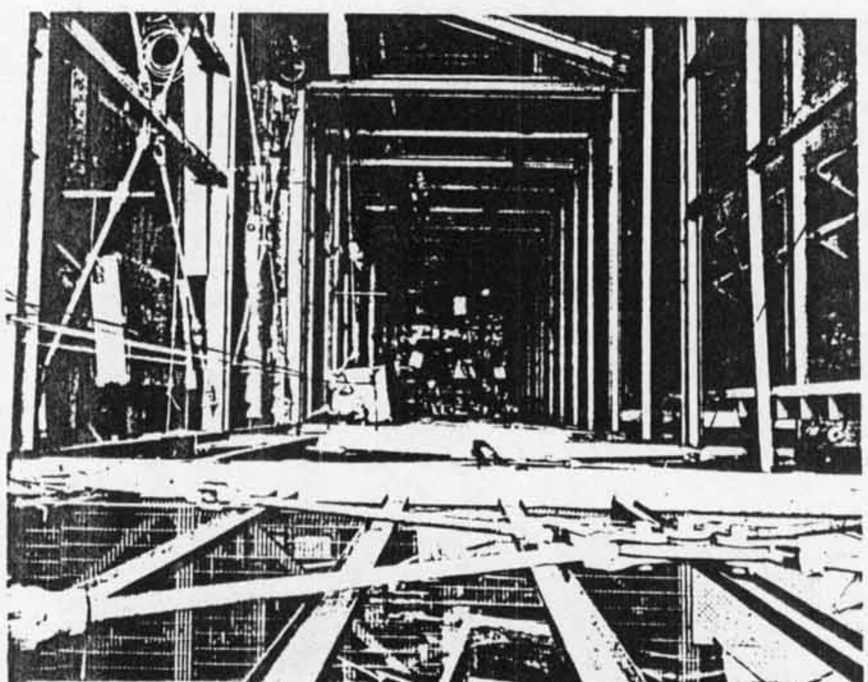
[illegible]. [illegible] [illegible] [illegible] 3 Nov 60. General view of sliplform in silo facing northeast shows concrete being discharged into hopper at slipform. Deck of slipform is at datum elev. 800. Note "spider" arrangement of cable used to control roundness of form and center-line [illegible]



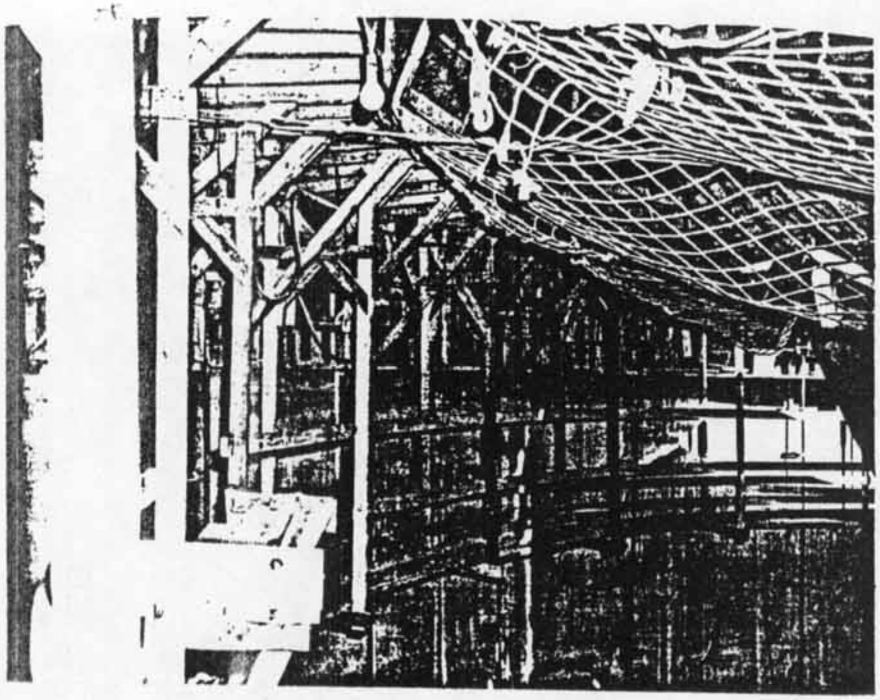
641[illegible]. [illegible] 12, [illegible] 3 Nov 60. Northeast view shows concrete "buggies" being unloaded to the left of collimat[illegible] [illegible] plate. Det. elev. about 800.



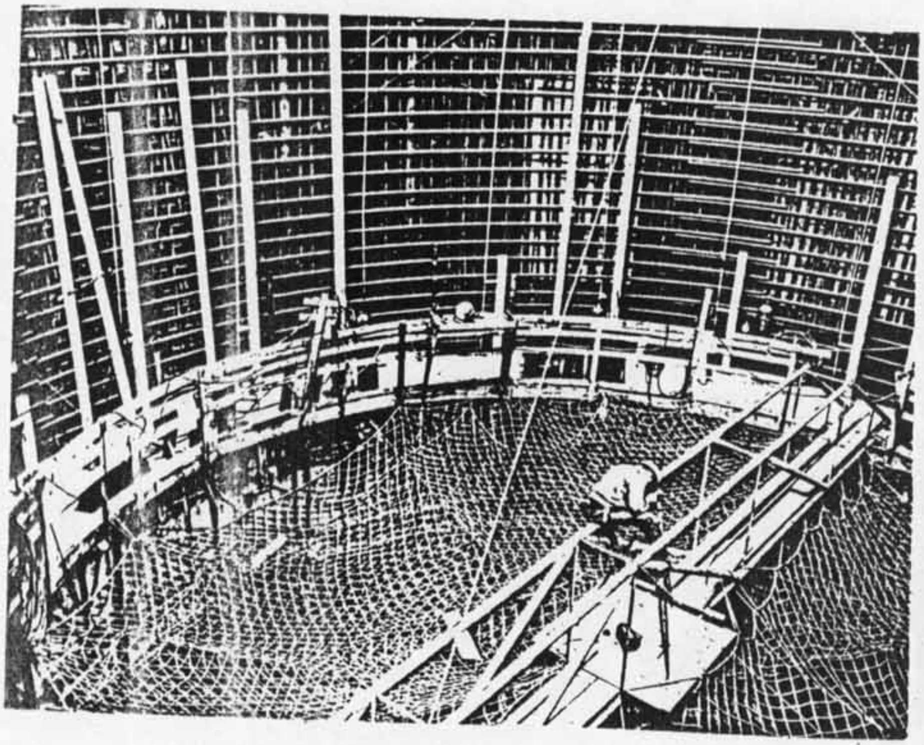
Typical view of
Crib Steel
Support with
Shock Strut
GD/A Photo No.
51567.



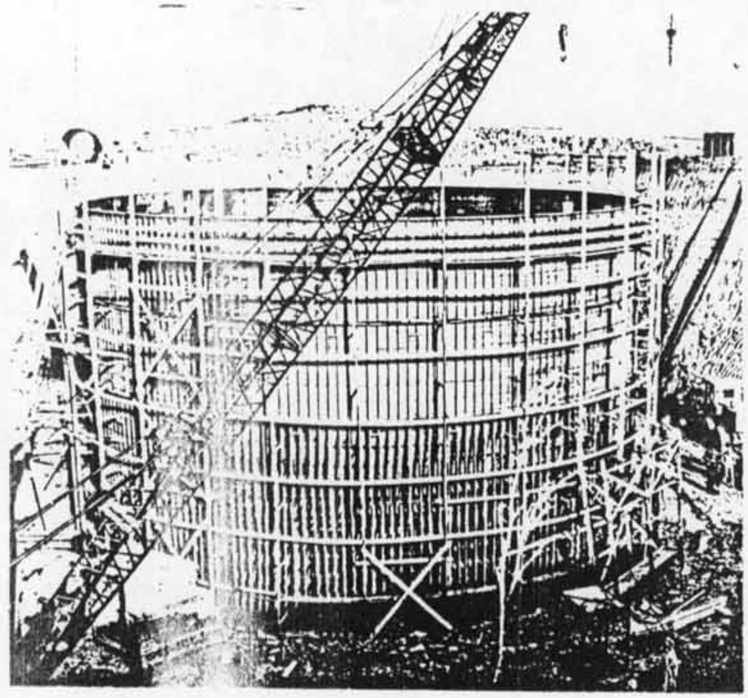
View facing north downward from Level 1 shows work platforms in missile area. Facilities Interface Cabinet at left has just been lowered to Level 3. GD/A Photo No. 51555.



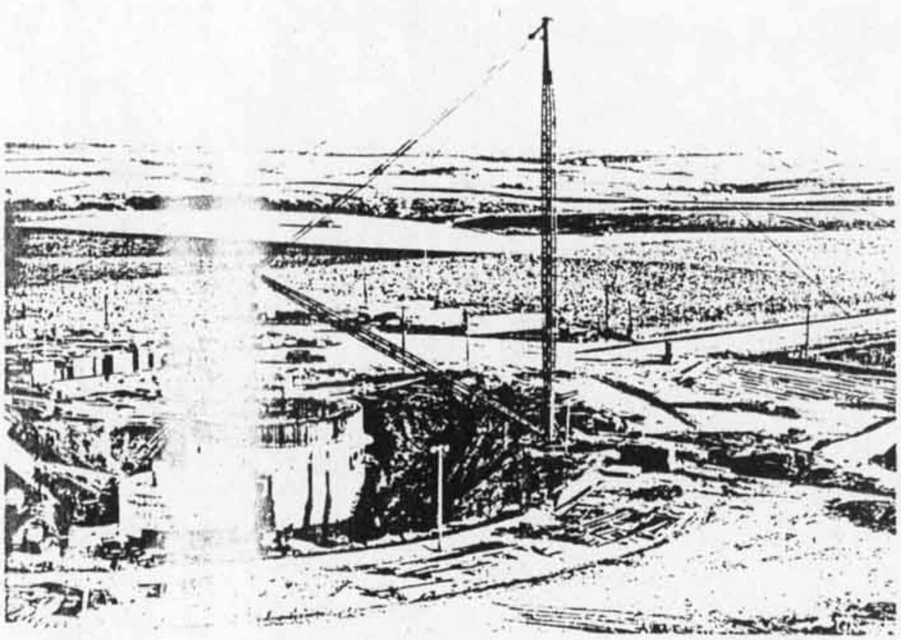
[illegible] SITE [illegible], [illegible]. 1 Mar 61. Detail of finishers platform under slipform showing safety net ties to the slipform structure.



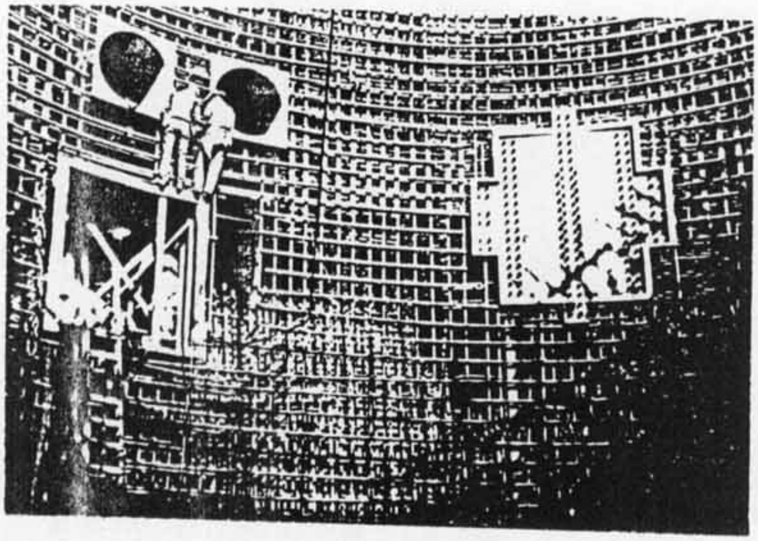
[illegible] SITE [illegible]. 4 Apr 61. Southeast view from silo vestibule shows slipform deck and safety net installation prior to pouring "haunch" section of silo.



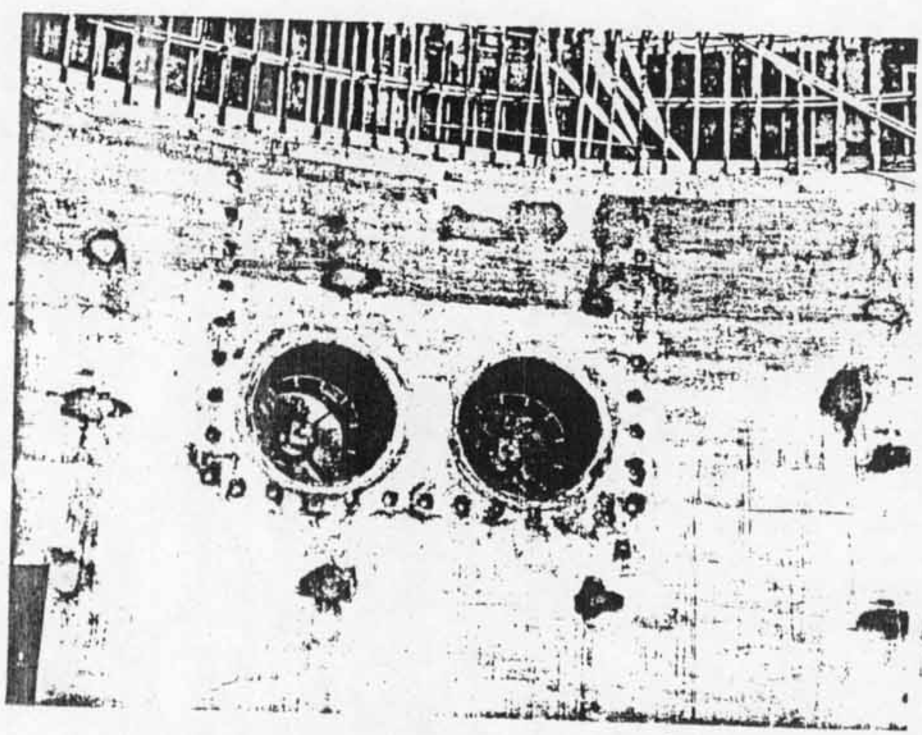
View of "[illegible] form" used to pour "haunch" section of silo to [illegible] 991. Note blockout forms at lower left [illegible] silo vestibule and conduit openings. G[illegible] #5104[illegible].



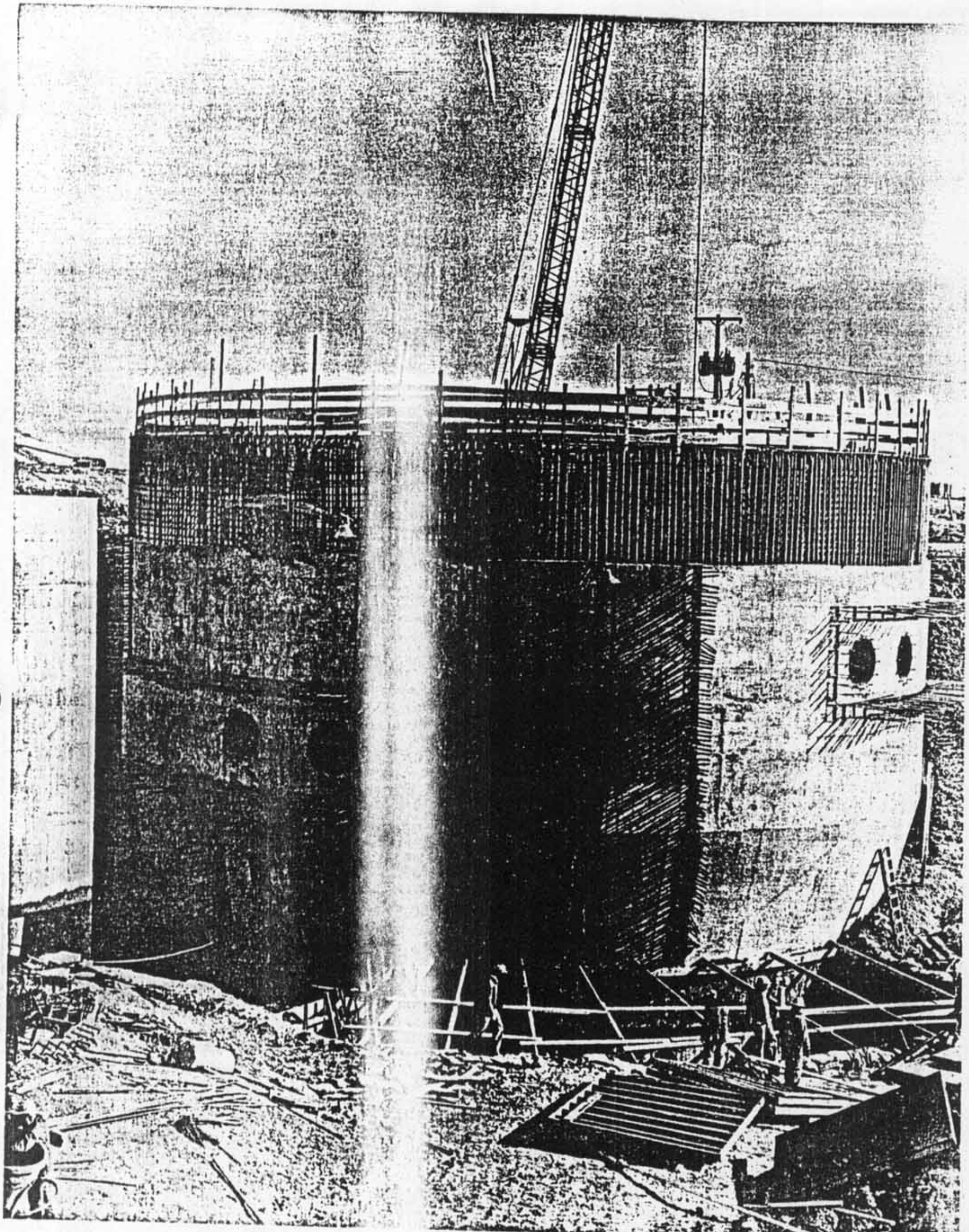
Aerial vie[illegible] completed "haunch" pour to elev. 991. White coati[illegible] curing compound. [illegible] photo.



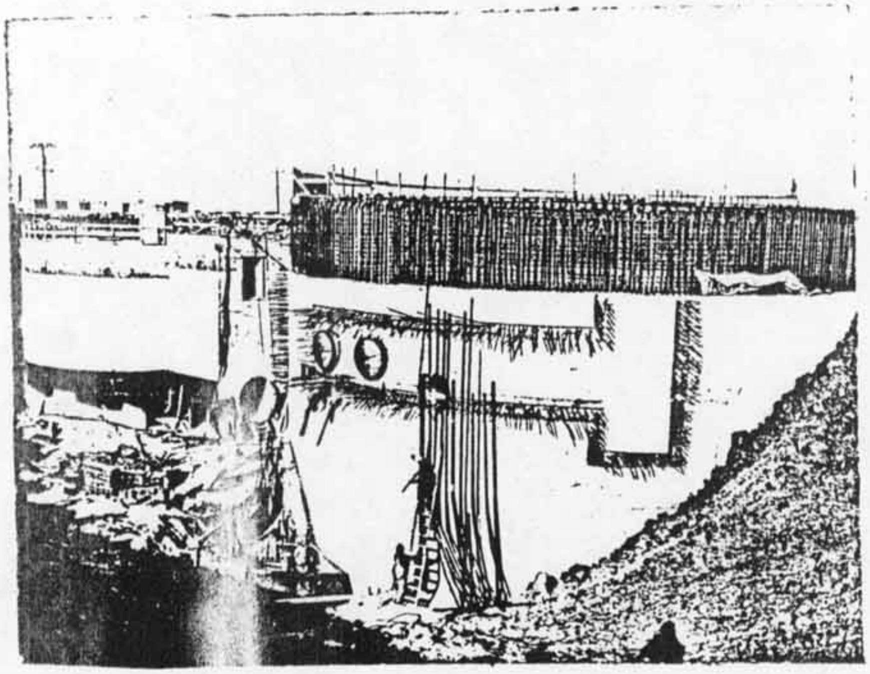
[illegible]-3. SITE 4, CORTLAND. Nov 60. View facing north shows silo vestibule entrance blockout, 40" OD air exhaust sleeves and shock hanger insert plate prior to pour of second lift or "haunch" section of silo from elev. 945 to 971. Note wooden frame constructed around the shock hanger insert plate to facilitate passage of slipform.



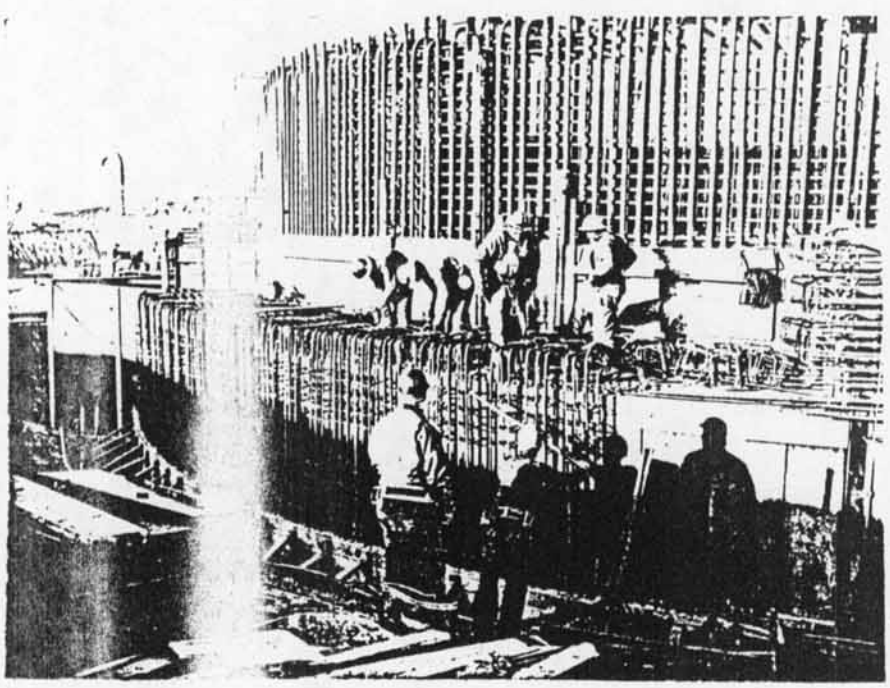
[illegible]. SITE 4, CORTLAND. Nov 60. Southwest view shows Air Intake Blast Closure mechanisms installed in silo wall sleeves.



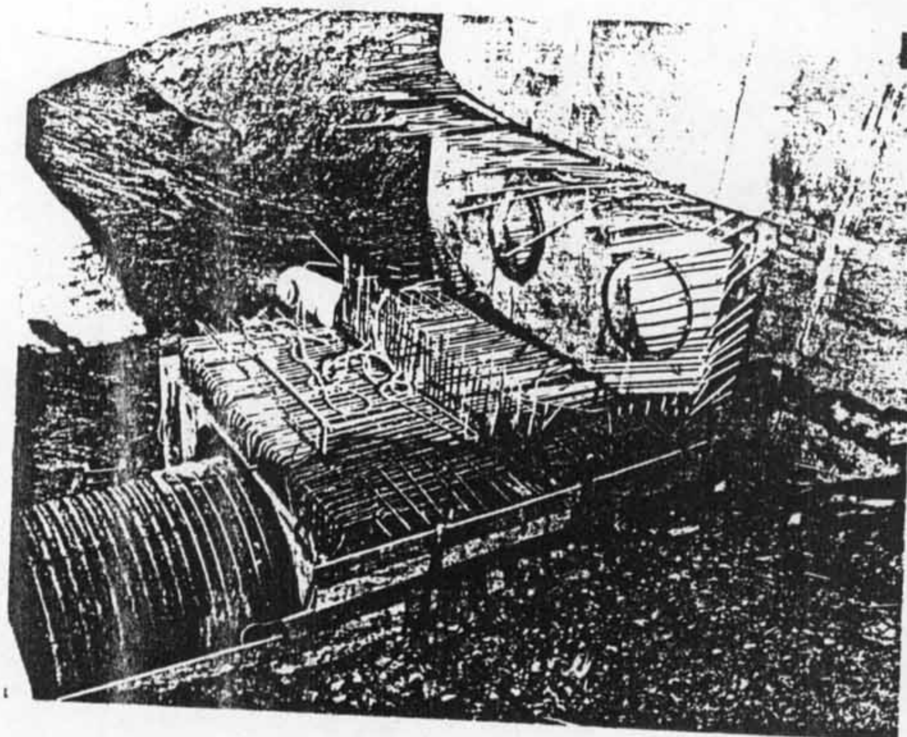
Silo concrete complete through Elevation 991 with re-steel complete for silo curtain wall from Elevation 991 to 1000.



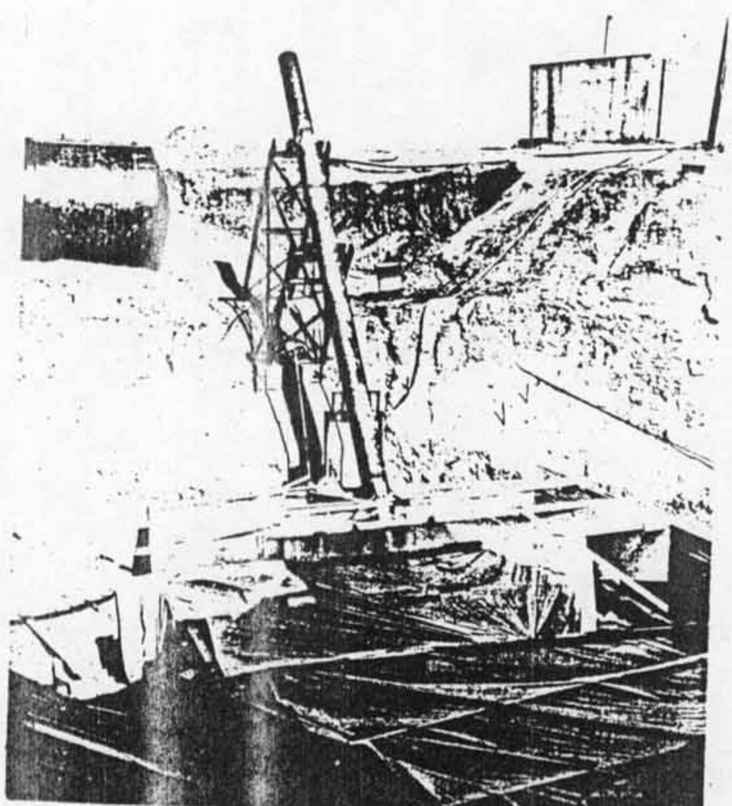
SITE 2. NEB[illegible]KA CITY. 1 Dec 60. View facing north shows dowels [illegible]jecting from silo walls for air intake tunnel. Note [illegible]eyways at dowel lines. Exterior portion of blast Clo[illegible] mechanism at left of intake tunnel blockout. [illegible]75.



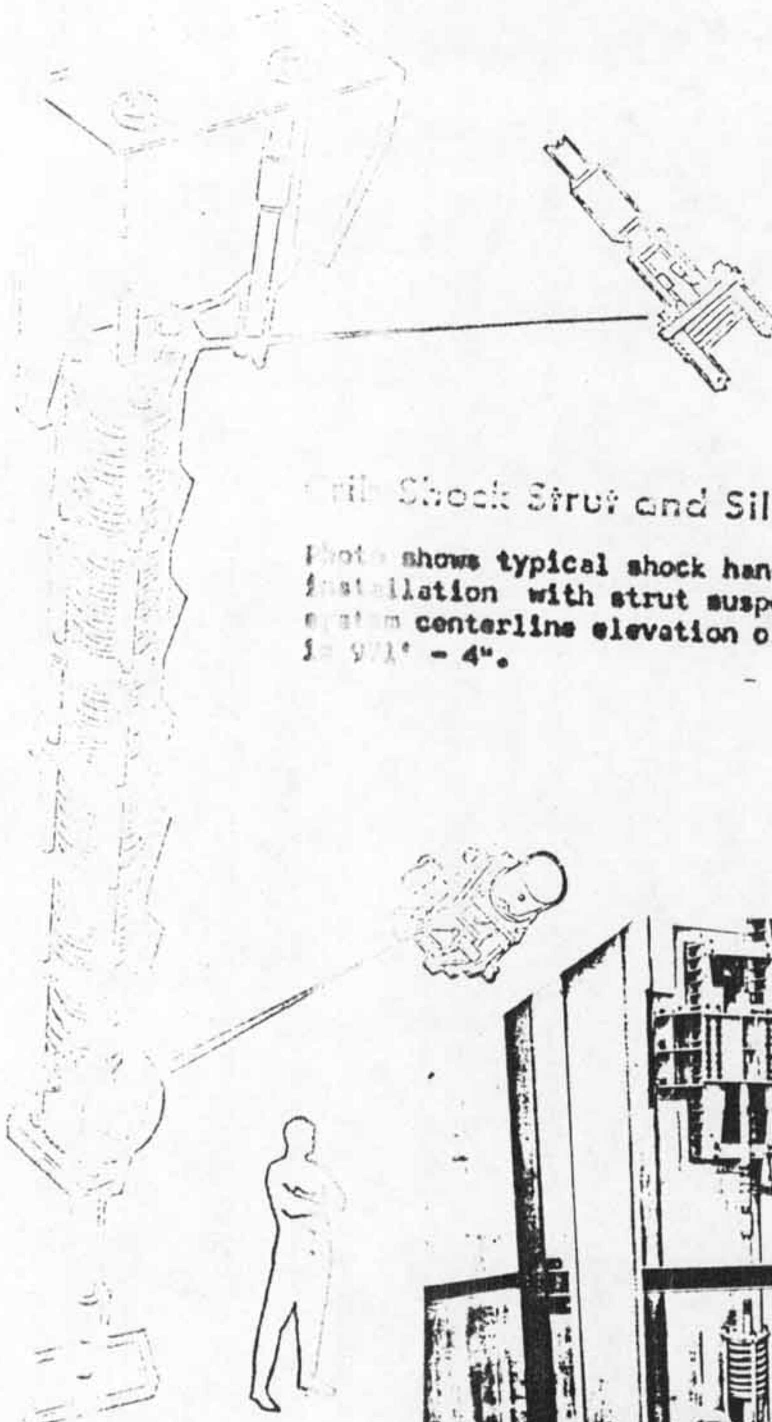
SITE 6. WH[illegible] 7 Dec 60. Ironworkers setting reinforcing stee[illegible]or air intake tunnel structure. [illegible]300.



SITE 7. YORK. 1 Mar 61. View facing southeast shows dowels and key ways for silo air exhaust tunnel, exhaust blast closure valves and reinforcing in place for silo vestibule roof. #43008.

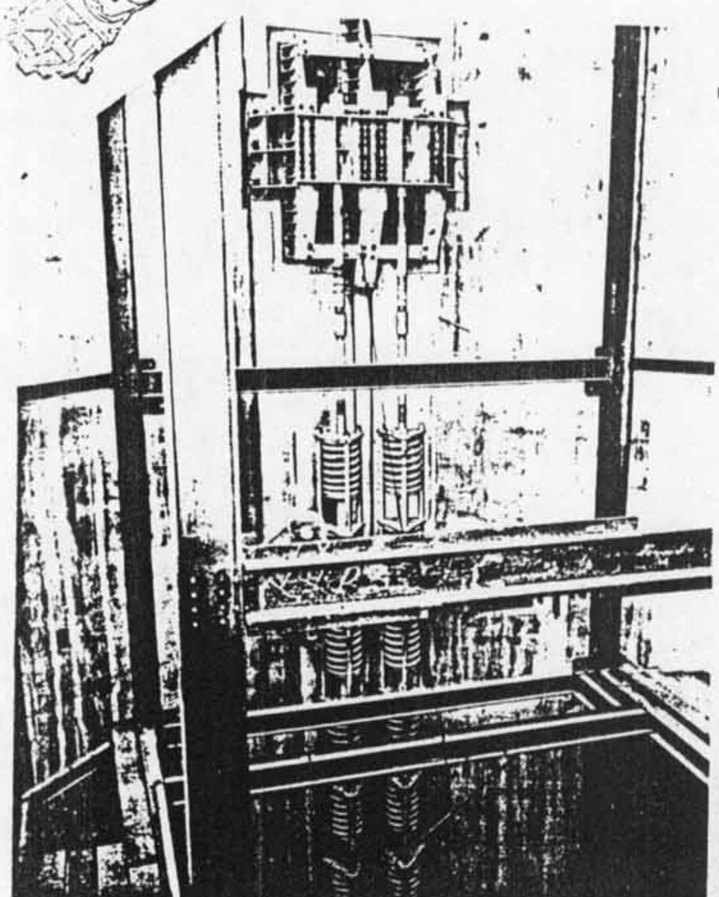


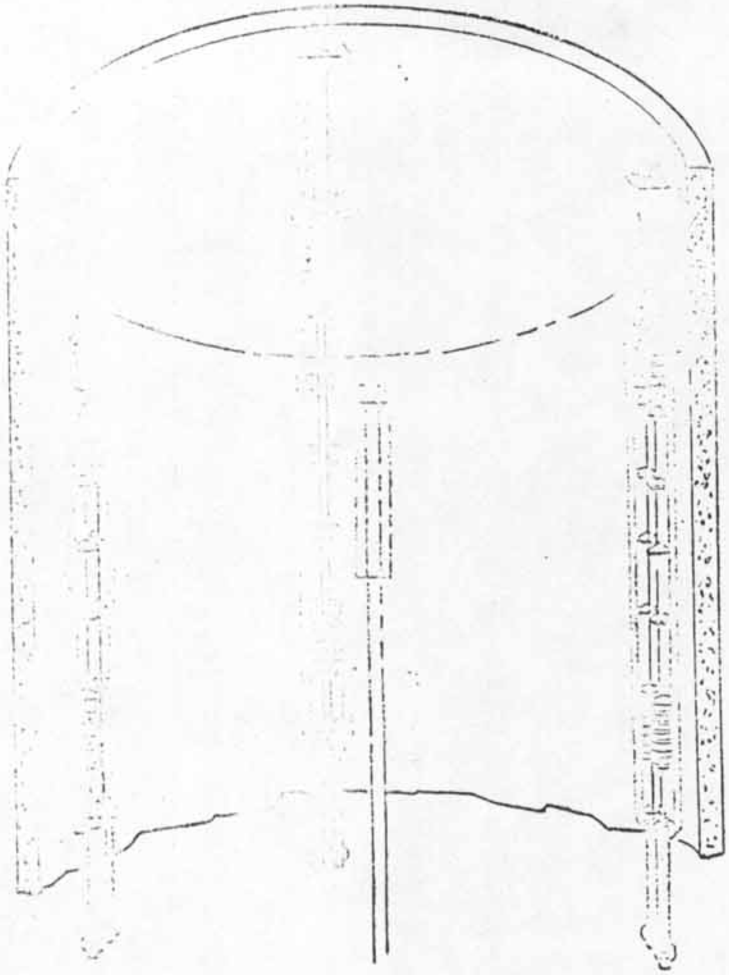
SITE 10. ELMWOOD. 1 Mar 61. View facing north shows projection of sighting tube and supports prior to backfilling. #43492



Crib Shock Strut and Silo Bracket

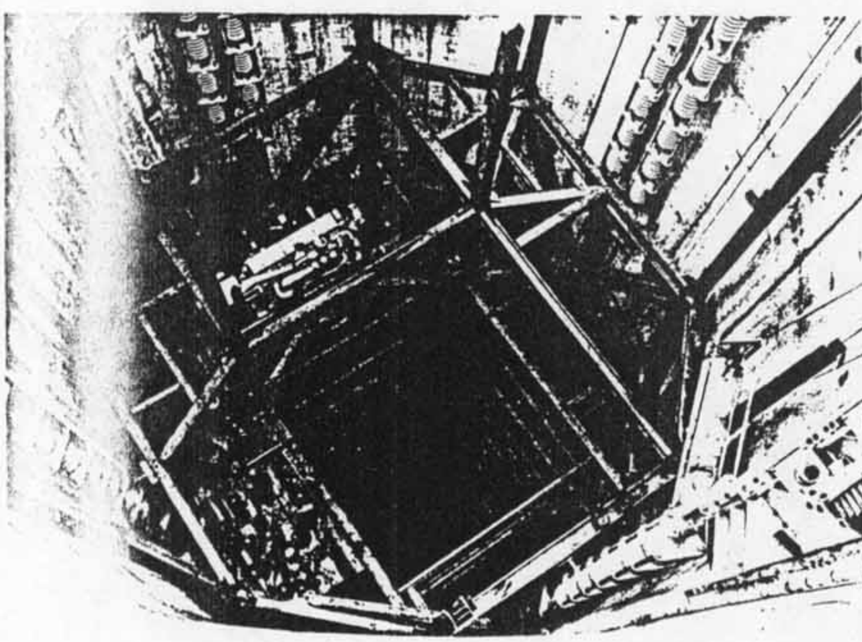
Photo shows typical shock hanger bracket installation with strut suspension system centerline elevation of bracket is [illegible]' - 4".

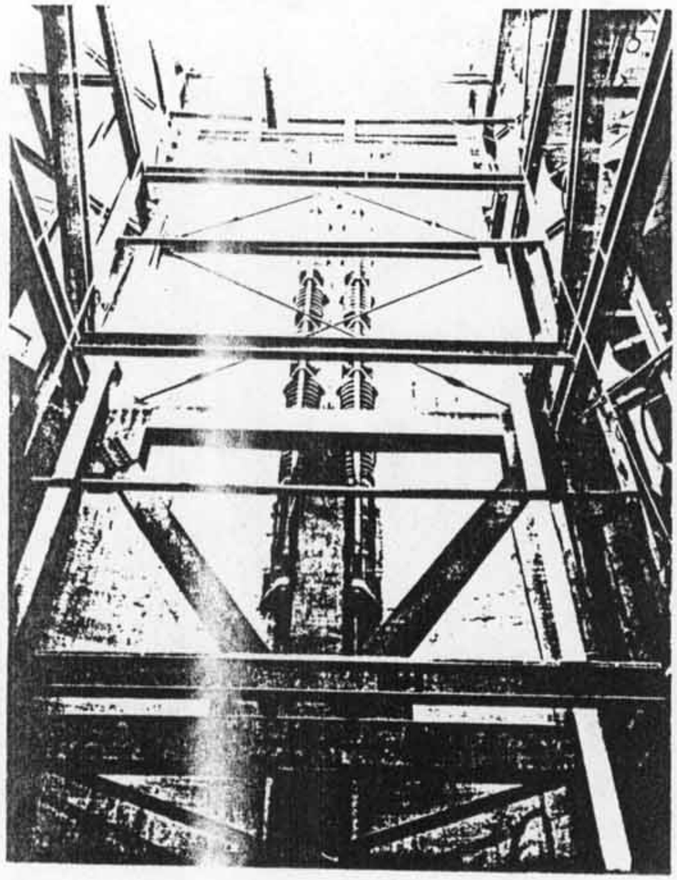




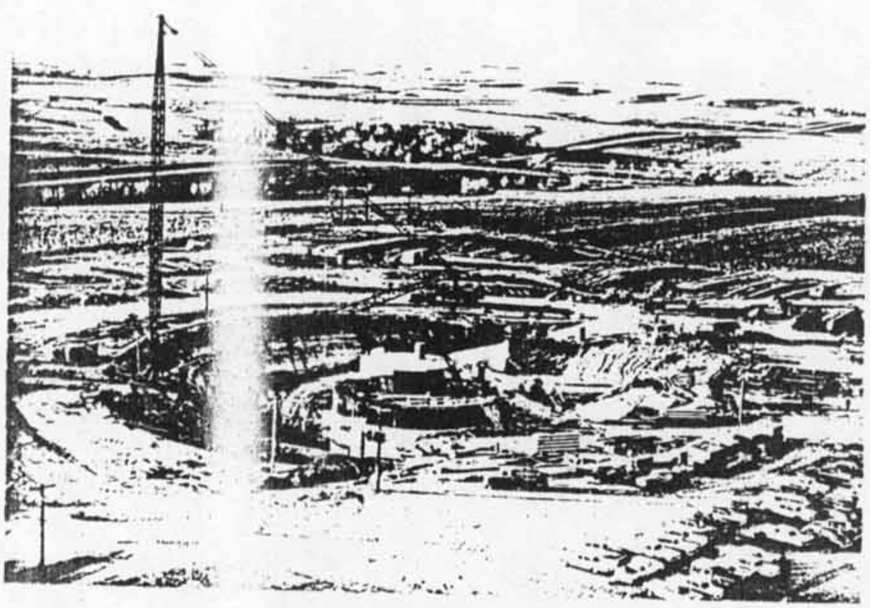
View shows partial completion of crib steel erection to level 4. Diesel Generator units set in place on levels 6 and 5. All shock struts are in place.

SUSPENSION SYSTEM

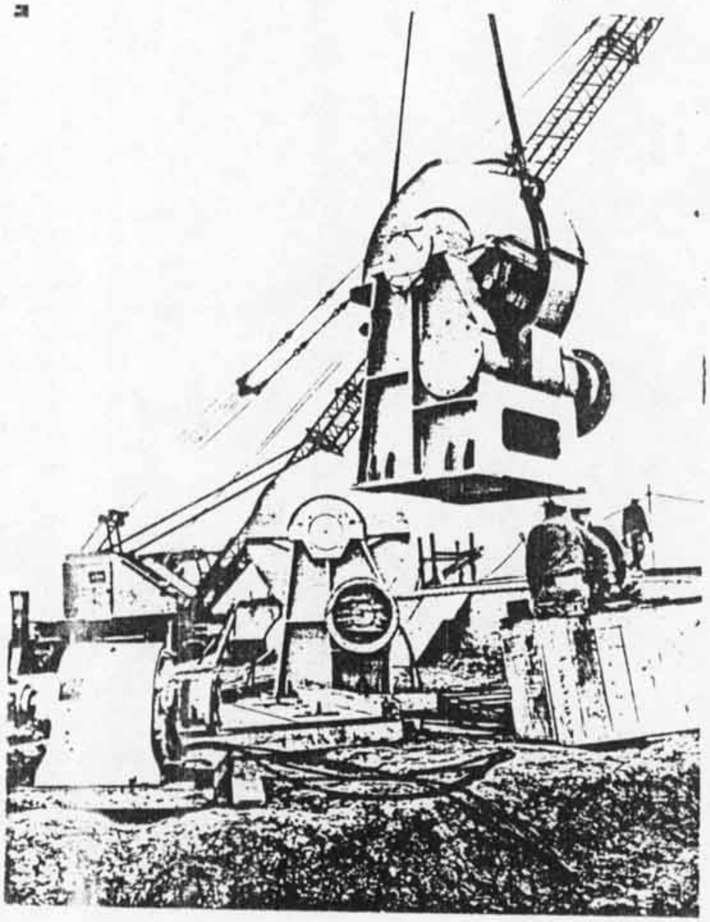




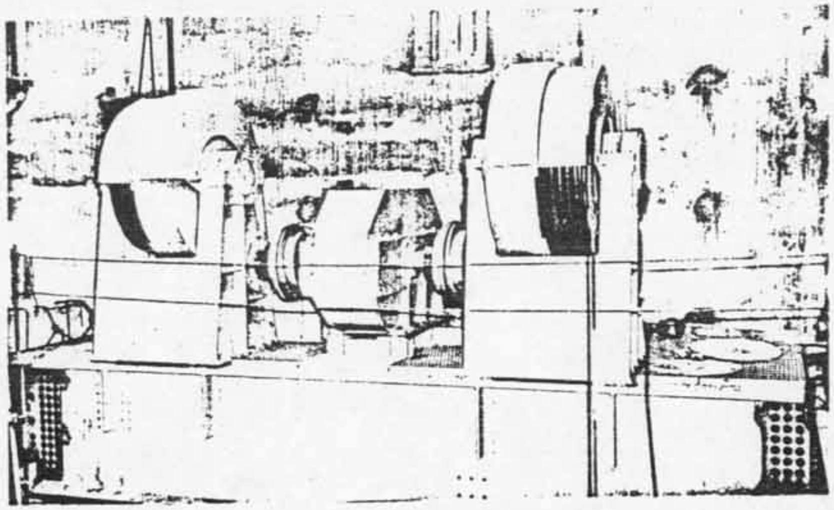
View upward shows Crib Suspension Bracket. Suspension point at bottom center. GD/A 051573.



SITE 9. BR[illegible]RD. 140' Guy Derrick in position to lower heavy equipment.

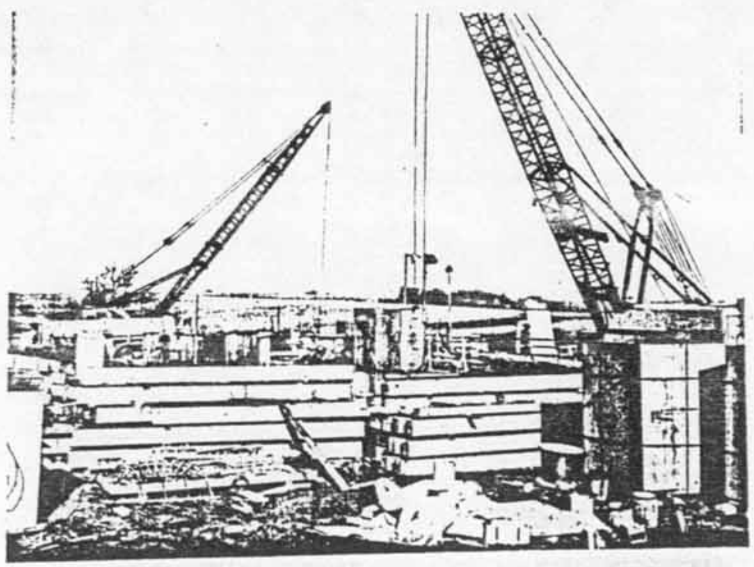


SITE 12. [illegible]. 4 Apr 61. View shows sections of Launch Platform Drive Base being hoisted for lowering into silo. #44103.

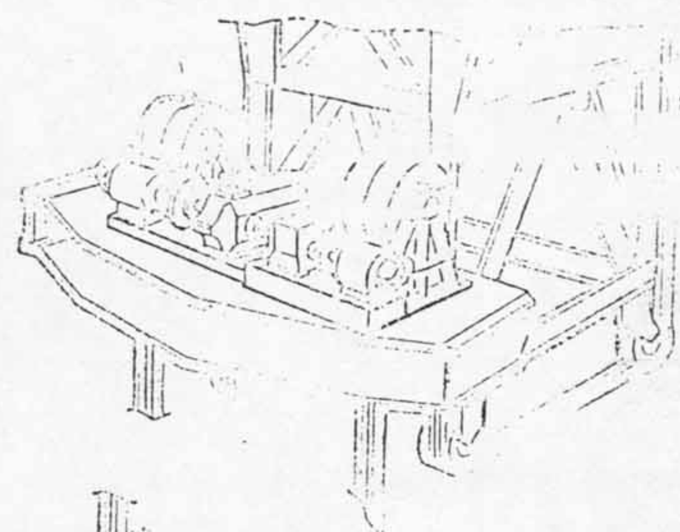


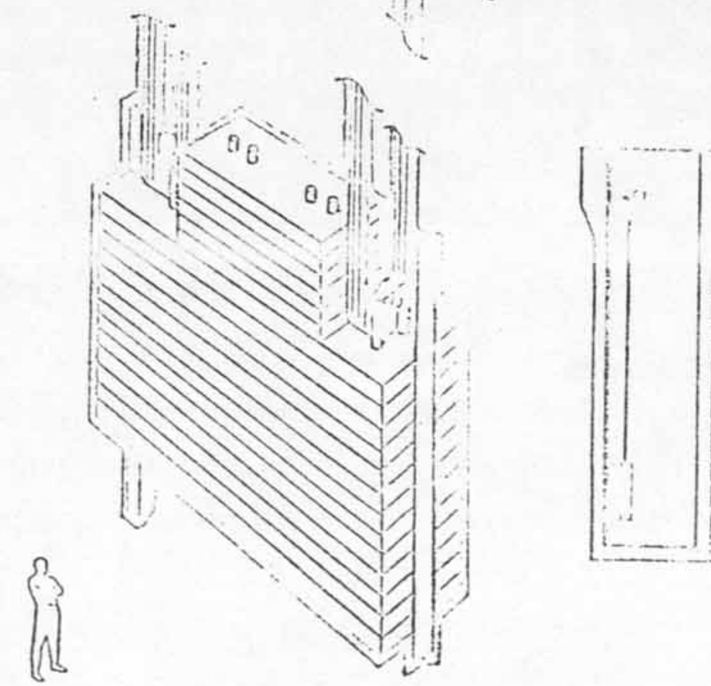
LAUNCHER PLATFORM DRIVE SYSTEM

KCC Photo below shows counterweights for Launch Platform being readied for lowering into silo.



