XVIII-19-1

HISTORY

OF

CORPS OF ENGINEERS

ACTIVITIES

AT

SCHILLING AIR FORCE BASE

MARCH 1960 --- DECEMBER 1961

"FOR OFFICIAL USE ONLY"

HISTORY

OF

CORPS OF ENGINEERS

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SCHILLING AIR FORCE BASE

MARCH 1960 --- DECEMBER 1961

"FOR OFFICIAL USE ONLY"

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UNITED STATES ARMY
CORPS OF ENGINEERS BALLISTIC MISSILE CONSTRUCTION OFFICE
LOS ANGELES 45, CALIFORNIA

WS-107 A-1, ATLAS F MISSILE SILO
SCHILLING AIR FORCE BASE
SALINA, KANSAS

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INTRODUCTION

This history is a complete and factual summary report of contract and construction activities encountered by the Corps of Engineers during the construction of the 12 Silo Type Atlas "F" Missile Complexes at Schilling AFB, Salina, Kansas.

It provides a concise history of construction progress, a background on contract administration actions and it is hoped that it will furnish a precedent for solving similiar problems and develop techniques for future ICBM construction.

This history also includes but is not limited to the following areas of interest -- scope of work, personnel and organization of Area Office and SATAF, delays, unusual and unforseen events and what impact they had, major accidents with recommendation for prevention of same, special events, visits by VIP's and ceremonies, relation with SATAF, problem areas, conclusions and recommendations.

Also incorporated are numerous (63) photos, (25) charts, and several (5) newspaper clippings for clarity.

It is hoped that a better appreciation and understanding of the various problems encountered in all areas here at Schilling AFB will be felt by the reader upon review of this history.

As a periferal introduction to the key elements that made the construction at Schilling possible, we have four main agencies involved in this missile construction and installation program, two were military and two were civilian. Each one had a definite and unique function:

a. U. S. Army Corps of Engineers Ballistic Missile Construction Office (CEBMCO) --- directly supervised the construction of the 12

launching silos through the prime contractor (UMS), and several support facilities (LOX Plant, MAB building, etc), by other contractors.

b. USAF Site Activation Task Force (SATAF), Ballistic Systems Division, DCAS, AFSC --- "Purchasing or Using" Agency.

c. Utah-Manhattan-Sundt --- the prime contractor, who physically constructed and placed within the silo that portion of the contract which is stated under the construction section of this history. It does not include the installation of the Atlas F Missile and numerous other related areas.

d. General Dynamics, Astronautics (GD/A) --- designed the Atlas ICBM and who installed it, after the construction phase was completed.

This history covers part a completely; it will cover parts b & c only to the extent necessary for a complete and concise report; it will not cover part d at all.

PART I

ADMINISTRATION

1. U. S. ARMY

CORPS OF ENGINEERS BALLISTIC MISSILE CONSTRUCTION OFFICE

(CEBMCO)

ESTABLISHMENT AND FUNCTION

The U. S. Army Engineers opened a new Ballistic Missile Construction Office in Los Angeles on 1 August 1960. The office was established to further streamline, strengthen, and expedite ICBM site construction. ICBM construction consists of Atlas, Titan and Minuteman squadron sites at various bases, as well as certain testing facilities at Vandenberg AFB, California and Cape Canaveral, Florida.

The Corps of Engineers Ballistic Missile Construction Office (CEBMCO) is commended by Colonel T. J. Hayes.

CEBMCO through the various "Construction Directorates" controls the overall missile site construction program and supplied to the Area Offices any guidance that was requested of them, ie; Construction, Electrical, Mechanical, Engineering, P.L.S., Administration, etc.

Since the Atlas F Areas were quite distanced from CEBMCO, numerous visits were made by CEBMCO representatives to the various areas, thereby assuring CEBMCO of a continual "up to dateness" on what was occuring in the field.

The organization chart (Fig 1) shows the five directorates under CEBMCO, with a further breakdown of the Atlas "F" Directorate, showing its' six areas.

ORGANIZATION CHART
CORPS OF ENGINEER BALLISTIC MISSILE CONST. OFFICE
U S ARMY
LOS ANGELES, CAL.