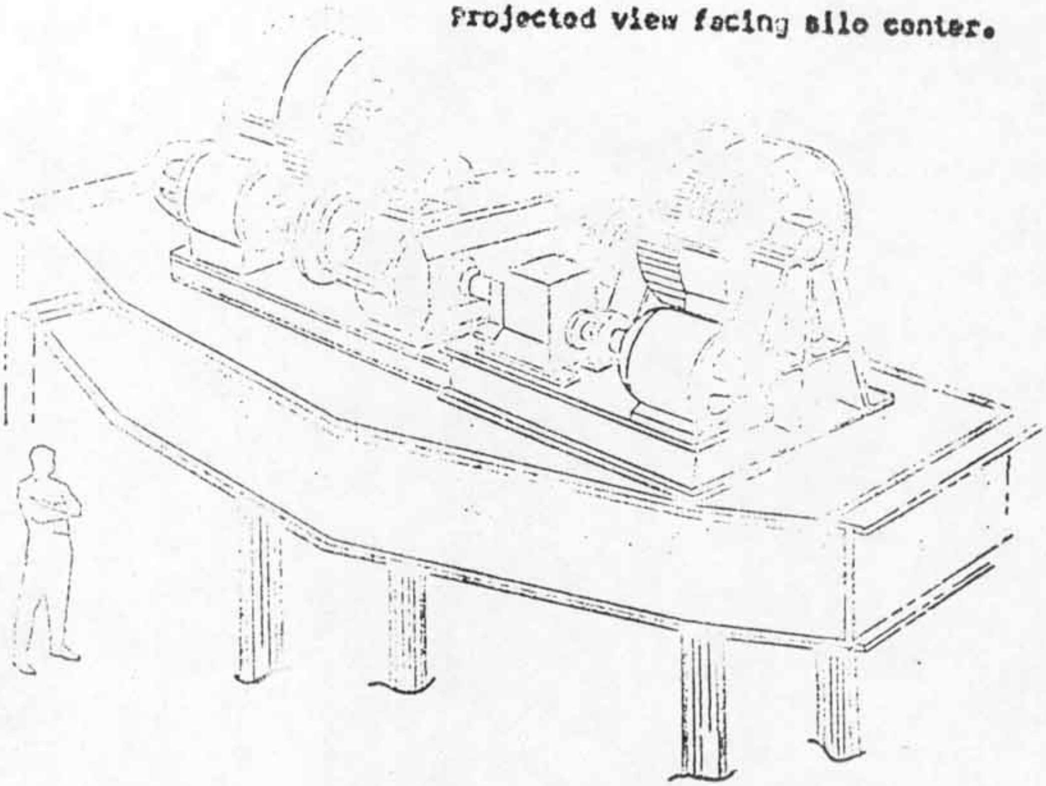
Projected view facing ter of Silo.
Launch Platform Installed by I & C Contractor

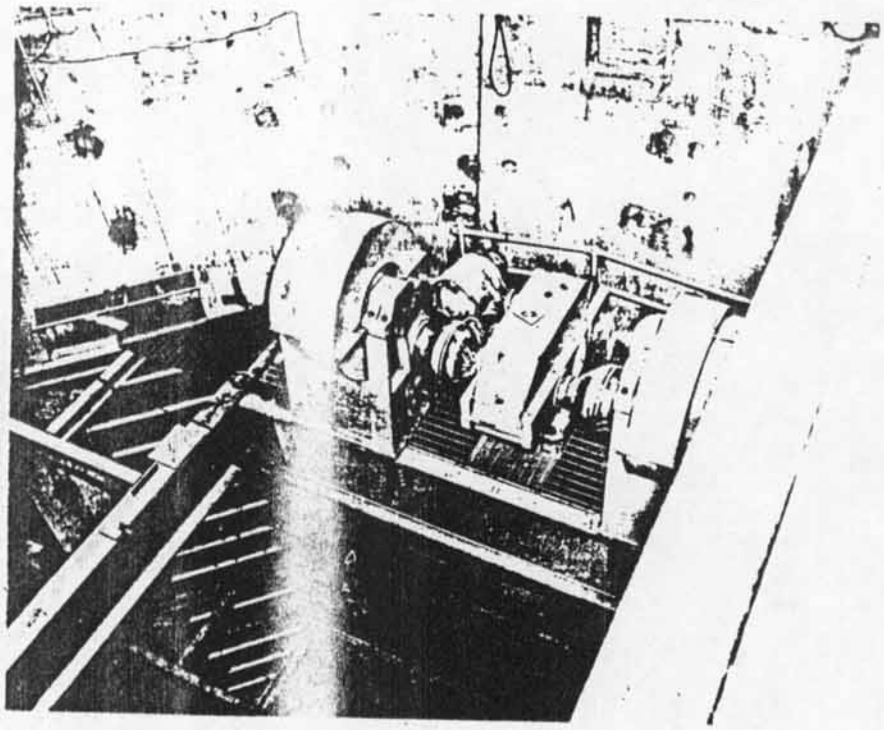




... Drive and Base Assembly

Projected view facing silo center.

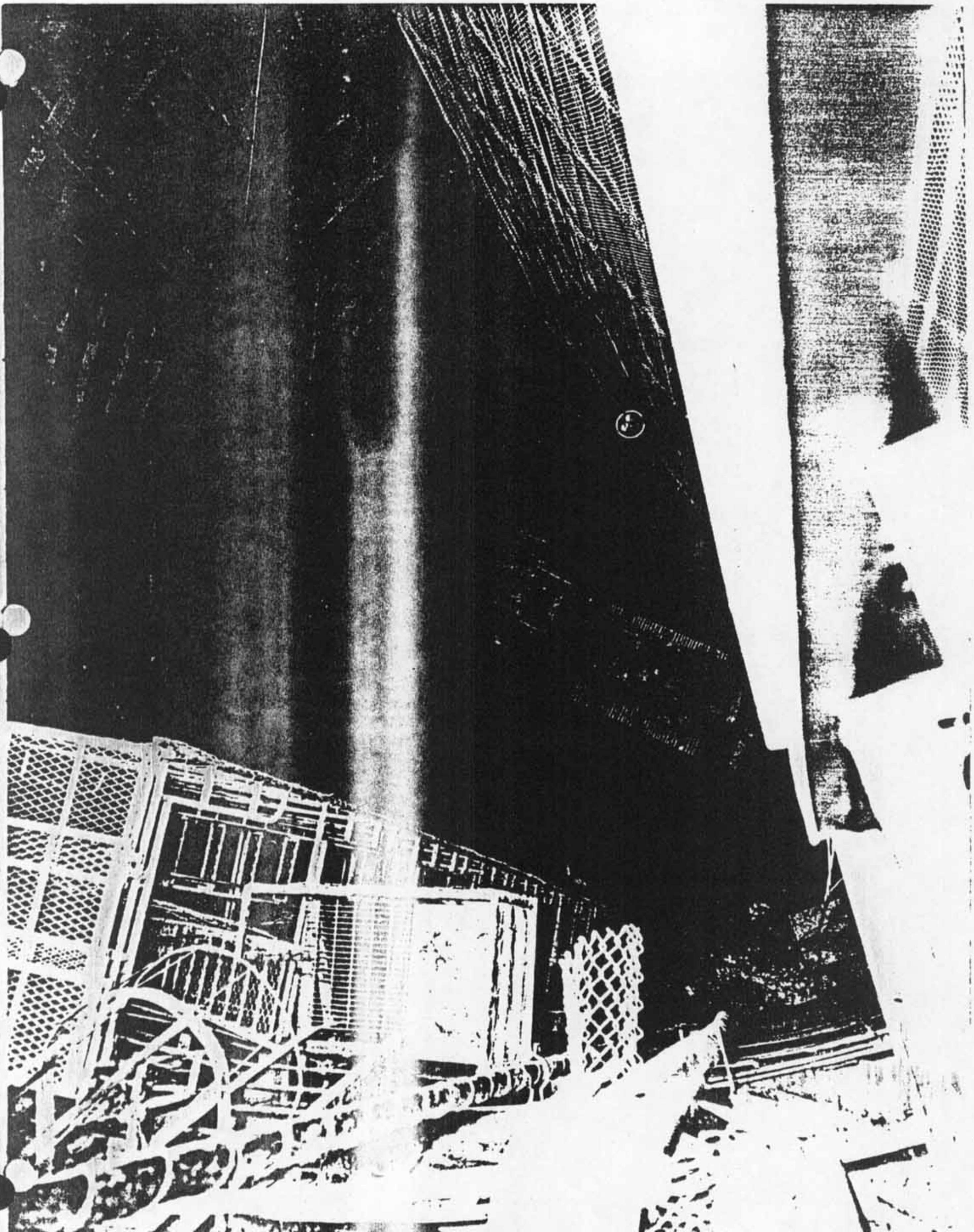




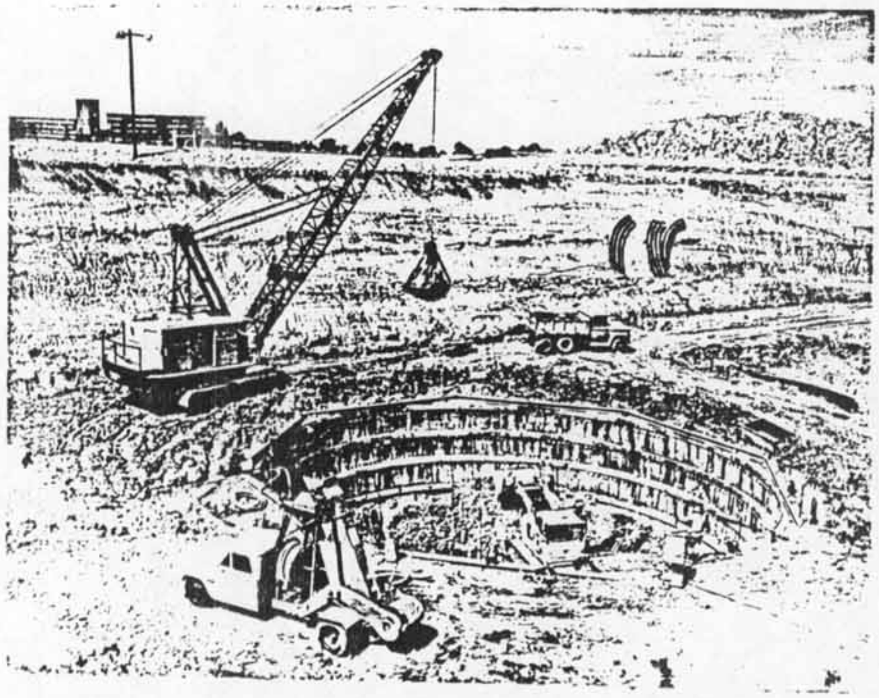
SITE 10. ELMWOOD. May 61. View from surface shows LP Drive Assembly in place. Polyethylene covers have been installed on motors and couplings for weather protection. Supply Air Duct at left. #4503B.

[illegible] INTO SILC DURING MINING

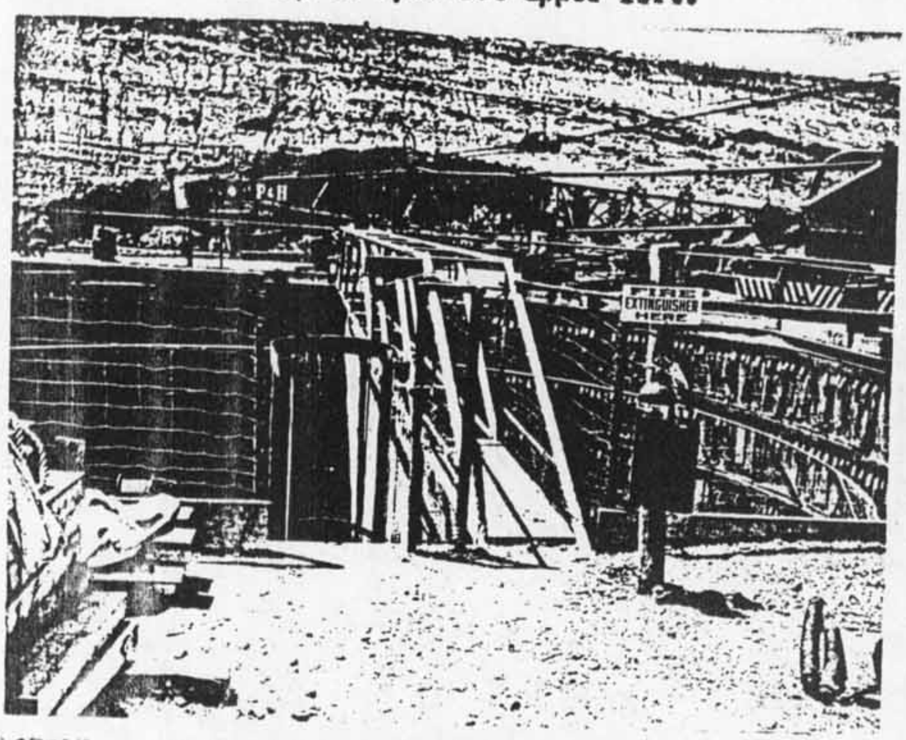
This view shows typical arrangement of facilities and equipment used during mining operations. Entrance ladder and enclosed stairway at left. At lower left, canvas air supply duct and overhead protective shelter for "phone man" who gave directions to crane operators on surface. Front end loaders generally 2 cy capacity. Safety net at right was extended as necessary to a distance of 8' to 10' above silo floor.



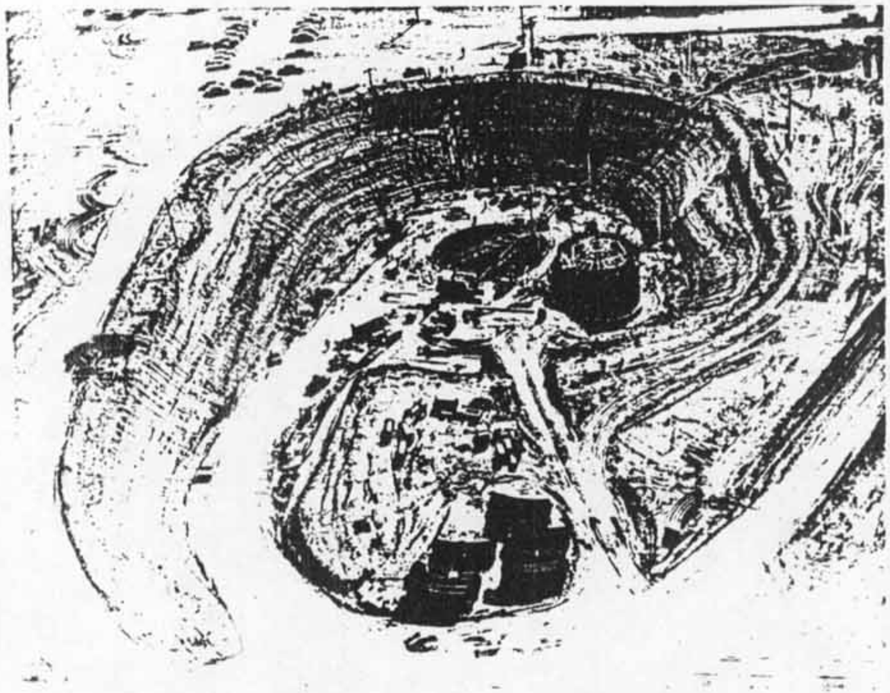
General view of open cut looking north. Excavation for Missile Silo in foreground. Depth of Silo to 10 feet.



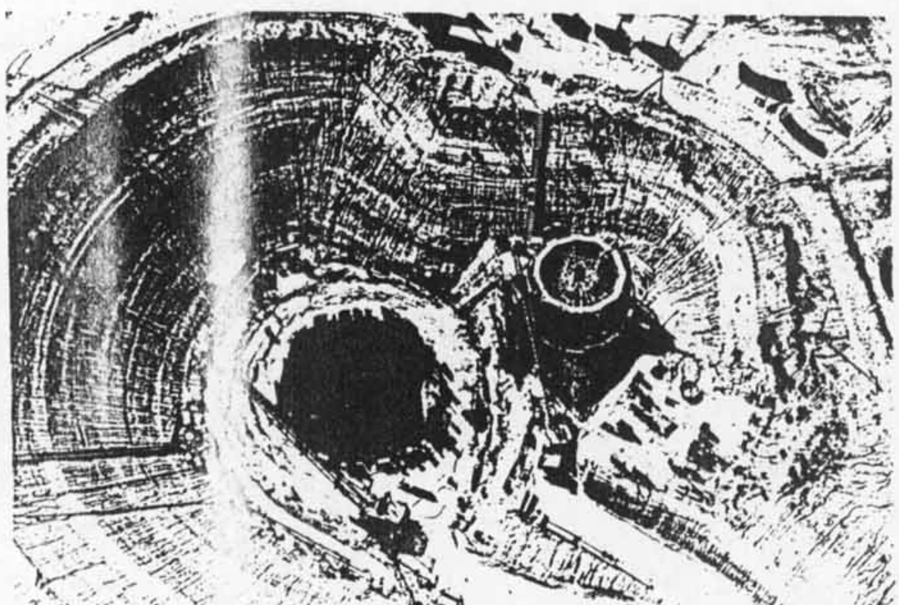
#39275. SITE 10, ELMWOOD. 9 Aug 60. Looking northwest from top of open cut, view shows excavation in progress for ring beam #5. Ring beams are stored at slope shoulder and at top of open cut upper left.



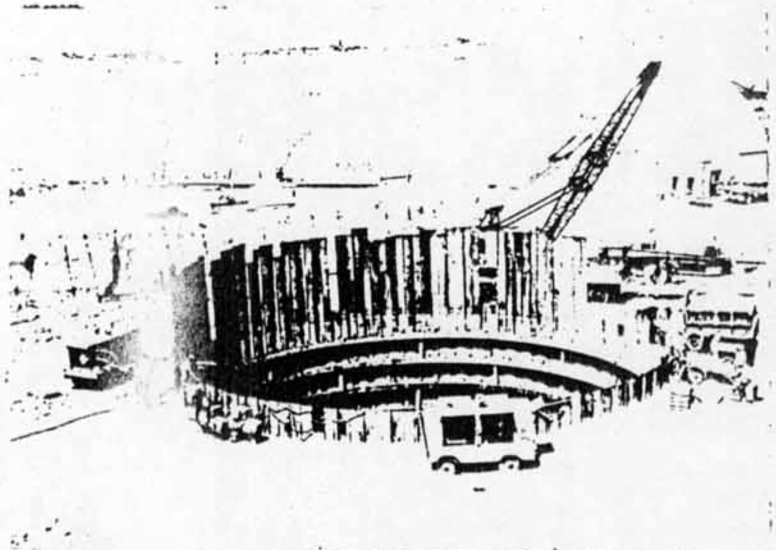
#38557. Shows a typical "off center" installation of bridge used to suspend safety net to near bottom of excavation. Net was fabricated from "chain link" fencing material.



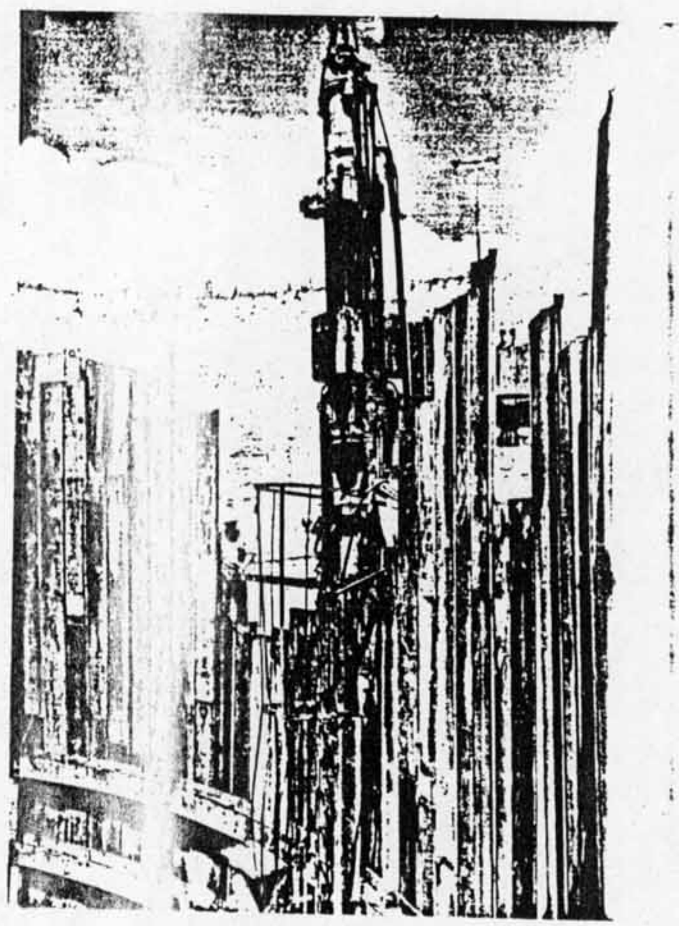
#41297. SITE 7, YORK. 1 Oct 60. Aerial view looking south. Note ring beam segments stored in foreground and silo Blast Closure Sleeves stored forward left.



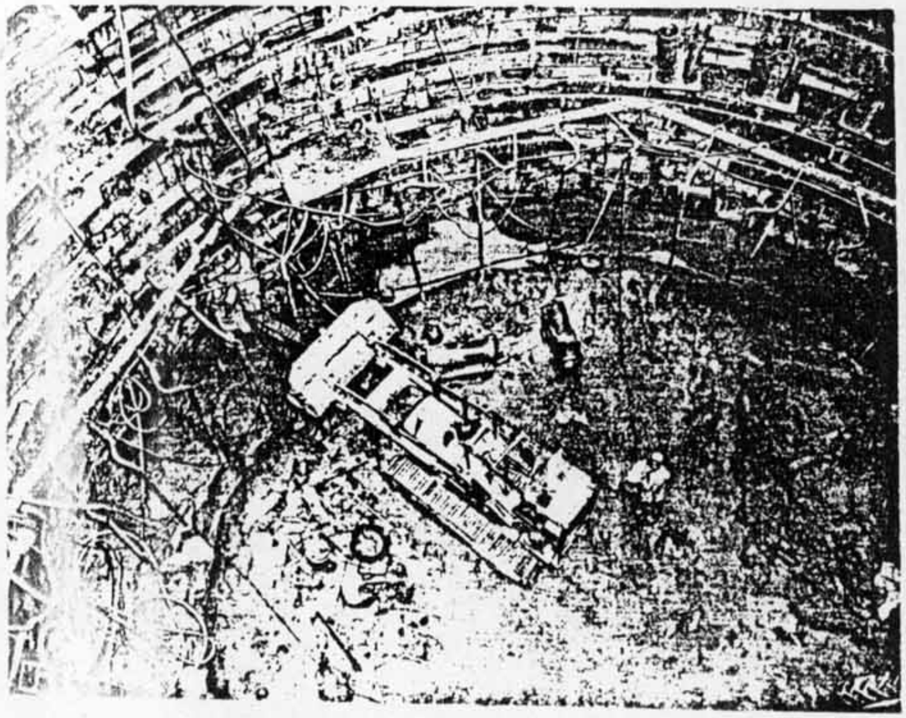
#41304. SITE 8, SEWARD. 11 Oct 60. Aerial view looking west. Note sheet piling around silo. Work platform is in place around top of LCC in preparation for wall pour.



#C-19. SITE 7, YORK. Shows partially completed sheet piling installation around the periphery of silo to protect excavation.

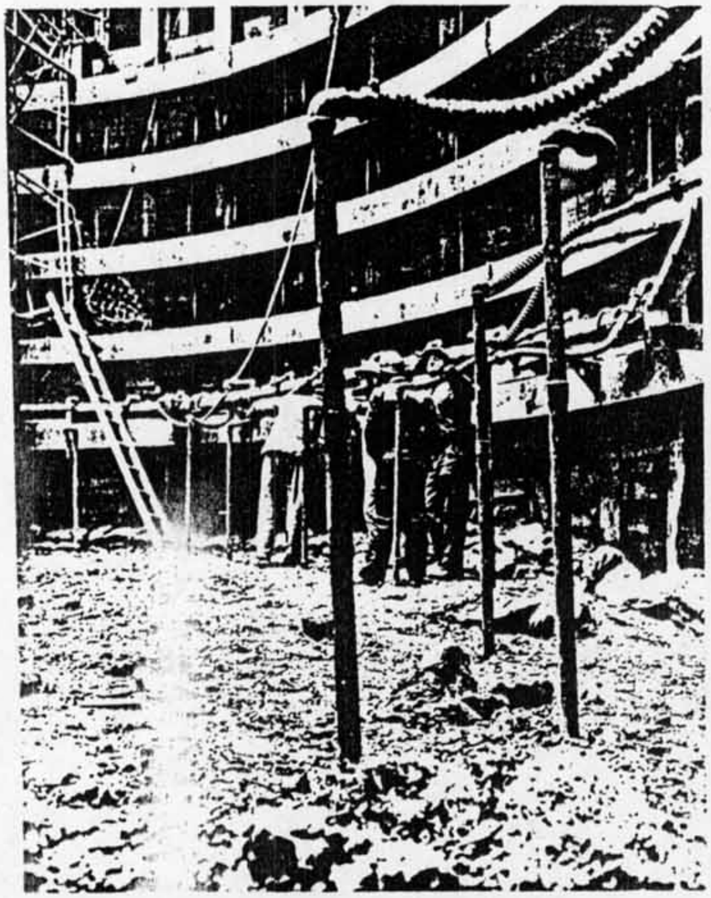


#40202. SITE 8, SEWARD. 7 Sept 60. Closeup view shows type of pile driving equipment in use at this Site.



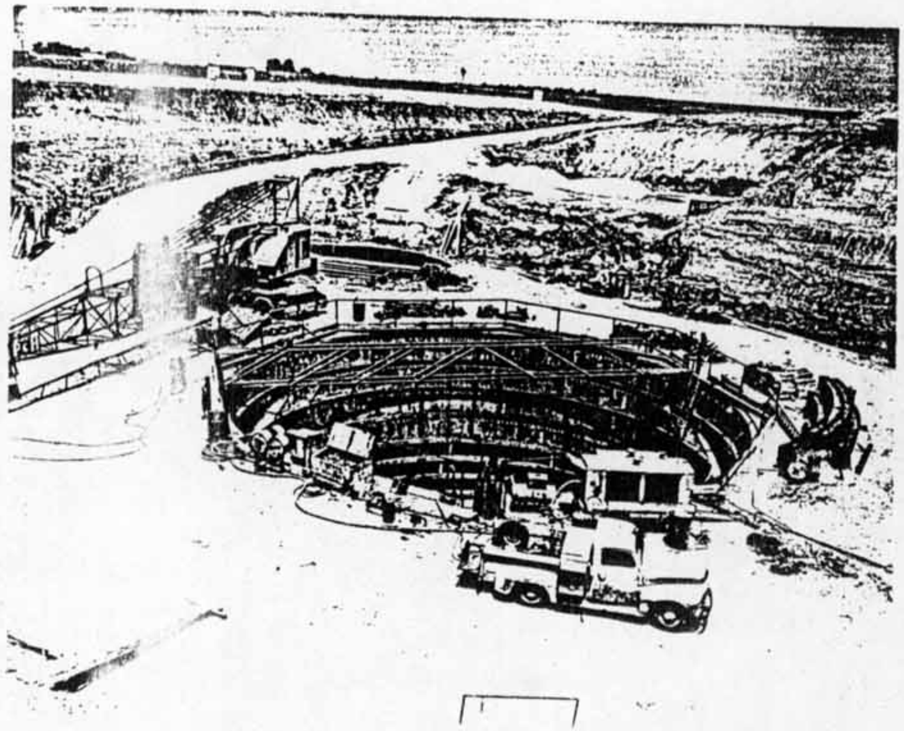
[illegible] SITE 8, SEWARD, NEBRASKA. 3 Jun 61. View look[illegible]n and to west at bottom of shaft showing fro[illegible]r and extremely wet conditions. Note system of [illegible]nts and manifolding around perimeter.

[illegible]CC Photo. SITE 8, SEWARD, NEBRASKA. Shows closeup of well point[illegible] and flexible connections to manifold.

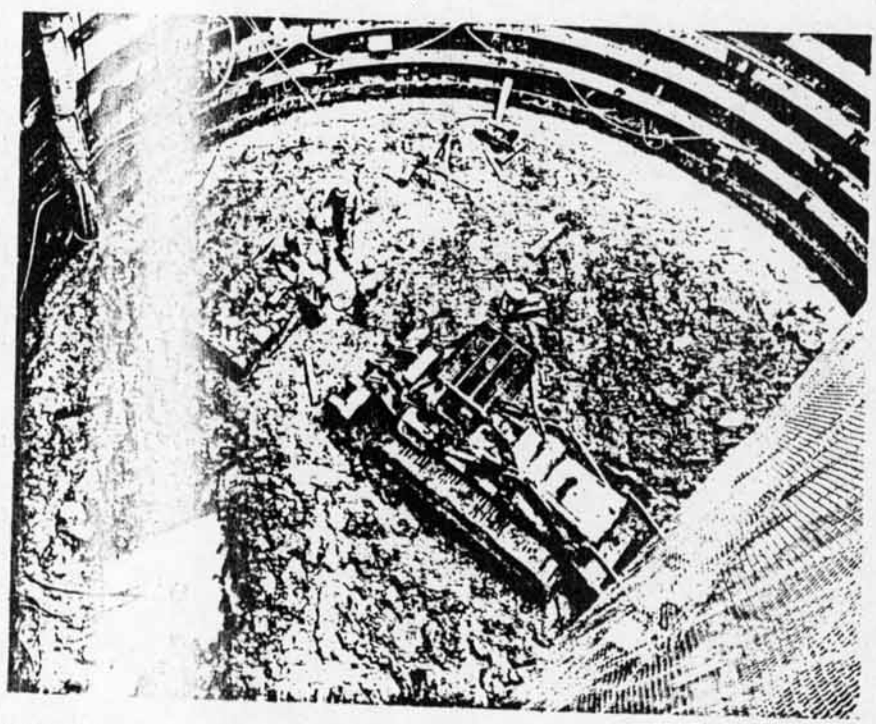


MCC Photo.
SITE 8. [illegible].
Closeup view
of well point
system. Ladder
and sectional
scaffolding
provide access
to surface.

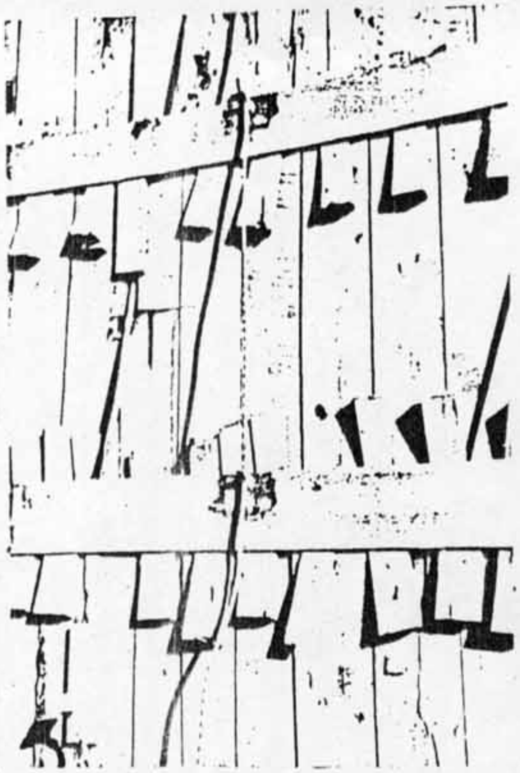
MCC Photo.
View looking
into silo shows
portion of
angular safety
fence project-
ing inward from
transition beam
and typical posi-
tion of suspended
safety net.



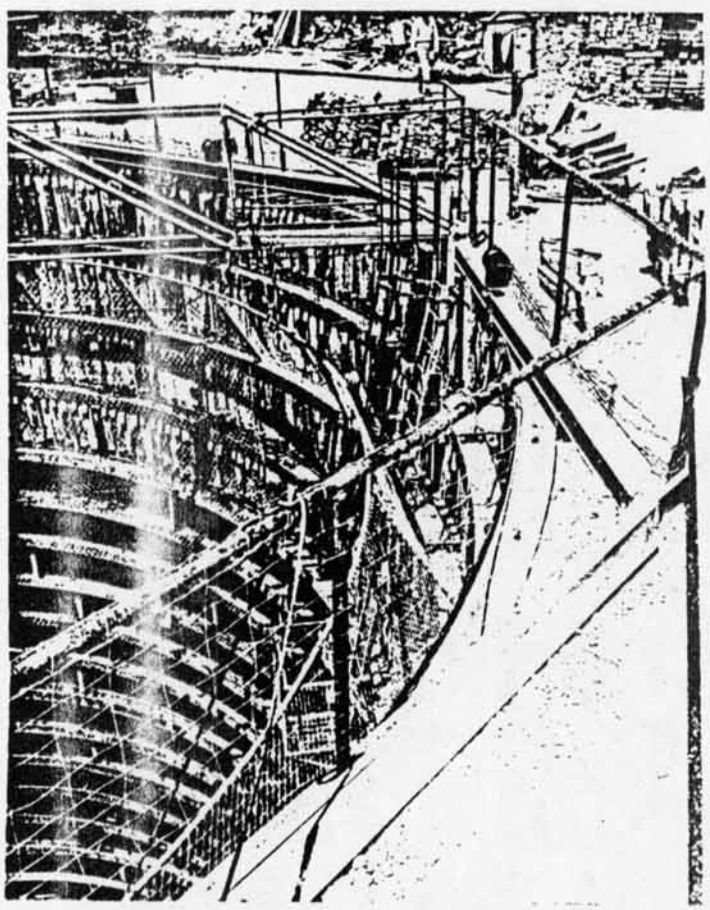
#33551. View facing northwest shows typical installation of guard rail, safety bridge and site machinery. King beam segments at right. Covering has been placed over LCC "lean concrete" pad in background.



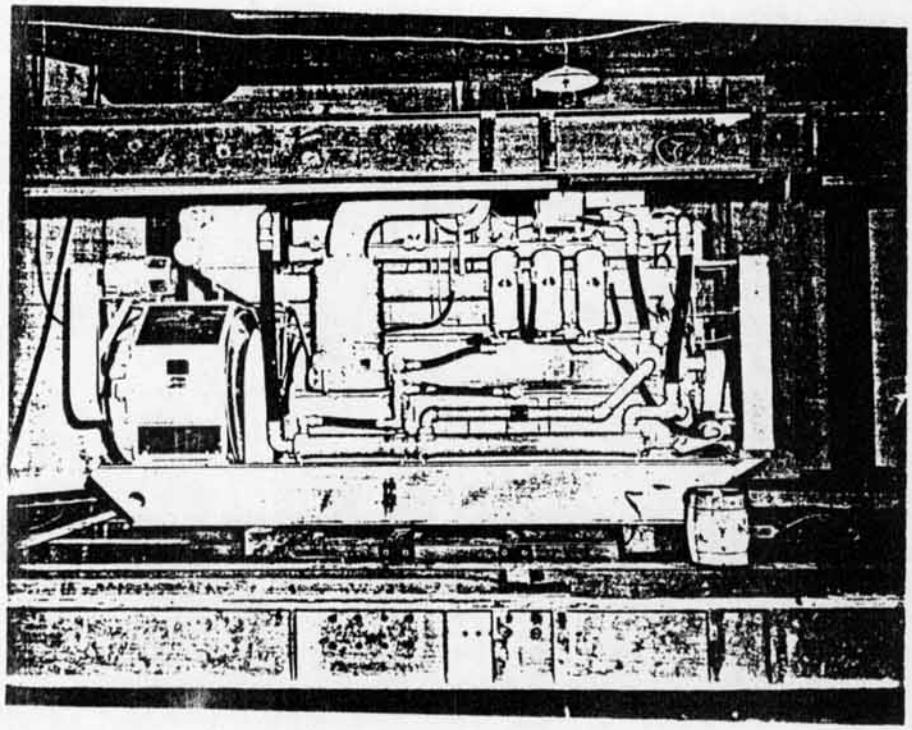
#39184. View into silo shows fresh air supply duct at upper left, material "skip" being unloaded on bottom of excavation and typical location of suspended safety net. Note protective mesh over operator's seat on loader.



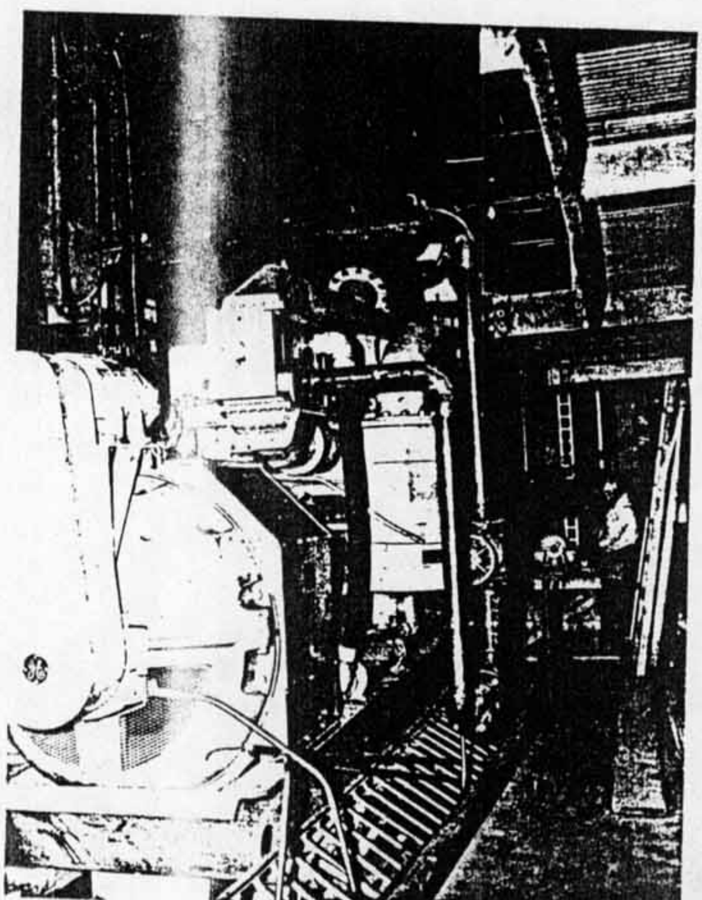
#C-7. Nov. 60. Close-up of ring beam structure shows manner in which oak wedges were used to secure the oak lagging behind the ring beams. Wedges were held with 50 & 60d nails. Note grounding cable attached to ring beams by exothermic welding process. Grounding lug at lower left. Wedges typical all sites using lagging.



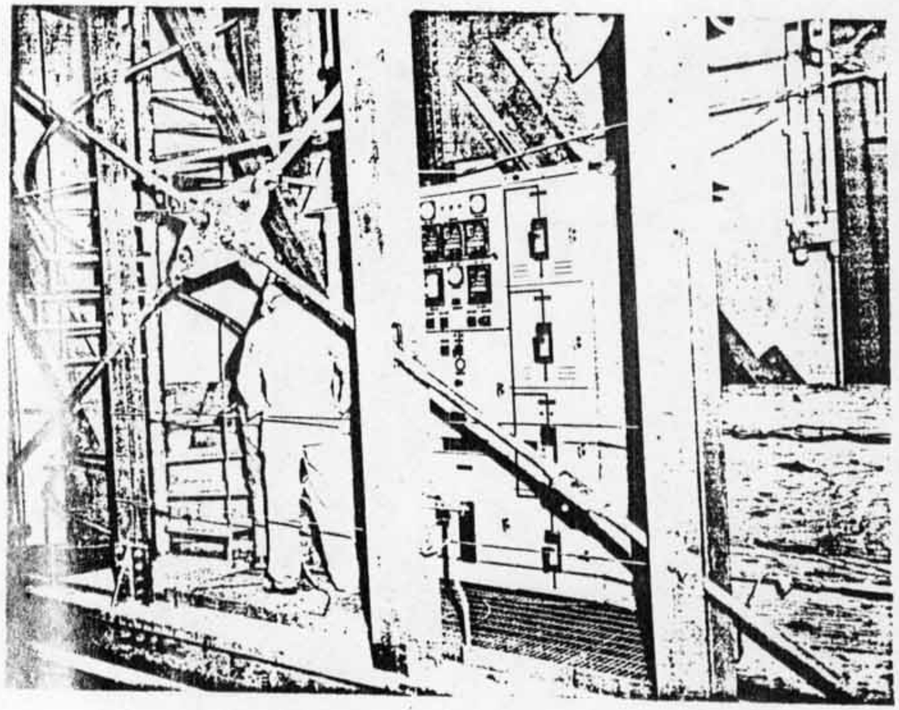
#33556. Shows view of well maintained working area. Note outer guard rail with toe board. Entrance ladder typical all sites. Sloping inner safety fence formed from "chain link" fence. Lagging stored upper right.



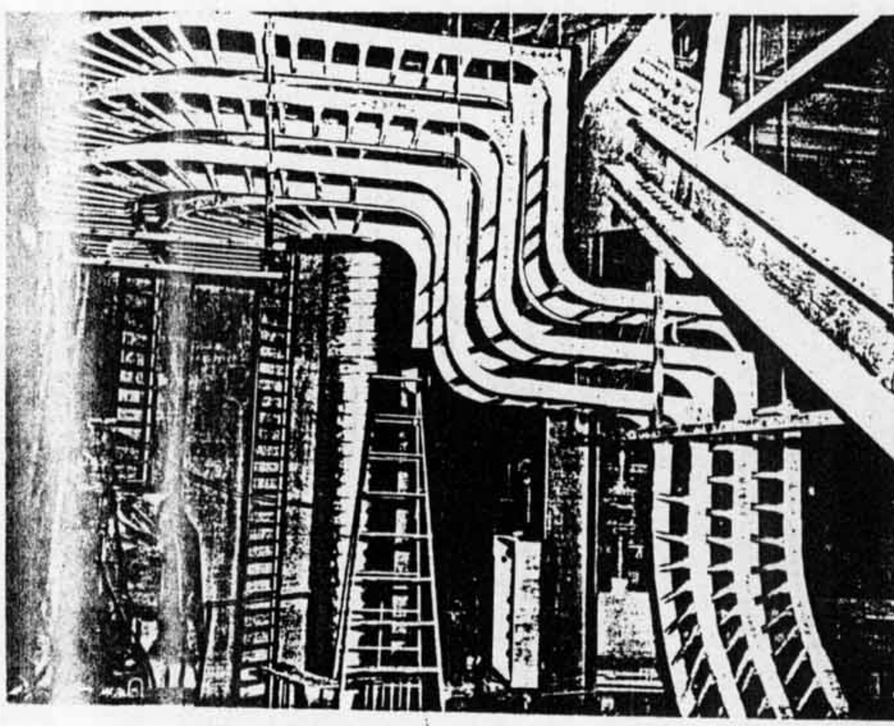
SITE 4. CORTLAND, NEBRASKA. View shows diesel generating unit shortly after being lowered into silo. Engine is White "Superior" Diesel, 8 cylinder, Bore 9 1/8, stroke 10 1/2, 715 BHP operating at 720 RPM. Two units installed, one each on levels 5 and 6. #42535



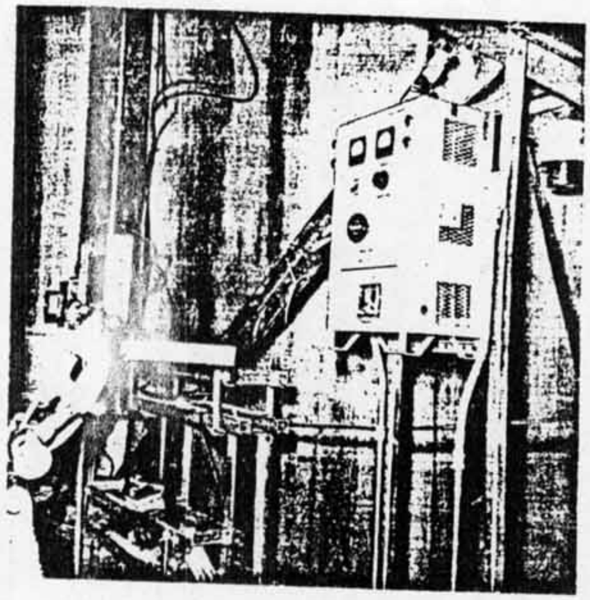
SITE 9. BRAINARD, NEBRASKA. 1May62. View facing north shows generator end of diesel generating unit. Unit is General Electric 500 KW, 625 KVA, 480 V., 3 phase, 60 cycle. Power factor 80%. #43769.



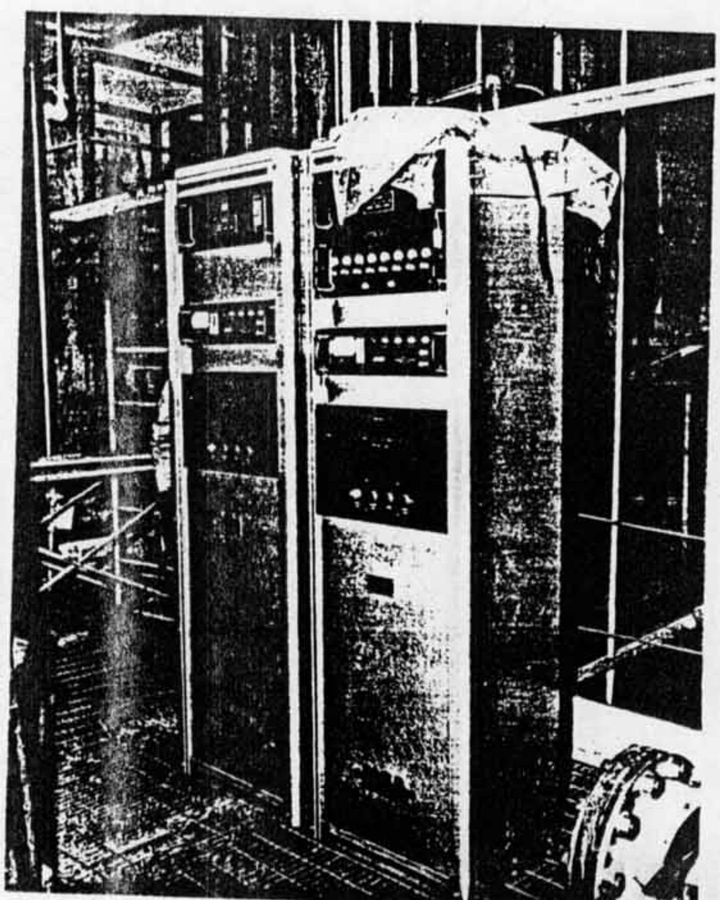
SITE 11. AVOCA, NEBRASKA. 3 April 61. View facing southeast on level 5 shows General Electric 480 Volt, Type AKD Switchgear used with generating units. #44409



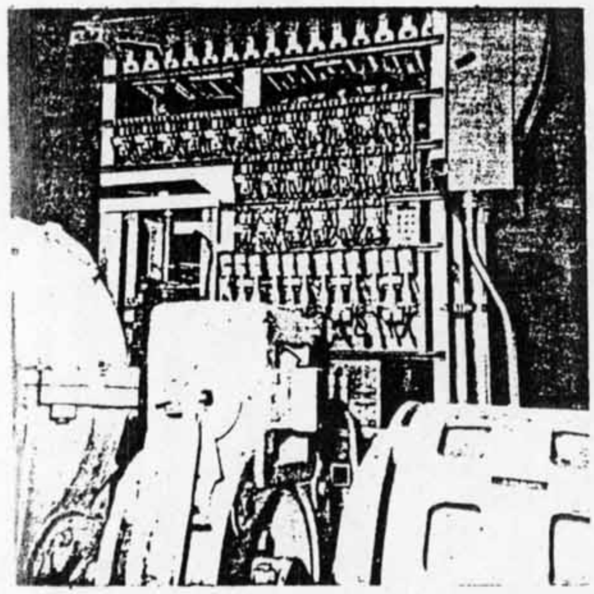
SITE 5. BEATRICE, NEBRASKA. 2 March 1961. View from spiral stairway facing west shows complex of cable trays for feeders to Launch Platform. #43876.



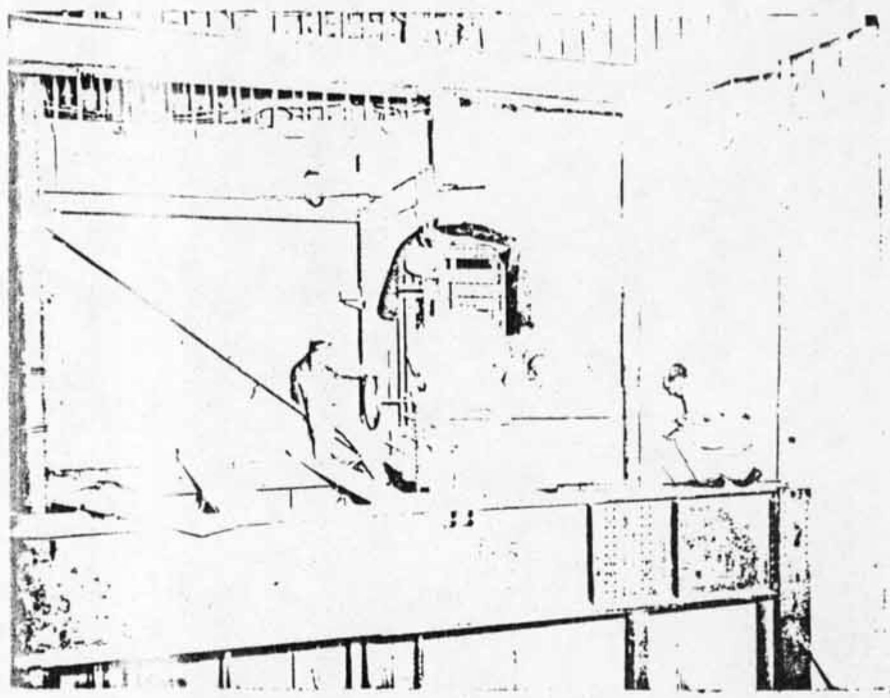
View facing east shows typical installation of the Charging Unit for the 48 Volt DC system. Rack for 48 Volt batteries at lower left. C-9.



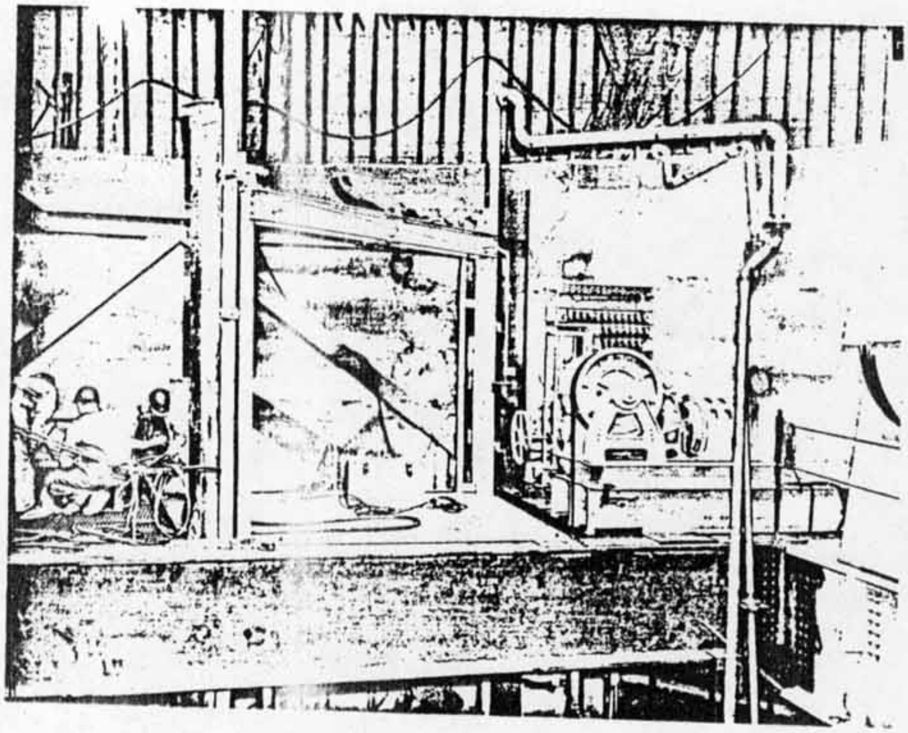
SITE 2. NEBRASKA CITY. 2 May 61. View facing north on level 7 shows left to right - Diesel Vapor Detector and RP-1 Vapor Detector. Sensing lines not installed. #45069.



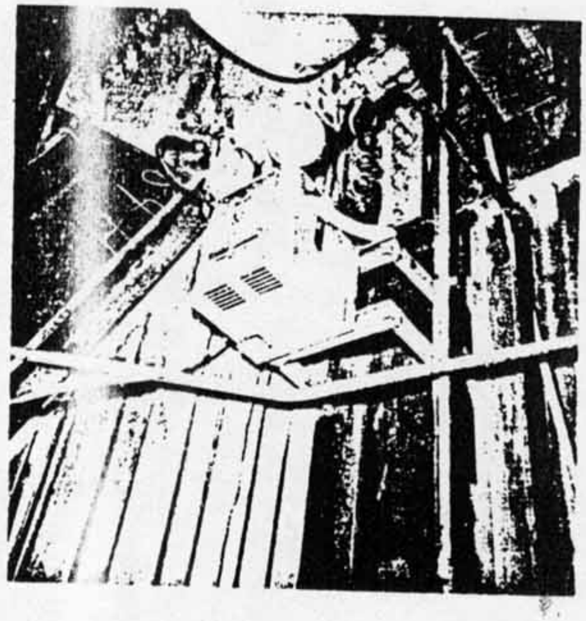
View facing north of typical installation showing portions of facility elevator drive. Left to right - Gear Box, Brake Housing and 440 Volt-22 HP drive motor. Floor controller in background. Otis Facility Elevator has a normal capacity of 6000 pounds. #C-6.



SITE 2. [illegible], NEBRASKA. 3 Jan 61. View facing slightly northeast at level 1 shows installation of drive mechanism and controller equipment for facility elevator. #42747.



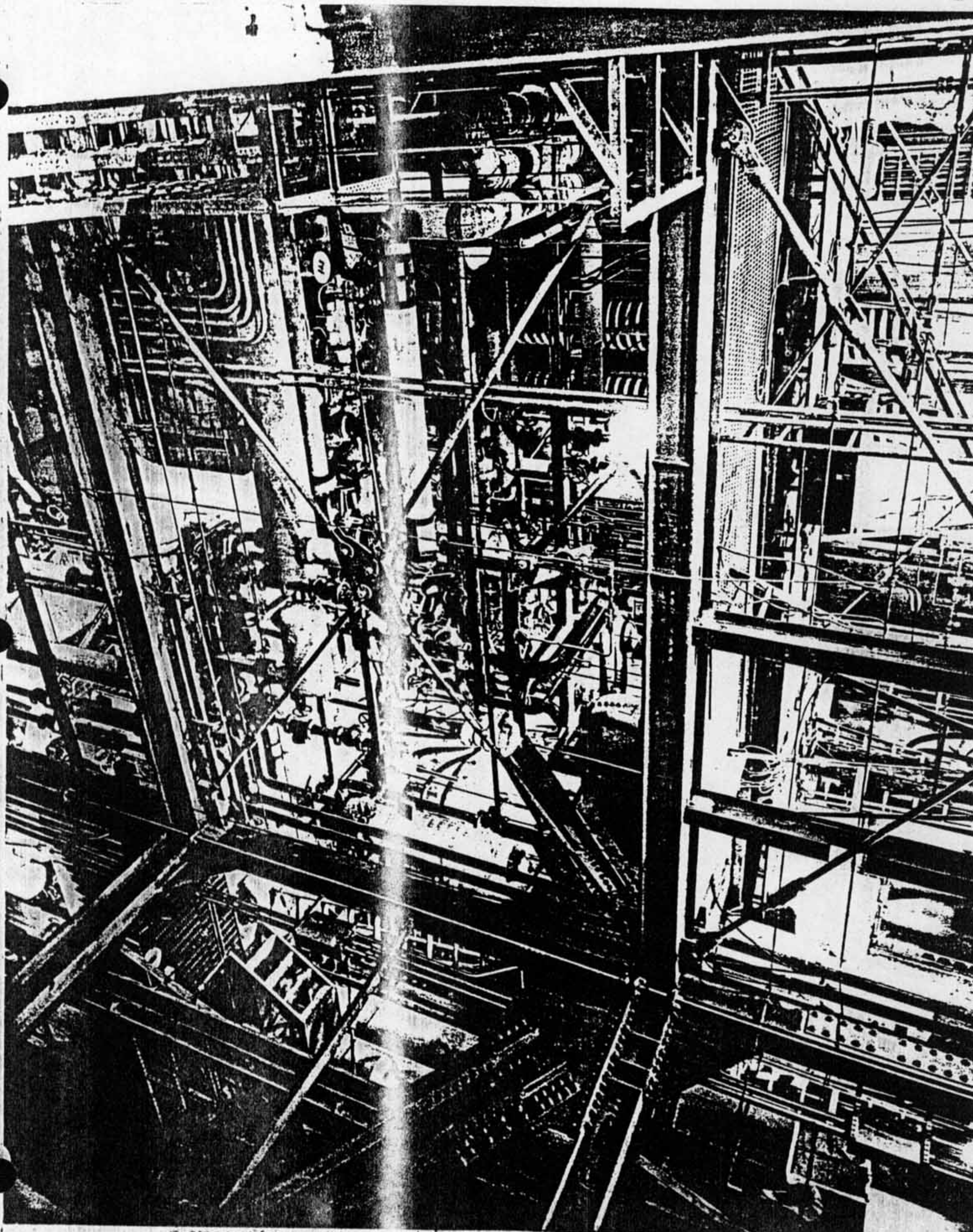
SITE D. BEATRICE. 2 Mar 61. View facing slightly northeast at level 1 shows progress being made on the erection of the Facility Elevator. [illegible]3030.

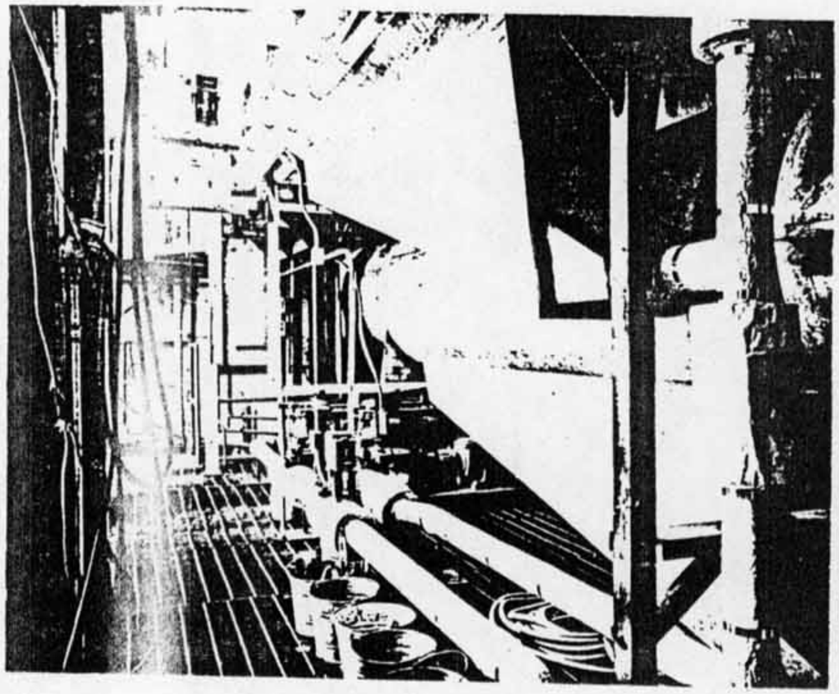


Typical silo and LCC Battery Powered Emergency Lighting Unit. #D-13.

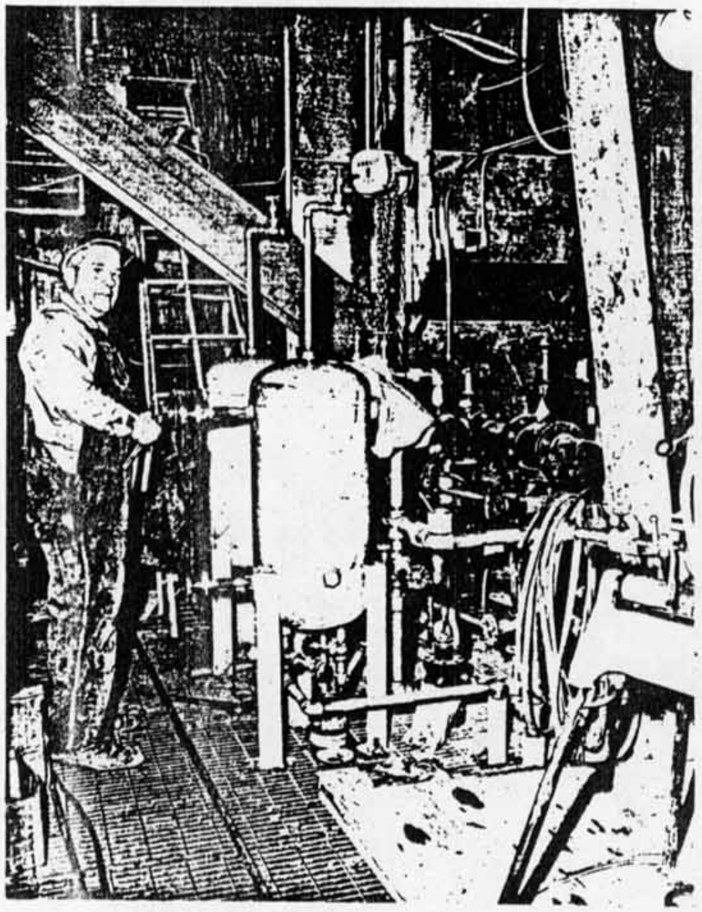
GENERAL VIEW OF SILO LEVEL #4
SHOWING PIPING AND MECHANICAL EQUIPMENT CONSTRUCTION

View from spiral stairway. In left foreground is water chiller #51 with hot water tank #63 and hot water pumps #60 and #61. Close examination will show condenser water pumps #30 and #31, electric motor operated valves (MOV's) and small fittings.

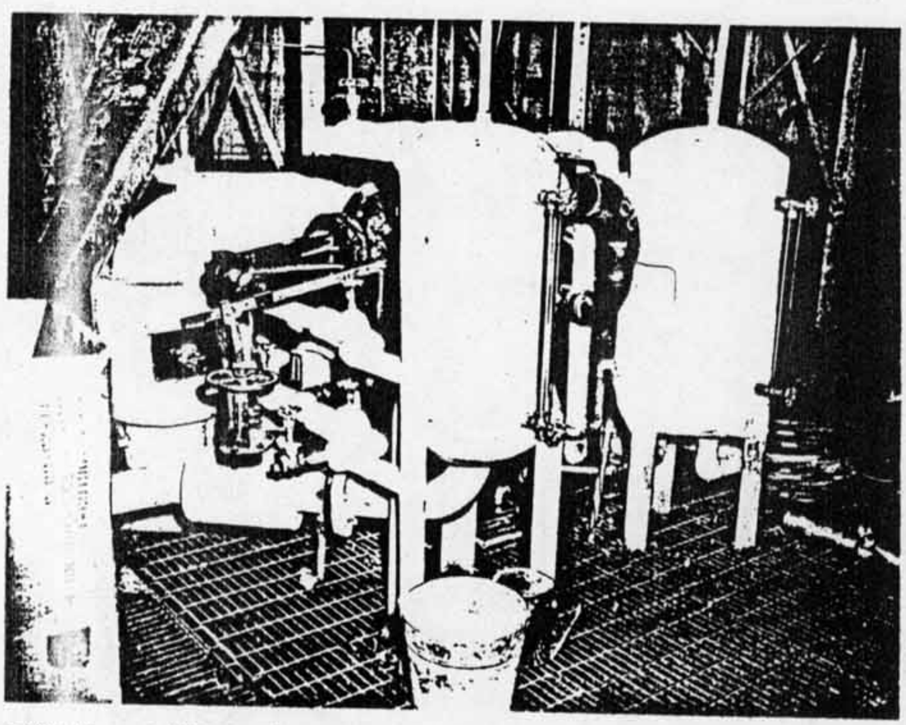




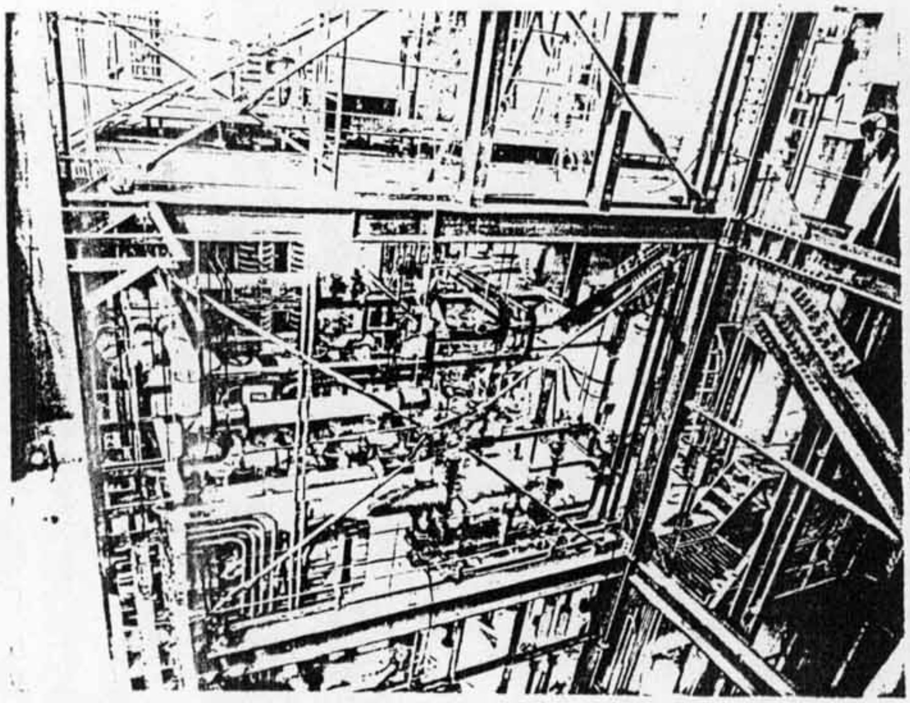
SITE 2. [illegible]. Air washer dust collector units on silo level A1. Supply water piping and electric motor operated valves in foreground. [illegible] #52330.



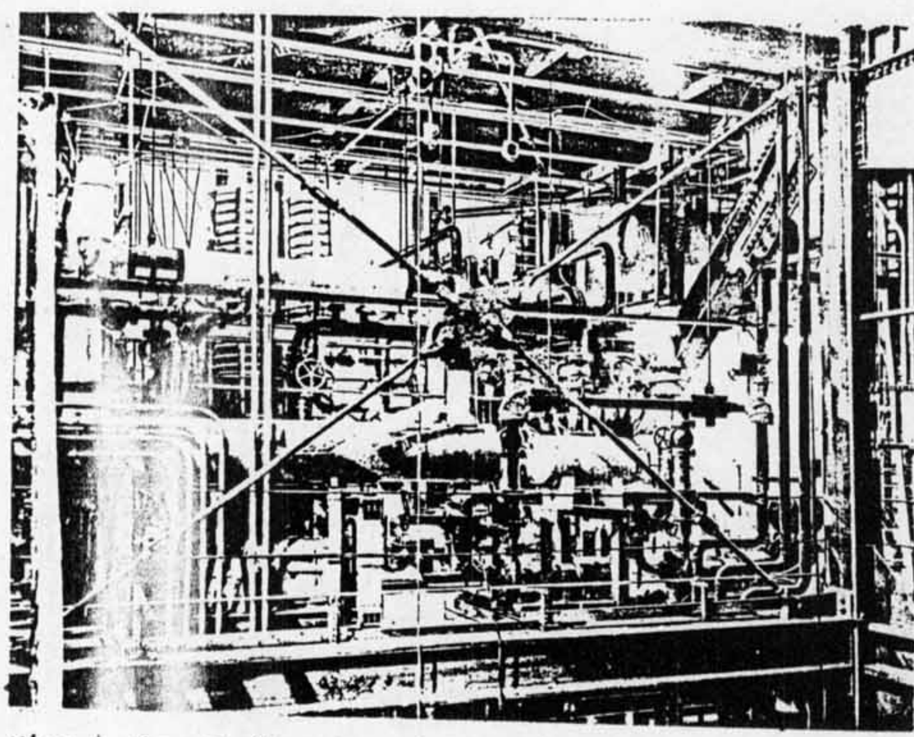
#45103. SITE 3 TECUMSEH, 2 May 61. View facing south shows construction in progress on the Chilled Water Makeup and the Air Washer Make-up Tanks on Level I. In the right background is the Intake Plenum for the Intake Air System.



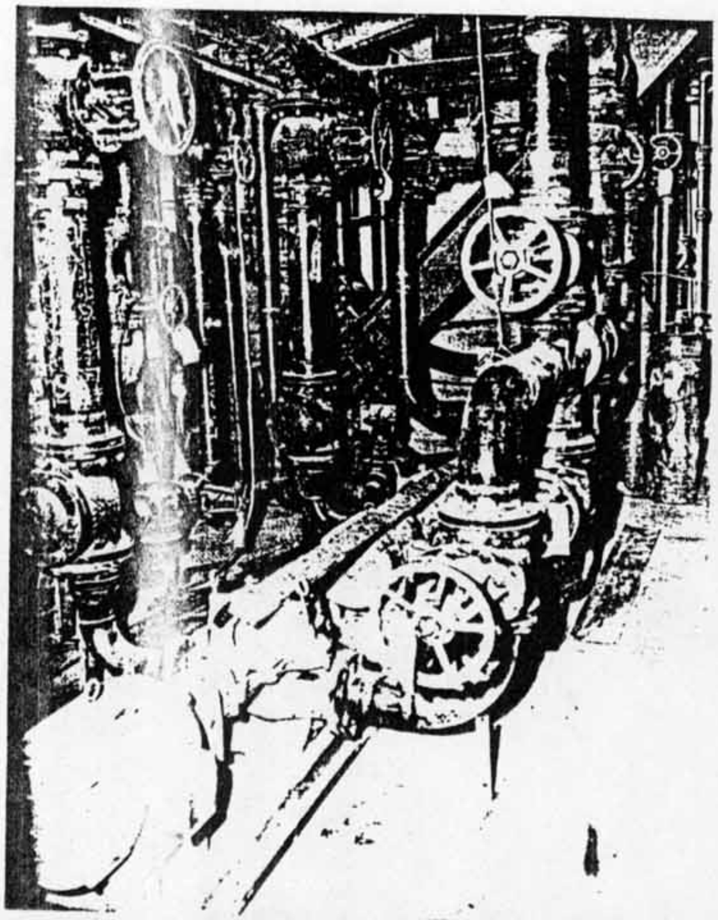
#45104. SITE 9, BRAINARD, NEBRASKA. 13 June 61. View facing northwest on level 1 shows nearly completed installation of Chilled Water & Air Washer Tanks including Liquid Level Control Valve.



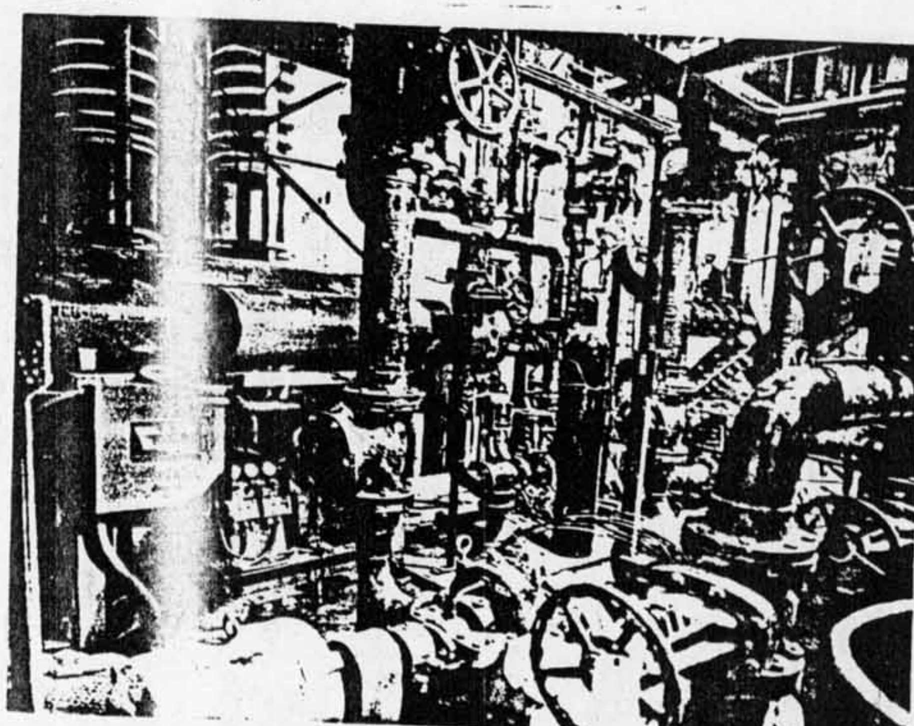
View facing northwest from spiral stairway shows near completion of piping complex on level 4. WCC photo.



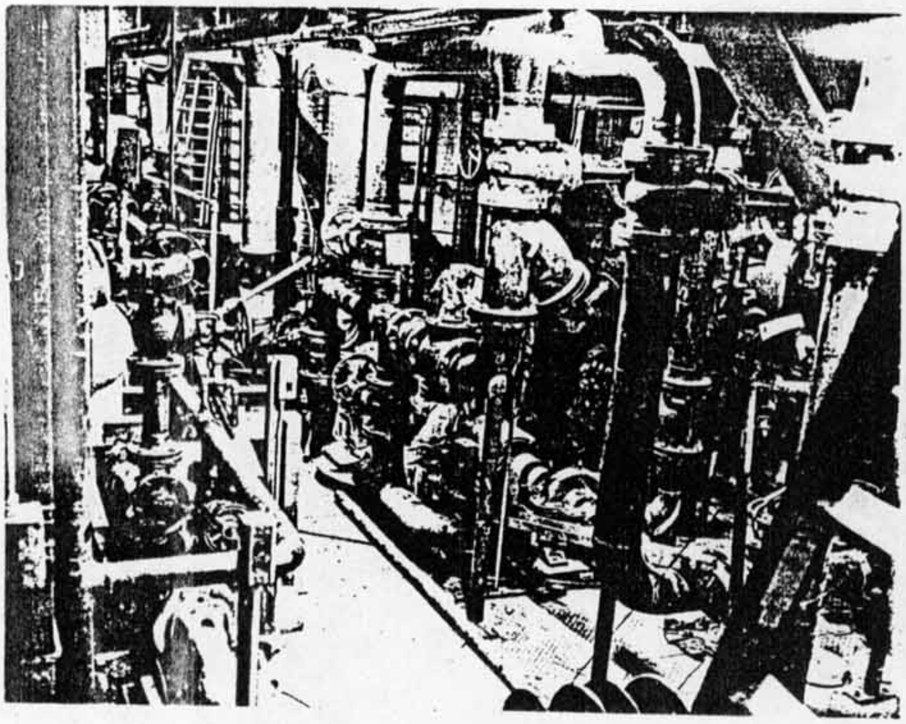
View facing northwest on level 4 shows piping complex, water chiller #31, Hot Water Expansion Tank #63 in foreground and upper section of shock struts in background. WCC Photo.



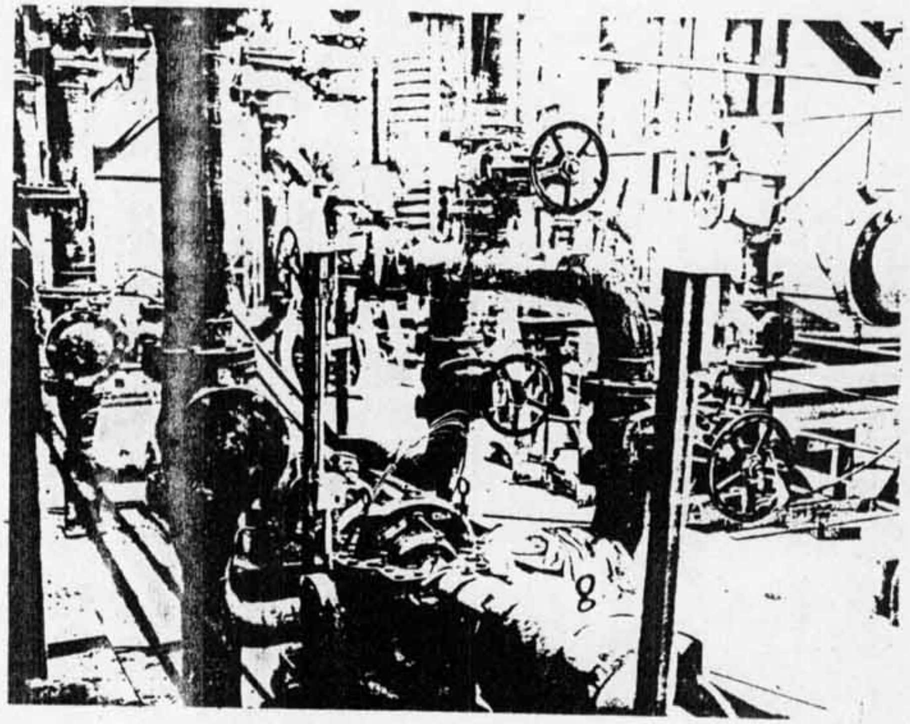
#43537. SITE 6
WILBER, NEBRASKA
2 Mar 61. View
facing north
shows Condenser
Water Pump
[illegible]-31 and
associated
piping on level
4.



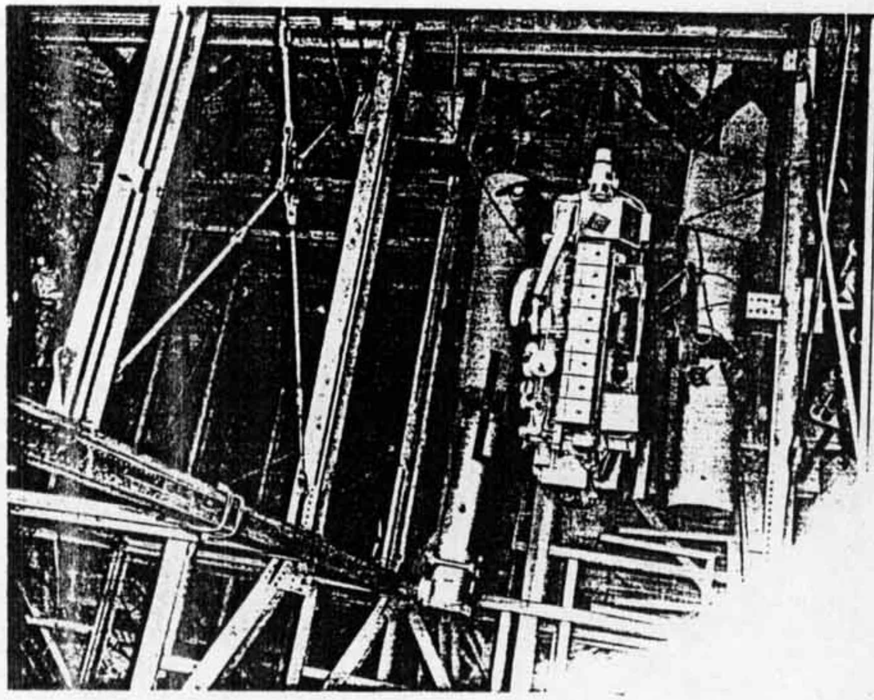
[illegible]. Facing northeast, shows progress on installation of piping on level 4 of silo. [illegible]-31 in foreground, water chiller [illegible] at left.



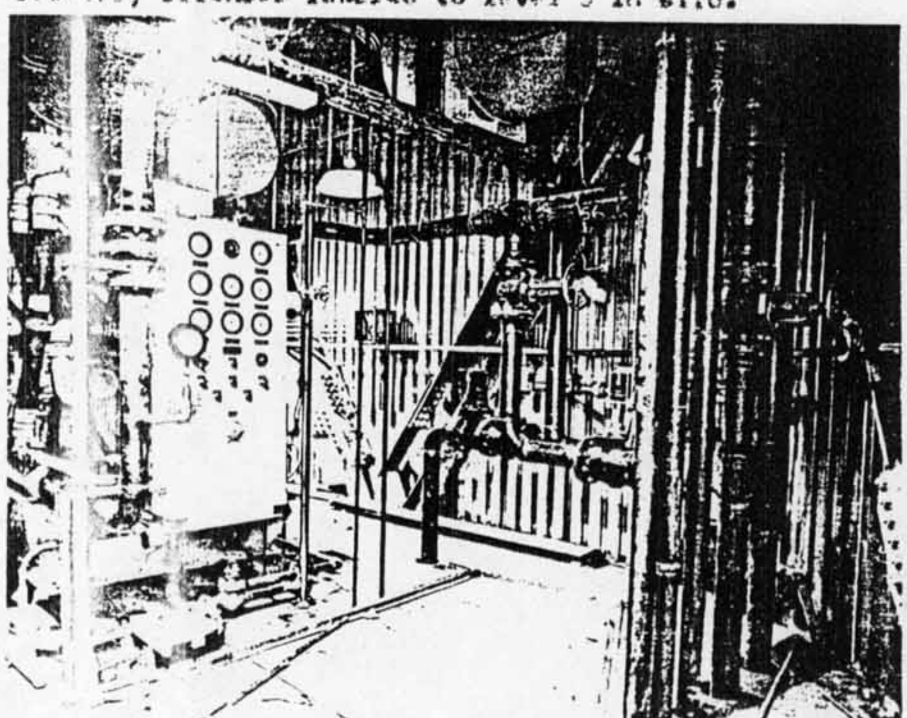
[illegible]. View facing southeast from column [illegible] shows construction progress of piping complex on Level 4.



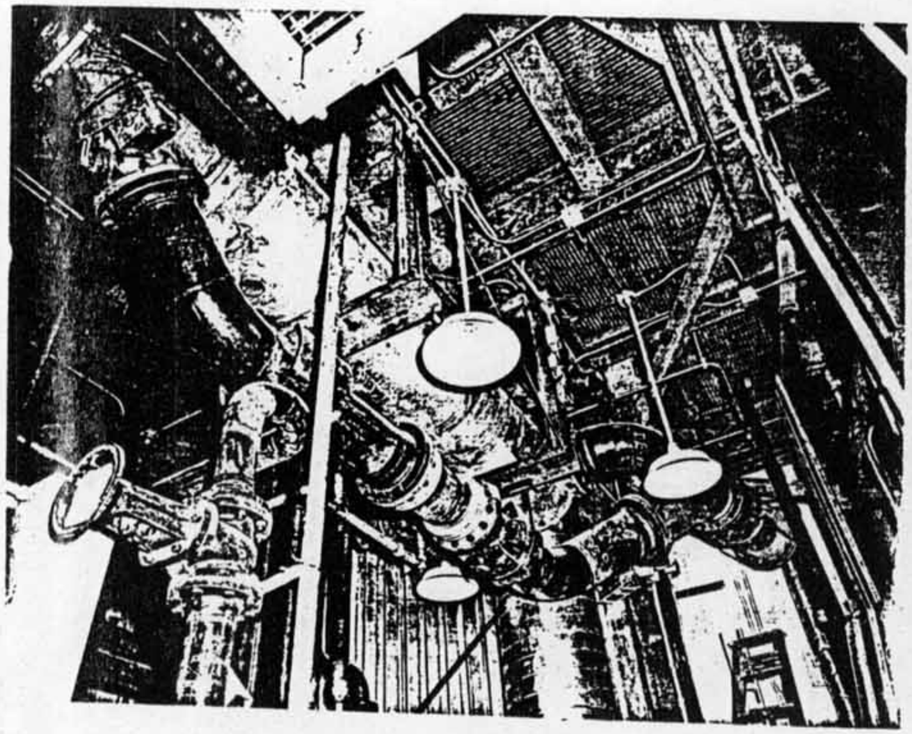
[illegible]. View facing north on level 4 shows [illegible] in fore- [illegible]



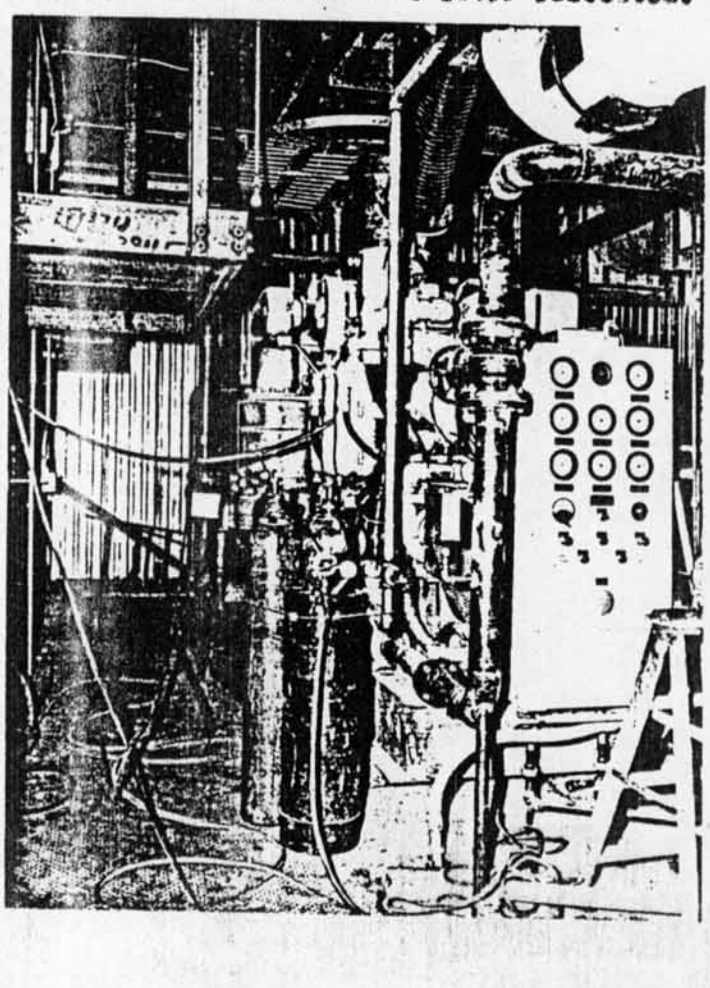
[illegible]. [illegible] 1[illegible], [illegible], [illegible]. 1 Feb 61. View south [illegible] shows diesel generator unit, diesel fuel day tank, clean and dirty lube oil tanks and heat recovery silencer lowered to level 5 in silo.



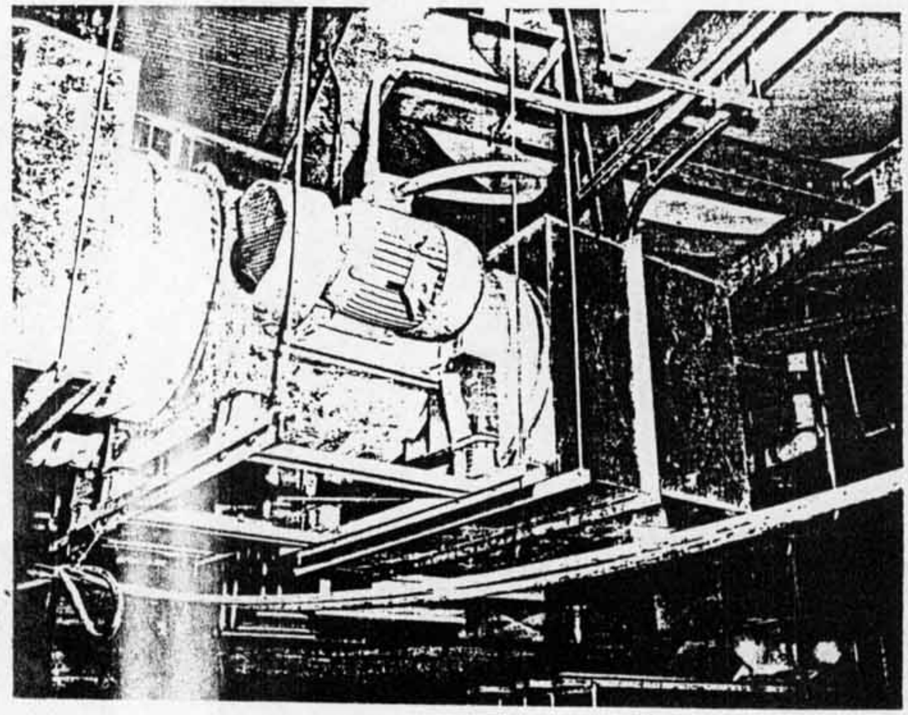
[illegible] View facing southwest on level 5 shows control panel of diesel generator at left, hot and cold water piping at the right and lube oil tanks overhead.



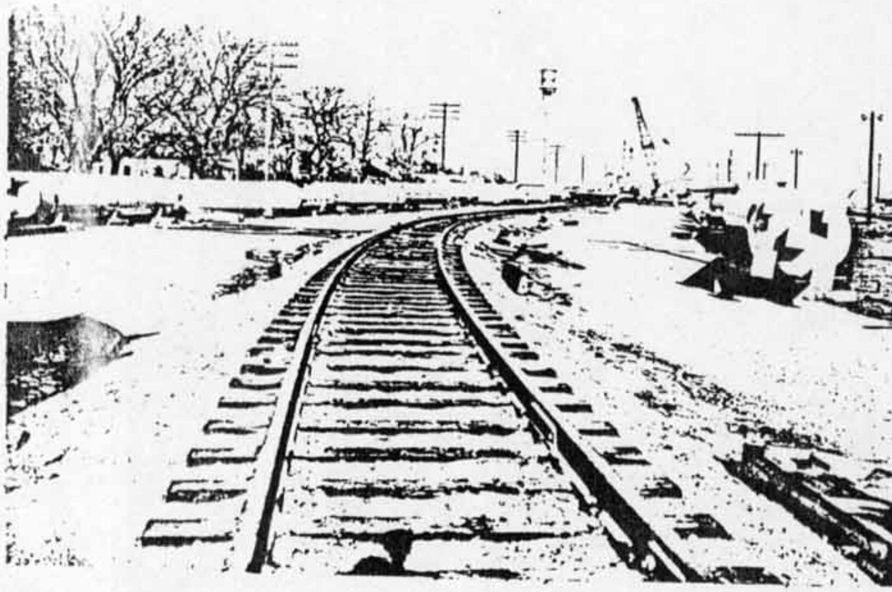
[illegible]. View north upward from diesel generating unit on Level 6 shows the Heat Recovery Silencer and by-pass piping. Note motor driven damper control at upper left and flexible steel expansion joint at center of by-pass. Note also interference of lighting fixture at right with piping. This fixture was later relocated.



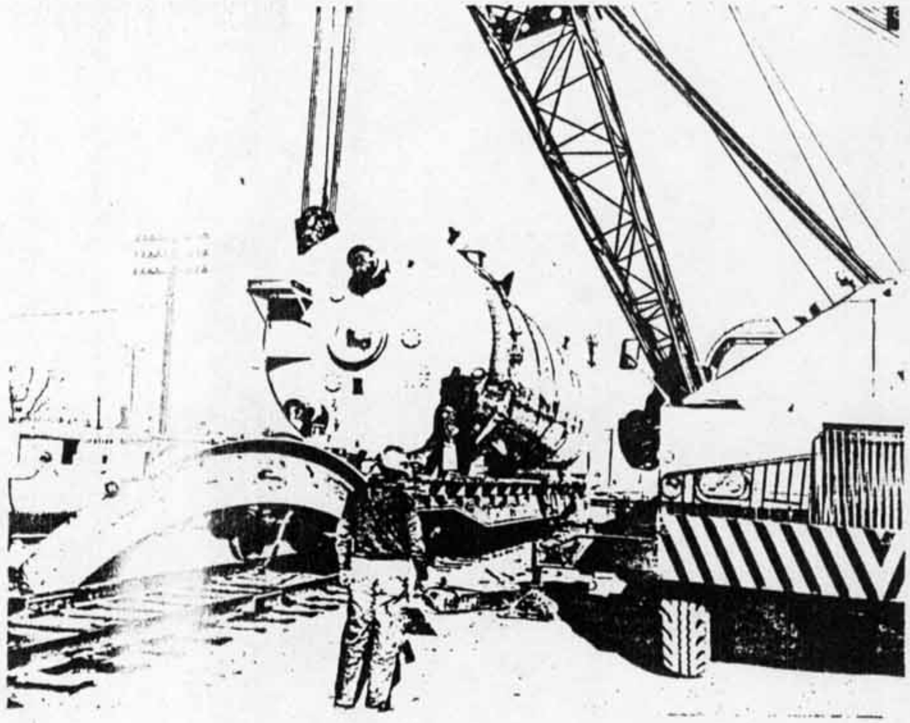
#44690. SITE 9. BRAINARD, NEBR. 4 Apr. 61. View south on level 6 shows diesel engine control panel and elevated work platform. Note cable trays in background.



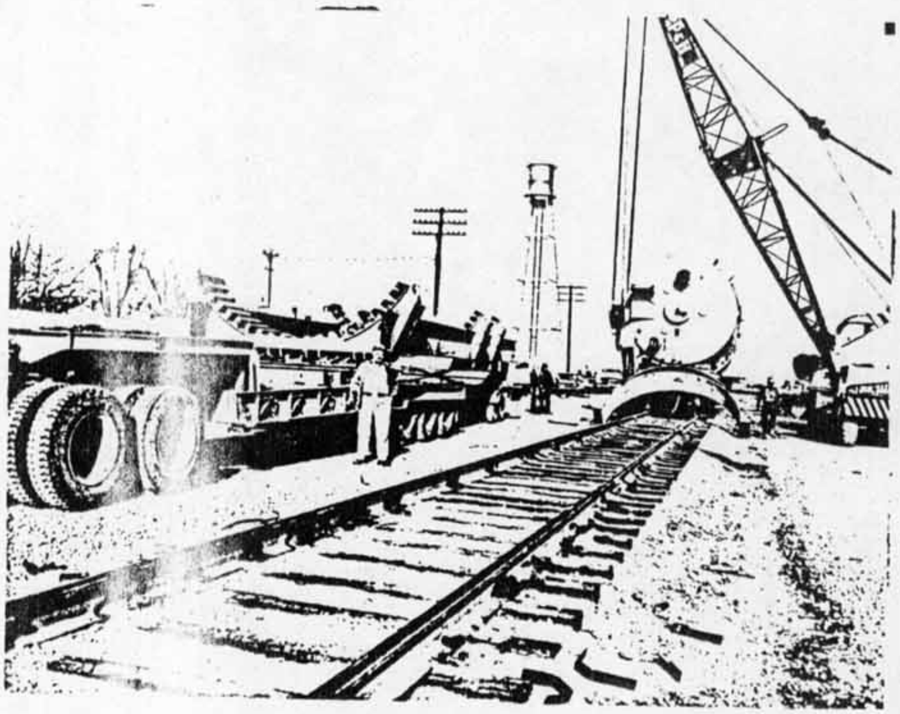
#44630. SITE 9, BRAINARD, NEBRASKA. [illegible] Apr 61. View north upward from silo floor shows ducting and flexible couplings for Exhaust Fans EF-40 and EF-41.