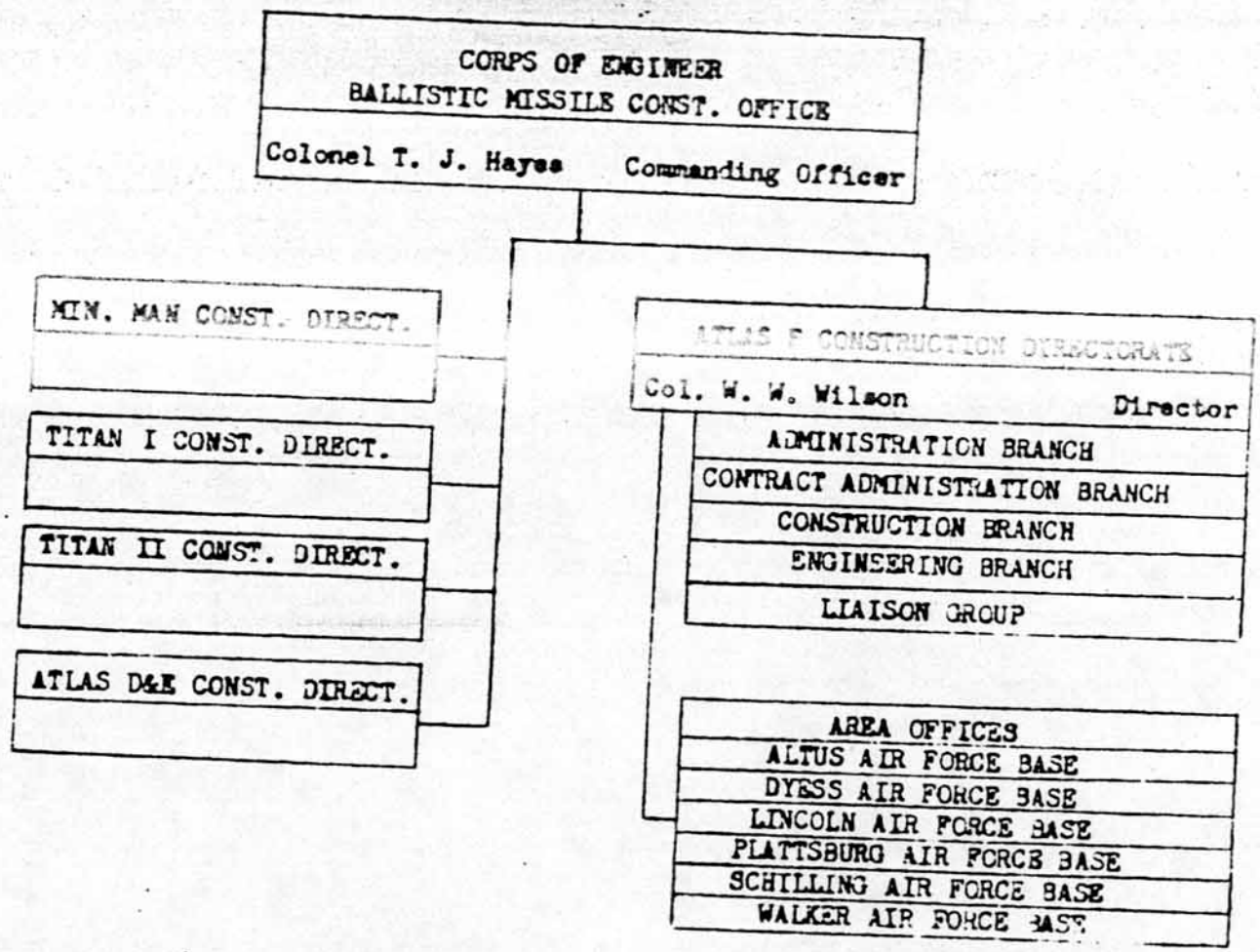