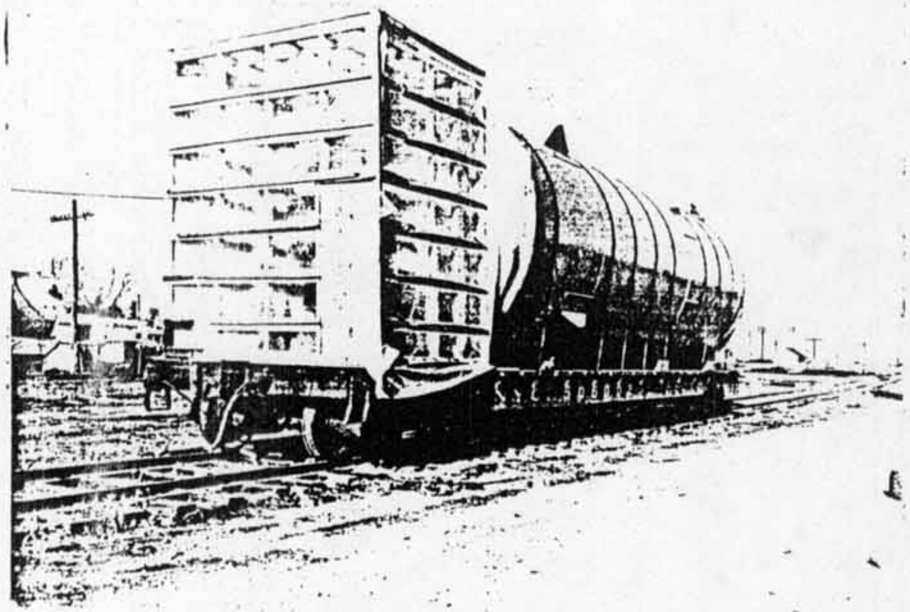
E4201[illegible] Cortland Nebraska Rail Siding. Dec 60.
View facing north shows storage of Gaseous Helium, Nitrogen and Oxygen pressure vessels prior to shipment to sites. Unloading Liquid Oxygen vessels with crane.



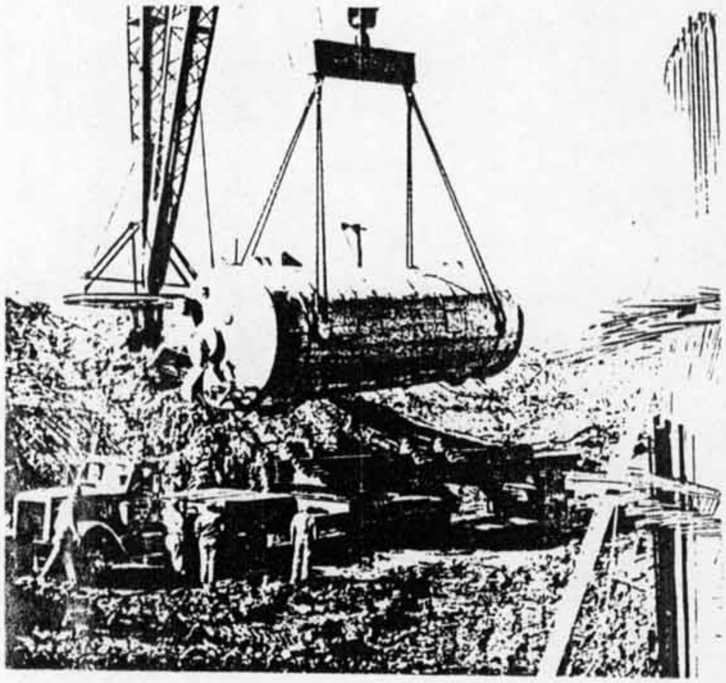
[illegible]4[illegible]10. [illegible]land, Nebraska Rail Siding. [illegible]ec 60. View sho[illegible] [illegible]quid Oxygen Storage Tank on flatcar. Preparatio[illegible] are bei[illegible] made to install the lifting bands shown in [illegible] foreground. Tank is of the "[illegible]ewer" type construc[illegible] with mild steel outer shell, stainless steel li[illegible] [illegible]ith vacuum-insulated annular space. Length of tank, [illegible] [illegible]"; diameter, 12' 8"; weight, 10[illegible],000 pounds; capacity [illegible],000 gallons.



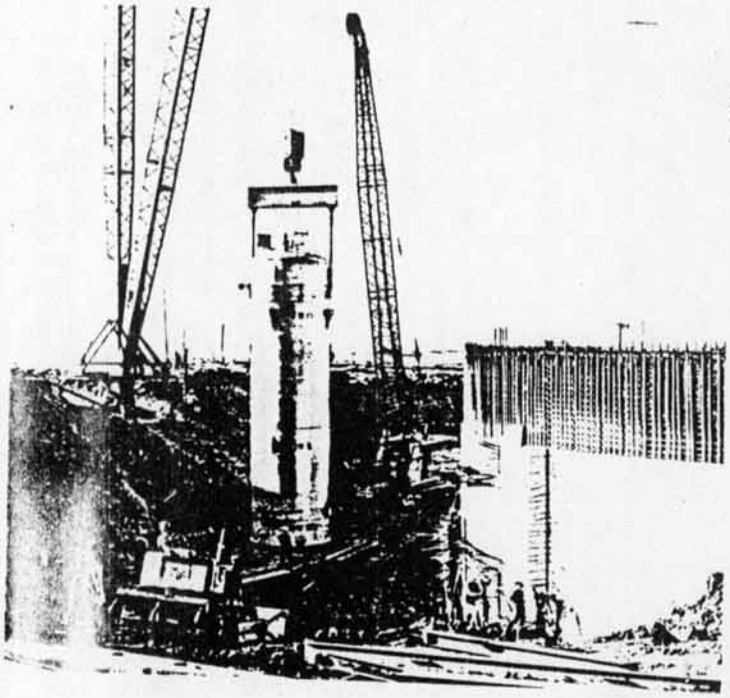
84.515. Cortland Rail Siding. View shows specially constructed "low boy" and dual trailer used to transport [illegible] vessels from receiving and storage area to sites. This siding served as receiving and distribution point for [illegible] vessels to all twelve sites.



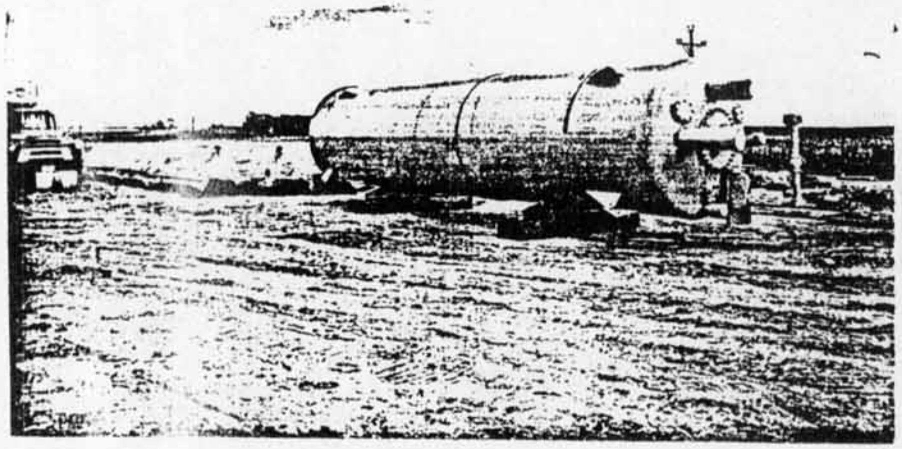
A42613. Cortland Rail Siding. Jan 61. View facing north shows temporary protective shelter erected over end (top) of Liquid Oxygen Storage Tank to facilitate emergency repairs to tank in field avoiding costly reshipment to factory. Due to the cleanliness requirements of the PLS System, a positive pressure of filtered dry nitrogen was maintained in the vessel and in the shelter. This made it necessary to provide breathing oxygen for the workmen and inspection personnel involved.



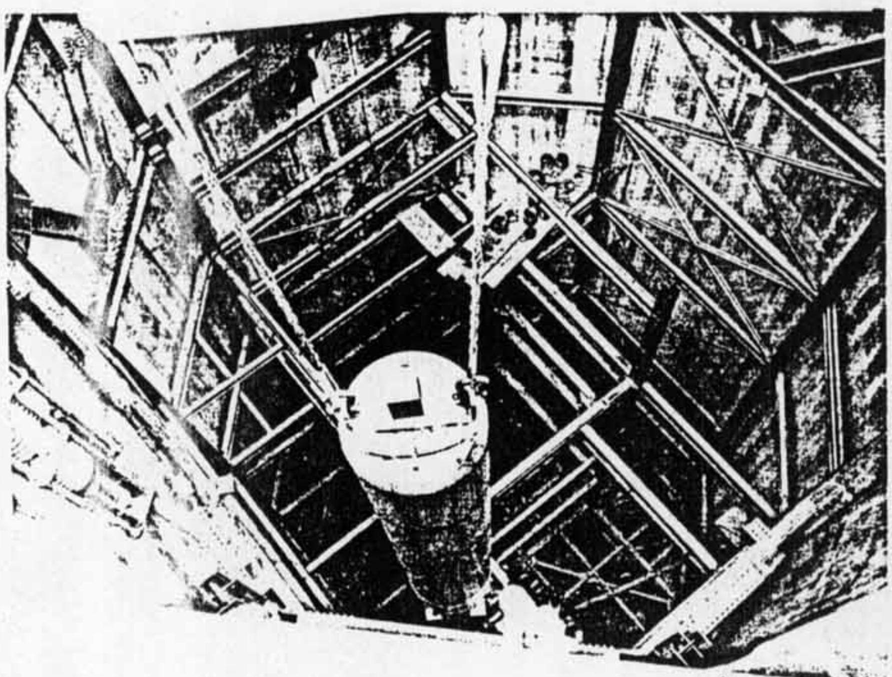
SITE 3. TECUMSEH. Liquid Oxygen storage tank being unloaded from truck. CE/A #51058



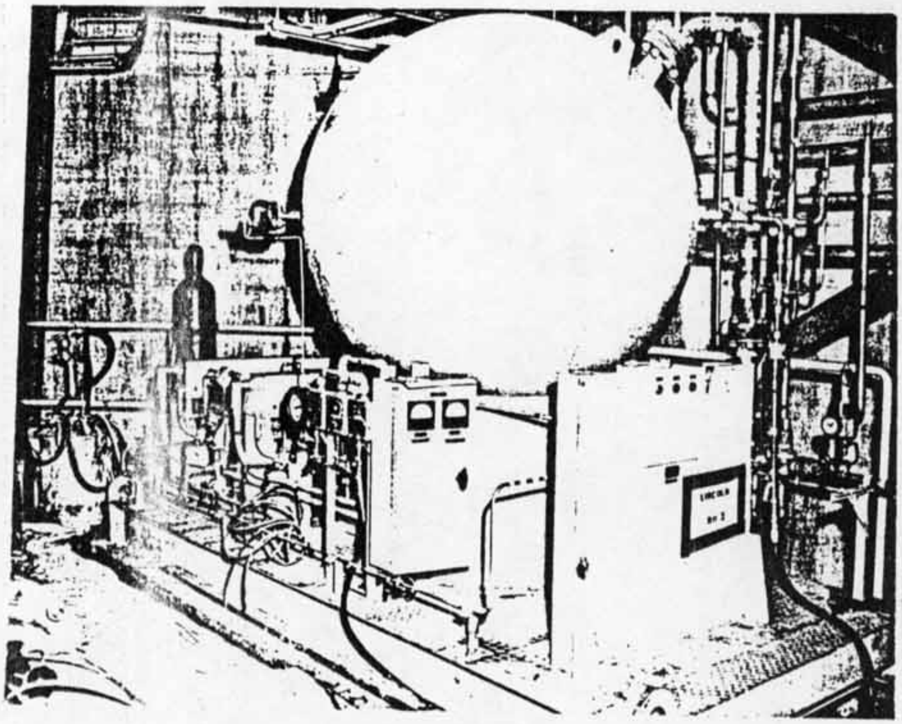
SITE 3. TECUMSEH. Liquid Oxygen storage tank being hoisted for lowering into silo. CE/A #51066.



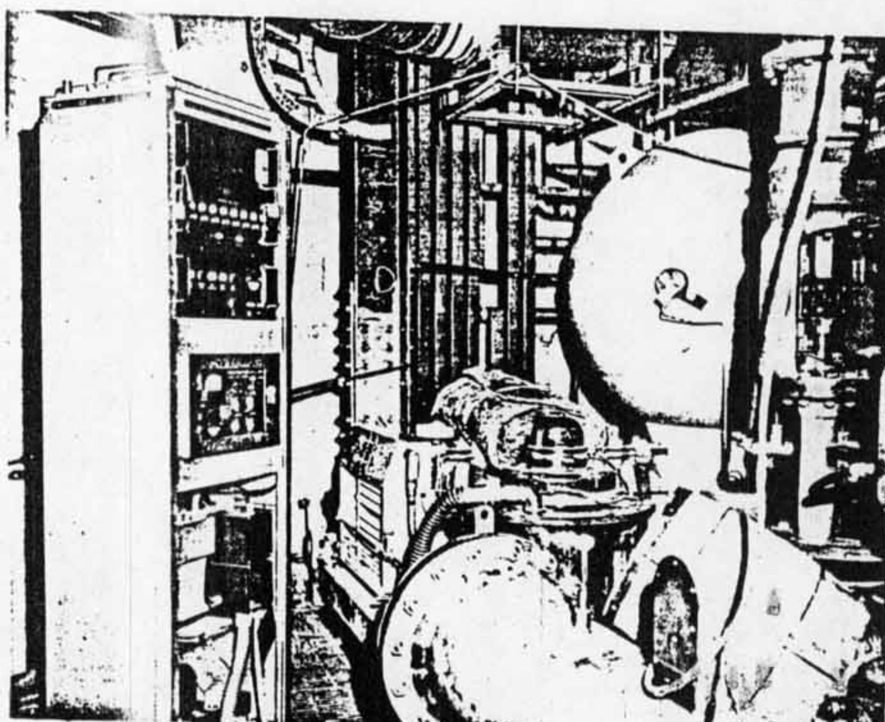
[illegible]418[illegible]. SITE 6, GILEAD, NEBRASKA. [illegible] Nov 60.
Liquid Oxygen Topping Tank on site. Note lugs near right which will enable tank to be suspended in vertical position.



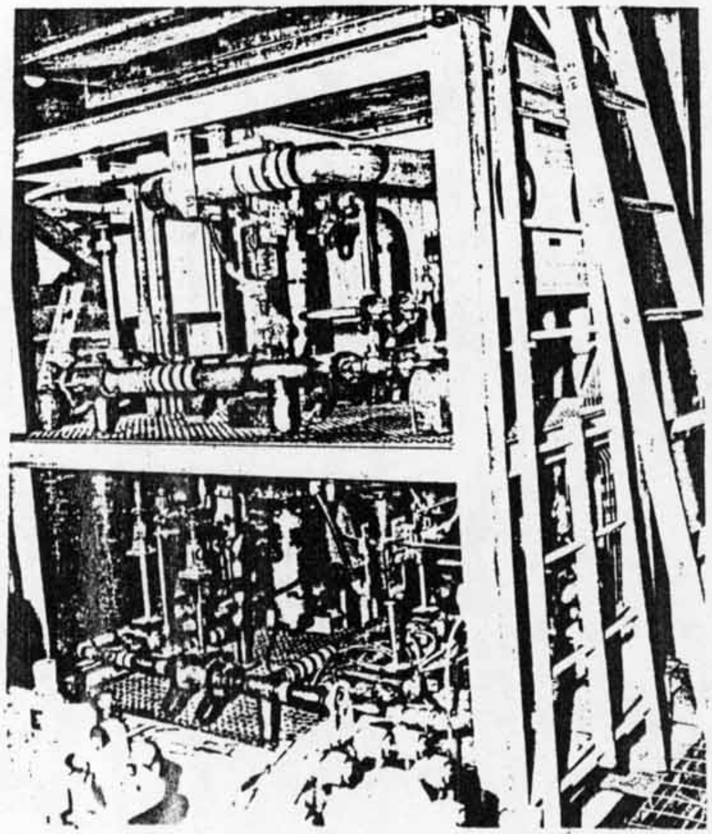
[illegible]4175[illegible]. SITE 3, TECUMSEH, NEBRASKA. 2 Nov 60. View into silo shows Gaseous Oxygen Storage Vessel being lowered into silo.



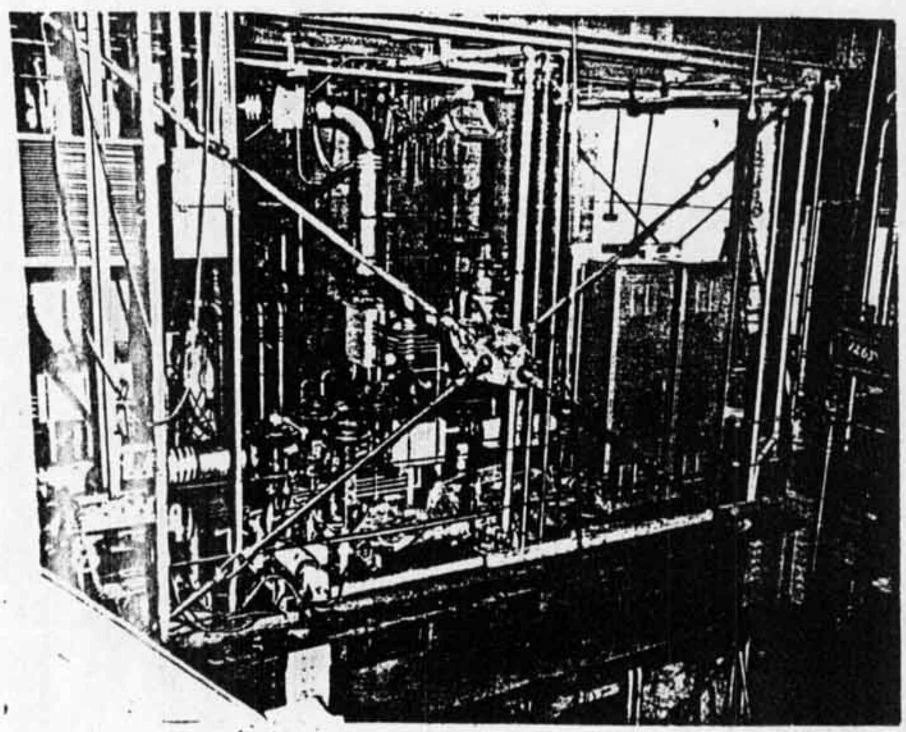
[illegible]. SITE 7. [illegible], NEBRASKA. 13 June [illegible].
View facing southeast shows Instrument Air Prefab, Level 7.



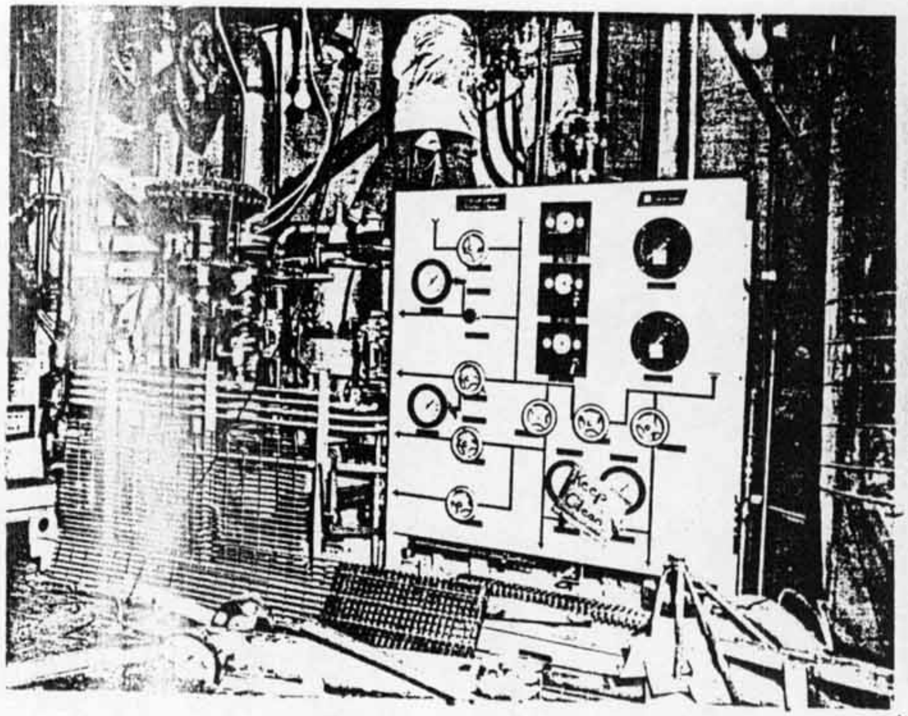
[illegible]. SITE 1. [illegible], NEBRASKA. 3 April 1961.
View of Level 7, south side, shows Gaseous Oxygen Detector Cabinet and control panel for Instrument Air Compressors.



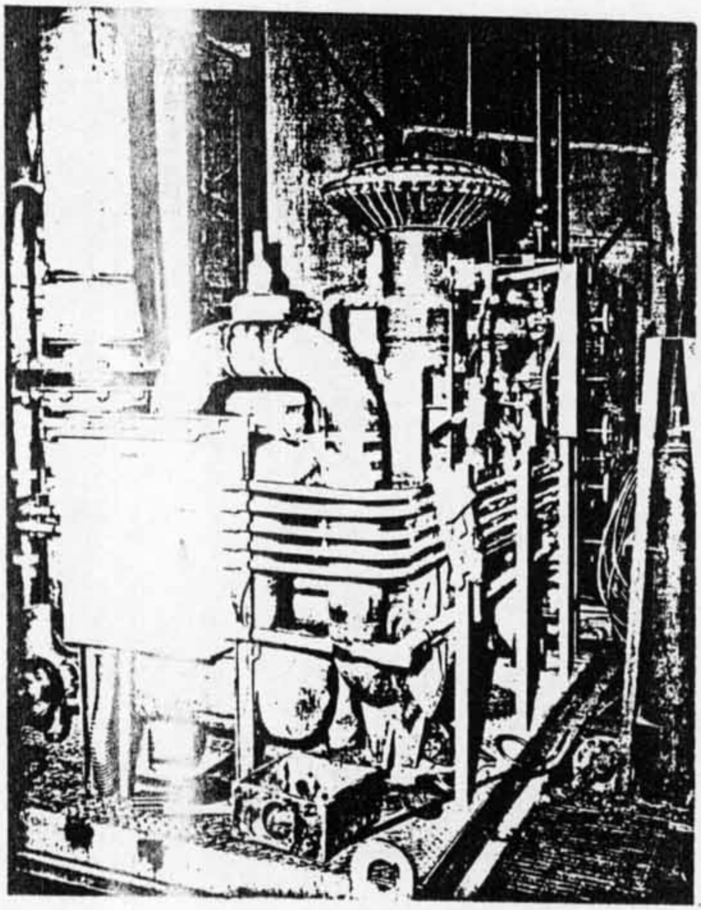
[illegible]. SITE 9. DRAINAGE, NEBR. 1 Mar 61. View facing southwest shows piping complex of the Liquid Nitrogen Pre-fab.



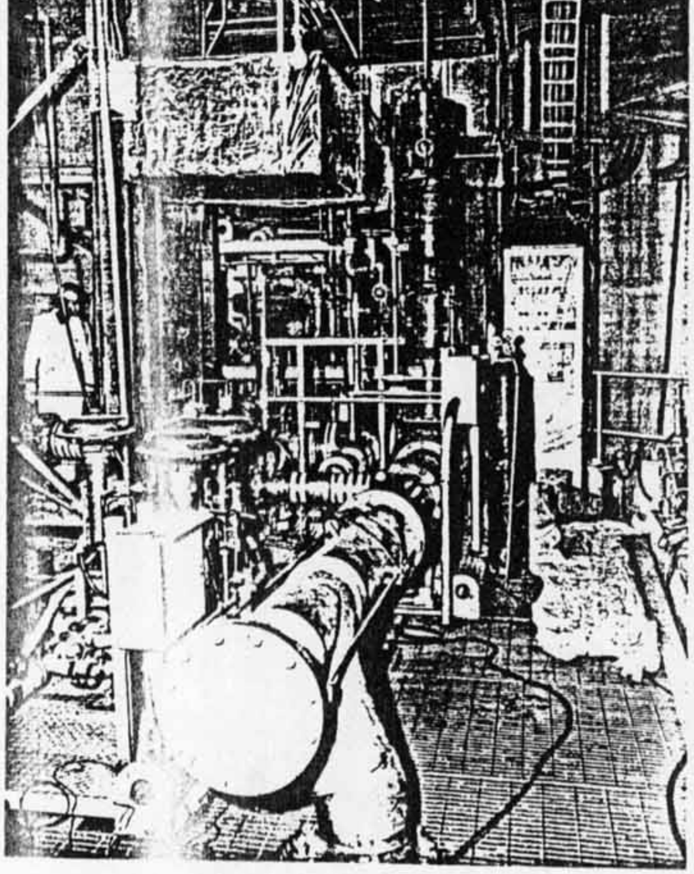
[illegible]. SITE 7, [illegible], [illegible]. 13 June 61. View facing northwest from spiral stairway shows general progress of the piping installation to [illegible], level 7. Right foreground shows back of [illegible]-1 Fuel and Diesel Fuel Gas [illegible]etectors.



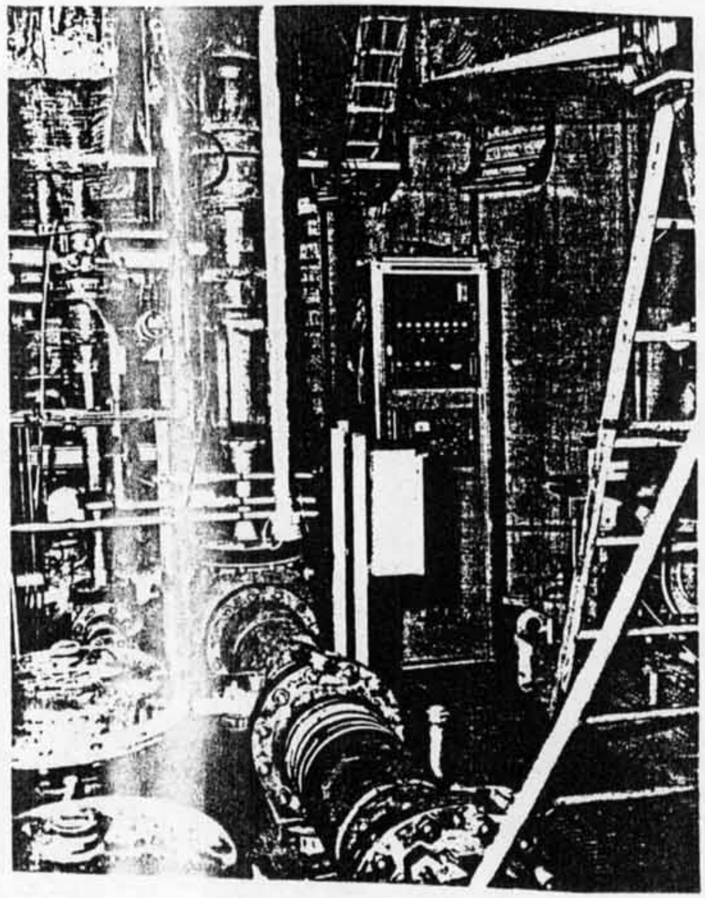
[illegible] [illegible] 9, [illegible], NEBRASKA. 1 Mar 61.
View facing SW on level 7 shows Pressurization prefab during construction.



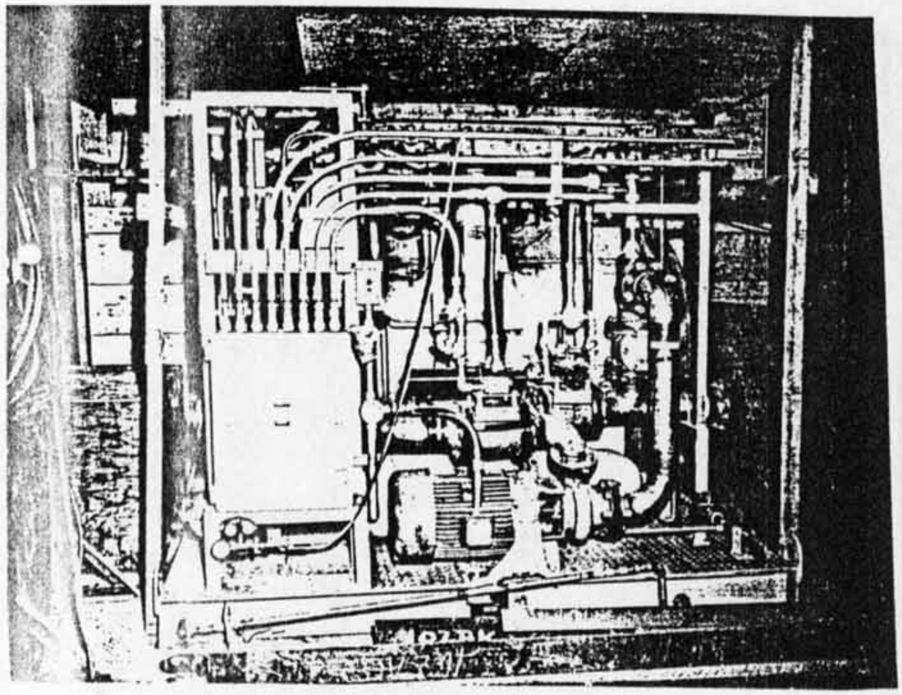
#45067. Site 2 Nebraska City. 2 May 61. View facing northwest shows south end of pressurization prefab level 7.



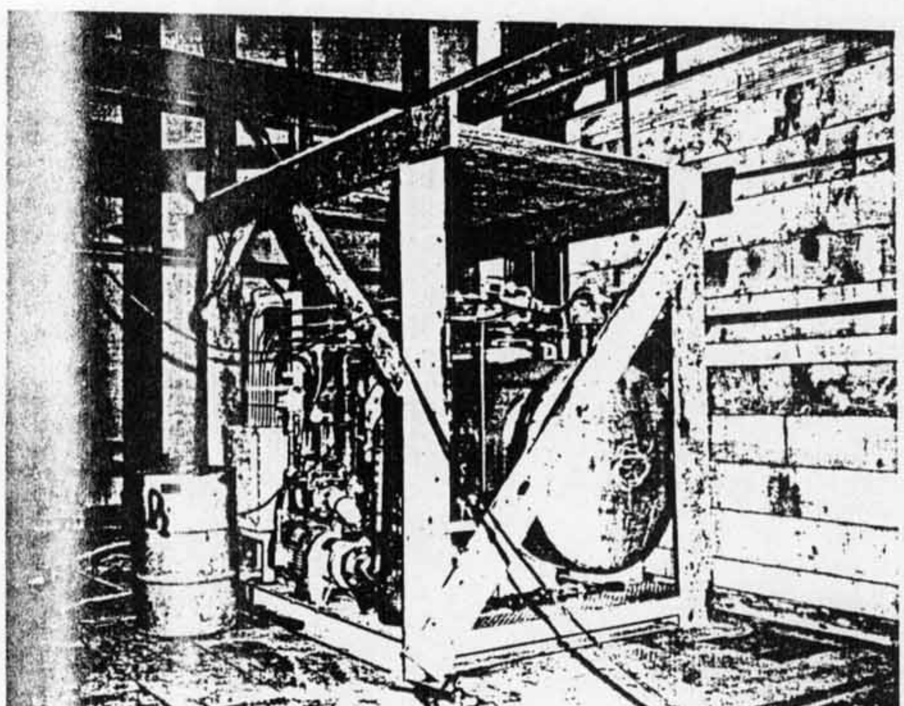
[illegible] III 9, BRAINARD, NEBRASKA. 13 June 61.
View facing south on level 7 shows 10" Liquid Oxygen header, Liquid Oxygen Fill and Liquid Oxygen Control Prefabs and Gaseous Oxygen Detector Cabinet (right rear). Overhead ducting used to carry exhaust air from diesel area on level 6.



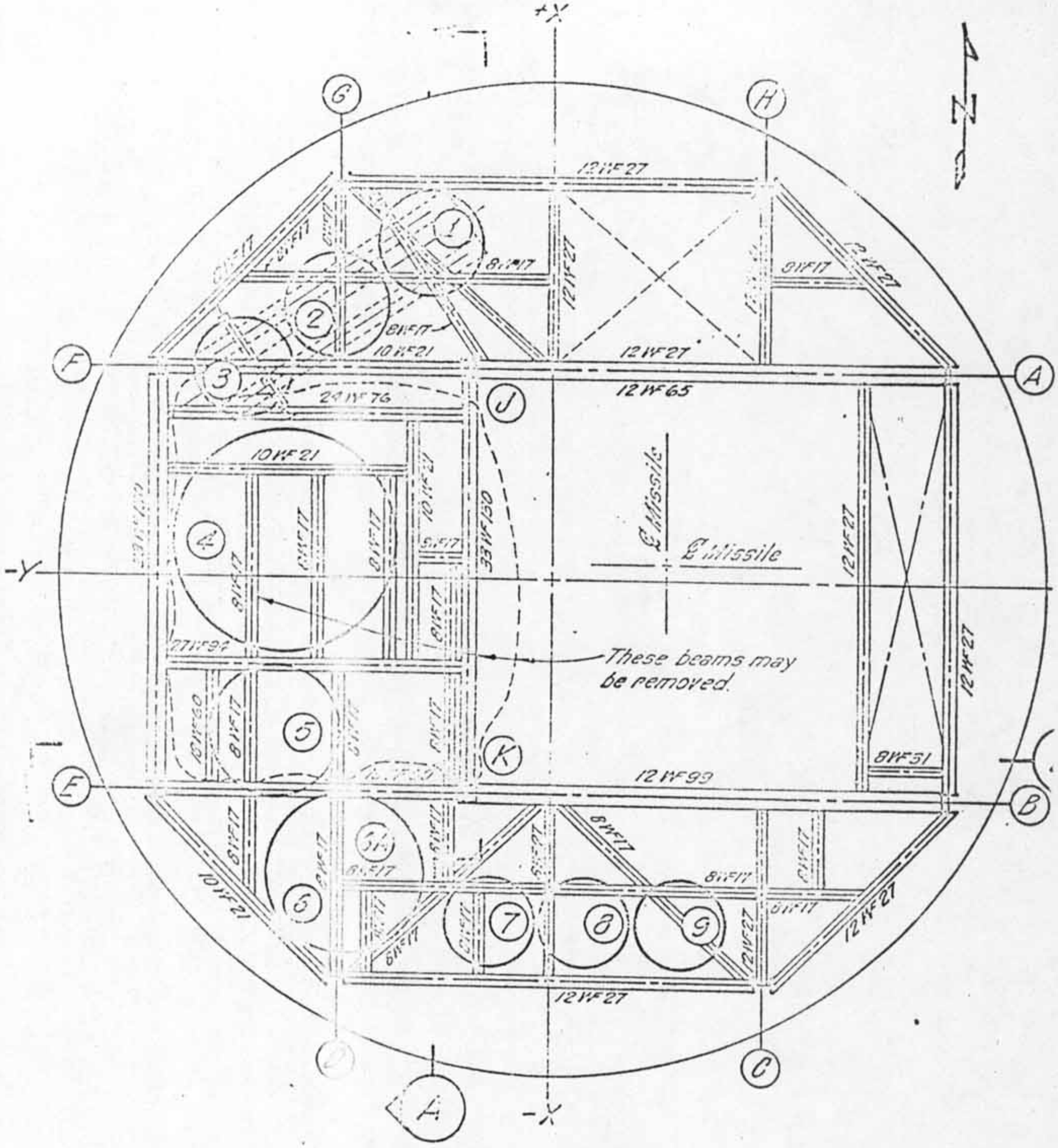
#45073. [illegible] 2, NEBRASKA CITY, NEBRASKA. 2 May 61. View facing south shows Liquid Oxygen Control Prefab and Gaseous Oxygen Detector Cabinet (at right).



[illegible]. SITE 2, NEBRASKA CITY, NEBRASKA. 2 Mar 61. View facing east shows RP-1 Prefab on level B. No piping has been connected to unit at this time.



[illegible]. SITE 7, YORK, NEBRASKA. 4 Apr 61. View facing northeast shows RP-1 Prefab and portion of Fuel Pressurization Tank.



PLAN

LEVEL-7, T.O.S. EL. 886'-10½"

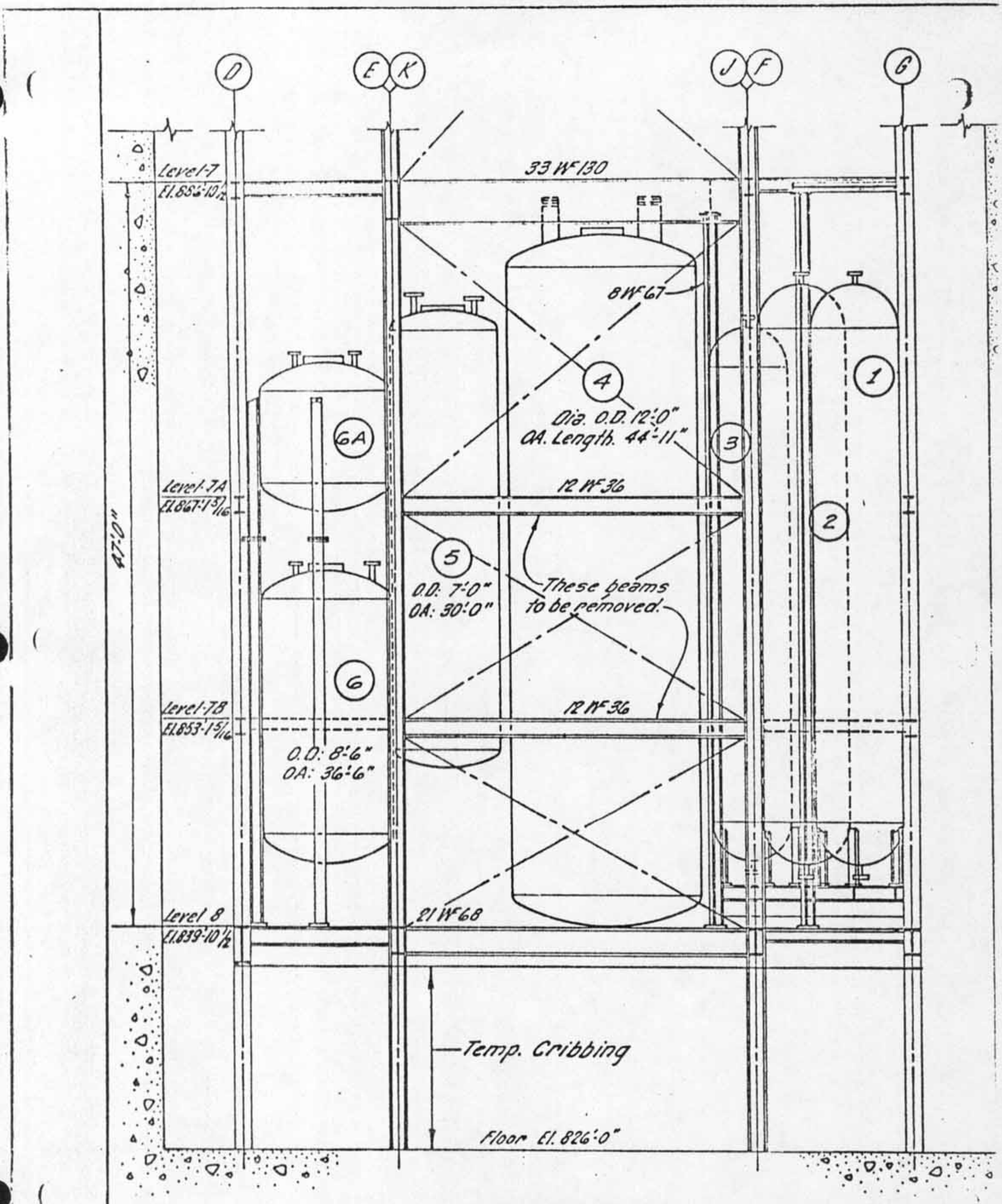
Note:
Vessels shown are below Level 7.

KEY

1. Gas Ox. I, Wt. 40.0 t.
2. Gas Ox. II, Wt. 40.0 t.
3. Gas Nitrogen, Wt. 44.5, t
4. LOX Storage Tank, Wt. 55.
5. LOX Topping Tank, Wt. 11.6,
6. LN Storage Tank, Wt. 15.2,
6A. LN/He Heat Exch., Wt. 6.0,
7. He Ground Pressure, Wt. 2
8. He In-Flight II, Wt. 20.7, t
9. He In-Flight I, Wt. 20.7, t

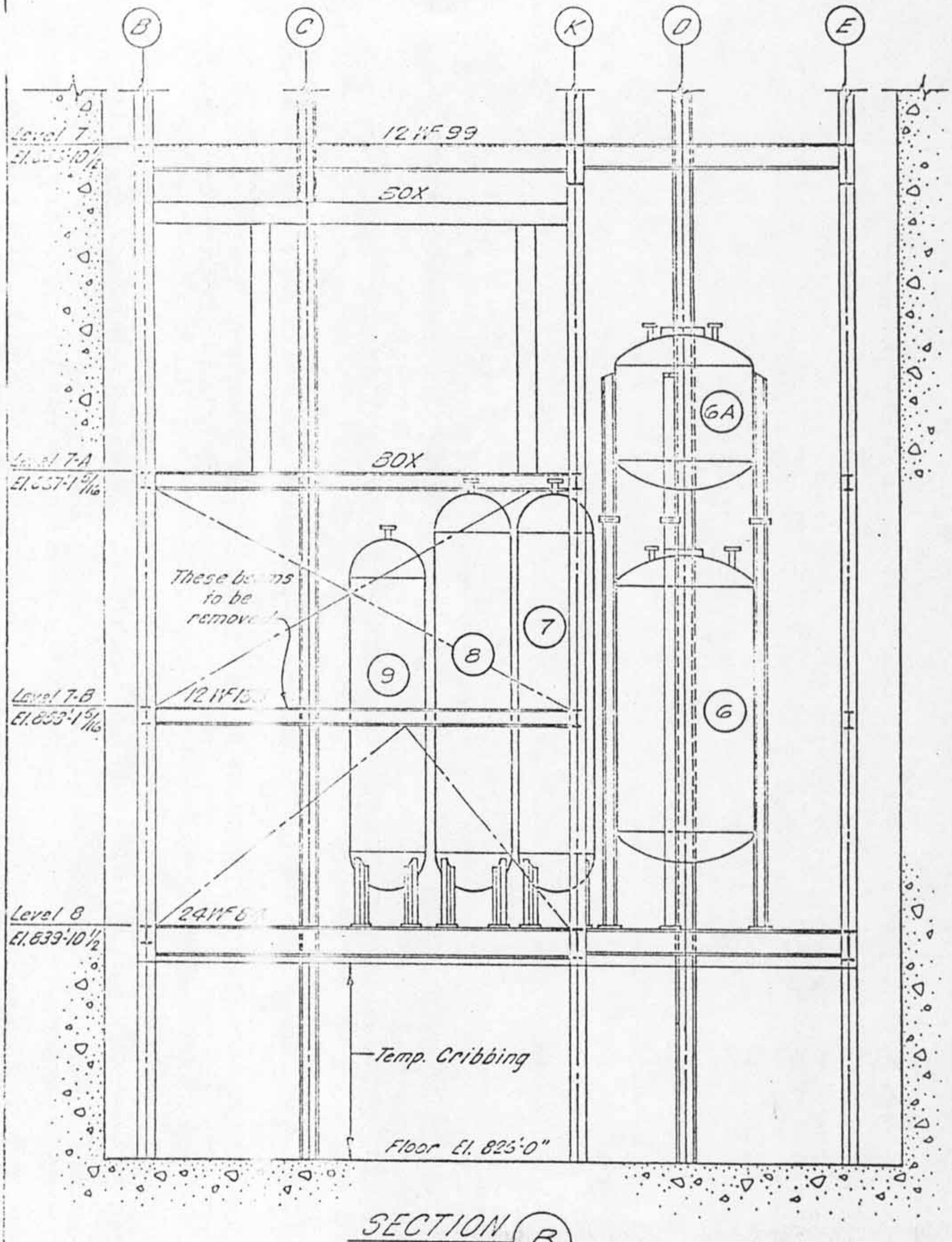
Note: Vessel weights are approximate.