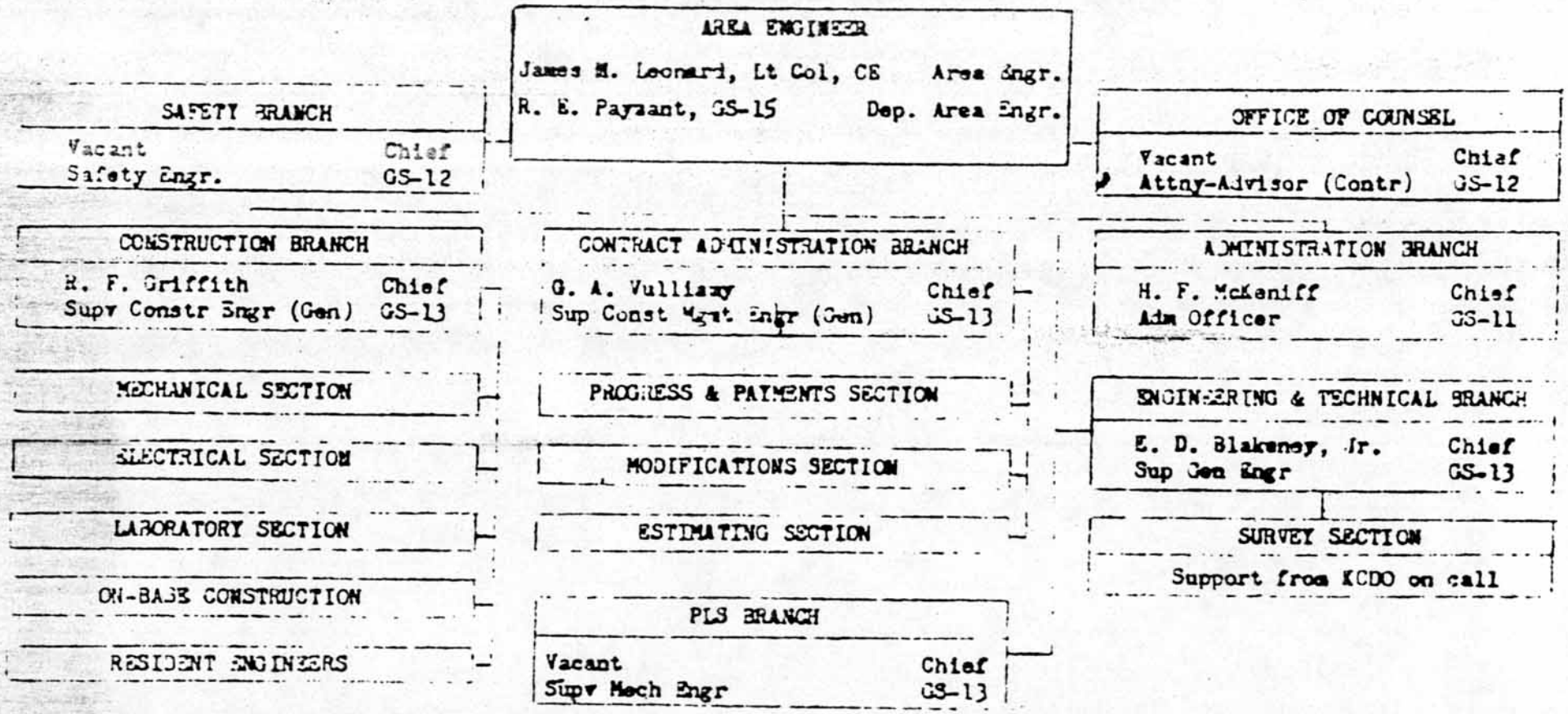