BECHTEL	ATLAS UNITARY SILO	DRAWN BY H.M. Whitelaw	Sketch N



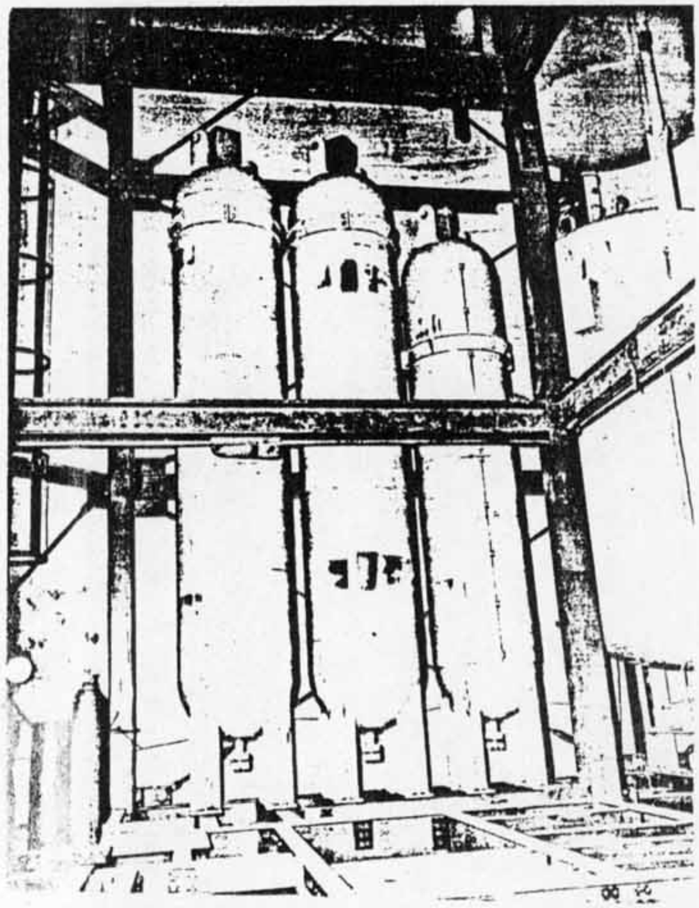
SECTION A

BECHTEL	ATLAS UNITARY SILO	DRAWN BY H.M. Whitelaw

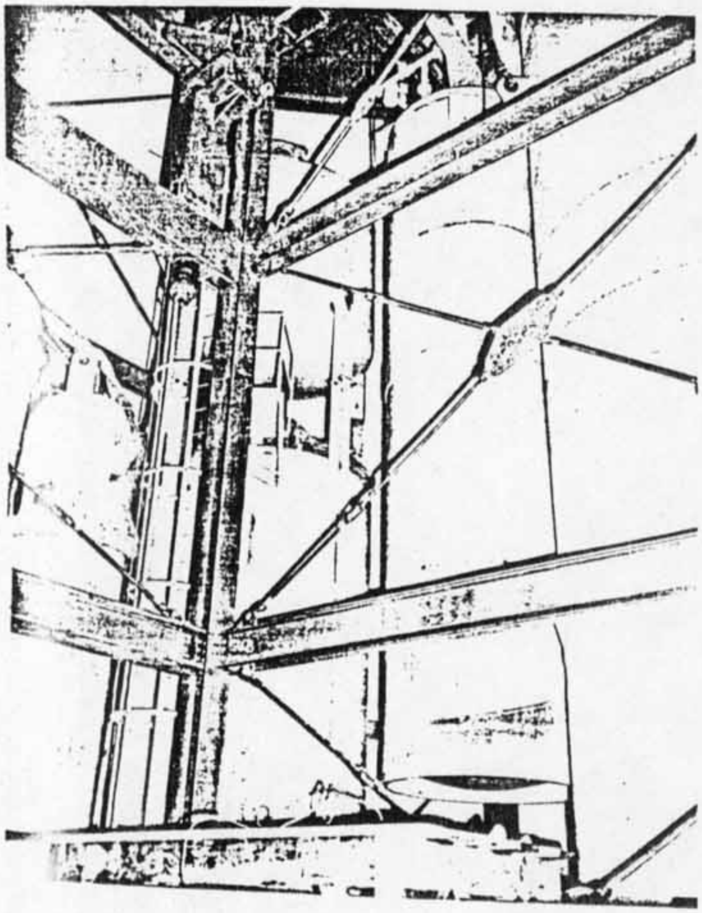


SECTION B

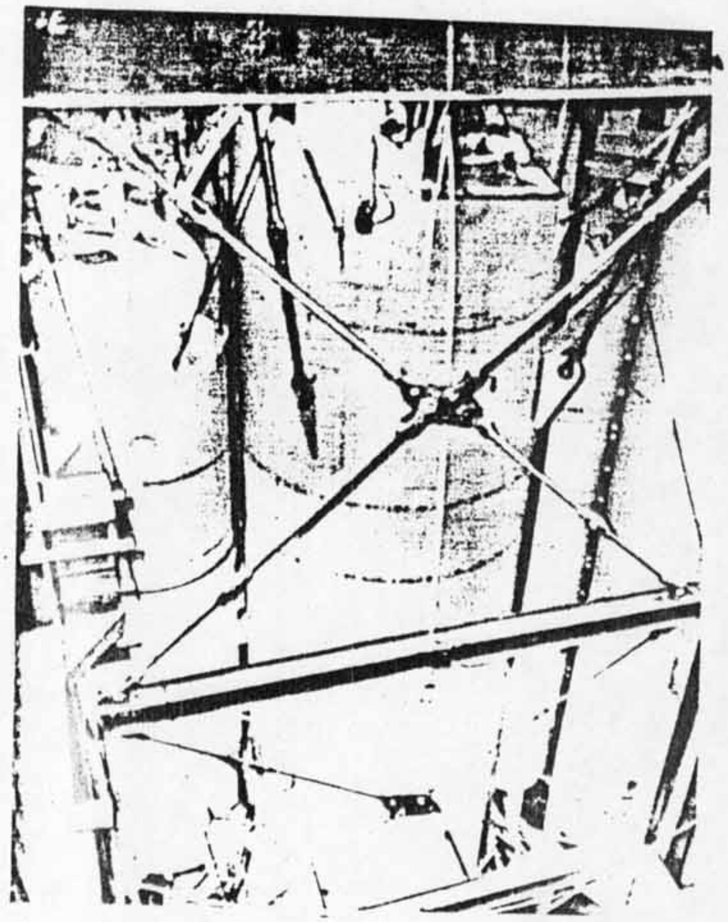
BECHTEL | ATLAS UNITARY SILO | DRAWN BY K.W. Whitelaw



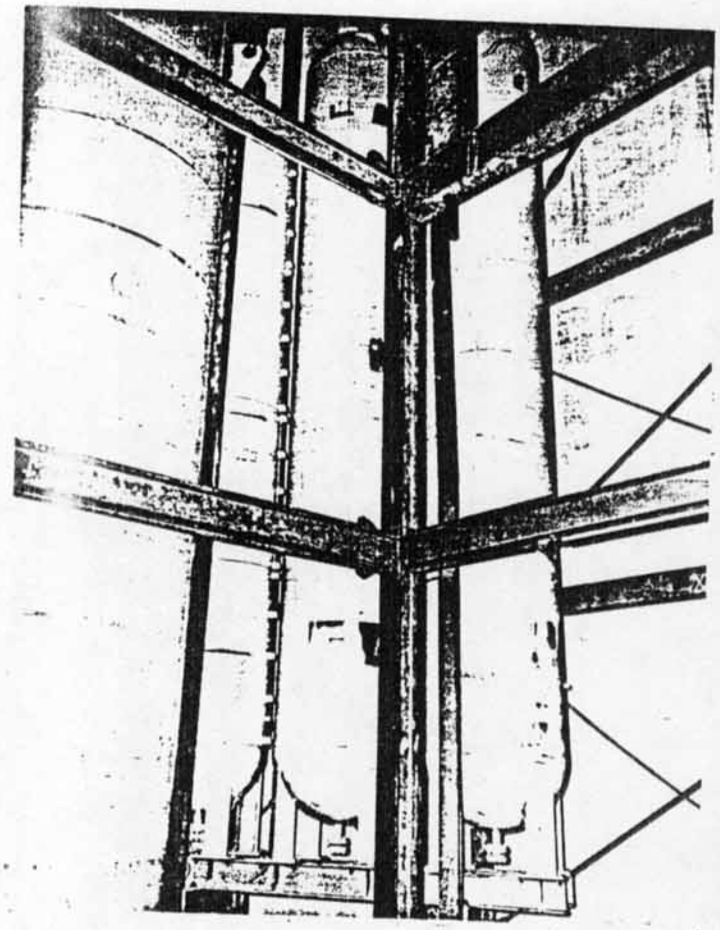
-426[illegible] [illegible] SITE 4, [illegible], [illegible]. Jan 61. View facing generally south on 8th level shows ?LS vessels I to [illegible] Helium Inflight I & II; He Ground Pressurization; Liquid Nitrogen Storage Tank with LN_2/He heat exchanger mounted directly above.



[illegible] SITE 7. Yuma, [illegible]. View facing southwest on 8th level shows PIF vessels left to right: He Ground Pressurization; LH2 storage with LN2/He heat Exchanger; Liquid Oxygen Topping Tank and portion of Liquid Oxygen Storage Tank. Liquid Oxygen Tanks are suspended from level 7 structure.



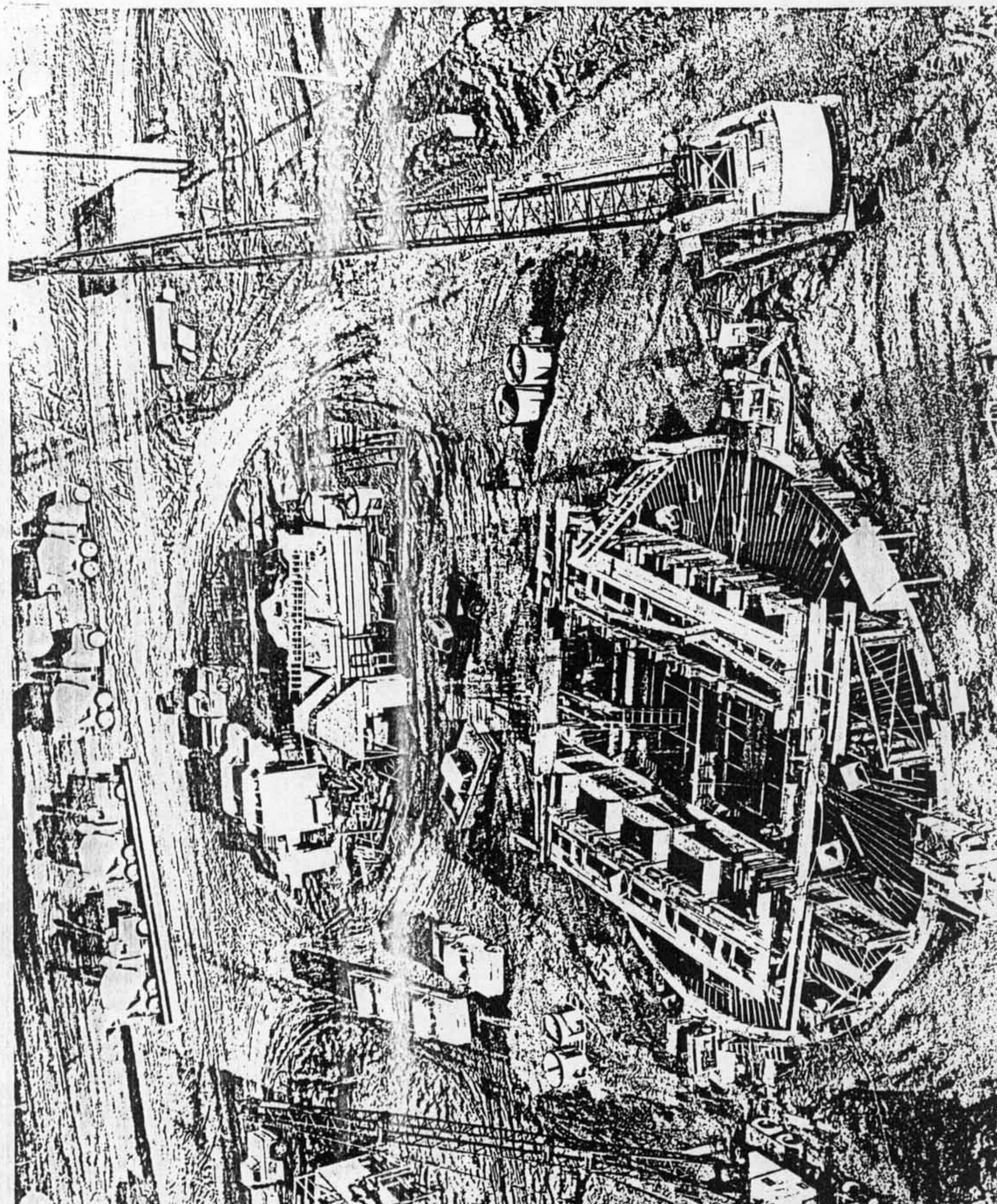
[illegible]51. [illegible] 10, [illegible], ARKANSAS. 1 Mar 61.
View from approximately elevation 680 facing slightly northwest shows PLS vessels left to right: Liquid Oxygen Topping Tank; Liquid Oxygen Storage Tank; Gaseous Nitrogen Storage; and Gaseous Oxygen Storage 1.

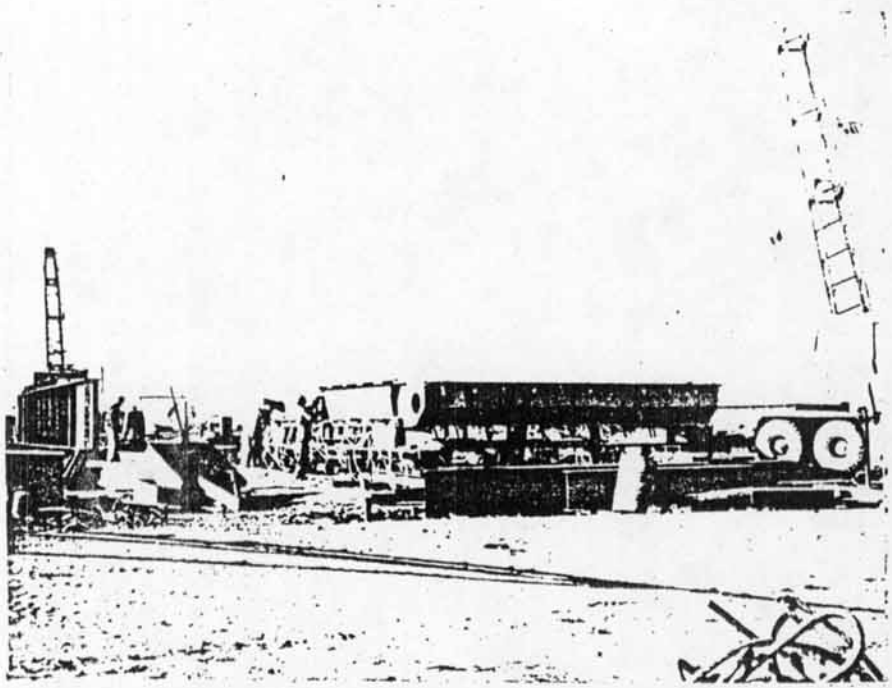


[illegible] ... 2, Cont'd ... [illegible] ... Jan 61. View facing northwest at level 8 shows left to right; a portion of Liquid Oxygen Storage Tank; Gaseous Nitrogen Storage I; and Gaseous Oxygen Storage I & II.

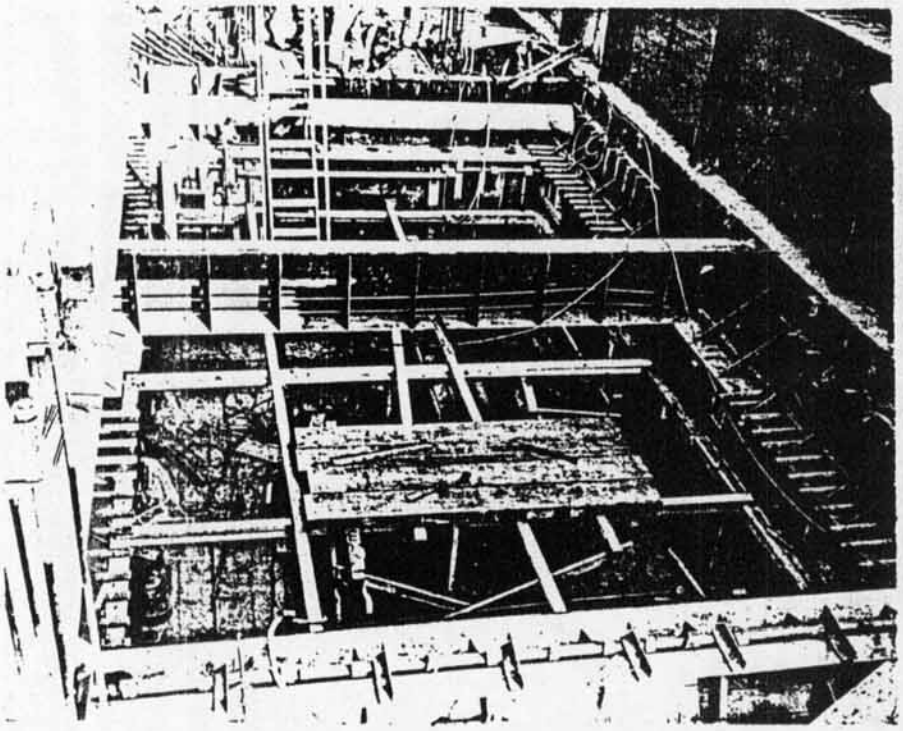
HELICOPTER VIEW OF FACILITIES
FOR SILO CAP FOUR

SITE 3. TECUMSEH. Aerial view shows facilities and steel support structure assembled for silo cap pour. Directly above silo in photo and resembling forms are the sectional platforms used to cover silo opening after 13" perimeter wall was poured. Condensor water cooling tower at upper left. Cranes in foreground are, left, Marion 37M Mobile and right Marion 93M.

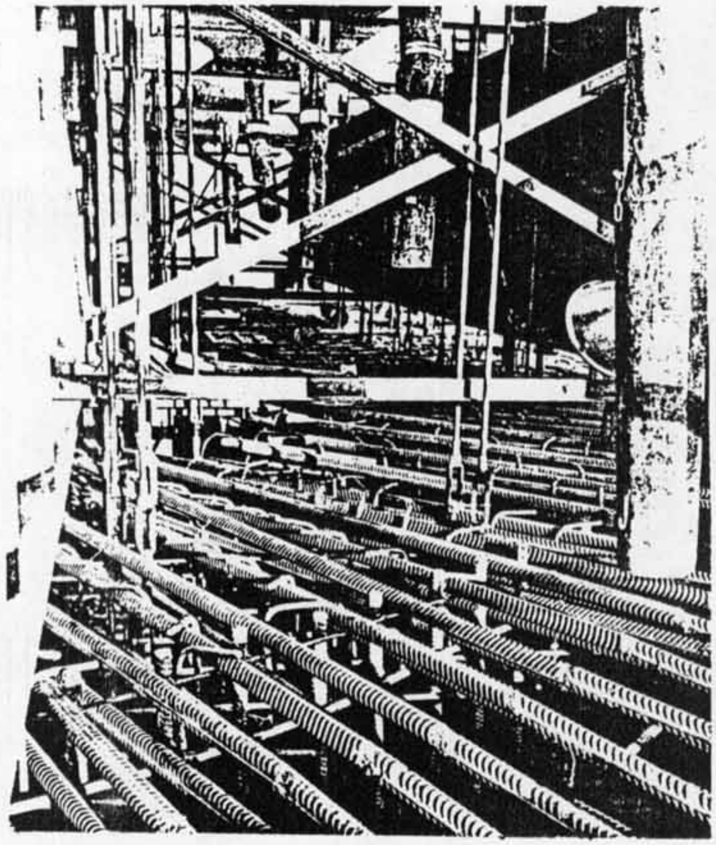




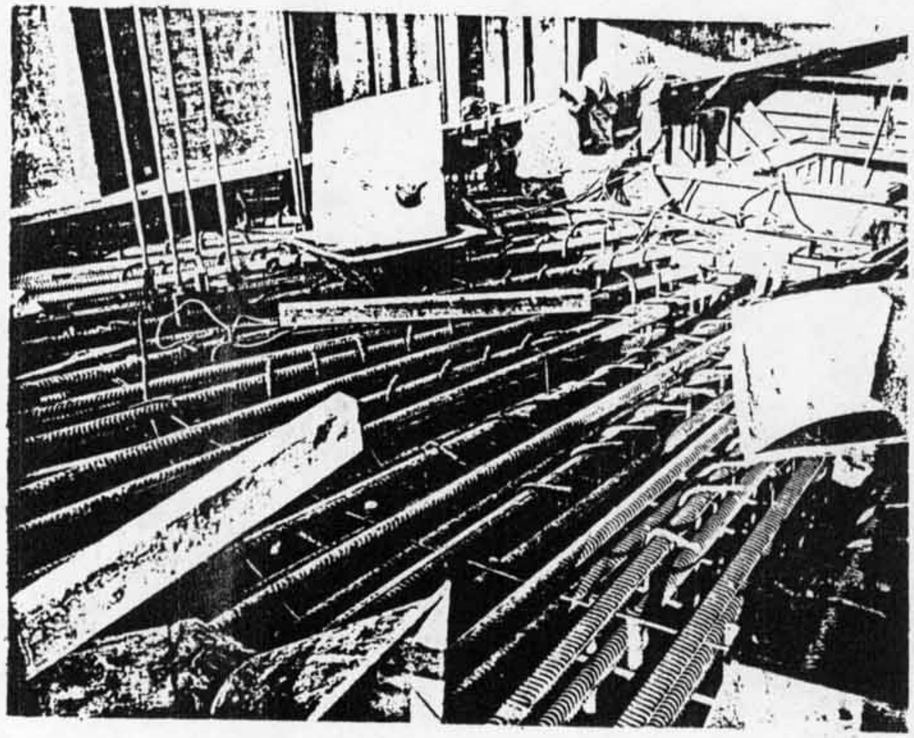
View shows typical working area for alignment and leveling of silo doors. Both doors were mounted on temporary supports and checked optically before mounting on cap forms. ACC Photo.

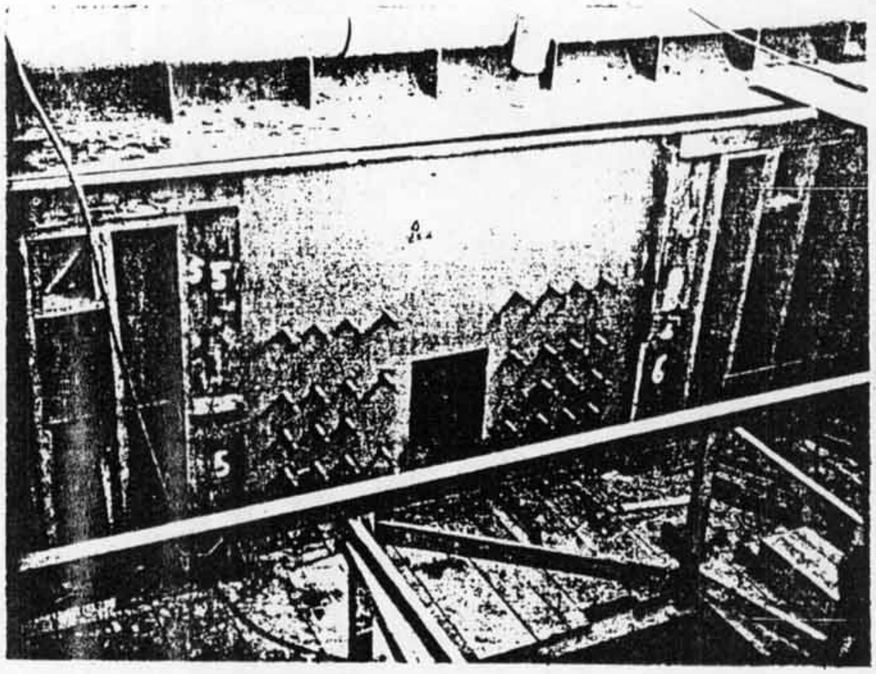


Silo door frames mounted in cap form structure prior to pour. ACC Photo.

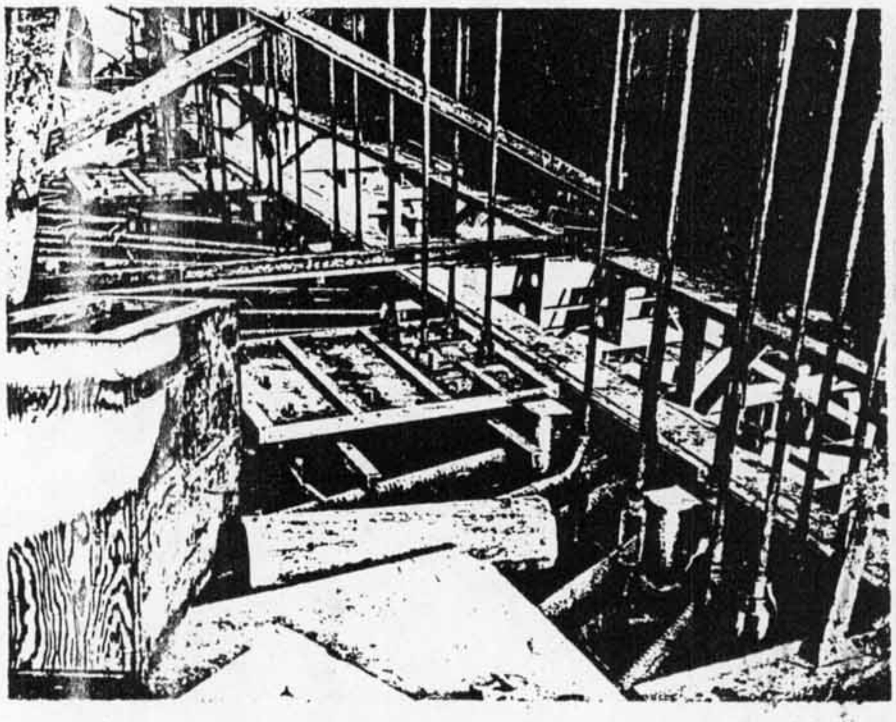


Two views of silo cap support structure. Upper shows "A" Girder on right, lower shows "B" Girder on left. #18 reinforcing steel in foreground.

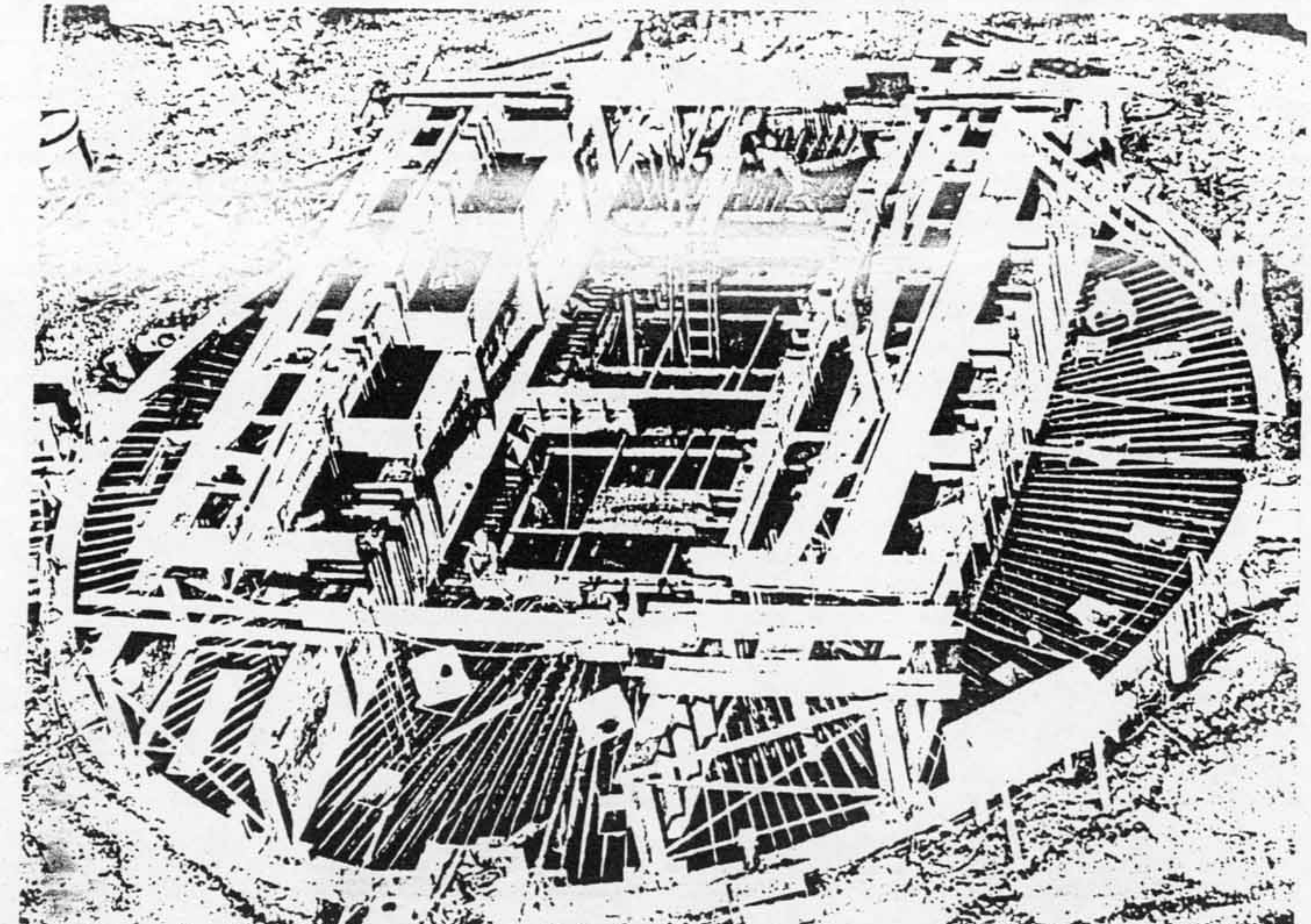




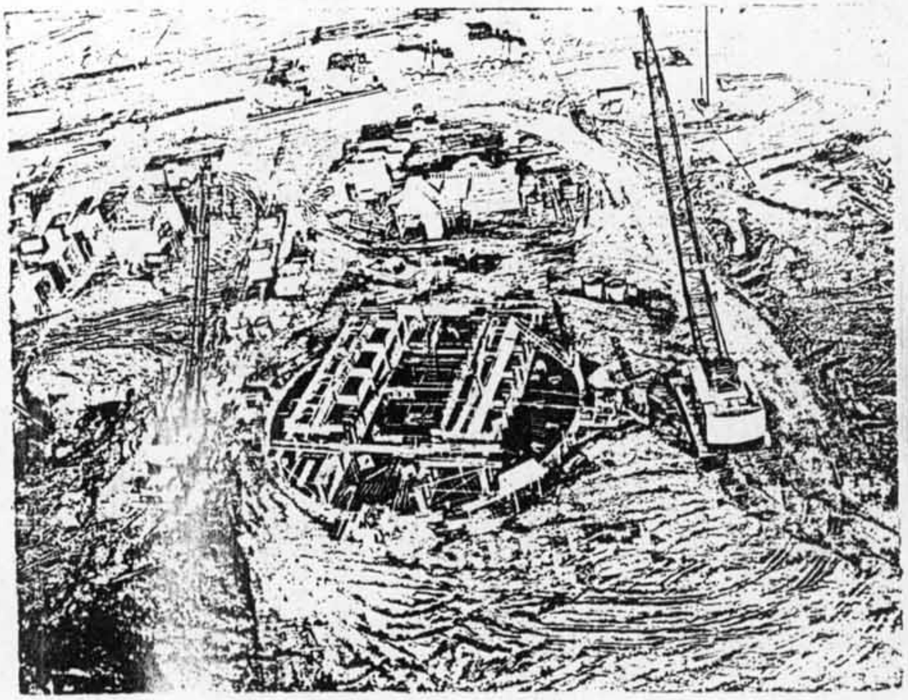
Actuator bracket positioned in form prior to cap pour.



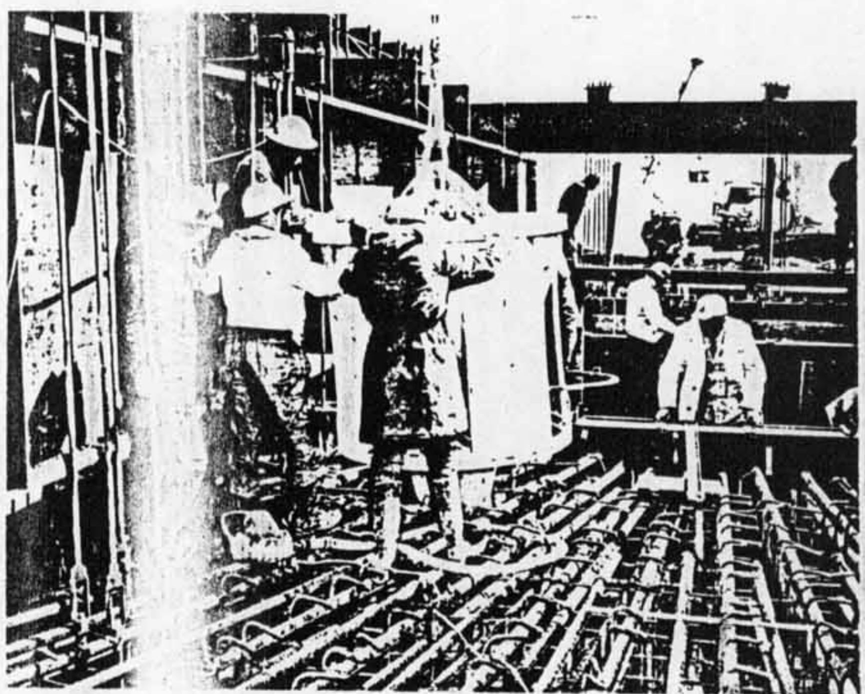
View shows hanger rods used to support bottom form for this cap.



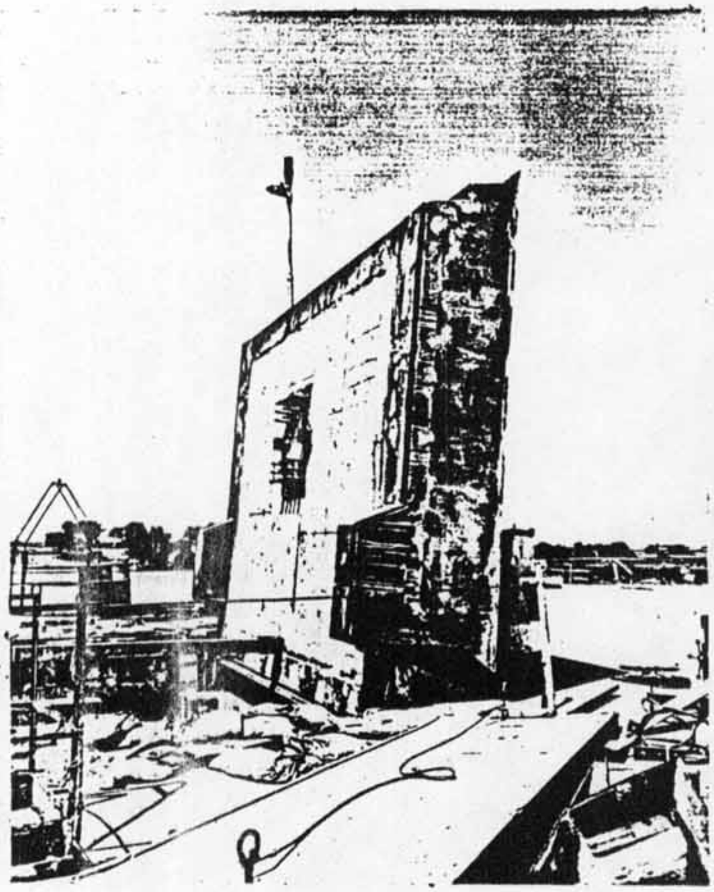
Enlarged portion of helicopter view shows typical silo cap support installation prior to pour. "Built-up" Girders rest on 18" perimeter wall 9' high. Outside Girders "A" have 48" web. Inside Girders "B" have 72" web. Large diameter reinforcing steel rods are #18.



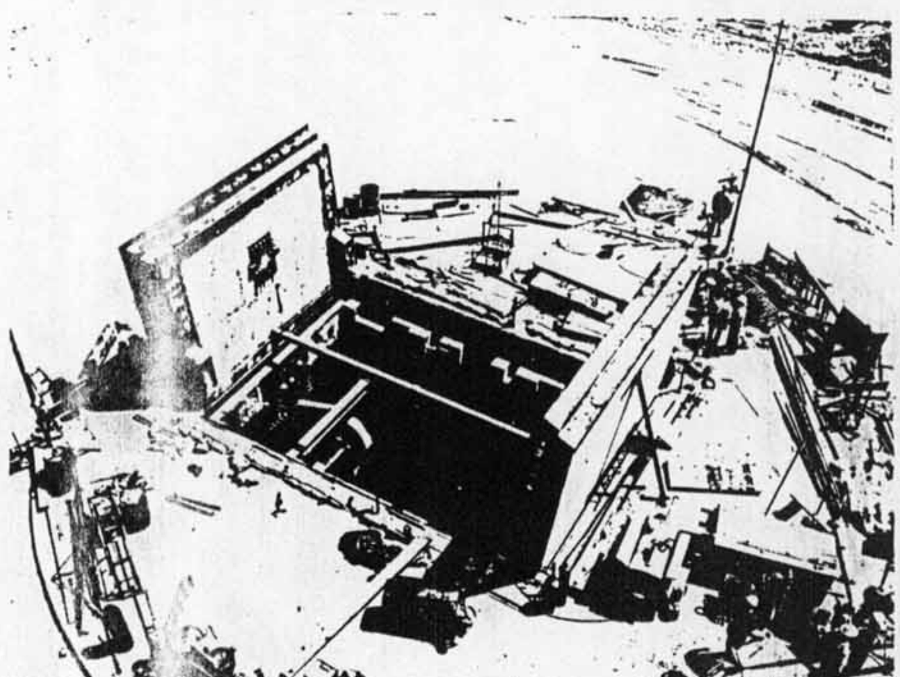
SITE 2. DECEMBER. View from helicopter shows final preparations for silo cap pour. MCC Photo.



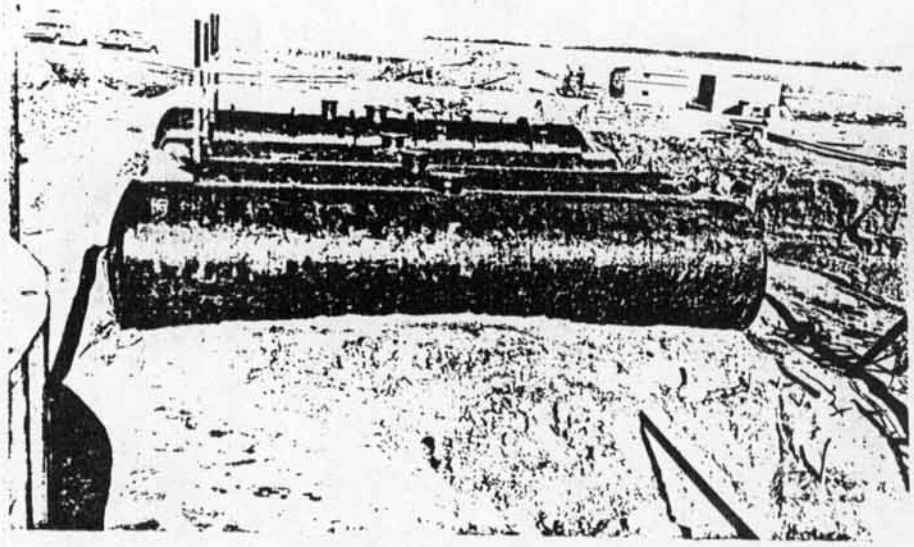
SITE 3. DECEMBER. Silo cap pour in progress. MCC Photo.



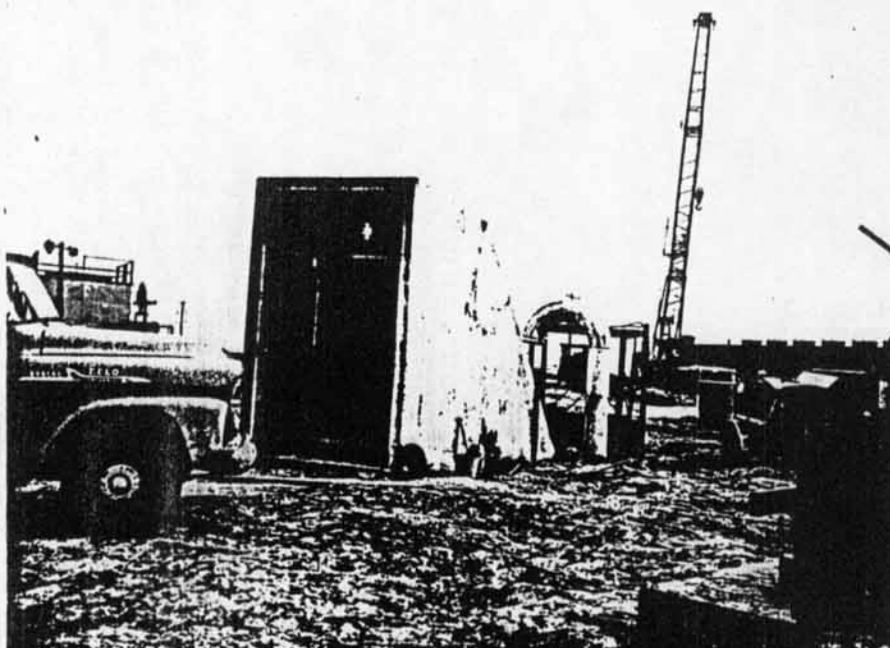
SITE 6. WILBER
12 June 61
View of east missile door showing ground and buffed areas complete except for painting. #45438.



SITE 6. WILBER. View facing southeast shows both silo cap and missile enclosure door complete except for painting. #45437

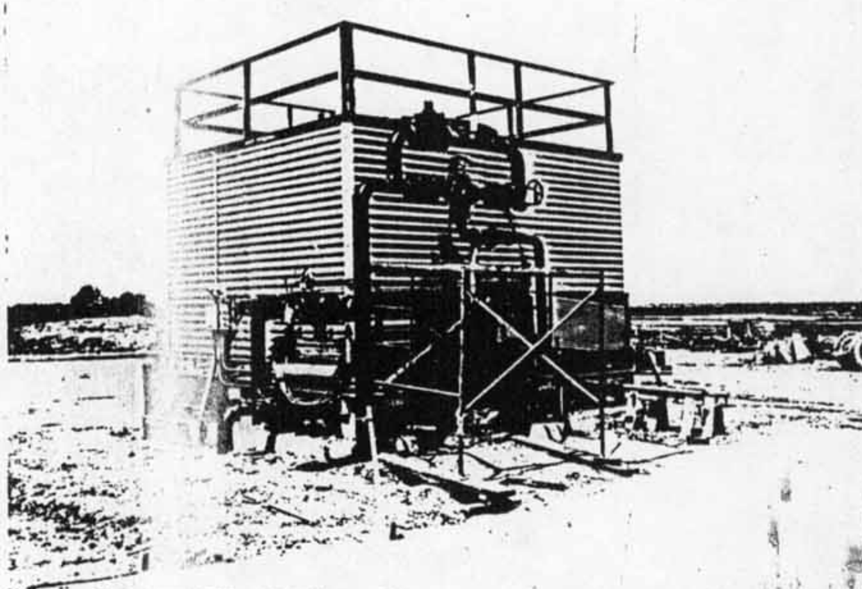


SITE 10. [illegible], NEBRASKA. [illegible] Jan 61. View facing northeast shows placement of water storage tanks prior to backfilling. #[illegible].

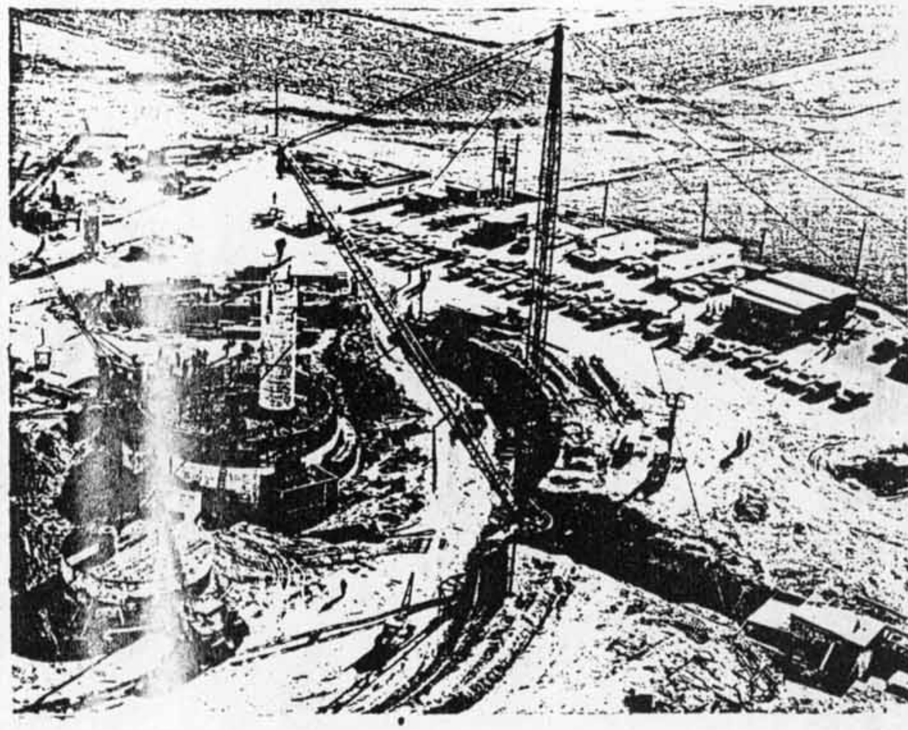


SITE 3. TECUMSEH, NEBRASKA. 2 Mar 61. View facing southeast shows entrance to LCC entrance tunnel. #44109.

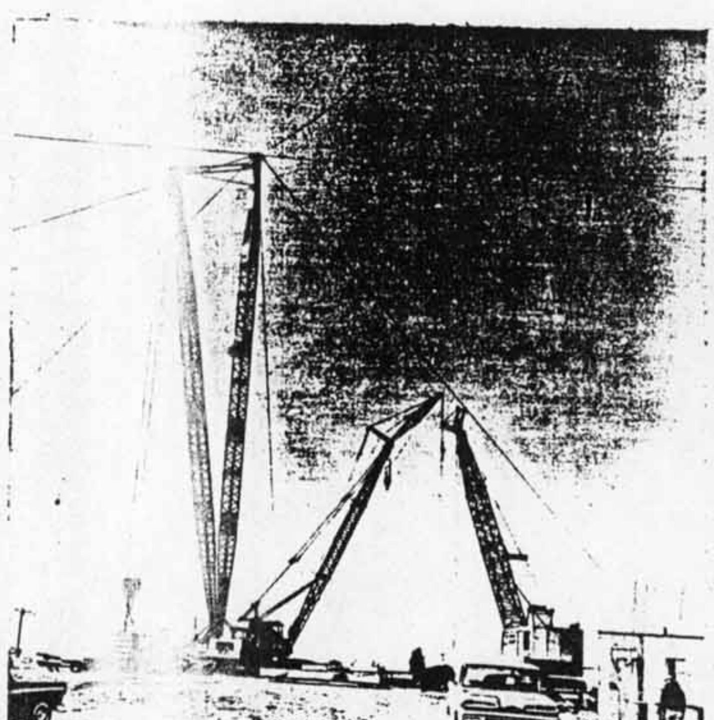
SITE 6. WILBER, NEBRASKA. 2 May 61. General view facing northwest shows three Type 2 pumphouses. #45130.



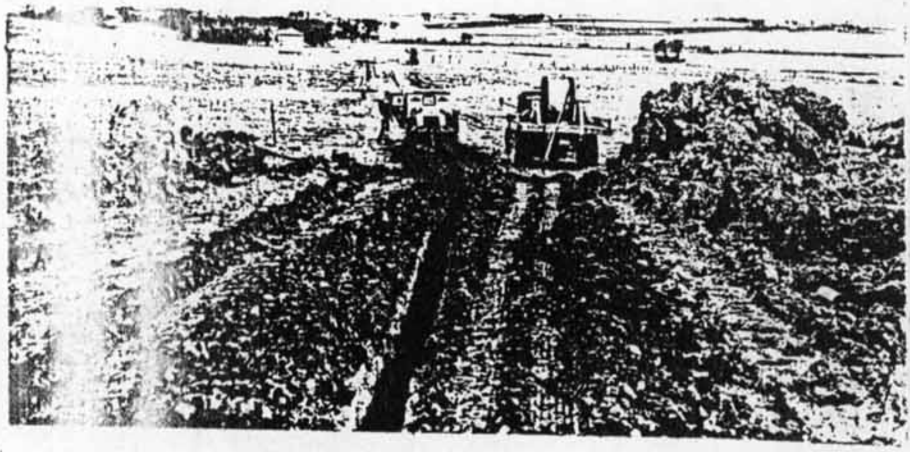
SITE 6. WILBER, NEBRASKA. 12 June 61. View facing northwest shows completed Induced Draft Cooling Tower typical for all sites. #45441



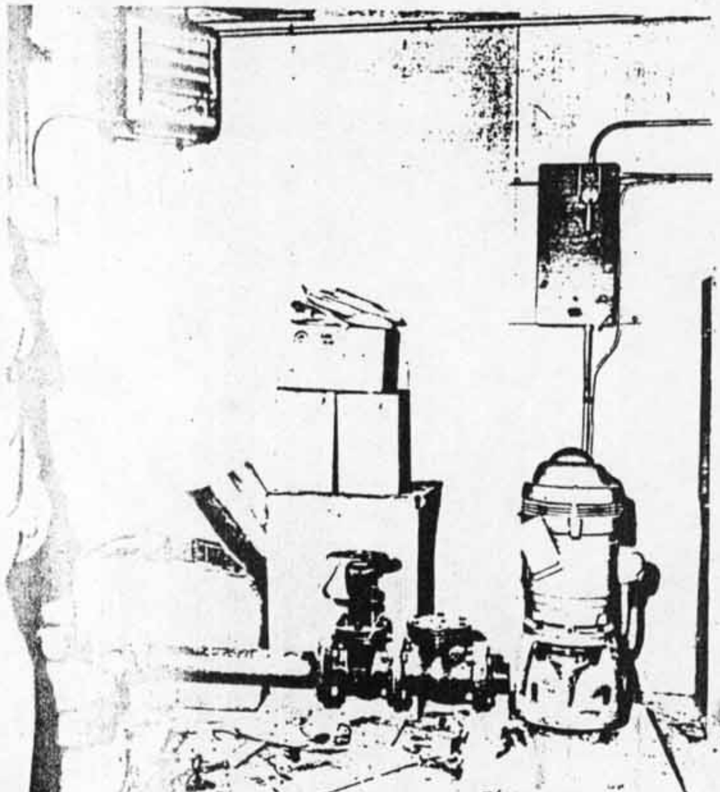
SITE 6. WILBER, NEBRASKA. General aerial view shows progress made in backfilling, general site and work in progress on fill and vent shaft and intake air shaft tunnel. Liquid Oxygen Storage tank is being lowered into silo with 140' guy derrick. [illegible].



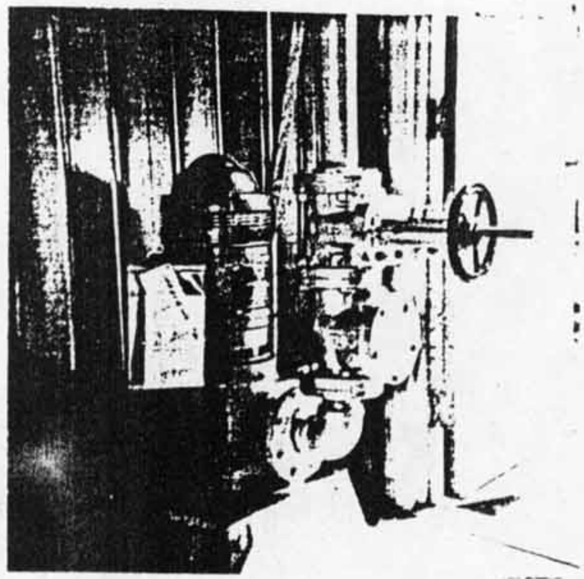
SITE 7. YORK. 1 Mar 61. General view facing northwest shows guy derrick being tested with Launch Platform Counterweights. #43794.



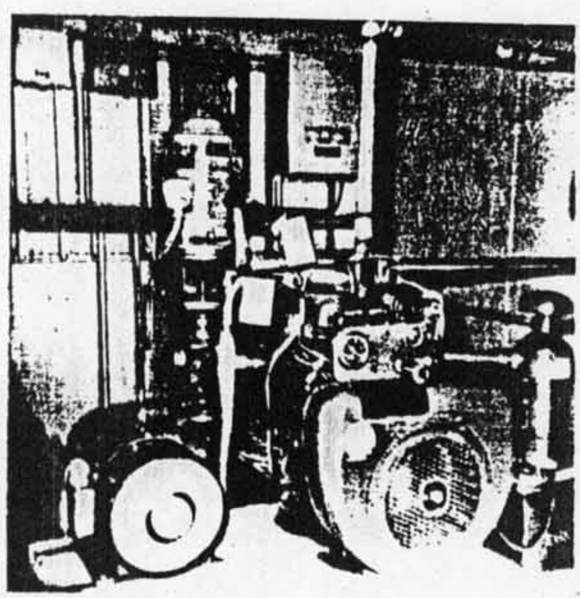
SITE 12. PALMYRA, NEBRASKA. 4 Apr 61. General view, facing northeast, shows "Jeep" mounted trencher in use excavating for direct burial cable to pump house. #44479



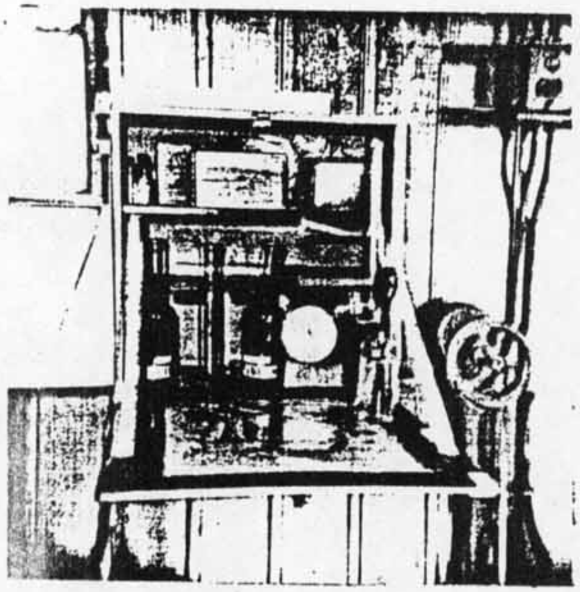
SITE 6, WILBER, NEBRASKA. 2May61 View shows pump installation that is typical for the three well houses at this site. #45131



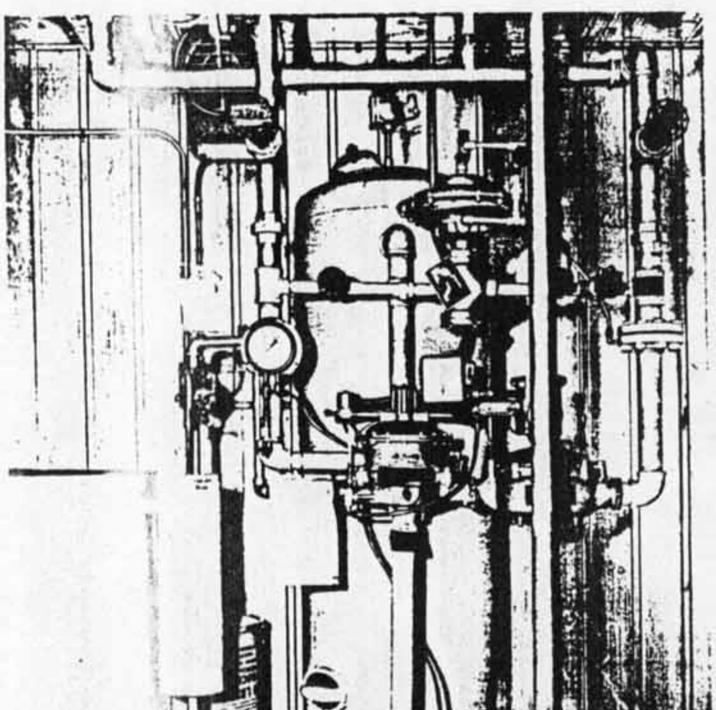
Site 5. Beatrice. Pump at water Treatment Plant.



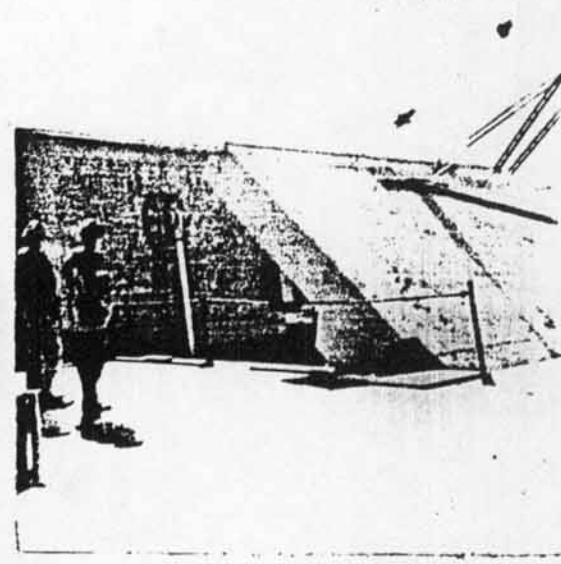
Site 5. Beatrice. Gasoline driven pump unit in "off site" wellhouse.

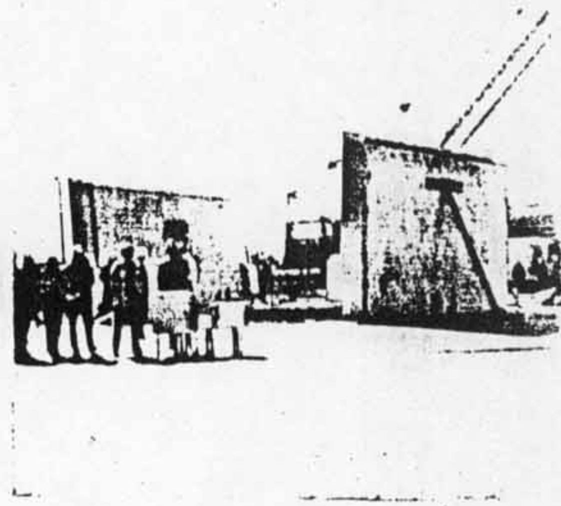


Site 5. Beatrice. Water treatment plant test kit used to monitor "hardness" of plant water output. Automatic burette at right.



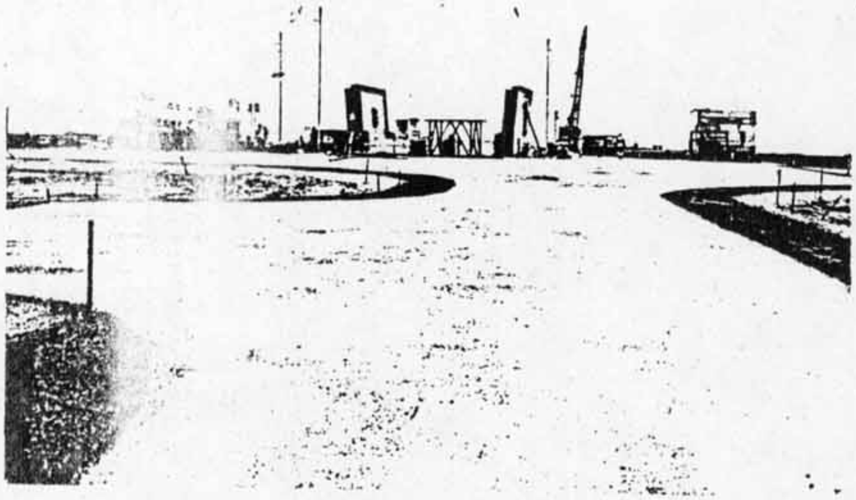
Site 5. Beatrice. View of interior of Water Treatment Plant shows L. to R. - Brine tank, Zeolite Vessel. Flow meter at center. Electric heater at top left.



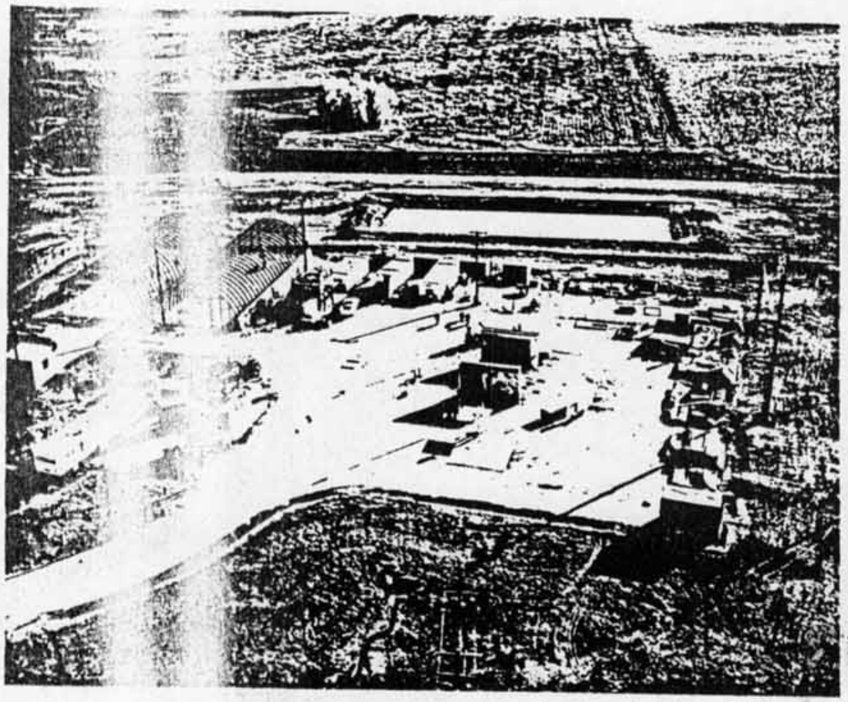


Site D. Beatrice. Silo doors being opened for testing by GD/A.

✓



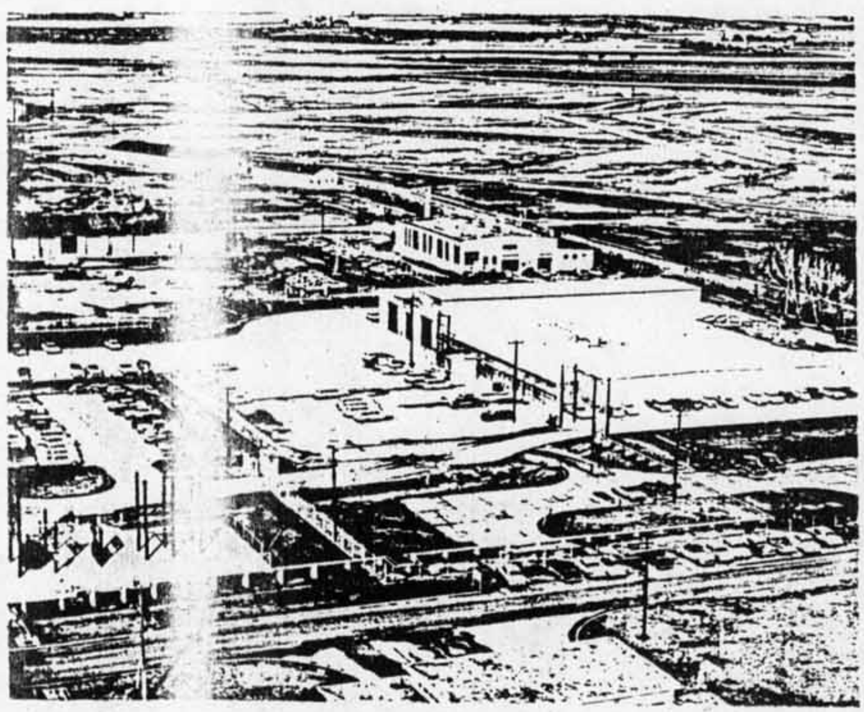
View of finished complex at time of BCD. # 45457



SITE 8, SEWARD

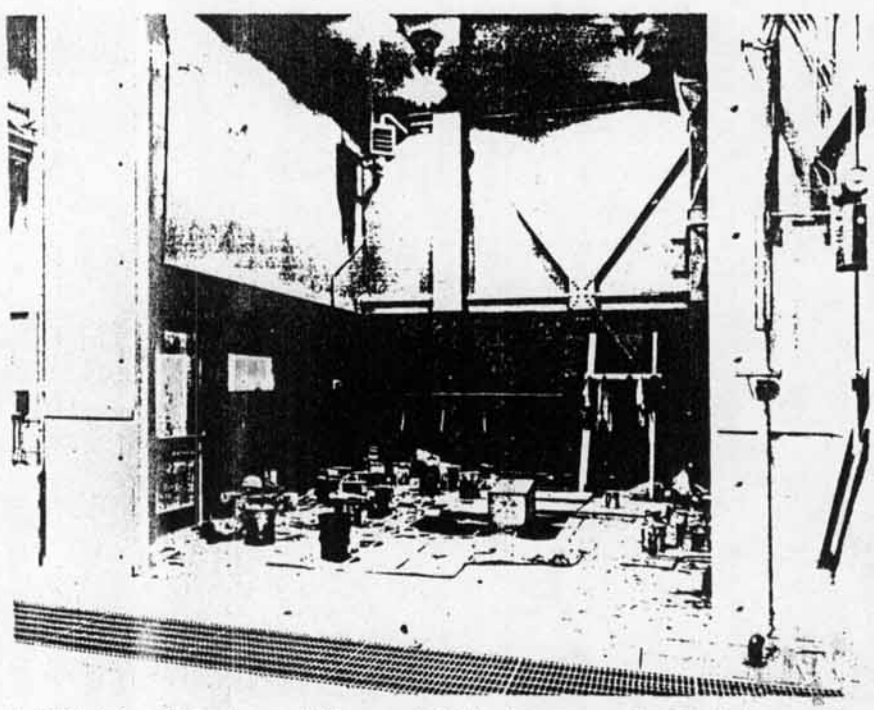
Aerial view of complex after BOD. GD/A Photo # 52939.

Missile Assembly and Maintenance Building - Front ext. view to [illegible] - LAFB. GD/A Photo # 52423 D.

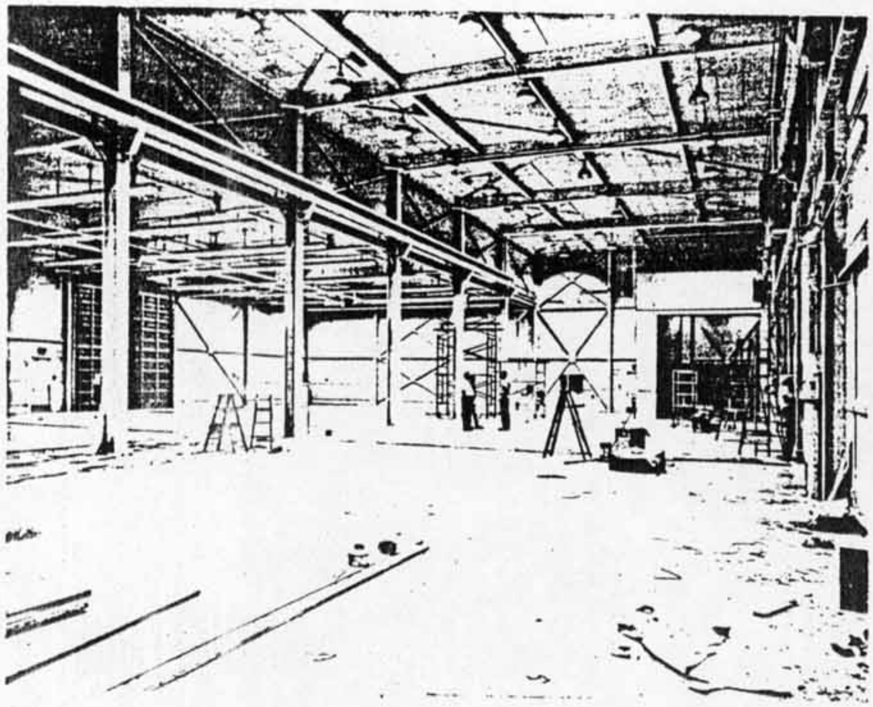


Aerial view of LAFB Missile Assembly and Maintenance Building. [illegible]/A Photo # 53326 D.

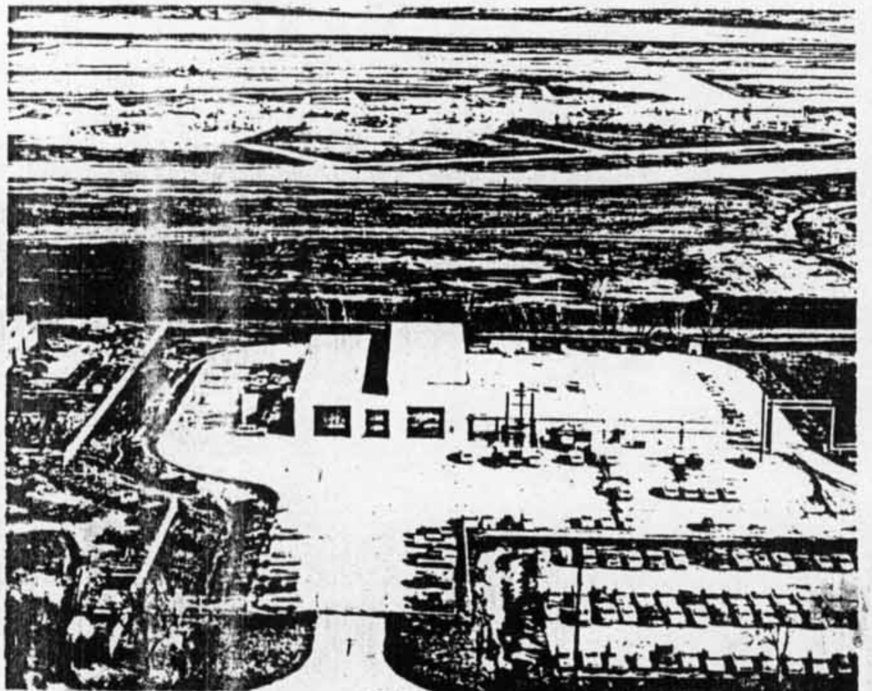
Aerial view LAFB Missile Assembly and Maintenance Building looking SE. GD/A Photo # 53024 D.



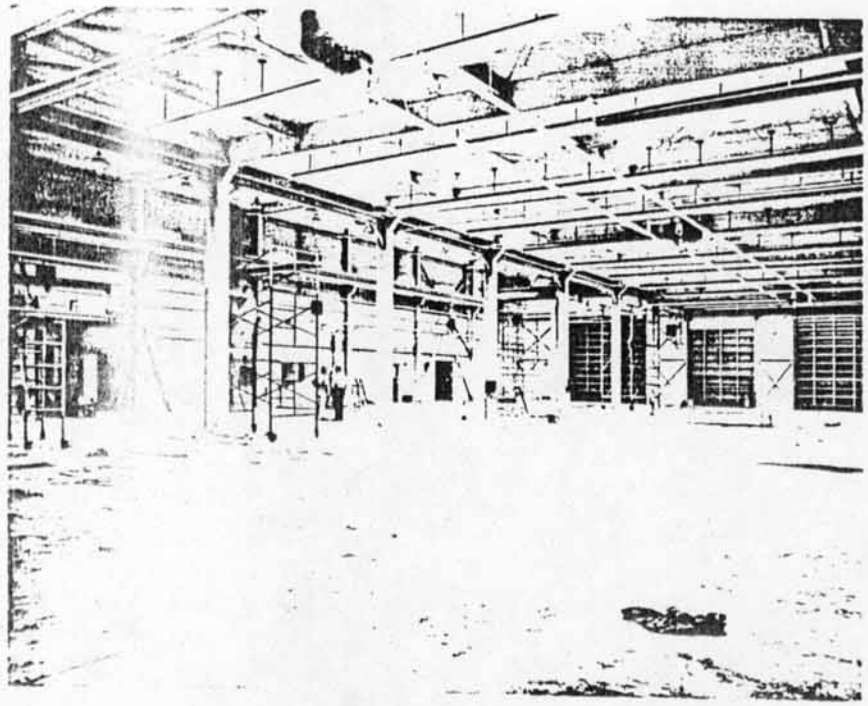
LAFB Missile Assembly and Maintenance Building Engine Flush and Purge Room. GD/A Photo # 52432 D.



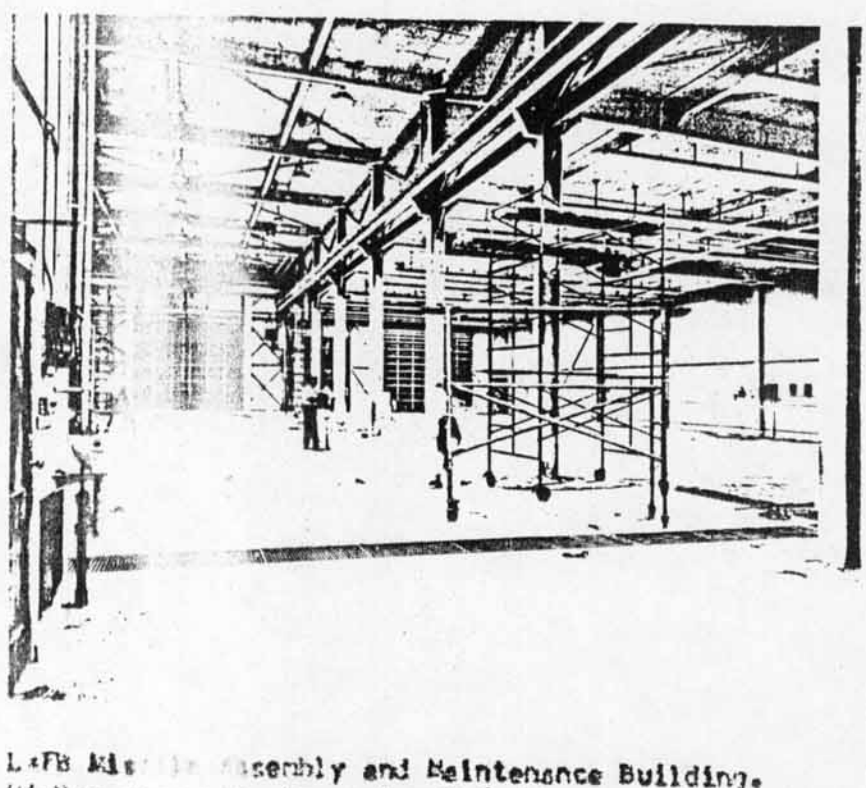
LAFB Missile Assembly and Maintenance Building east to engine maintenance area. GD/A Photo # 52430 D.



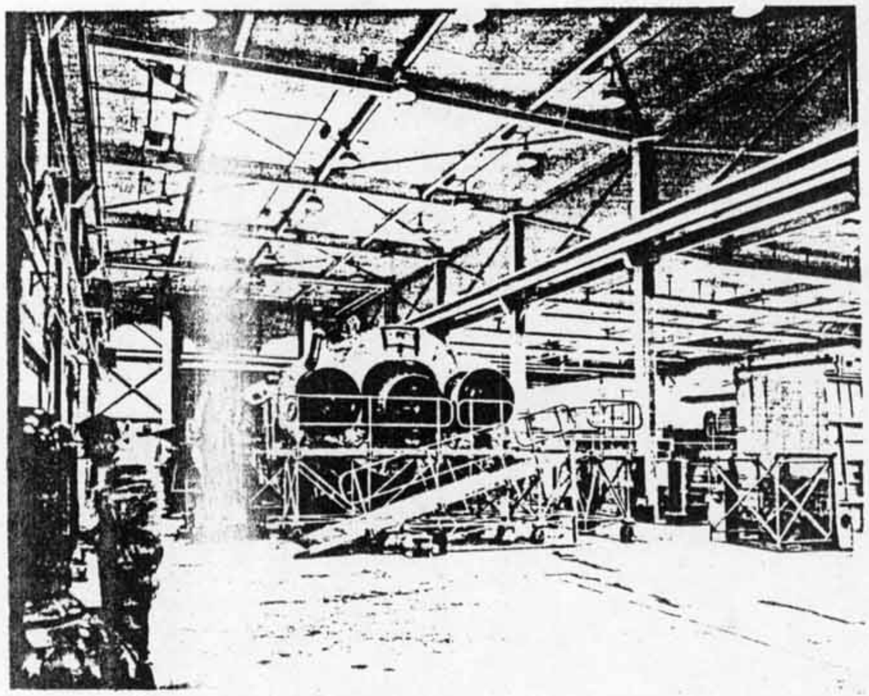
Aerial view of LAFB Missile Assembly and Maintenance Building - view looking east. GD/A Photo # 53525 D



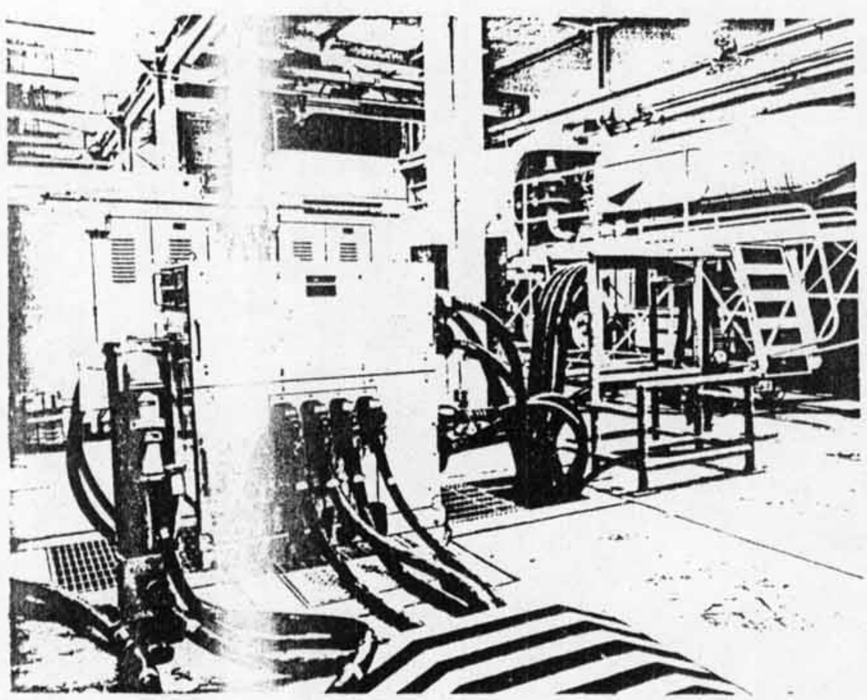
L*FB [illegible] Assembly and Maintenance Building.
Lo-Bay [illegible] view to SW. GD/A Photo # 52427 D.



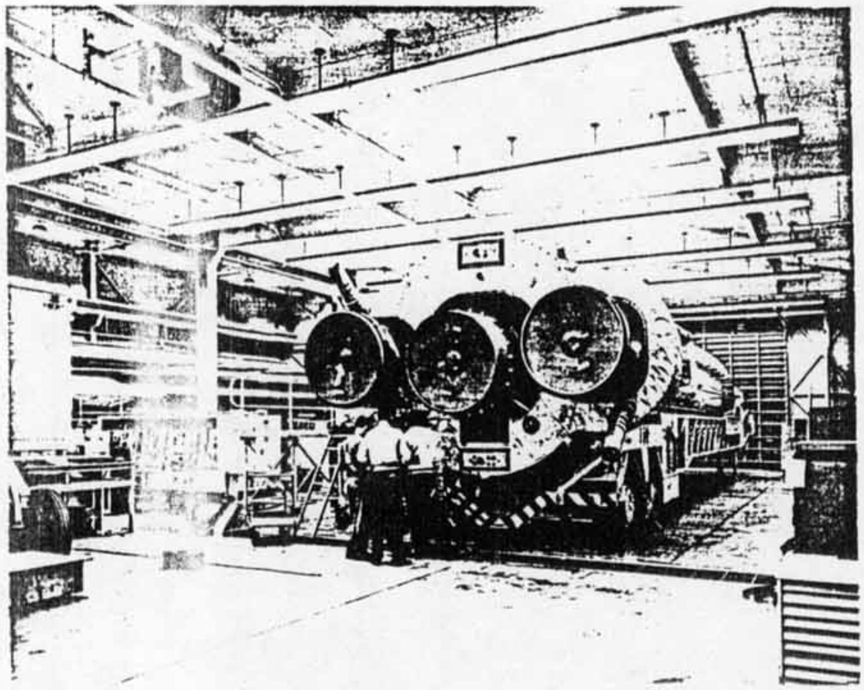
L*FB Mis[illegible] Assembly and Maintenance Building.
Hi-Bay a[illegible] view to west. GD/A Photo # 524[illegible] D.



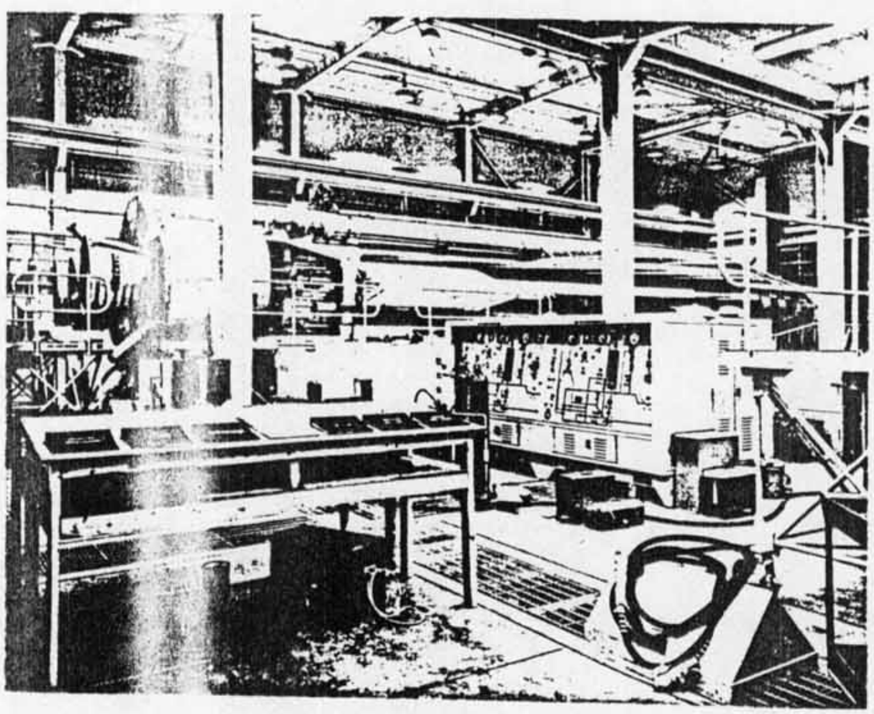
LAFB Missile Assembly and Maintenance Building - Looking west from SE. Operational. GD/A Photo # 53125 D.



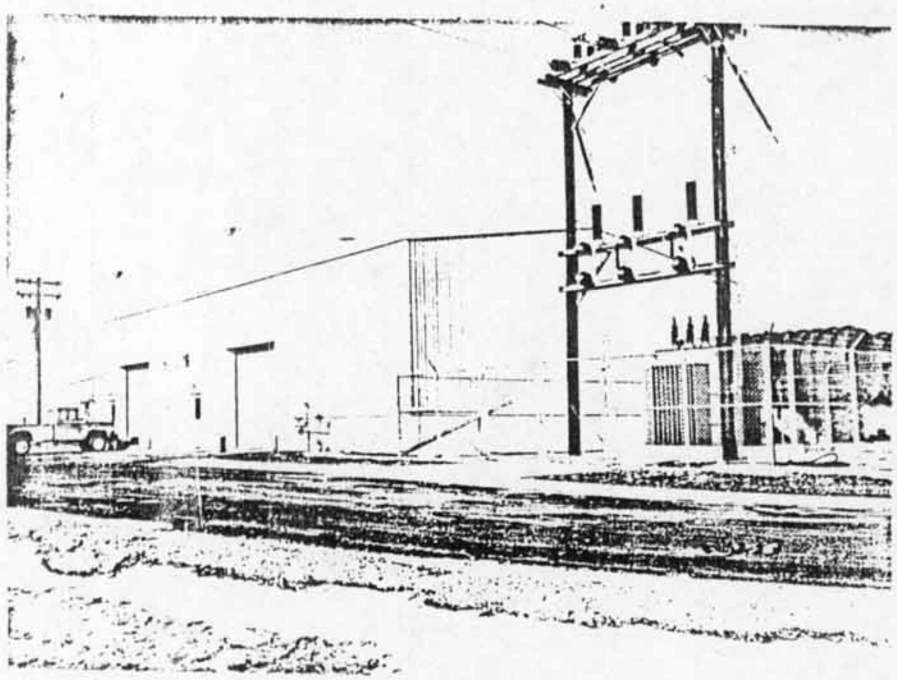
LAFB Missile Assembly and Maintenance Building - Looking SE at heater power panel. Operational. GD/A Photo # 53129 D.



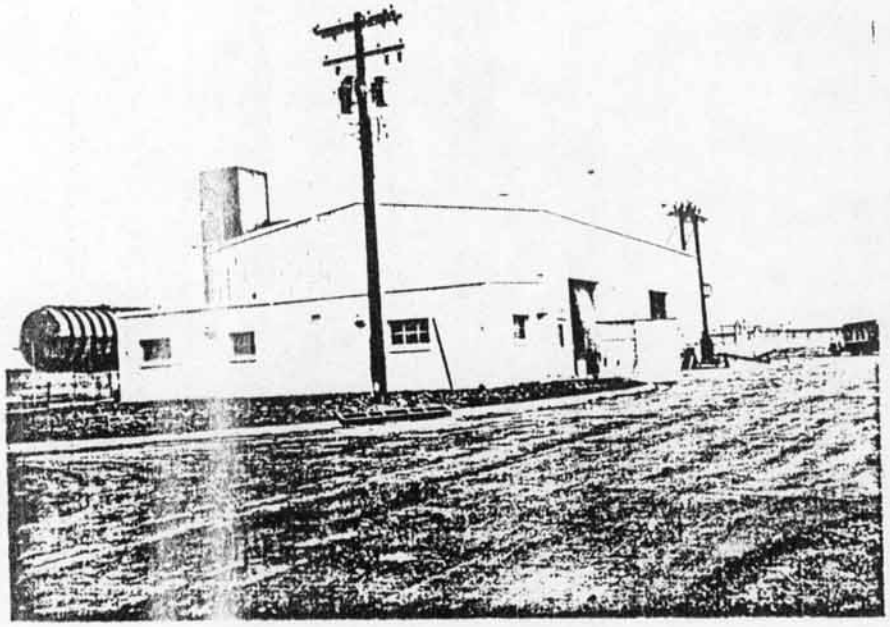
LAFB Missile Assembly and Maintenance Building -
Looking [illegible] from NE. GD/A Photo # 53126 D.



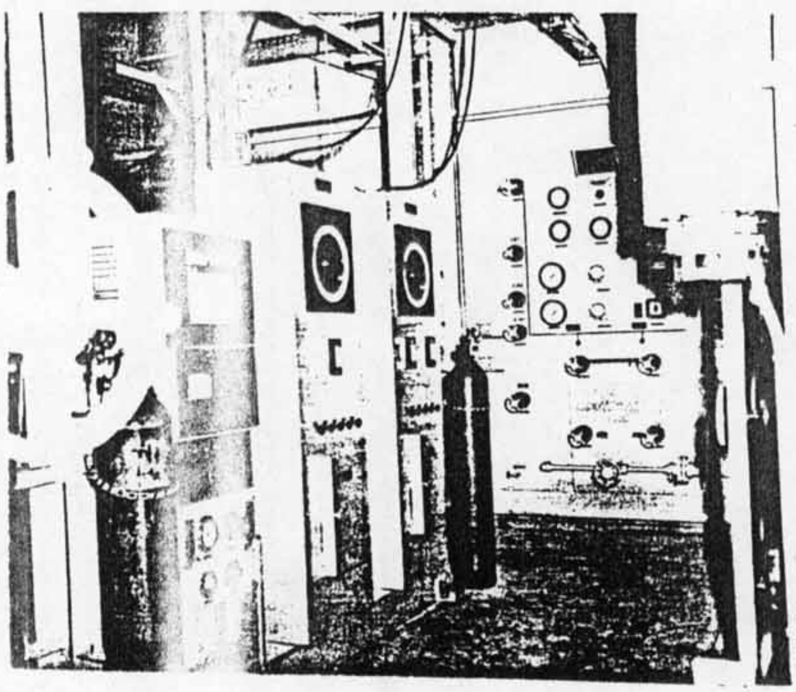
LAFB Missile Assembly and Maintenance Building -
Looking [illegible] NW. GD/A Photo # 53127 D.



Liquid Oxygen (LOX) Plant. View looking northwest shows building and fenced-in substation rated 2,000 KVA, 34,400 volts to 2400/4160 volts, 3 phase, 60 cycles. View also shows gas line entrance into building. Note the cluster of three transformers on pole at left. Each is rated 10 KVA, 2400/4160 to 120/208 volts. Contract DA-6221. #43193. 30 Jan 61.



West and south elevation showing road, one cryogenic tank not yet installed. Note cluster of transformers on pole. #41745. 2 Nov 60.



View shows the Oxygen and Nitrogen Purity Analyser and Instrument panel (near center) for liquified gas generating process. #43182. 30 Jan 61.

DESCRIPTION OF OXYGEN-NITROGEN-HYDROCARBON ANALYSERS

(Left to right:)

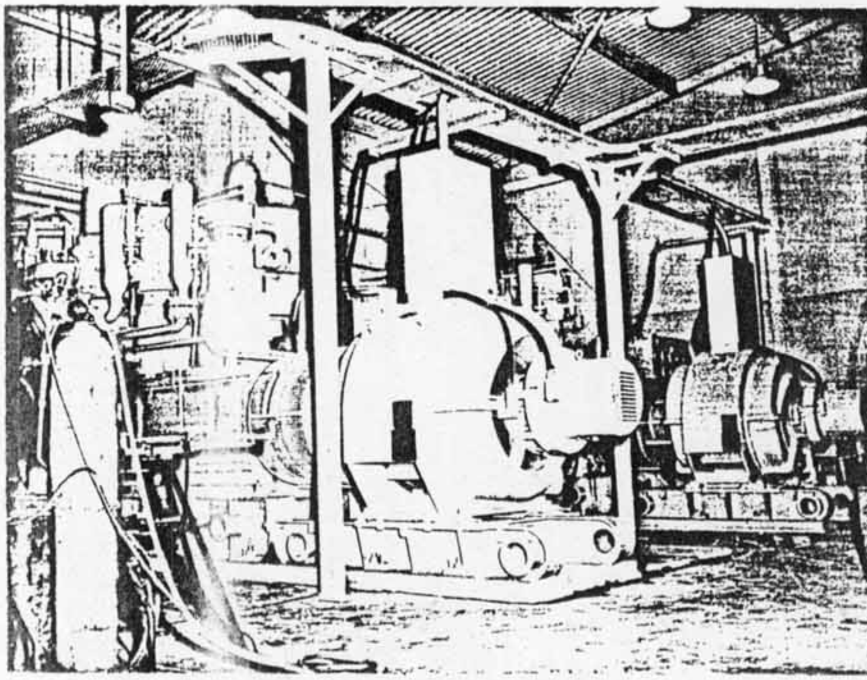
Hydrocarbon Analyser by Air Products Inc., Trexlertown, Pennsylvania, Serial #7891-3.

The Infra-red type analyser unit contained is supplied by MSA (Mine Safety Appliance Company), Pittsburgh, Pennsylvania. This unit in center of cabinet. The instrument at top is a Honeywell (Brown) Recorder.

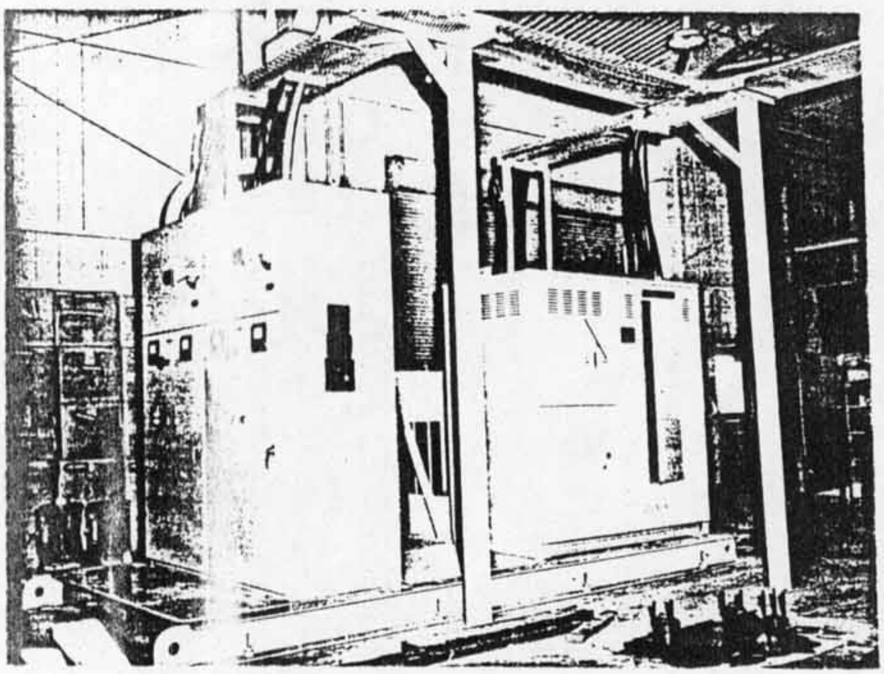
The Nitrogen Purity Analyser (center) by Thermco of La Porte, Indiana.

Oxygen Purity Analyser by Thermco of La Porte, Indiana.

Both units use Brown Recorders.



Interior view of LOX plant, shows the two compressors driven by synchronous motors. #43172. 30 Jan 61.



View of synchronous motor control cubicles. #43175. 30 Jan 61.

DESCRIPTION OF SYNCHRONOUS MOTOR DRIVEN COMPRESSORS

EM Synchronous Motors
Type BRKT
HP - 900
Volts - 2300/4000
Phase - 3
Amperes - 177/102

Frame 5300
RPM 900
Cycles 60
Power Factor 1.0
Instruction Book 60

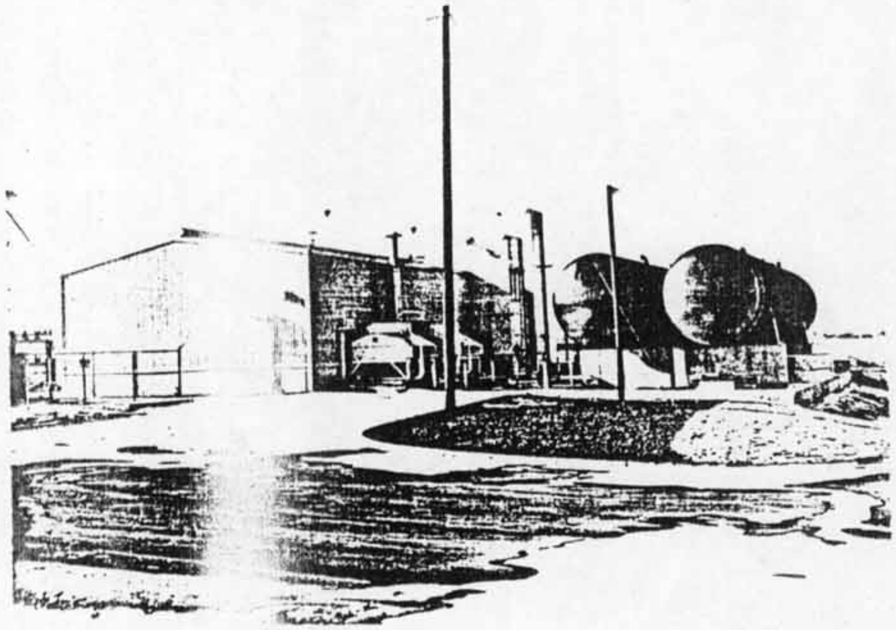
Armature 40° C rise by thermometer
Field 50° C rise by resistance

Exciter,
Rated Amps. - 31.5
Rated Volts - 125
(Electric Machinery Company - Minneapolis)

Compressors:

Chicago Pneumatic Company

	Cylinder Size		Stages Approx. Disch. Pressure
Horizontal	[illegible]	[illegible]	50 PSIG
Horizontal	[illegible]	I	50 PSIG
North vertical	[illegible]	II	175 PSIG
Vertical center	[illegible]	III	450 PSIG
Vertical south	[illegible]	IV	1200 PSIG
Horizontal	[illegible]	V	3000 PSIG



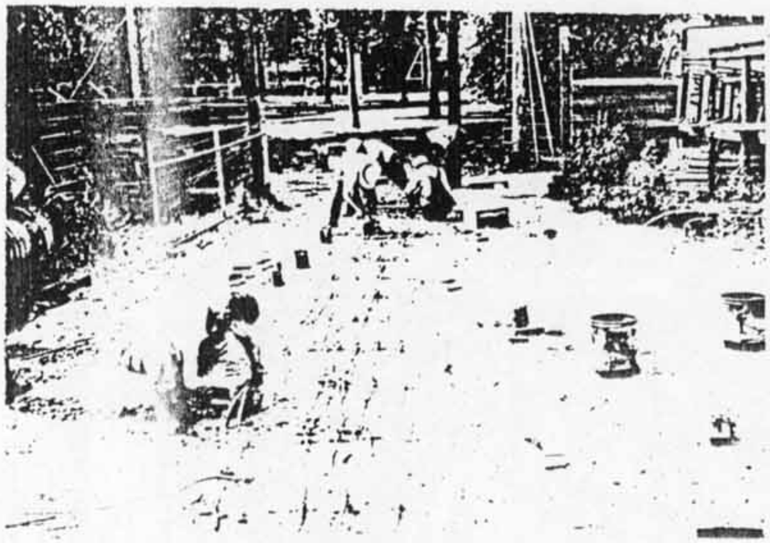
Looking west [illegible]ing building, with Liquid Nitrogen (LN_2) and LOX tanks [illegible]talled. #43191. 20 Jan 61.