FIG. 1

ORGANIZATION CHART
SCHILLING AREA OFFICE
SCHILLING AFB, KANSAS



MAY 60 - NOV 60

FIG. 2

2. SCHILLING AFFA ORGANIZATION

ESTABLISHMENT OF AREA OFFICE

The SCA Engr Area (Mil) Schilling was established as a field unit of the Kansas City District by KCE Order No. 60-19, dated 15 February 1960. This area was subsequently given the responsibility for supervising construction of ICBM facilities and missile launch complexes in the vicinity of Schilling AFB.

On 25 October 1960, by General Order No. 34, Office of Chief of Engineers, dated 4 October 1960, this area came under the control of CERMCO and was removed from the control of the Kansas City District.

MISSION

The mission of the Schilling Area Office was to perform those portions of contract administration which were delegated from the Atlas F. Directorate of the Corps of Engineers Ballistic Missile Construction Office to the Schilling Area Office. The contracts to which this mission applied were those under which twelve Atlas F ICBM Launch Base Complexes and their related support facilities were constructed. Administrative and logistical support was provided the Area by CERMCO and the Kansas City District to the extent indicated in the document entitled "Division of Responsibilities, Administrative and Logistical Support, Schilling Area Office."

AREA ORGANIZATION AND FUNCTIONS

The Schilling Area Engineer's Office was organized with six branches reporting directly to the Area Engineer. Organization chart Fig. 2 shows organization under Lt Col J. M. Leonard, the Area Engineer, from May 1960 to November 1960. During most of this time, the Schilling Area Office

was under the control of the Kansas City District Office. Organization Fig. 3 shows organization under Colonel E. B. Jennings, the Area Engineer, from November 1960 to September 1961, and organization chart Fig. 4 shows the organization under Lt Col J. H. Leonard, the Area Engineer, from September 1961 to December 1961. The six branches were Administrative, Engineering, Contract Administration, Construction, Safety and Office of The Counsel. Resident Engineer Offices were established as necessary at the construction sites to inspect and supervise contract construction. Originally, Resident Engineers reported directly to the Chief, Construction Branch, but later reported directly to the Area Engineer. The Propellant Loading System (PLS) was a separate branch for a short time, later becoming a section under the Construction Branch.

The functions of the branches of the Schilling Area Office were as follows:

AREA ENGINEER

Supervised assigned construction contracts, represented the Contracting Officer and enforced contract provisions. Directed and coordinated Area Branch activities.

DEPUTY AREA ENGINEER

Assists the Area Engineer, and acts as the Area Engineer during periods when the Area Engineer is absent from the Area.

Provides direction to the technical and advisory and administrative staff in all matters of a technical nature.

EXECUTIVE OFFICER

Assists the Area Engineer and the Deputy Area Engineer in a staff capacity in delegated matters not requiring the immediate or personal attention of those officials, normally assumes duties which include

CORPS OF ENGINEERS
BALLISTIC MISSILE CONSTRUCTION OFFICE
ATLAS F CONSTRUCTION DIRECTORATE

SCHILLING AREA OFFICE
Salina, Kansas

Col Edward B. Jennings	Area Engineer
Lt Col James M. Leonard	Dep Area Engr (Mil)
Richard E. Payzant	Dep Area Engr (Civ)
1/Lt James L. Metallios	Exec Officer