LAUNCHING SILO GROUNDING-BONDING SYSTEM

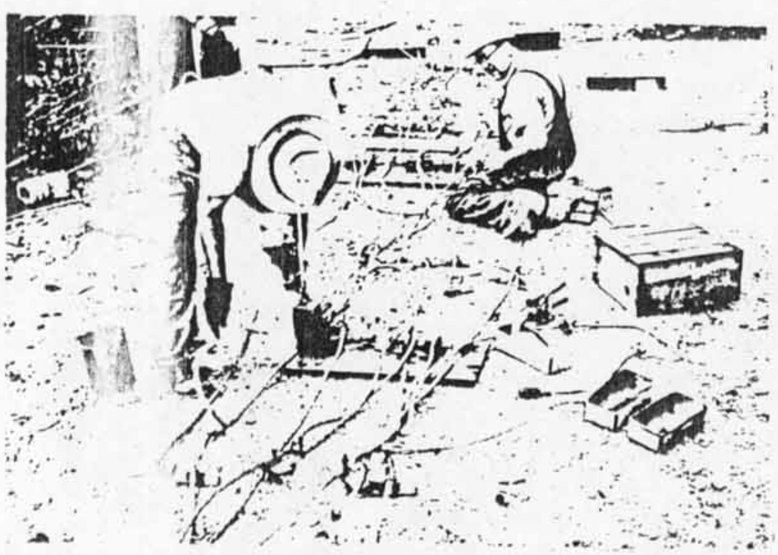
Problems were encountered in exothermically welding the vertical grounding cables to the ring beams because of the water that existed in the top web of many of the beams, as well as wet beams. In addition, these were heavy beams. On determination of the relatively poor welds it was determined that by exothermically welding the 4/0 copper ground conductors to 2" x 5" x ¼" steel plates and then welding the plates to the beams, more satisfactory results, much better and more secure bonding was secured by this method.

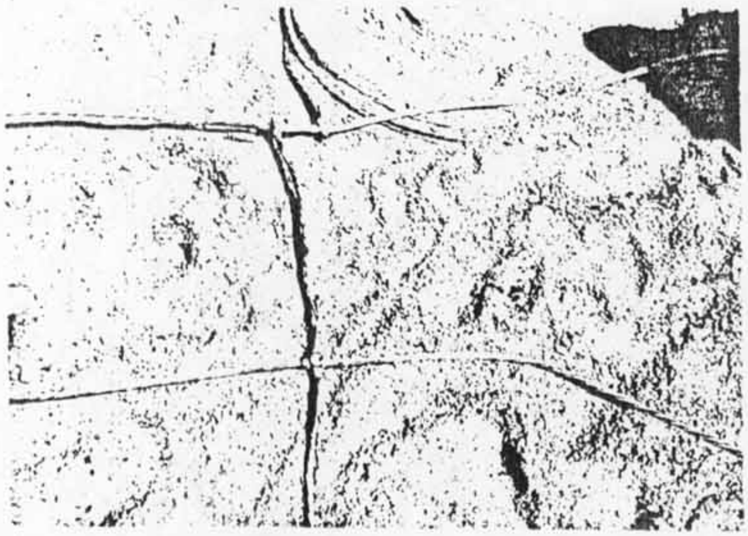
The following two pages of photographs show how the electrical subcontractor mobilized his forces to exothermically weld the 4/0 copper conductor to the plates.

Annex R gives the resistance reading of the grounds that were installed.

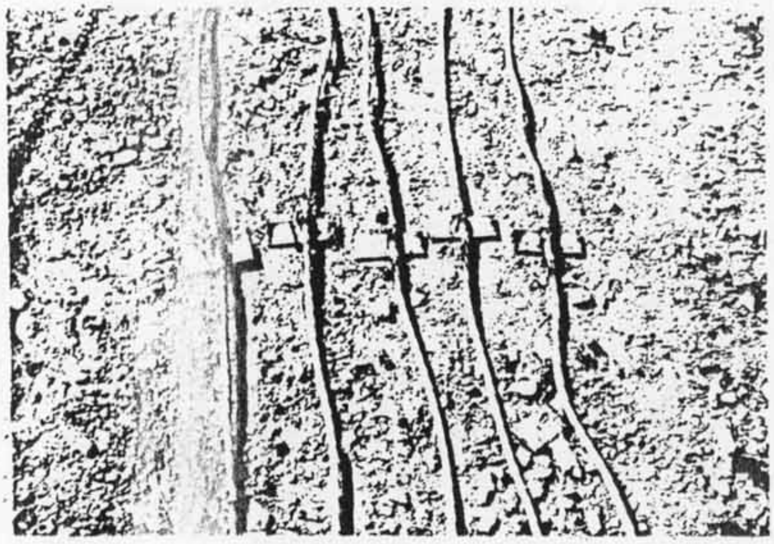


Two views show grounding cable grids being assembled in shop areas. In the lower view, a weld is being made by the exothermic process.





Upper view shows type of copper to copper welds used in LCC grounding grid. Welds were made by Exothermic method.



Lower view shows steel plates attached to copper grounding cables by exothermic process. The steel plates were then welded to ring beams and other structural members as required.

PART IX

Factors that Effected the Time of Construction and Ultimate Costs.

1. The Remoteness of the Location

2. The Proximity of the Material and Supply Sources and Means of Transportation

3. The Effects of the Weather and Climate Versus the Period Covered by the Construction Period

4. The Availability of Skilled Labor for Construction.

5. The Relationship Between Contractors and Labor and Between the Crafts

6. The Productivity of Construction Labor

7. The Contractors Management, Including use of Pert, Critical Path and Other Techniques, if Applicable.

8. Contractor - Subcontractor Working Relationship

9. The Effect Subcontracting had Upon Operations, Efficiency, and Total Costs

10. The Effect of Joint Occupancy

11. The Area Engineer-SATAF Relationship with Regards to Interpretation of Contract Conditions and Turnover of Facilities

FACTORS THAT EFFECTED THE TIME OF CONSTRUCTION AND ULTIMATE COSTS

1. The Remoteness of the Location

The sites for the Lincoln complex were selected on a criteria of protective dispersion over a wide areafor what was presumed to be the last of the "soft-stands" for the Atlas "D" Missile. When the facility was upgraded to the first of the "hard-stands" for the Atlas "F" program, the site locations were not modified accordingly into a more compact workable group. The separation of the work areas, in some cases as much as 100 miles apart, nullified the economic advantage a building a series of like structures through the repetitive use of trained crews, central supply depots, equipment pools and simplified supervisory control. Each site became a project with all the added costs incident to custom construction.

2. The Proximity of The Material and Supply Sources and Means of Transportation

The sites were well located adjacent to state or interstate highway systems within an hours trucking distance from Lincoln and Omaha as source of supply for nominal builders materials. However, this locale is an agricultural area and all manufactured or fabricated items such as structural steel, sheet metal, pumps and motors, heavy tanks and piping, etc. had to be procured, scheduled and shipped from industrial sections of Chicago, Houston or Los Angeles. This distance-communication problem became acute when modifications were further modified sometimes to the sixth index snarling in-process inventories and production controls and causing drastic rescheduling. These delays created an impact on all downstream work which had to be bought back as acceleration costs in order to maintain the integrity of contract time and Air Force need dates.

3. The Effects of The Weather and Climate Versus the Period Covered By The Construction Period.

a. The sites for the Lincoln complex were originally selected for the coffin type launcher without any consideration for the subterranean conditions. When the complex was later modified to the hard type launcher, the foundation exploration and rewrite of the method specification for mining the silo shafts were hurriedly assembled with all the resulting inadequacies of haste.

b. When the mining operation started running into wet excavation and quick silts not shown on the boring logs or covered in the contract, the contractor claimed a changed condition and requested necessary guidance. At that time, it was not considered administratively expedient to recognize the claim for changed conditions and the contractor was forced to proceed under an inadequate method specification.

c. This resulted in a 30-60 day delay in a pacing item which threw the concrete pour for the silo haunch and the site backfill into winter construction. Winters on the Great Plains are severe and the costs incident to frozen backfill and weather protection of construction are incalculable. Likewise the wet springs contributed immeasureably to the many problems and further delays at many of the sites. (See Appendix A for climatological information.)

A.4. The Availability of skilled Labor for Construction

a. Eastern Nebraska and Western Iowa are primarily an agricultural community with a skilled labor market adjusted to the normal annual highway and school building type of construction. There are no experienced miners and an insufficient supply of skilled electricians, iron workers, pipe fitters, etc. for a project of this magnitude.

b. A majority of the skilled workers were recruited from the more highly industrialized areas and either given a subsistance pay or a promise of substantial overtime.

c. This shortage became critical when a relatively large supply of skilled labor was required for short periods under the accelerated program of buying back time lost on the multitudinous modifications.

d. Workmen came from many parts of the country. To some, this project was another job; to others, it was a challenge to do the best job possible under adverse circumstances.

5. The Relationship Between Contractors and Labor and Between The Crafts

a. The critical shortage and competition for labor was intense in the Lincoln area and was further complicated by demand for follow-on construction and installation activity at the sites. This accelerated the turn-over of skilled personnel and generated an adverse situation favorable for slow-downs and strikes.

b. This condition was further confused by territorial claims and disputes between hiring-halls in Omaha and Lincoln with significant variations in rates and jurisdiction and resulted in little labor empires being built up at each site with personalities and wildcat strikes causing costly delays. The Lincoln complex recorded 1,810 man-days lost due to strikes.

c. There were many petty differences as to which skill was to do certain types of work.

6. The Productivity of Construction Labor

a. The critical shortage of skilled labor, the physical and mental fatigue resulting from over-time work under the accelerated program, the distance between sites and the restricted area for feeding materials to the job combined to reduce the effective labor effort to approximately 33% of norm.

b. Considering the conditions involved, it is doubtful if, as a general matter, productivity could have been improved. This is particularly true because of the many modifications and changes which required re-working in areas in which a certain craft had finished work and a subsequent craft was continuing the construction.

7. The Contractors Management, Including use of Pert, Critical Path and Other Techniques, If Applicable.

a. The distance between sites, the magnitude of the work and the compressed construction schedule demanded highly qualified supervisory staff at each launcher. The prime bid the contract without syndicating the work and responsibility and, as a single contractor, found it impossible to staff each site with competent supervisory personnel.

b. As a result, the contractor tried to manage the project through a horizontal control of the principle items of work directly under and reporting to the Project Office in Lincoln. This system became chaotic with the accelerated program when two or more pacing items were concurrently under construction or installation at a site. There was no immediate vertical control except through a distant office already over burdened with engineering and administrative proglems, no effective management of labor pools or efficient use of available equipment.

c. The contractor did not use advanced electronic equipment controls in scheduling work, labor or equipment; however, a pesudo critical path technique was incorporated in tracing the history and justifying the costs during negotiations on the claims.

8. Contractor - Subcontractor Working Relationship

a. The prime contractor built the forms, placed all concrete, erected the structural steel and installed all the mechanical equipment on the Lincoln sites. The principle subcontracts were limited to the A.S.C. equipment, painting, furnishing and placing all the concrete reinforcement and the electrical work.

b. There was some minor friction generated between contractor and subcontractor personnel at the working level as a result of the compressed time schedule, concurrent operations, limited work space and lack of vertical supervision at the job site. However, at the administrative and planning level, the relationship of management was very cordial and cooperative with the single possible exception of the PLS piping ASC contract.

c. The engineering and inspection of the PLS system was directed under a special separate branch in the Area Office, the control and duties of the Contracting Officer were never completely transferred to CEBMCO, and the ASC contract was not wholly assigned as a subcontract to the prime. This quasi-subcontract was more-or-less administered at arms length by the prime and there appeared to be differences at the management level.

9. The Effect Subcontracting had Upon Operations, Efficiency, and Total Costs.

a. Since the prime on the facility contract accomplished the major portion of the work with his own forces under his own direction, to that extent, at least, the confusion and downstream impact generated by the multitudinous number of modifications on modification, revisions and field changes of the plans and specifications was reduced to a minimum.

b. This feature of the contract was also reflected in the negotiations of the claims and modifications, the majority of which were settled without the payment of a duplication in overhead costs and profit.

c. The heating and ventilating and electrical contractors were two of the larger working subcontractors who did, all things considered, excellent work.

10. The Effect of Joint Occupancy

a. Joint occupancy of the job site by GD/A and the Corps' follow-on contractors has not created any material problems or adversely effected the operations. There have been some minor irrigations at the working level, either from the lack of knowledge or desire for premium pay, and in a few specific cases rescheduling of work was necessary, but there have been no serious delays or contractors claims for interference resulting from the concurrent operations. The relationship between the Area Office and SATAF and their respective parties has been most cordial and cooperative.

b. Generally, the relationship improved as individuals of the two agencies became acquainted. It developed that many GD/A people looked to several of the Corp's personnel for information and assistance.

11. The Area Engineer-SATAF Relationship with Regards to Interpretation of Contract Conditions and Turnover of Facilities

SATAF and the Lincoln Area Office have enjoyed a very free and open relationship with due respect and full appreciation of the mutual problems. Controversial opinions on contract conditions and the interpretation of plans and specifications were amicably settled generally at an informal staff level.

PART X

Safety Training and Accident Record

SECTION 1

Responsibility for Safety

SECTION 2

Safety Record under the Omaha District

SECTION 3

Safety Record under CEBMCO

SECTION 4

Accident Experience

SECTION 5

Fatal Accidents

SAFETY AND ACCIDENT PREVENTION PROGRAM

Safety and accident prevention was a constant subject, both in the office and the field. It was a special problem because of the nature of the excavation and construction, smallness of area, confinement in space and congested areas within the structure.

While under the Omaha District, there were numerous inspections by the two Safety Engineers, with on-the-project discussions of the safety requirements and corrections to be made, many of which were corrected immediately, while others required some intensive follow-up. This was continued even by our own Safety Engineer as well as inspectors.

The two letters that follow typify the concern that the Area Engineer had for safe practices.

ACCIDENT PREVENTION RESPONSIBILITIES
AS DIRECTED TO CONSTRUCTION BRANCH
BY AREA ENGINEER

In reply
refer to: ENGMA-AB-L

SUBJECT: Responsibilities in Accident Prevention

TO: Chief, Construction Branch
U. S. Army, Corps of Engineers
Ballistic Missile Construction Office
P. O. Box 953
Lincoln, Nebraska

1. It is desired to point out your specific responsibilities with regard to indoctrination and education of our employees in matters pertaining to safety and in the enforcement of safety requirements.

2. You, through your Resident and Project Engineers, will be held responsible for the application and enforcement of the Safety Program on all work under your supervision, both by hired labor and by contract. Those responsibilities include, but are not limited to, the following:

a. Making an accident control study prior to initiation of construction operations to determine the type of hazards likely to be encountered, and developing control measures to eliminate such hazards. Informing the contractor at pre-construction meeting of these hazards and the required planning to prevent accidents.

b. Holding pre-construction meetings with new contractors to indoctrinate them in safety policy procedures on contract work and safety contractual requirements.

c. Assisting contractor personnel in planning and conducting frequent Safety Meetings and Conferences to be attended by all contractor personnel and providing technical assistance and advice on problems which may arise, and on preparing accident reports.

d. Assisting all contractors in formulating an effective practical Safety Program.

e. Instructing subordinates in accident prevention techniques.

f. Insuring that all new Government employees receive an adequate safety indoctrination course at time of their employment.

g. Insure that accident prevention is emphasized in inspector training courses.

h. Evaluate field supervisors on their attitude and their effectiveness in promoting the safety program and take such steps as may be necessary to correct deficiencies.

i. Insure that no plant or equipment under their jurisdiction is placed in service until it is in a safe operating condition; see that boilers are inspected, unfired pressure vessels inspected and tested, and elevators inspected; insure the inclusion of appropriate safety features in all designs, technical specifications and operating instructions issued or reviewed. Establish a fire protection and fire prevention program including fire fighting organizations where needed.

j. Hold supervisors responsible for the inspection of all plant and equipment used under their supervision.

k. Evaluate the accident prevention program on each of the various jobs and projects under their supervision and issue instructions for improvement.

l. In conformity with the policy and directives of the Commander, Directors and Area Engineers, prepare and issue written instructions to all supervisory and inspection personnel under their supervision in the field, outlining in detail their responsibilities and duties in accident prevention and the authorities which each position holds relative to the enforcement of safety regulations and the methods by which enforcement will be obtained.

m. Enforce the use of personal protective equipment for both Government and contractor employees. Personal protective equipment which Government employees cannot reasonably be expected to buy will be provided.

n. Keep currently advised of the accident experience and the accident prevention status of all work under their supervision, and be prepared to evaluate the jobs when requested.

o. Review all accident reports to insure that the action taken to prevent a recurrence is positive, effective, and adequate and where such action is not satisfactory, will direct through command channels action to be taken.

p. Include accident and fire prevention in all field surveys and inspections and include in all reports appropriate comments on their findings. The Safety Officer will be furnished copies of such reports.

q. From time to time review such accidents as may occur to insure that the investigations conducted by field personnel are adequate and complete.

r. Insure that all safety requirements are endorced on the job and that all accident and other safety reports are promptly and properly submitted.

s. Keeping the Area Engineer informed of the status of safety on each project.

t. Representing and acting for the Area Engineer in various safety activities such as Safety Meetings and Councils, Sanitation and Fire Prevention Conferences, etc., as directed.

3. You, as Chief of the Construction Branch, have the authority to take all necessary actions to enforce safety and to prevent accidents; and you must use this authority, as required, to promote safe working conditions.

JOHN E. MINAHAN
Colonel, Corps of Engineers
Area Engineer

cc: Safety Officer

ACCIDENT PREVENTION RESPONSIBILITIES
AS DIRECTED TO RESIDENT
AND PROJECT ENGINEER

SUBJECT: Responsibilities in Accident Prevention

TO: Resident Engineers
Project Engineers

1. It is desired to point out the specific responsibilities of each Resident Engineer with regard to indoctrination and education of our employees in matters pertaining to safety and in the enforcement of safety requirements. Although each prime contractor is required by contractual agreement to comply with accident prevention regulations of the manual, "General Safety Requirements" and the specifications and is also responsible for planning, preparing and executing Safety Programs; however, the Resident Engineer is responsible for compliance.

2. Each Resident Engineer will:

a. Conduct a safety meeting once each week or oftener if necessary. The safety meetings will be conducted at each site as conference-type meetings and all inspectors are expected to participate and share in the discussions and have ample opportunity to discuss their field problems in order that the experience of all field personnel can be brought to bear on any given situation.

b. Keep currently advised of the accident experience and the accident prevention status of all work under their supervision (including the maintenance of a sufficiently adequate continuing record of each contractor's safety performance) to enable them to:

(1) Complete a safety performance rating when requested.

(2) Where required, prepare an accurate appraisal of safety performance on ENG Form 2456, "Contractors Performance Rating", at the close of the contract.

c. Review all accident reports on accidents occurring on their work to insure that the reports are complete and that the action indicated to prevent a recurrence is positive, effective, and adequate. Where such action is not satisfactory, direct the action to be taken and so indicate on the report or by an attached memorandum.

d. Personally investigate all serious accidents and insure that all other accidents are properly and fully investigated by Government and contractor personnel.

e. Personally follow through on the corrective action indicated on accident reports to insure that the action as indicated or directed is actually taken.

f. Hold periodic safety meetings of all Government supervisory personnel under their supervision. Act as chairman of such meetings and maintain appropriate records. The record will include names of those present, the subjects discussed and the time involved.

g. Hold site level safety meetings with contractor personnel as needed.

h. Require all inspectors to include in their daily report or logs their significant activities in accident prevention and the accidents that occur on work under their inspection.

i. Cooperate and coordinate your fire and accident prevention activities with the Acting Safety Officer and seek the advice, counsel and assistance of safety personnel in all matters affecting any phase of your program.

j. Insure that installations and field offices under your jurisdiction, both Government and contract, have adequate fire prevention and protection programs, including a fire fighting organization.

k. Provide for the continuing inspection of all jobs under your jurisdiction for compliance with safety regulations, programs and accident prevention plans.

l. Provide for orientation of all new employees and those reassigned to different duties or units in the control of hazards and potential hazards of the work and for subsequent training as required.

3. Government employees will be furnished such items of personal protective equipment and apparel as the hazards of the work require and which it is not reasonable to expect the employees to provide at their own expense. It is the duty of supervisors to provide and enforce the use of personal protective equipment and apparel when such is required. This protective equipment will usually be furnished by the prime contractor.

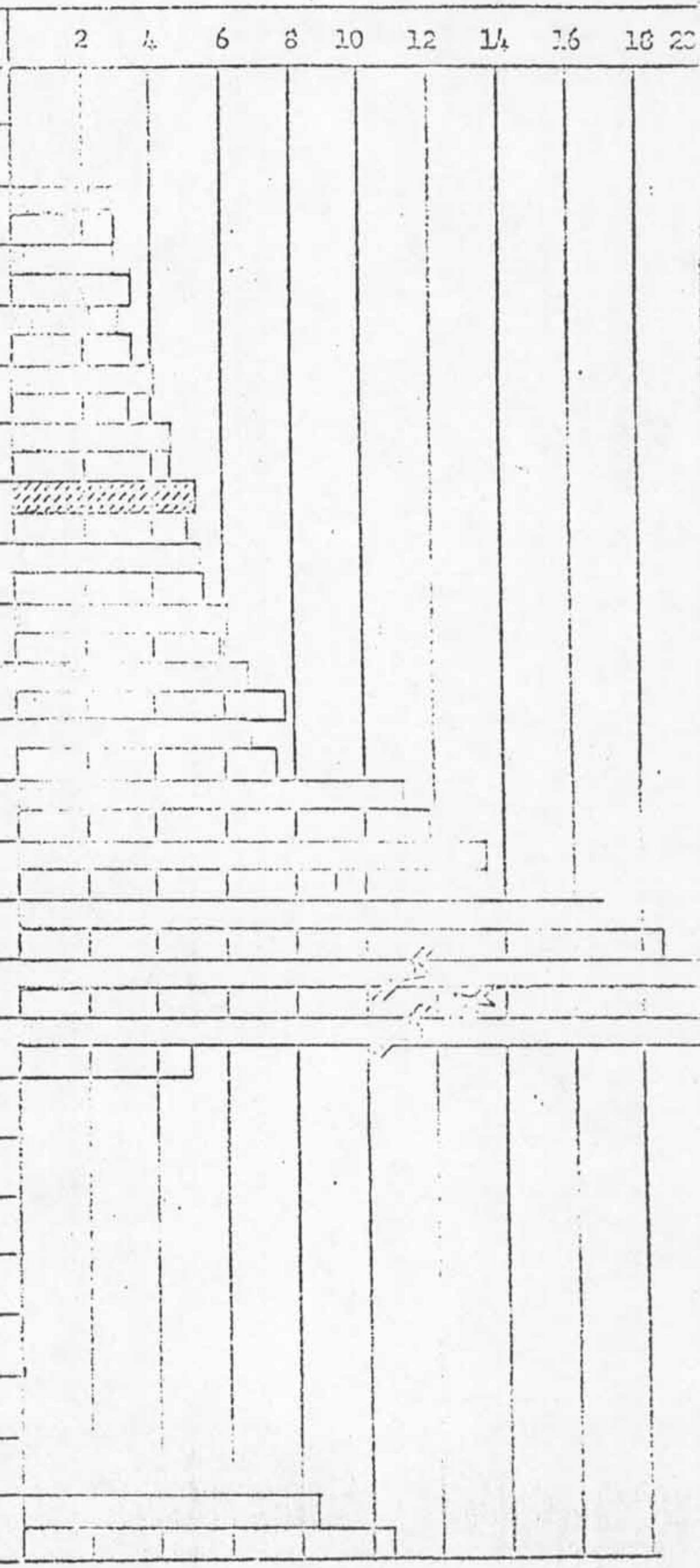
4. You, as the Resident Engineer, have the authority to take all necessary actions to enforce safety and to prevent accidents; and you must use this authority, as required, to promote safe working conditions.

JOHN E. MINAHAN
Colonel, Corps of Engineers
Area Engineer

cc: Safety Officer
Constr Br

OMAHA DISTRICT DISABLING INJURY FREQUENCY RATE
GOVERNMENT & CONTRACTOR EXPERIENCE COMBINED
JANUARY THROUGH OCTOBER 1960

REPORTING UNIT	FREQUENCY
Grand Forks Area	0.00 0.00
Omaha District Svc Base	0.00 0.00
Denver Resident Office *	2.91 2.94
Garrison Area	2.94 3.39
District Office	3.04 3.41
Cheyenne Area	4.07 3.30
Lincoln Area	4.54 4.48
DISTRICT AVERAGE	5.23 4.95
Rapid City Resident Ofc *	5.36 5.46
Oahe Area	6.08 5.96
Omaha Area	6.71 7.74
Offutt Area	6.78 7.50
Sioux City Area	11.09 11.95
Minot Area	13.59 9.17
Fort Randall Area	16.63 18.62
Gavins Point Area	20.23 22.87
Big Bend Area	20.93 4.97



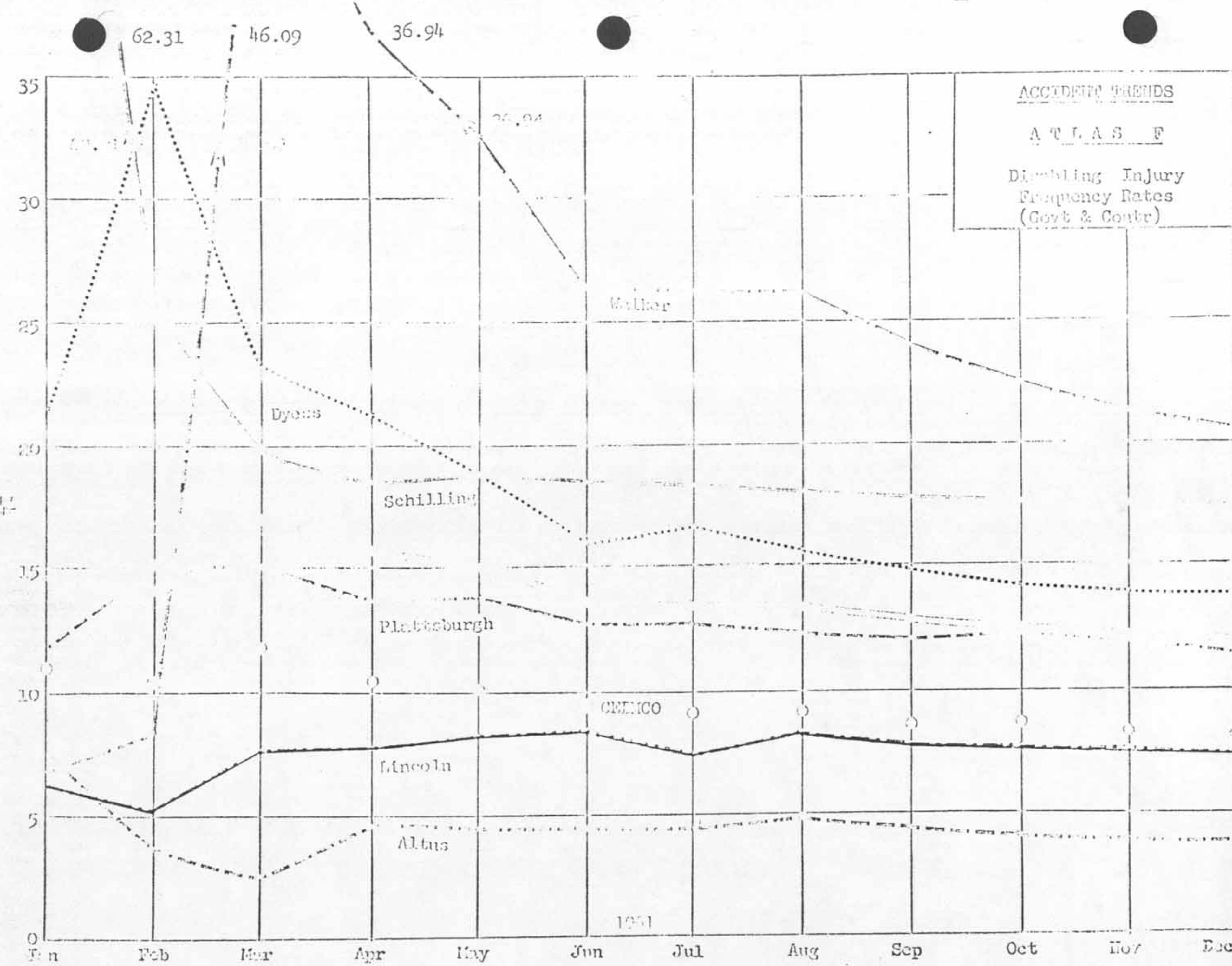
* Experience includes work performed prior to transfer of ICBM work to CEBMCO.

LEGEND: January through October
January through September

ACCIDENT EXPERIENCE
UNDER OMAHA DISTRICT

Month	Man-Hours Worked		Lost Time Injuries		Days Lost		Frequency Rate		Severity Rate	
	Monthly	Cum.	Monthly	Cum.	Monthly	Cum.	Monthly	Cum.	Monthly	Cum.
January	34641	34641	0	0	0	0	0.00	0.00	0.00	0.00
February	19259	53900	0	0	0	0	0.00	0.00	0.00	0.00
March	17626	71526	0	0	0	0	0.00	0.00	0.00	0.00
April	112734	184260	1	1	21	21	8.87	5.43	0.19	0.11
May	146235	330495	0	1	0	21	0.00	3.03	0.00	0.06
June	318374	648869	0	1	0	21	0.00	1.54	0.00	0.03
July	238893	887762	2	3	60	81	8.37	3.38	0.25	0.09
August	324103	1211865	2	5	19	100	6.17	4.13	0.06	0.08
September	349027	1560892	2	7	6050	6150	5.73	4.48	17.33	3.94
October	420677	1981569	2	9	156	6306	4.75	4.54	0.47	3.18
November	19504	2001073	0	9	0	6306	0.00	4.50	0.00	3.15
December	0	2001073	0	9	0	6306	0.00	4.50	0.00	3.15

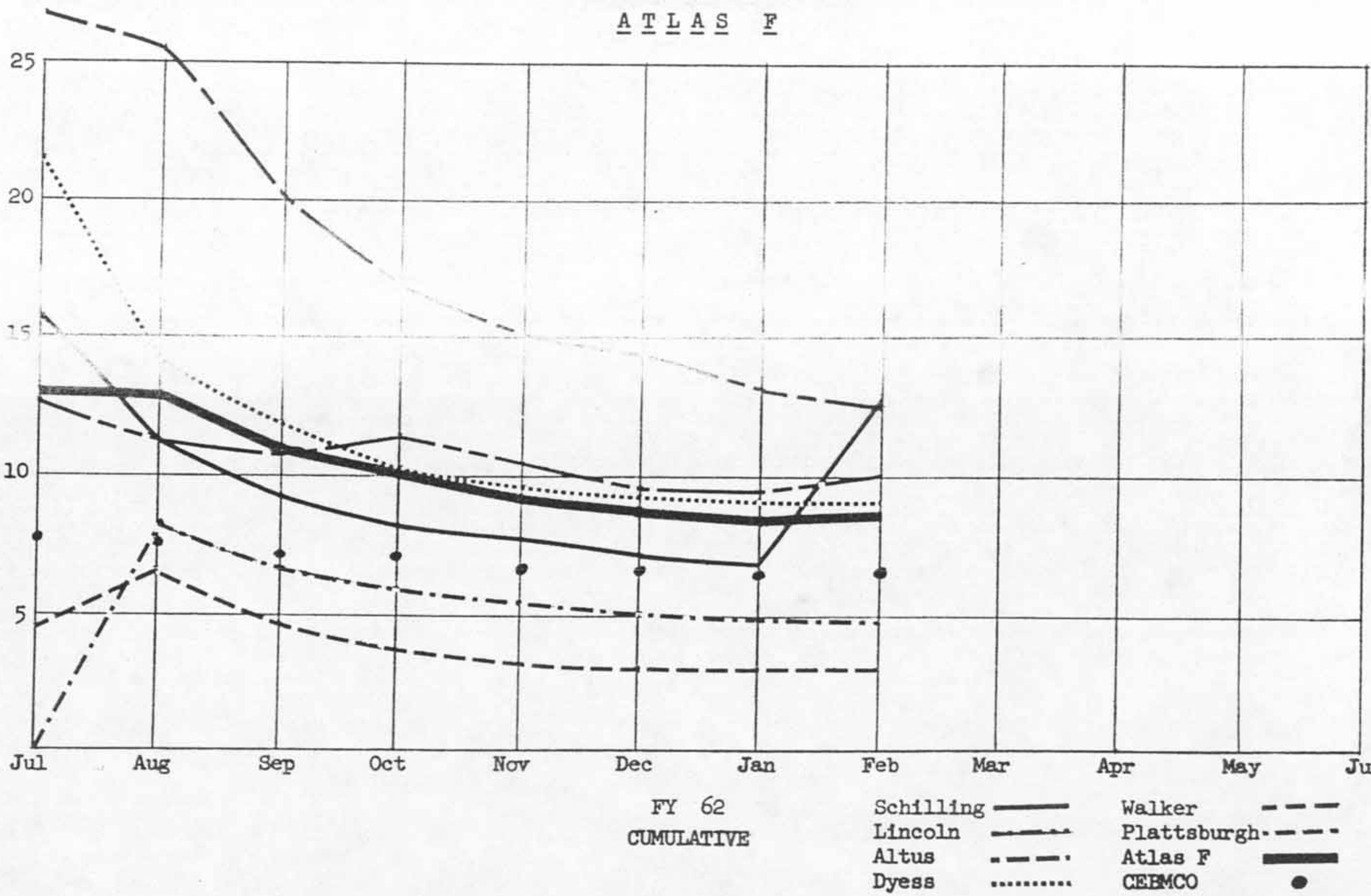
Month	Property Damage		Fire Loss	
	Monthly	Cum.	Monthly	Cum.
January	0	0	0	0
February	0	0	0	0
March	0	0	0	0
April	0	0	0	0
May	0	0	0	0
June	$5000	$5000	0	0
July	698	5698	0	0
August	0	5698	0	0
September	0	5698	0	0
October	0	5698	0	0
November	0	5698	0	0
December	0	5698	0	0



ACCIDENT TRENDS
A T L A S F
Disabling Injury
Frequency Rates
(Govt & Contr)
62.31
46.09
36.94
Walker
Dyess
Schilling
Plattsburgh
CELMCO
Lincoln
Altus
35
30
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

DISABLING INJURY FREQUENCY RATES
(Government & Contractor)

A T L A S F



ACCIDENT EXPERIENCE

GOVERNMENT AND CONTRACTOR COMBINED

Month	Manhours Worked	Disabling Injuries	Fatal-ities	Days Time Lost	Frequency Rate	Severity Rate
Since Assumption of Control by CEBMCO on 15 Oct 60 thru Dec 60	988,085	7	1	6,440	7.08	6.52
January 1961	480,177	3	0	72	6.25	0.15
February 1961	947,660	[illegible]	1	6,074	5.28	6.41
March 1961	[illegible]	[illegible]	2	[illegible]	7.82	9.53
April 1961	1,533,694	12	2	12,232	7,82	7.98
May 1961	1,913,634	16	2	14,103	8.36	7.37
June 1961	2,252,126	19	4	26,113	8.44*	11.59*
July 1961	2,504,075	19	4	26,113	7.59	10.43
August 1961	2,729,612	23	5	32,214	8.43	11.00
September 1961	2,729,612	23	5	32,214	8.43	11.00
October 1961	2,926,924	23	5	32,214	7.86	11.01
November 1961	2,975,478	23	5	32,214	7.73	10.83
December 1961	3,042,664	23	5	32,214	7.56	10.59
January 1962	13,123	00	0	0	0.00	0.00
February 1962	35,745	00	0	0	0.00	0.00

Cumulative month by month through year

PERSONAL INJURY ACCIDENTS

CONTRACTOR

MONTH	MANHOURS WORKED	DISABLING INJURIES	FATAL-ITIES	DAY TIME LOST	FREQUENCY RATE	SEVERITY RATE
January 1961	456,621	3	0	72	6.57	0.06
February 1961	894,583	5	1	6,074	5.59	6.79
March 1961	[illegible]	9	[illegible]	12,185	7.52	10.18
April 1961	[illegible]	11	2	[illegible]	7.72	8.58
May 1961	1,780,389	15	2	14,101	8.43	7.92
June 1961	2,096,084	18	4	26,111	8.59*	12,46*
July 1961	2,317,535	18	4	26,111	7.77	11.27
August 1961	2,525,970	22	5	32,212	8.71	12.75
September 1961	2,633,620	22	5	32,212	8.34	12.21
October 1961	2,698,231	22	5	32,212	8.15	11.94
November 1961	2,731,369	22	5	32,212	8.05	11.79
December 1961	2,791,873	22	5	32,212	7.88	11.54
January 1962	6,715	0	0	0	0.00	0.00
February 1962	24,621	0	0	0	0.00	0.00

PERSONAL INJURY ACCIDENTS

GOVERNMENT

MONTH	MANHOURS WORKED	DISABLING INJURIES	FATAL-ITIES	DAYS TIME LOST	FREQUENCY RATE	SEVERITY RATE
January 1961	23,556	0	0	0	0.00	0.00
February 1961	53,077	0	0	0	0.00	0.00
[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	0.02
April 1961	107,998	1	0	2	9.26	0.02
May 1961	133,245	1	0	2	7.50	0.02
June 1961	156,042	1	0	2	6.41	0.01
July 1961	186,540	1	0	2	5.36	0.01
August 1961	203,642	1	0	2	4.91	0.01
September 1961	217,032	1	0	2	4.61	0.01
October 1961	228,693	1	0	2	4.37	0.01
November 1961	244,109	1	0	2	4.10	0.01
December 1961	250,791	1	0	2	3.99	0.01
January 1962	6,408	0	0	0	0.00	0.00
February 1962	11,124	0	0	0	0.00	0.00

MOTOR VEHICLE ACCIDENT SUMMARY

GOVERNMENT ONLY

MONTH	TOTAL MILES DRIVEN	NO. OF ACCIDENTS	FREQUENCY RATE	COSTS GOVT	COSTS OTHER	PROPERTY DAMAGE (Govt & Contr)	FIRE LOSS (Govt & Contr)
January 1961	59,028	0	0.00	$ 0	0	$ 0	$ 0
February 1961	124,633	1	0.80	78	150	1,300	0
March 1961	185,084	1	0.54	78	150	1,300	0
April 1961	254,576	2	0.79	118	150	1,300	0
May 1961	324,252	2	0.62	118	150	1,300	1,200
June 1961	393,591	2	0.51	118	150	1,300	1,200
July 1961	453,812	2	0.44	118	150	1,300	1,200
August 1961	509,395	2	0.39	118	150	1,300	1,200
September 1961	573,020	2	0.35	118	150	5,050	1,200
October 1961	618,521	2	0.32	118	150	5,050	1,200
November 1961	673,563	2	0.30	118	150	5,050	1,200
December 1961	699,734	2	0.29	118	150	5,050	1,200
January 1962	325,332	0	0.00	000	000	0	0
February 1962	666,920	0	0.00	000	000	0	0

ACCIDENT EXPERIENCE

Under Omaha District, Corps of Engineers:

FATALITY: An oiler was pinned between the frame and cab of a crane. He was cleaning and oiling when crane was put into operation and was swung around.
RESULT: Fatal, 6,000 days standard time charge.
ACTION TAKEN: Oilers should do no cleaning while crane is in operation.

Since assumption of Control on 15 October 1960 by CEBMCO:

FATALITY: An iron worker fell 135 feet from reinforcing steel to bottom of silo while moving from one location to another.

RESULT: Fatal, 6,000 days standard time charge.

ACTION TAKEN: Install safety nets and provide more positive safety hooks on safety belts.

***

ACCIDENT: An iron worker was struck by rack used to lower rebar into shaft when the ring attached to the load line broke.

RESULT: Fractured arm, leg and foot; 200 days lost time.

ACTION TAKEN: All contractor-made rings being replaced with heavy shackles and all rigging to be constantly checked by foremen.

***

ACCIDENT: Government sedan ran into back of privately-owned pickup which had slowed down to make left turn at city intersection.

RESULT: $60 damage to government vehicle.

ACTION TAKEN: All drivers are being warned to be alert at all times when driving government vehicles.

***

ACCIDENT: A government construction representative fell when he stepped from an elevated board at the silo tunnel entrance onto a mound of earth.

RESULT: Broken leg, [illegible] days lost time.

ACTION TAKEN: All personnel cautioned to exercise care when stepping from any elevated walk-way or object.

ACCIDENT: While climbing crane boom to put a cable back onto a sheave, an oiler slipped and grabbed a hoist cable which pulled his hand through a sheave.

RESULT: Finger amputated at first joint, 75 days standard time charge.

ACTION TAKEN: All oilers again warned to stay off booms in motion.

***

ACCIDENT: An ironworker, placing horizontal rebar in silo, was struck on left foot by rebar which fell when tie broke.

RESULT: Broken instep, 45 days lost time.

ACTION TAKEN: All steel will be tied with more than one wire. A man will hold tied end of rebar while other end is being forced into position.

***

ACCIDENT: A carpenter was struck by a ladder which worked loose and fell from LCC Building.

RESULT: Injured spine, 30 days lost time.

ACTION TAKEN: Ladders checked for secure tie-down or removed.

***

ACCIDENT: An ironworker lost his balance and fell 15 feet to the bottom of the silo while pulling an impact wrench from a nearby beam.

RESULT: Compression fracture and bruises, 60 days lost time.

ACTION TAKEN: Orders issued that loose tools are not to be laid on beams.

1961 CEBMCO Accident Experience:

January 1961

ACCIDENT: Surveyor, working on silo floor, was struck by falling spud wrench.

RESULT: Lacerated buttock, 10 days lost time.

ACTION TAKEN: Ironworkers to be provided with proper wrench.

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ACCIDENT: Ironworker's fingers were pulled into sheave of derrick he was helping disassemble.

RESULT: Bruised and cut fingers, 2 days lost time.

ACTION TAKEN: Ironworkers instructed in proper way to place cables on pulley.

***

ACCIDENT: Ironworker's hand was pulled into sheave of derrick he was helping disassemble.

RESULT: Severe lacerations, 60 days lost time.

ACTION TAKEN: Ironworkers instructed in proper way to place cables on pulley.

FEBRUARY 1961

FATALITY: Lineman lost control of truck which skidded and overturned.

RESULT: Fatal, 6,000 days standard time charge; $1,300 damage to truck.

ACTION TAKEN: Accident publicized at safety meetings and drivers cautioned to maintain full control of vehicles.

***

ACCIDENT: Government vehicle struck private vehicle while changing lanes.

RESULT: $78 damage to government vehicle, $150 damage to private vehicle.

ACTION TAKEN: All vehicle operators cautioned to drive safely.

***

ACCIDENT: Electrician was struck on hand by piece of iron which fell from Level 4 to Level 8 in silo.

RESULT: Fractured hand, 2 days lost time.

ACTION TAKEN: Loose objects to be picked up. Director instructed Area Engineer to provide adequate protection from falling objects.

MARCH 1961

FATALITY: Ironworker struck on head by pipe vise which fell 107 feet from outer edge of silo level 3.

RESULT: Fatal, 6,000 days standard time charge.

ACTION TAKEN: Chain will be securely fastened to all small equipment and anchored to levels with safety snap on other end of chain.

***

ACCIDENT: Oxygen bottle slipped and fell on ironworker foreman's toes while he was changing its location.

RESULT: Two broken toes, 30 days lost time.

ACTION TAKEN: Men warned not to attempt to move oxygen bottles without help.

***

ACCIDENT: Pipefitter struck by support angles which fell when pipe weld broke.

RESULT: Scalp laceration and slight brain concussion,21 days lost time.

ACTION TAKEN: Employees cautioned to be sure that all material above them is safely sucred before working under it.

***

ACCIDENT: Mechanic's helper was struck by timber which fell from higher level in elevator shaft.

RESULT: Broken bones in foot, 60 days lost time.

ACTION TAKEN: Memos to site superintendents cautioning them of hazards of falling objects and requesting that conditions be corrected. Director instructed Area Engineer to direct contractor to take necessary action with his subcontractors to assure compliance with safety articles of the contract.

***

ACCIDENT: Government inspector slipped and twisted his knee while descending slope of excavation.

RESULT: Torn knee cartilage, 2 days lost time.

ACTION TAKEN: All employees advised to use caution while working or walking in hazardous locations.

APRIL 1961

ACCIDENT: Painter fell into open access hole when he disregarded instructions and entered launch control center while lights were temporarily off.

RESULT: Crushed ribs, 15 days lost time.

ACTION TAKEN: Instructions issued to keep access holes covered. Temporary railing must be erected around access holes when they are open.

***

ACCIDENT: Carpenter foreman, superivising placement of forms, lost his balance and fell from reinforcing steel.

RESULT: Cracked pelvis, 30 days lost time.

ACTION TAKEN: Accident discussed at safety meeting and employees instructed to be sure of secure footing and hand holds before walking onto steel.

***

ACCIDENT: Government carryall being backed out of snow-packed parking area, skidded against light pole.

RESULT: $40 damage to carryall.

ACTION TAKEN: Contractor's superintendent directed to clear snow from areas and keep such areas free of ruts.

MAY 1961

ACCIDENT: Painter foreman suffered a hernia when he picked up 130 lb. bucket of paint.

RESULT: 50 days standard time charge.

ACTION TAKEN: Men instructed not to lift this type of load without help.

***

ACCIDENT: Electrician was struck in eye when he cut temporary support wire.

RESULT: Scratched eyeball, 6 days lost time.

ACTION TAKEN: Men instructed to take proper care in cutting wire.

***

ACCIDENT: Laborer's hand was pulled into sheave block when crane operator slacked off the line.

RESULT: Mashed finger and damaged ligaments, 15 days lost time.

ACTION TAKEN: Instructed all employees to keep their hands off cables.

***

ACCIDENT: Gas from line ruptured by loader ignited.

RESULT: $1,200 damage to semitrailer warehouse van, tools and material.

ACTION TAKEN: All gas lines checked for leaks. Lines will be buried deep enough to prevent damage from heavy equipment.

***

ACCIDENT: Laborer struck against protruding snap tie in silo when he bent over to pick up a form.

RESULT: Loss of sight in one eye, 1,800 days standard time charge.

ACTION TAKEN: Men warned to be careful of protruding objects. Contractor to provide adequate lighting in all such small working spaces.'

JUNE 1961

FATALITY: Laborer, climbing ladder in fill and vent shaft, called for help and then fell 50 feet.

RESULT: Fatal, 6,000 days standard time charge.

ACTION TAKEN: All ladders over 30 feet in height, whether temporary or permanent, will be constructed with a rest platform near the mid point.

FATALITY: Pipefitter, helping remove the cap from the filter on PLS pressurization prefab, was blown over guardrail into the rattle space of silo. The workmen thought the filter was not pressurized.

RESULT: Fatal, 6,000 days standard time charge.

ACTION TAKEN: Foremen will be required to personally check to insure that pressurized gas is not trapped.

ACCIDENT: Pipefitter slipped and struck back against a pipe.

RESULTS: Bruised back, 10 days lost time.

ACTION TAKEN: Accident discussed at all safety meetings.

JULY 1961

No accidents reported.

AUGUST 1961

FATALITY: Pipefitter, descending ladder in fill and vent shaft without proper safety equipment, overcome by oxygen deficiency and fell. Two ironworkers attempting to rescue him were also overcome and fell from ladder.

RESULT: (1) Fatal, 6,000 days standard time charge; (2) skull fracture, 90 days lost time; (3) cuts and bruises, 10 days lost time.

ACTION TAKEN: Proper ventilation to be provided. Suitable breathing apparatus to be provided. All personnel instructed to follow prescribed safety procedures.

***

ACCIDENT: Pipefitter, working at level 7, struck by 2 x 8 plank which fell from level 1.

RESULT: Bruises, 1 day lost time.

ACTION TAKEN: All loose material to be fastened down or properly stored.

SEPTEMBER 1961

ACCIDENT: Tornado destroyed office trailer and caused extensive damage to station wagon.

RESULT: $3,750 total damage.

ACTION TAKEN: Trailers to be tied down whenever possible.

OCTOBER 1961

No accidents reported.

NOVEMBER 1961

No accidents reported.

DECEMBER 1961

No accidents reported.

JANUARY 1962

No accidents reported

FEBRUARY 1962

No accidents reported

FATAL ACCIDENT NO. 1

1. In accordance with Area Memorandum No. 60-9 dated 17 September 1960, an investigation of the fatal injuries to Joseph R. Lee, age 21, an oiler employed by Western Contracting Corporation, on 16 September 1960, was concluded and the Report of Investigation submitted. The Investigation Board consisted of the following members:

Major Lester J. Henderson, Chairman
Captain Edward C. Fike, Member
Mr. John P. Shields, Jr., Member

2. Joseph R. Lee, oiler, was fatally injuried at approximately 1630, 16 September 1960, when pinned and crushed between the truck frame and revolving assembly of a truck mounted crane at Site 2 approximately 4 miles west of Nebraska City, Nebraska. Mr. Lee died about 1740 in a Nebraska City hospital.

3. The following witnesses and personnel were questioned by the Investigating Board:

Mr. Matt Spremich	Lead Walker
Mr. Raymond Gerdes	Carpenter
Mr. Kenneth Lauritsen	CE Inspector
Mr. Richard McAdoo	Crane Operator

4. From witnesses statements and questions asked them, the following summary of the accident is presented:

a. About 1630, 16 September, at Site No. 2, Nebraska City, Nebraska, Mr. Joseph R. Lee, oiler on a 37M Marion truck mounted crane belonging to Western Contracting Corporation, was performing some of his duties as an oiler, by wiping down the truck frame. Lee was positioned just behind the truck cab working between the structural framework of the truck. Mr. Raymond Gerdes, a carpenter for the same company, had just previously come up out of the hole and noticed Lee wiping down the rig as he walked around the crane to the edge of the silo excavation to check and see if his saws and equipment were coming up from the bottom on the cage. As the cage cleared the safety fence and the crane operator started his swing to remove the cage from the open hole and set it down on the ground, Gerdes heard a grunt or groan from Lee. Gerdes turned around, saw that Lee was caught between the frame and counterbalance, hollered at the crane operator, Mr. Richard McAdoo, who stopped the swing of the boom right away and reversed his swing to the other direction to free Lee. Mr. Matt Spremich, the lead walker, and the night foreman, both from Western heard Lee holler, saw the crane operator stop his boom and reverse the swing. They got to Lee just as his body fell free of the crane. Both of these men got hold of Lee while he was still bent over and helped him to the ground. Gerdes meanwhile had gone to the first aid shack to get the stretcher, and another man went topside to send for an ambulance, which arrived at the site within fifteen minutes. After Gerdes arrived with the stretcher, he held Lee's feet until the ambulance arrived. Lee was taken to a Nebraska City hospital where he died at approximately 1740 the same day.

b. From witnesses statements and questions asked them, it is apparent that Joseph Lee was definitely a good, conscientious worker and was not a playboy or show off. Lee had been working for Western about seven weeks and had been an oiler on the crane for two or three weeks.

c. Mr. Richard McAdoo, the crane operator, had raised the cage from the bottom of the hole and started to swing the boom to his right to set it down on firm ground when Gerdes hollered at him to swing back the other way. As he brought the boom back over the hole to set it down on the other side of the hole, he noticed a man lying down behind the truck cab. This was the first indication he had that something had happened. He continued operating the crane until he had set the cage down on the ground to his left so the men in the cage could get out. He then locked his controls and shut the crane down. McAdoo is considered to be one of the best crane operators on the job, has been operating the crane since the job started around the middle of June this year, and has about six to eight years experience as a crane operator.

d. All concerned seem to feel the accident was just one of those unexplainable things that happen when you least expect it to, that it was not the fault of anyone present, nor was the accident the result of either mechanical defects or failure. If anything, the accident can be attributed to a human element affair.

5. The conclusions of the Board:

a. The death of Joseph R. Lee was caused by injuries received when he was crushed between the frame and counterbalance of a truck mounted crane, while he was wiping down the same at Site 2, Nebraska City, Nebraska.

b. Although Lee was seen in the fatal position by at least one man, no one warned him of the danger of being there, nor was he aware of his own danger.

c. Apparently Lee had never been warned of the extreme danger of becoming preoccupied in his work that he would overlook safety precautions.

6. Recommendations of the Board:

a. Safety personnel of the Contractor should give more complete indoctrination to oilers and other individuals relative to the extreme hazards of working around cranes or other heavy equipment.

b. A warning sign of some nature should be stenciled on all revolving portions of cranes and other equipment.

c. A more vigorous safety program should be instituted at all sites to prevent the recurrence of this or any similar accident.

d. Union officials should give instructions and indoctrinate inexperienced oilers.

FATAL ACCIDENT NO. 2

1. In accordance with Area Memorandum No. 60-12 dated 7 November 1960, an investigation of the fatal injuries to Delbert Tom Ryan, age 24, a steel worker for Salyer Re-Bar Erection, Inc., a subcontractor of the Western Contracting Corporation, on 6 November 1960, was concluded and the Report of Investigation submitted. The Investigating Board consisted of the following members:

Captain Robert A. Bush, Chairman
Captain Edward C. Fike, Member
Mr. John M. Clems, Member

2. Delbert Tom Ryan, steel worker, was fatally injured at approximately 2320, 6 November 1960, as a result of falling from the upper structure (in the vicinity of shock hanger at Plus X Axis, Quadrant 1, approximately 16 feet above the slipform platform) of the Atlas launch silo under construction at Site 4, located approximately 4 miles from the Village of Cortland, in Gage County Nebraska. He was believed dead on recovery of his body at the bottom of the silo. He was taken directly to the mortuary, Griffiths - Fox Chapel, in Beatrice, Gage County, Nebraska. The death certificate was signed by Dr. Dwight L. Moell, of Beatrice.

3. Actions of the Investigating Board.

a. The following witnesses and personnel, present or in the immediate vicinity of the silo at the time of the accident were questioned by the Investigating Board:

Mr. Victor M. Castrodad, CE Inspector
Mr. Robert J. Smith, steel worker, Salyer Re-Bar Co.
Mr. Earl (NMI) White, steel worker foreman, Salyer Re-Bar Company

b. The site at which the accident happened was visited by the members of the board. Photographs were secured of area involved; position of deceased when last seen; broken railing; and bolt and plate.

4. The Conclusions of the Board:

a. The death of Delbert Tom Ryan was the result of falling from the rebar transition area at approximate elevation of 967', referenced against the 1000 feet silo elevation, hitting the guard rail and falling to the bottom of the silo, approximately 139 feet. The guard rail consisted of three 1" x 6" boards, all three of which were broken.

b. His falling appears to have been the result of failure to observe basic safety practices which should be expected of his particular skill. He was considered an excellent iron worker and was a union member for ten months with prior experience in South

Dakota. It was indicated that safety practices were called to his attention at different times.

(1) No climber should release a grip with one hand until testing the security of the next grip.

(2) Climbers were prohibited from moving laterally, but were required to climb down to the walkway if available before moving to a new position.

c. Had a protective fenced guard, in addition to the guard rail been placed around the slip form walkway, or had a net been located below the slip form, the fall would have bean less severe with possibly less serious consequences.

d. There is substantial evidence that the Chief of Construction Branch and Area Engineer recognized the importance of paragraph 2A-13 of the contract by calling the matter of the utilization of safety nets, and closed or snap type hooks on safety belts to the contractor's attention by letter, telegram, and telephonic communications.

e. The type of open hook used on the safety belts of these iron workers does not provide the safety the iron workers should have. The reason given for the use of an open hook on the belt, instead of a snap type was that hooks on belts commercially available could be used on rebar up to and including #11 in size, while bars used on this project are up to and including #18 in size.

f. The sub-contractor provides a lanyard also for the iron workers; however, it appears that there is some objection to their use by the workers, as a safety hazard.

g. The sub-contractor now has on order four dozen of the large size snap hooks for use on the larger size of rebar, such as are reported to be in use on the Denver Area Titan sites.

5. Recommendations of the Board:

a. Contractor's personnel should be apprised of the circumstances surrounding the death of Ryan and use this as an object lesson for making the workmen more safety conscious.

b. Representatives of the unions and contractors' Safety Engineers should emphasize the need of constant personal safety practices on the part of the individual worker.

c. Safety nets should be utilized in such construction work as required by the contract and as emphasized by communications to the contractor.

d. Safety belts equipped with a snap or latching type of hook should be used by the steel workers.

e. The utilization of a safety line or lanyard, with snap or latching type of hooks, should be given every consideration for this work. The iron and steel workers are subjected to considerable hazard, especially at the time of placing the reinforcing bar. A rebar, on being lowered into the area or into place could dislodge a man as a result of uncontrolled swinging, at a time when his safety belt was unhooked.

f. Lighting conditions should be such as to provide satisfactory working conditions, both for safety and increased efficiency.

g. The reinforcing bars should be controlled by use of tag lines while being lowered and placed into position in the silo.

h. The latter portion of the statement of the foreman of the sub-contractor made three requests for improvement of safety conditions. (It is to be noted that a net was installed in the silo at this site two days following this accident. Additional lighting was being planned for installation prior to this accident.)

FATAL ACCIDENT NO. 3

1. In accordance with Area Memorandum No. 61-4 dated 14 February 1961, an investigation of the fatal injuries to Robert P. Forey, age 37, a Lineman for Power Engineering Company, a subcontractor of the Western Contracting Corporation, on 13 February 1961, has been concluded and this Report of Investigation is submitted. The Investigating Board consisted of the following members:

Captain Robert A. Bush, Chairman
Captain Edward C. Fike, Member
Mr. John M. Clema, Member

2. Robert P. Forey, Lineman, was fatally injured at approximately [illegible] hours, 13 February 1961, as a result of a single vehicle accident which occurred about one-half mile east of 56th Street on State Highway No. 2 at the southern edge of Lincoln, Nebraska. Mr. Forey was returning from Site 12, Palmyra, Nebraska, to the local office of Power Engineering Company, 6317 Havelock, Lincoln, Nebraska, at the time his truck skidded across the road, turned over throwing him out of the truck, and crushing his head and chest when the truck landed on him. Mr. Forey was believed still alive and was sent by ambulance to the Bryan Memorial Hospital in Lincoln where he was pronounced dead on arrival.

3. Actions of the Investigating Board.

a. The following witnesses and personnel, present at the scene or arriving shortly after the accident, were questioned by the Investigating Board:

Mr. [illegible] F. Sorenson, Witness
Mrs. [illegible] M. Sorenson, Witness
Lt. [illegible] E. Kruger, Nebraska Safety Patrol

b. The accident scene was visited by members of the Board and photographs were taken to show skid marks, where the truck left the pavement, and the approximate location of the truck at the bottom of the embankment.

c. Members of the board visited the Nebraska Safety Patrol Headquarters, talked with the Investigating Officer and reviewed his accident report.

4. The conclusions of the Board:

a. As a result of going off the concrete onto the shoulder of the road, the deceased veered sharply to the left and lost control of his vehicle causing the fatal accident.

b. Although the deceased was traveling within the legal speed limits it is felt that he was traveling too fast for the loading conditions of his truck.

c. The deceased's death was caused by his being thrown out of the vehicle which then landed on him crushing his head and chest.

d. The use of safety belts on this vehicle may have prevented the fatal injuries received in the accident.

5. Recommendations of the Board:

a. Drivers should be instructed to operate their vehicles at a speed which will take into account the conditions of the road along with the conditions of and loads carried by their vehicle.

b. Consideration should be given to equipping vehicles with safety belts and drivers required to use them for highway driving.

FATAL ACCIDENT NO. 4

1. In accordance with Area Memorandum 61-5 dated 6 March 1961, an investigation of the fatal injuries to Milo J. Olson, age 40, an ironworker employed by the Western Contracting Corporation, on 6 March 1961, was concluded and the Report of Investigation submitted. The Investigating Board consisted of the following members:

Major Edward F. Brady, Chairman
Captain Edward C. Fike, Member
Mr. John M. Clema, Member

2. Milo J. Olson, ironworker, was fatally injured at approximately 1130 on 6 March 1961 as a result of being hit by a falling pipe vise while working in an Atlas Launch Silo under construction at Site 10 approximately 7 miles from the city of Elmwood, Nebraska. Mr. Olson was still alive when removed from the bottom of the Silo and was taken to the Bryan Memorial Hospital in Lincoln, Nebraska where he died of a skull fracture with brain damage at 1505 on 6 March 1961. The death certificate was signed by Dr. H. G. Ahrens of Lincoln.

3. Actions of the Investigating Board.

a. The following personnel: Mr. Richard W. Lintner, Electrical Foreman, Mr. Paul Frank Opocensky, Electrician, Mr. James P. Crownover, Welder's Helper, who were involved in this accident were questioned by the Investigating Board.

b. The Site at which the accident occurred was visited by the members of the Board. Photographs were secured of the area in which the deceased fell when struck by the falling pipe vise. A model was posed to show the deceased's position prior to falling. A similar pipe vise was posed in the approximate location of the fatal vise. A similar cable tray was posed with a similar vise to show situation prior to dislodgment of fatal vise. In addition, two photographs which show the decedent's hard hat and welding shield after the accident were obtained.

4. The Conclusions of the Board.

a. The prime contractor, Western Contracting Corporation, did not act as a reasonably prudent contractor and provide sufficient protective devices to prevent injury from falling objects.

b. The Corps of Engineers was remissin its duties by not insisting at an early enough date that these devices be provided.

c. Mr. Richard W. Lintner exercised poor judgment in placing a pipe vise too close to the edge of level 3 without securing it.

d. Mr. Paul Frank Opocensky in using the pipe vise improperly, ie, as a sawhorse, unintentionally was guilty of causing this vise to fall from level 3.

e. Mr. Milo Olson contributed to his own death by working in an unprotected location without overhead protection.

5. Recommendations of the Board.

a. The contractor should without delay complete the installation of sufficient protective devices to prevent objects from falling off of any level in the Silo.

b. The contractor must provide some form of overhead cover for workers who must work in the missile or rattle spaces of the Silo.

c. All portable tools, equipment, ladders, etc. must be secured to the structure when in use. Portable tools not in use must be returned to the tool box or other safe location.

d. All levels of management within the contractor's organization, the Corps of Engineers, the sub-contractors, and labor unions must provide aggressive safety direction and education to all personnel working on this type of construction.

FATAL ACCIDENT NO. 5

1. In accordance with Area Memorandum 61-12 dated 13 June 1961, an investigation of the fatal injuries to Cecil Belcher, age 42, a laborer employed by the Western Contracting Corporation, on 13 June 1961, was concluded and the Report of Investigation submitted. The Investigating Board consisted of the following members:

Captain Edward C. Fike, Chairman
1st Lt. Paul R. DeMaagd, Member
Mr. John P. Shields, Jr., Member

2. Cecil Belcher, laborer, was fatally injured at approximately 1330 on 13 June 1961 as a result of a 50 - 55 foot fall from a ladder in the fill and vent shaft while working on an Atlas Missile Silo under construction at Site 9 approximately 11 miles east of David City, Nebraska. Mr. Belcher was believed dead when removed from the bottom of the shaft and taken to the Knott Funeral Home in David City, Nebraska, where he was pronounced dead of multiple skull fractures with severe brain injury and multiple fractured ribs with possible internal injuries. The death certificate was signed by Dr. L. J. Ekeler of David City, Nebraska. An autopsy was performed by Dr. Frank Tanner of Lincoln, Nebraska, the official results of which may be obtained from Mrs. Belcher's lawyers, Healey, Wilson, and Barolw, 1521 Sharp Building, Lincoln, Nebraska.

3. Actions of the Investigating Board

a. The following personnel, Mr. Gunnar Gregersen, Labor Foreman and Mr. Gernie Teckle, Laborer, the only eye witnesses, were questioned by the Investigating Board and statements were obtained.

b. The Corps of Engineers' site personnel along with two men who assisted in removing the deceased's body were questioned but did not have any first hand knowledge of how the accident happened.

c. The Site at which the accident occurred was visited by the members of the Board. Photographs were secured of the area in which the deceased fell.

4. Conclusions of the Board

a. Western Contracting Corporation did not act as a reasonably prudent contractor and provide sufficient safety devices as required by the contract and instructions issued by the Area Engineer.

b. The Corps of Engineers was negligent in their duties by only instructing and not directing that the contractor provide proper safety devices at an early enough date to prevent accidents of this nature.

c. Mr. Belcher contributed to his own death by not stopping on the ladder and locking his arms or legs through the ladder rungs when he found he was tired or exhausted.

5. Recommendations of the Board

a. The contractor should without delay provide adequate ventilation in all shafts, holes, rooms, or other areas to prevent the occurrence of toxic fumes.

b. The contractor should without delay be instructed to complete construction on the permanent ladder system in the fill and vent shafts, ie., cross-over platforms at the third points of shaft depth, and the center section of the ladder secured to the opposite wall of the shaft. These platforms will provide resting places for employees and eliminate any extended ladder climbs.

c. All levels of management within the contractor's organization, the Corps of Engineers, the sub-contractor's, and labor unions must provide aggressive safety direction and education to all personnel working on this type of construction.

FATAL ACCIDENT NO. 6

1. In accordance with Area Memorandum 61-5 dated 6 March 1961, an investigation of the fatal injuries to Styles R. Berry, age 58, a pipe fitter employed by Paul H. Hardeman, Inc., subcontractor of Western Contracting Corporation, the Government Prime Contractor, on 16 June 1961, was concluded and the Report of Investigation submitted. The Investigating Board consisted of the following members:

Major Lester J. Henderson, Chairman
Major Edward F. Brady, member
Mr. Charles J. O'Grady, member

2. Styles R. Berry, pipe fitter, was fatally injured at approximately 1010 hours on 16 June 1961 as a result of either being hit by a high pressure blast which blew out of the N-29 filter cartridge during removal of the cap from the filter casing or the resultant fall some sixty feet through the rattle space to the bottom of the silo. Dr. F. G. Travnicek, attending physician, has stated that in the absence of X-rays and an autopsy death could have been caused by any one of the injuries sustained (basal skull fracture, broken neck, crushed chest). It is possible that the blast which caused the decedent to fall could also have been the cause of any one or more of the decedent's injuries. Death occurred within 5 minutes after the accident. The death certificate was signed by Dr. F. G. Travnicek of Wilber, Nebraska.

3. Actions of the Investigating Board.

a. The following personnel: Mr. Robert E. Deines, pipe fitter foreman, Mr. Sam Glantz, pipe fitter, and Mr. Clifford Thompson, pipe fitter, who were at the scene of this accident were questioned by the Investigating Board.

b. The site at which the accident occurred was visited by the members of the Board. Photographs were secured of the rattle space into which the decedent fell after receiving blast released from prefab line.

4. Conclusions of the Board.

a. Mr. Styles R. Berry, the deceased, caused his own death by failing to properly check for pressurization in the N-29 filter casing and using improper procedure in the removal of the cap of subject filter casing.

b. Mr. Robert E. Deines, pipe fitter foreman of the Paul Hardeman, Inc., failed to act in a reasonable prudent manner by assigning his men to a potentially hazardous task without personally checking to insure that the N-29 filter casing was properly depressurized.

c. The suggested safety practices and procedures published by the Area Office have been enforced throughout the Lincoln Missile Project until the time of this fatal accident. On the day of the fatal accident it appears Hardeman's foreman and the three fitters involved ignored normal safety practices in depressurizing the lines before disassembly thus endangering their lives and causing the death of Mr. Berry.

5. Recommendations of the Board.

a. Written instructions should be issued to all sites explaining the proper procedure for depressurizing the N-29 filter casing prior to installation of filters after completion of cold flow test.

b. Paul Hardeman's foremen will be required to personally check to insure that trapped pressures are adequately bled off prior to any disassembly during the security test phase.

c. All fitters working on PLS installation must be re-instructed to the proper defensive methods of disassembly of units which might be under pressure.

FATAL ACCIDENT NO. 7

1. In accordance with Area Memorandum 61-16 dated 26 July 1961, an investigation of the fatal injuries to Harold B. Odle, age 26, a Pipefitter Foreman employed by Paul Hardeman, Inc., a subcontractor of Western Contracting Corporation, on 25 July 1961, was conducted and the Report Of Investigation submitted. The Investigating Board consisted of the following members:

Captain Edward [illegible] Fike, Chairman
1st Lt. Paul R. DeMaagd, Member
Mr. Gaylen K. Hargrave, Member

2. Harold Odle, Pipefitter foreman, was fatally injured at approximately 1425 hours on 25 July 1961 as the result of a 38 - 42 foot fall from the vicinity of the first landing in the fill and vent shaft to the bottom of the shaft while working on an Atlas Missile Silo under construction at Site 7, approximately 7 miles west of York, Nebraska. Mr. Odle was believed alive when removed from the bottom of the shaft, but was pronounced dead by Dr. Jim Bell of York, Nebraska, who arrived at the Site shortly after Odle was removed from the shaft. The Death Certificate was signed by Dr. Jim Bell with cause of death as concussion and hemorrhage of skull and brain.

3. Actions of the Investigating Board

a. The following personnel were questioned by the Investigating Board and statements were obtained: Mr. Jerry C. May, Ironworker, who performed the rescue operations; Mr. Edwin L. Welch, Ironworker Foreman; Mr. Alvin H. Hazell, Test Superintendent; Mr. Thomas A. Nelson, Corps of Engineers construction representative; and Mr. John Van Steenberg, UTL PLS Inspector for the Corps.

b. Other personnel having general knowledge of the accident and pertinent circumstances were interviewed, but no statements were taken. Mr. R. H. Ha[illegible], a survivor of the accident, was interviewed at the York Hospital and gave his account of the accident.

c. The Site at which the accident occurred was visited by members of the Board. Photographs were secured of the area in which the deceased and would-be rescuers fell, along with objects found within the shaft following the accident.

4. Conclusions

a. Harold B. Odle contributed to his own death by disregarding the safety instructions he had given his men and others during a safety meeting held on 18 July 1961, and by descending the shaft without life lines, not having emergency breathing apparatus available, and disregarding advice given him by his fellow workers.

b. That Paul Hardeman, Inc. and Western Contracting Corporation did not act as reasonably prudent contractors and provide sufficient safety devices as required by the contract and instructions issued by the Area Engineer.

c. The fan provided by the contractor did not introduce a supply of fresh air into the shaft as required by the specifications.

d. Robert Hartsoe contributed to his accident by descending the ladder without a life line, even though told to wear one by a Corps Inspector, and attempting to use breathing apparatus which he did not know how to operate.

e. Warren D. Miller, in an attempt to rescue a fellow worker, descended the ladder without life line or breathing apparatus; therefore, contributing to his serious accident and possible total disability or death.

f. Corps of Engineers Inspectors tried to keep people from entering the shaft without proper safety precautions by all means short of physical restraint.

g. That Jerry May acted admirably and in a safe manner during rescue operations.

5. Recommendations

a. That the contractor should, without delay, be required to provide adequate ventilation in all shafts, holes, rooms, or other areas to prevent the occurrance of toxic fumes or oxygen deficient atmosphere.

b. Oxygen breathing apparatus shall be provided in the immediate vicinity of men working in this shaft and all men having an occasion to work in this shaft whall be thoroughly instructed in its use. The breathing apparatus should be such that once in operation, it is capable of supplying oxygen continuously without requiring further manual operation by the user.

c. In addition, men working in this shaft should be secured by life lines attenddd at all times from the top of the shaft and direct line communication should be provided between the men and the attendant.

d. All levels of management within the contractor's organization, his subcontractors, labor unions, and Corps of Engineers must provide aggressive safety direction and education to all personnel working on this type of construction. Direct violations of these safety principles will be cause for work stoppage and/or dismissal of personnel involved.

e. The Corps of Engineers Inspectors present at the accident should be absolved of any blame as it is felt they tried to keep the men from entering the shaft unprotected.

f. That Mr. Jerry C. May be commended for his rescue operations.

PART XI

Special Events

SECTION 1

Visits by Higher Command and Dignitaries

SECTION 2

Changes of Command

SECTION 3

Presentation of Awards

SECTION 4

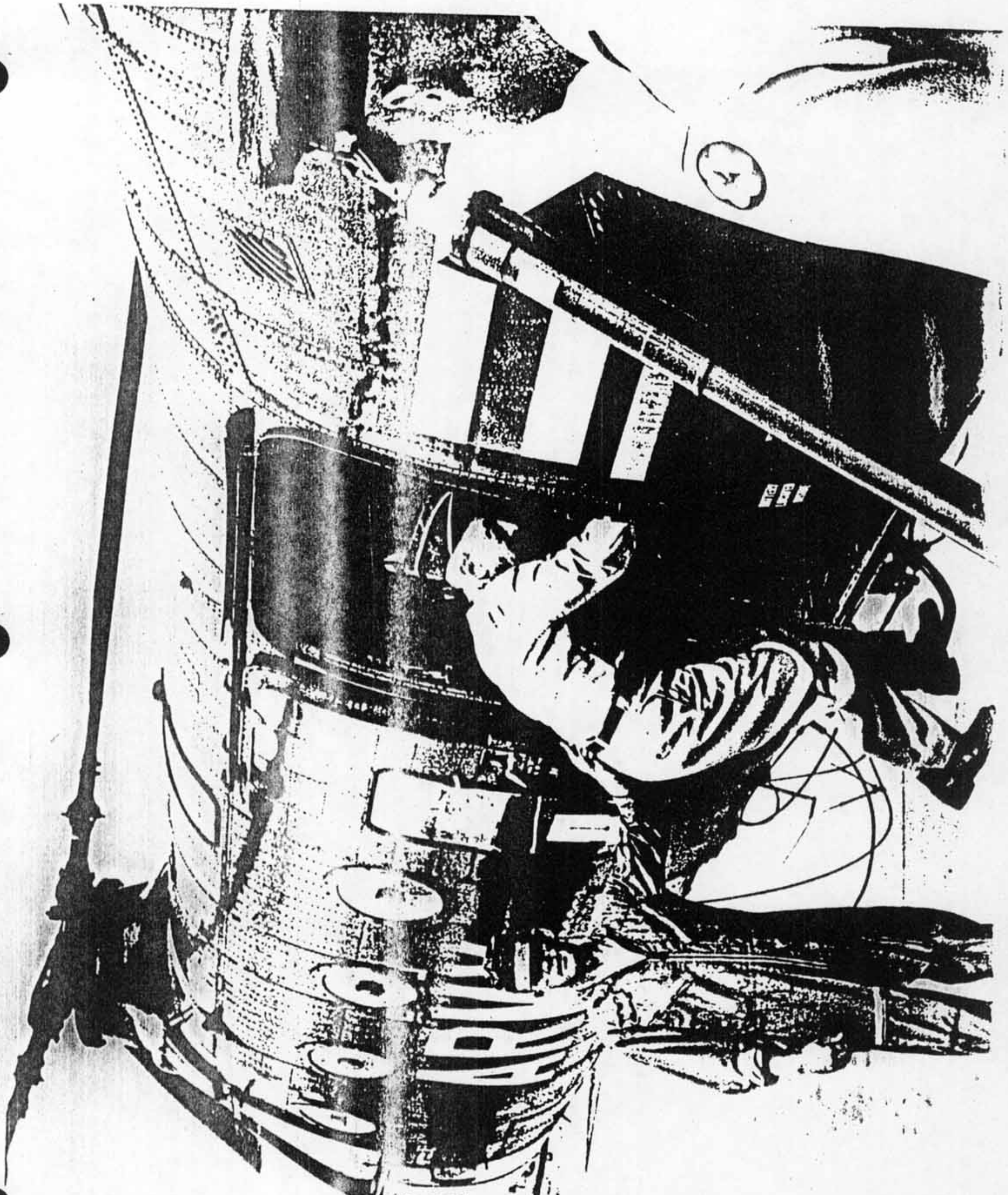
Social "Hour"

SECTION 5

Results of Windstorm

GENERAL E. C. ITSCHNER
. ARMY CORPS OF ENGINEERS

Lt General E. C. Itschner as he climbs into helicopter at [illegible] Complex in Lincoln Area. Lt. Colonel Hal L. Schroeder at right. 19 Aug 60.



Lt. General E. C. Itschner, Chief Army Corps of Engineers and others, being briefed by Colonel Harry Woodbury, District Engineer Omaha District, on the progress of construction of the Atlas "F" Missile Complexes in Lincoln Area, 19 August 1960.

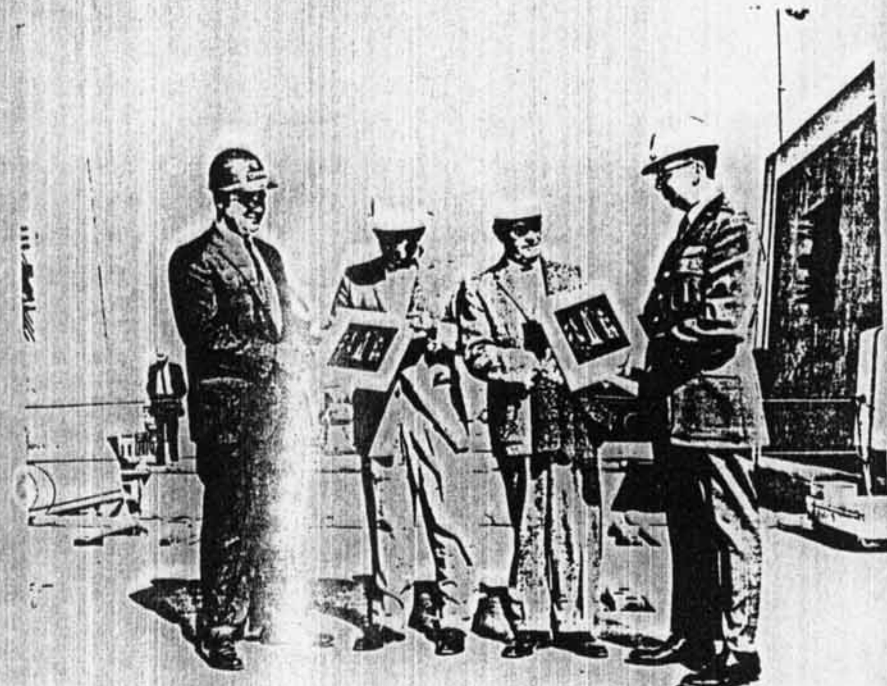
Colonel Woodbury (left standing), Major General Keith Barney (left front seated); General Itschner (center front); Colonel Corbin, U. S. Air Force (left, hand to chin); Lt. Colonel Frye (name tagged); Colonel Comm; Colonel V. L. Hastings, SATAF, Commander (right); L. Phillip Thierault, Lincoln Deputy Area Engineer.

ATLAS SITE STUDIED

Maj. Alexander P. de Seversky, aviator, aircraft designer and author, visited Lincoln Air Force Base Tuesday for a briefing and inspection of Atlas missile complex developments. The Russian-born World War I ace visited the Brainard Atlas site by helicopter. De Seversky has been a frequent consultant to the Secretary of the Air Force. **(Star Photo)**

Corps of Engineers, Area Engineer, Colonel John E. Minahan, hands "key" to Complex 8 to SATAF Commander, Colonel Hastings, at ceremonies on 16 October 1961. Complex 8 was the last of the 12 complexes to be completed. (Left to right) Mason Travis, Project Manager for Western Contracting Corporation; Colonel John E. Minahan; Colonel Vernon L. Hastings; Colonel Thomas J. Corbin, Commander, 818th Strategic Aerospace Division, Lincoln Air Force Base. GD/A #52888.

Turnover of Complex 8, Seward, by Corps of Engineers to Air Force on 16 October 1961. (Left to right) John Lundy, GD/A; Mason Travis, Project Engineer, Western Contracting Corporation; Colonel John E. Minahan, Lincoln Area Engineer; Colonel Vernon L. Hastings, Commander, SATAF; Colonel Thomas J. Corbin, Commander, 818th Air Division; Colonel Edward P. Denton, Commander, 551st Strategic Missile Squadron; D. D. Rutledge, President, Seward Chamger of Commerce; William I. Dowding, Mayor, City of Seward.



SATAF - GD/A present photograph of Atlas to Mr. Rutledge and Mayor Dowding to celebrate the turn-over of last complex, Site 8, by Corps of Engineers to SATAF on 16 October 1961. (Left to right) John Lundy, GD/A Site Supervisor; O. D. Rutledge, President, Seward, Nebraska Chamger of Commerce; Mayor William I. Dowding, Mayor of City of Seward; Colonel Vernon L. Hastings, SATAF Commander. GD/A #52891.

Change of Command. Colonel John E. Minahan turns over office of Area Engineer to Lt. Colonel Lester J. Henderson, effective 1 Jan 62.

Lt. Colonel Lester J. Henderson, Colonel Vernon L. Hastings, SATAF Commander, and Colonel John E. Minahan.

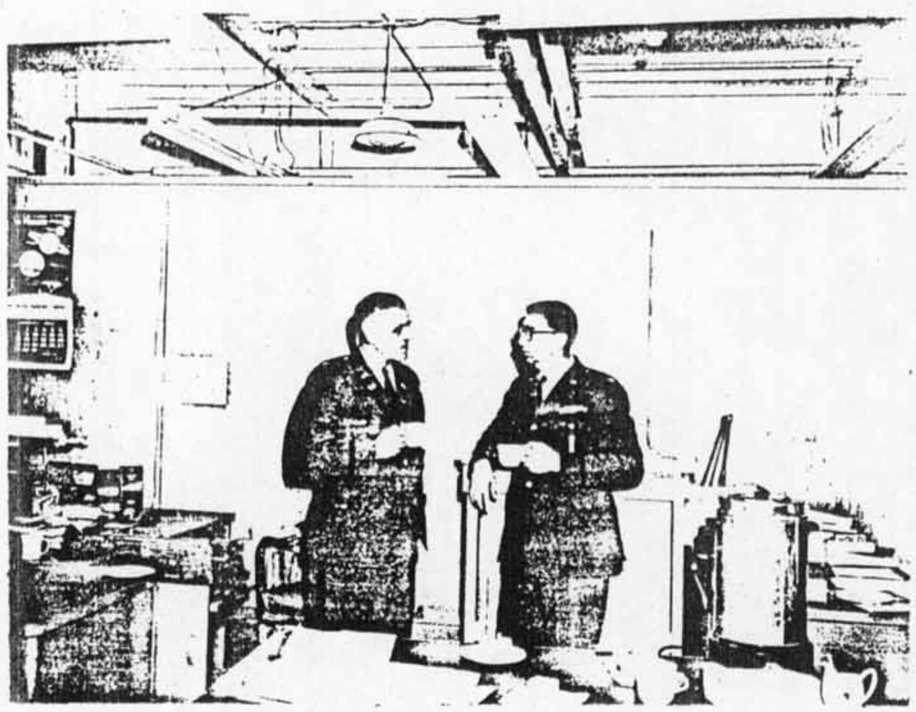
Sustained Superior Performance Awards presented to (left to right) Lloyd Duscha, Chief, Engineering & Technical Branch, Harold Anderson, Chief Contract Administration Branch, and Ed Thurber Lincoln Resident Engineer. Presented by Colonel John E. Minahan, Area Engineer. 1961.

Lt. Colonel Henderson presents Sustained Superior Performance Award to John C. W. Carroll, Chief, Engineering and Technical Branch. Mr. Carroll was assigned Chief of this Branch when Mr. Duscha was assigned to the Minot Area. 1962.

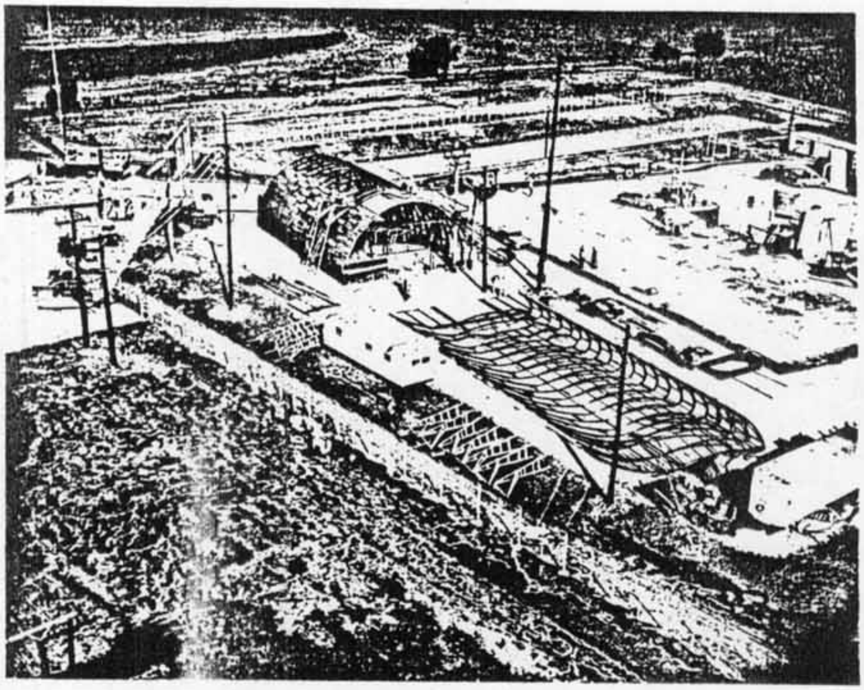
Colonel Minahan presents Sustained Superior Performance Award to Mrs. Dorothy Fencl, Secretary to Chief of Engineering & Technical Branch.

Certificate of Achievement awarded to John M. Clems, Electrical Engineer and Chief of Validation and Test Section by Colonel Minahan.

Plenty of work to do but when people leave we at least like coffee and cake and a bon voyage. Lt. Col. Henderson (near center foreground), Colonel Hastings (right of center background) Col. Minahan (at right).



Colonel John E. Minahan talks with Colonel Hastings during this particular farewell.



SITE 10, ELMWOOD
Aerial view of damage to quonset structures as a result of violent windstorm on 2 September 1961. GD/A Photo No. 52731.

SITE 10, ELMWOOD
Trailer overturned on GD/A station wagon during same period. GD/A Photo No. 52722.

PART XII

Conclusions and Recommendations

PART XII - CONCLUSIONS

The difficult was done immediately, and the impossible took a little longer.

MISSION ACCOMPLISHED!

Refer to copies of letters on following pages:

Letter of Commendation dated 10 October 1961 from Colonel Vernon L. Hastings, Commander, SATAF, to Colonel John E. Minahan, Area Engineer, Lincoln Area.

Letter of Appreciation and Accomplishment dated 26 February 1962 from Colonel T. J. Hayes, Commanding Officer, CEBMCO, to Area Engineer, Lincoln Office, CEBMCO.

HEADQUARTERS
SITE ACTIVATION TASK FORCE COMMITTEE Wahoo
BALLISTIC SYSTEMS DIVISION (AFSC)
United States Air Force
Wahoo, Nebraska

REPLY TO ATTN OF: DSC 10 | 10 Oct 61

SUBJECT: Letter of Commendation

TO: Colonel John E. Minahan
Area Engineer, Lincoln
U. S. Army Corps of Engineers
Ballistic Missile Construction Office
Post Office Box 953
Lincoln, Nebraska

Dear John

1. Prior to the further phase-out of personnel in your office, I would greatly appreciate your passing on to them the following message.

2. Within the next few weeks this SATAF will accept from the Area Engineer the final complex in SMS 551. The acceptance of this complex, and the previous ones, will in each case be prior to the Air Force Need Dates for beginning our Installation and Checkout Phase.

3. As this SATAF commences its next phase of work we are all confident that the quality of facility which you have helped furnish is without equal in the entire Atlas "F" program. This is due, in a large degree, to the tireless efforts of each of you individually.

4. We have had many problems during construction, but in each case we have overcome these through an amicable, unified effort by all concerned. This clearly indicates a devotion to duty and a great interest in making your contribution to our efforts to preserve our freedom.

5. I personally would like to congratulate each of you for a job well done, and feel sure that each of you in the future, will look back with a feeling of pride on the tremendous job you have done here at Lincoln.

Sincerely,

Vernon L. Hastings

VERNON L. HASTINGS
Colonel, USAF
Commander, SATAF Wahoo

Copies to:
General Gerrity
General Welling
Colonel Hayes, CEBMCO

U. S. ARMY, CORPS OF ENGINEERS
BALLISTIC MISSILE CONSTRUCTION OFFICE
5651 WEST 96TH STREET
LOS ANGELES 45, CALIFORNIA

MAIL ADDRESS
A. F. UNIT POST OFFICE
LOS ANGELES 45, CALIFORNIA

26 February 1962

IN REPLY REFER TO: ENGMA-VE

SUBJECT: Letter of Appreciation

TO: Area Engineer, Lincoln
U. S. Army, Corps of Engineers
Ballistic Missile Construction Office
P. O. Box 953
Lincoln, Nebraska

1. As I leave this Command, I wish to express my gratitude and thanks to you, and the personnel of your Office, for the way you have accomplished the vital task of constructing the ICBM facilities at Lincoln Air Force Base. There have been no easy tasks within CEBMCO. However, your position of Area Engineer was one of the most important, the most demanding, and the most difficult. Your achievements speak well for the fine team you have headed and the able way they have performed.

2. We all know that it is the people out in the field, the ones on the firing line as it were, whose accomplishments determine the success of any effort. We at Headquarters are well aware of the difficulties you have faced and successfully surmounted. We recognize that each of our Areas has made a tremendous contribution to the urgent ICBM program. Each of our Area Engineers is to be congratulated, both for his personal efforts and for the way he built and directed a competent and effective organization in the face of unprecedented handicaps.

3. I want to thank you for your tireless efforts and unflagging support. I realize these went far beyond the ordinary. Please extend my personal thanks and my gratitude to all of your personnel for the part they played in helping to achieve the goals demanded by our critical mission. Through their skill and talent, their hard work,

ENGMA-VE
SUBJECT: Letter of Appreciation

26 February 1962

and their high standards, they have made your Base an important contribution to construction history.

4. With great appreciation for your work, and with a hearty "Well done!" for your success, I extend my sincere best wishes for the future.

T. J. HAYES
Colonel, Corps of Engineers
Commanding

PART XIII

References and Miscellaneous

REFERENCES & MISCELLANEOUS

The Geological Report really covers more than the geologic aspects of these sites. Generally, there are excellent resumes of the problems encountered and methods employed in their solution as extracted from the site engineer's daily logs.

Some of the background information and material was secured from Bechtel Corporation and General Dynamics/Astronautics personnel, from Headquarters of CEBMCO, and the Omaha District.

The photographs carry a numerical designation generally; however, in some cases they do not. Those that carry numbers are in four categories:

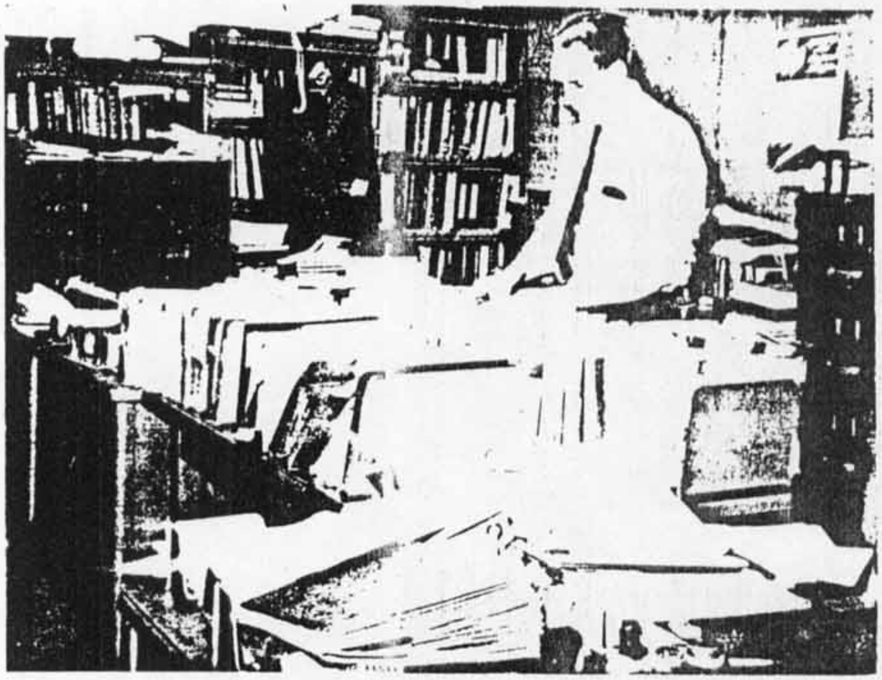
1. Those which were taken by the Omaha District, Corps of Engineers, where the negatives are located.

2. Those from General Dynamics/Astronautics which negatives are at their California headquarters.

3. Those with the letter "C" preceding the number were taken by John M. Clema, the compiler of this resume, negatives for which are available to the Corps.

4. Numbers preceded by "WCC" cover photographs from negatives provided by the Western Contracting Corporation of Sioux City, Iowa.

John M. Clama, Assistant Chief, and Mrs. Audrey Dunn, Secretary, Construction Branch, reviewing material to be placed in Historical Summary. Material on table has been sectionalized prior to collation and assembly.



The corner of the room in Construction Branch where this historical summary was brought to fruition.

RECOGNITION FOR WORK DONE

Recognition for providing material for this documentation should be given to: Lt. Colonel Lester J. Henderson who wrote "Unusual Features of Missile Construction Contracts"; Harold D. Anderson, former Chief of Contract Administration Branch on contract history; John C. W. Carroll, Chief of Engineering and Technical Branch on Structural Steel, Floors and Silo Cap; Loyal F. Harle and Frank Preisinger, Mechanical Technicians, who were of material assistance in the preparation of many pages of this summary; Captain Robert Bush who prepared the original chart on the Time Concurrency Study; Obed Cramer, Management Engineer, who checked some of the sections; and Mrs. Cruzita Cook who did some typing.

Last but definitely not least special thanks to Mrs. Audrey Dunn, Secretary in the Construction Branch who spent many hours typing, pasting, checking, collating and in many other ways assisted in bringing these books to fruition.

JOHN M. CLEMA
Historical Officer