RESIDENT ENGINEERS

SPECIAL ASST FOR EACE COST, TIME STUDIES & ESTIMATES

Earnest G. Moon	Chief
Supv Civ Engr (Gen)	GS-13

ADMINISTRATION BRANCH

H. F. McKeniff	Chief
Adm Officer	GS-11

CONSTRUCTION BRANCH

R. F. Griffith	Chief
Supv Constr Engr (Gen)	GS-14

PLS SECTION

LABORATORY SECTION

ON-BASE CONSTRUCTION

MECHANICAL SECTION

ELECTRICAL SECTION

ENGINEERING AND TECHNICAL BRANCH

E. J. Blakeney, Jr.	Chief
Sup Gen Engr	GS-13

CONTRACT ADMINISTRATION BRANCH

G. A. Vulliamy	Chief
Sup Const Mgmt Engr (Gen)	GS-13

PROGRESS & PAYMENTS SECTION

MODIFICATION SECTION

ESTIMATING SECTION

SAFETY BRANCH

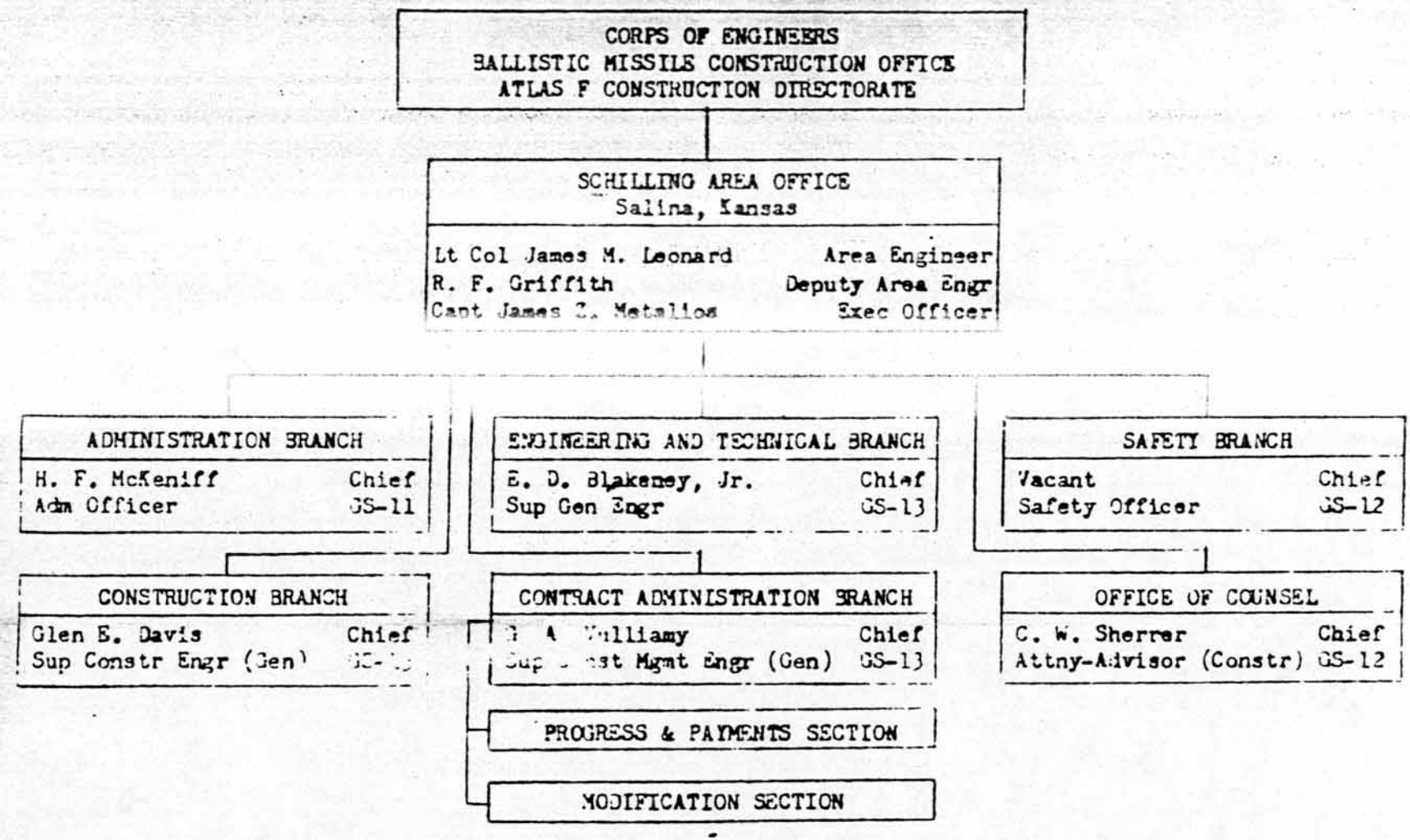
James C. Watkins	Chief
Safety Officer	GS-12

OFFICE OF COUNSEL

C. W. Sherrer	Chief
Attny-Advisor (Constr)	GS-12

NOV 60 - SEPT 61

FIG. 3



SEPT 61 - DEC 61

FIG. 4

coordination, review or approval of matters where guidelines of action have been clearly defined, serves as focal point in all matters relating to the Administrative and Advisory staff, coordinates matters of organization, personnel staffing and space allocation, serves as the principal Administrative Assistant to the Executive Office, coordinates in those matters relating to overall administration where executive action is required, supervises military personnel administration as directed, and performs additional duties as specifically assigned.

ADMINISTRATION BRANCH

Distributed and dispatched incoming and outgoing mail. Maintained area correspondence files and directed the records retirement program. Furnished instruction to clerical personnel and provided stenographic and typist assistance. Maintained control of all required periodic reports, not assigned to other branches. Provided office service including: supply, communication, reproduction and transportation. Coordinated management improvement and security programs. Prepared for signature and distributed all DD Forms 290 and related documents for transfer of construction, and insured that property lists on Form 290 were in proper form for property accounting. Directed civilian personnel actions and maintained records to include: time and attendance, leave, travel orders, cost and pay.

ENGINEERING AND TECHNICAL BRANCH

Provided engineering and technical assistance to area personnel. Reviewed plans and specifications and furnished comments to CERBCO. Resolved conflicts and design inadequacies in plans and specifications and instituted change order action. Furnished contract plans and specifications for use by other branches. Maintained set of all contract plans

and specifications and files of all approved material and shop drawings. Provided Administration Branch with documents (shop drawings, catalogues, etc.) required by using service. Prepared as-built drawings. Performed technical and engineering approvals of soils, concrete, and other materials and equipment. Performed engineering inspections of construction to insure adequate construction standards and compliance with design criteria. Maintained liaison with Architect-Engineer, USAF AMC/BMD Field Office, CEMCO, NCDO, and other Corps of Engineer Districts on engineering and technical matters.

CONTRACT ADMINISTRATION BRANCH

Advised area personnel on contractual matters. Processed progress schedules from contractors, reviewed same, and initiated action for revision or approval. Prepared progress reports. Furnished Engineering Branch with comments for addendum changes on plans and specifications. Maintained budget control of construction contract costs. Prepared contractor pay estimates. Monitored proposed change orders within area office and initiated change order action with contractors. Conducted modification negotiations and prepared and distributed modification documents. Initiated action, and follow-up on government furnished equipment until arrival at job site or railhead. Expedited construction materials. Furnished monthly to Administration Branch current and projected contractors' earnings for inclusion in Government Cost Reports. Reported work stoppages to CEMCO.

CONSTRUCTION BRANCH

Supervised and conducted continuous inspections of construction activities. Directed the job-level Instructor Training Program. Reported

to the Engineering Branch conflicts and design inadequacies occurring in the plans and specifications. Assisted in the negotiations for change orders, and reviewed proposed changes for construction feasibility and time impact. Provided Contract Administration with information for pay estimates and progress reports. Insured maintenance of a set of contract prints showing as-built conditions. Arranged for transfers of construction to the Using Agency. Provided Administration Branch with data for ENG Form 290 and other transfer documents. Established and furnished construction completion and acceptance dates to Contract Administration Branch. Reported work stoppages to Contract Administration Branch and prepared formal work stoppage reports. For a period of time, directly supervised the Resident Engineers.

SAFETY BRANCH

Worked under the general supervision of the Area Engineer. Duties included the administration of and operation of the Area Accident Prevention Program. Reviewed contractor's pre-work proposals. Advised on technical aspects of contractor construction work methods. Detection of hazards and recommended corrective action. Implemented Regulatory Controls, Safety Standards and Codes. Developed or reviewed design of safety guards, scaffolds, ventilating systems, etc., was responsible for fire prevention and protection. Insured adequate and prompt reporting procedures, and lastly, originated or directed Safety Engineering Studies when new, unusual or novel problems arose due to new requirements of missile site construction.

OFFICE OF AREA COUNSEL

The Area Counsel advised the Area Engineer and his staff on administrative actions where legal questions were involved and as to the

Government's rights and obligations under construction contracts. He considered claims under construction contracts and made recommendations to the Area Engineer. He advised personnel assigned to Contract Administration duties on legal problems confronting them during the administration of contracts requiring interpretation of contract clauses and/or technical provisions of contracts. He also coordinated problems that arose via labor relations.

PART II

CONSTRUCTION HISTORY

3. SCOPE OF WORK

The design Architect-Engineer was Bechtel Corporation of San Francisco, California.

The original contract consisted of 9 underground silos and launch control centers. A few months later this was increased by negotiated modification to 12 silos and launch control centers.

The concrete silos (LS) were 52'-2" in diameter and 174' in finished depth, heavily reinforced with a 9' thick reinforced concrete cap that is equipped with hinged double doors. The heavily, reinforced concrete launch control centers (LCC), which provided quarters for the launch crews as well as all launch control equipment, are connected to the silo by an underground tunnel equipped with blast doors.

The silo and the launch control center contain structural steel cribs suspended on steel hangers and are fully equipped with heating, ventilating, air conditioning, diesel electric generators, plumbing, process vessels and piping for the propellant loading system, fire and gas detection systems, etc., and along with the exterior underground fuel and water storage tanks, provide an installation which is self-sustaining and independent of outside supply for a considerable length of time.

Exterior to the silo and launch control center there are water wells, underground diesel fuel tanks, water storage tanks, sewage sand, filter tile fields and a blast detection system. Also, paved roads and parking areas were made available within the security fence as well as a paved access road connecting with the nearby public road net.

The following itemized areas are of importance as major problem areas which caused delays here at Schilling:

a. Changed Conditions

b. Design Changes

c. Process Vessels

d. Propellant Loading System Prefabs

e. Diesel Generator Operation

f. Government Furnished Property

g. Relocation of Access Roads

h. Differences in Tolerance

i. Gas Detection System

j. Emergency Lights

k. Blast Closures

l. Silo Submersible Pumps

m. LCC Sewage Pumps

The above mentioned items are covered in detail in this section and in the Contract Administration Section of this report.

UTILITIES

The utilities during construction (as required by the specifications) were provided by the contractor. At some sites commercial power was provided. All sites were equipped with a portable generator to provide power in case of an emergency. Some sites had more than one generator.

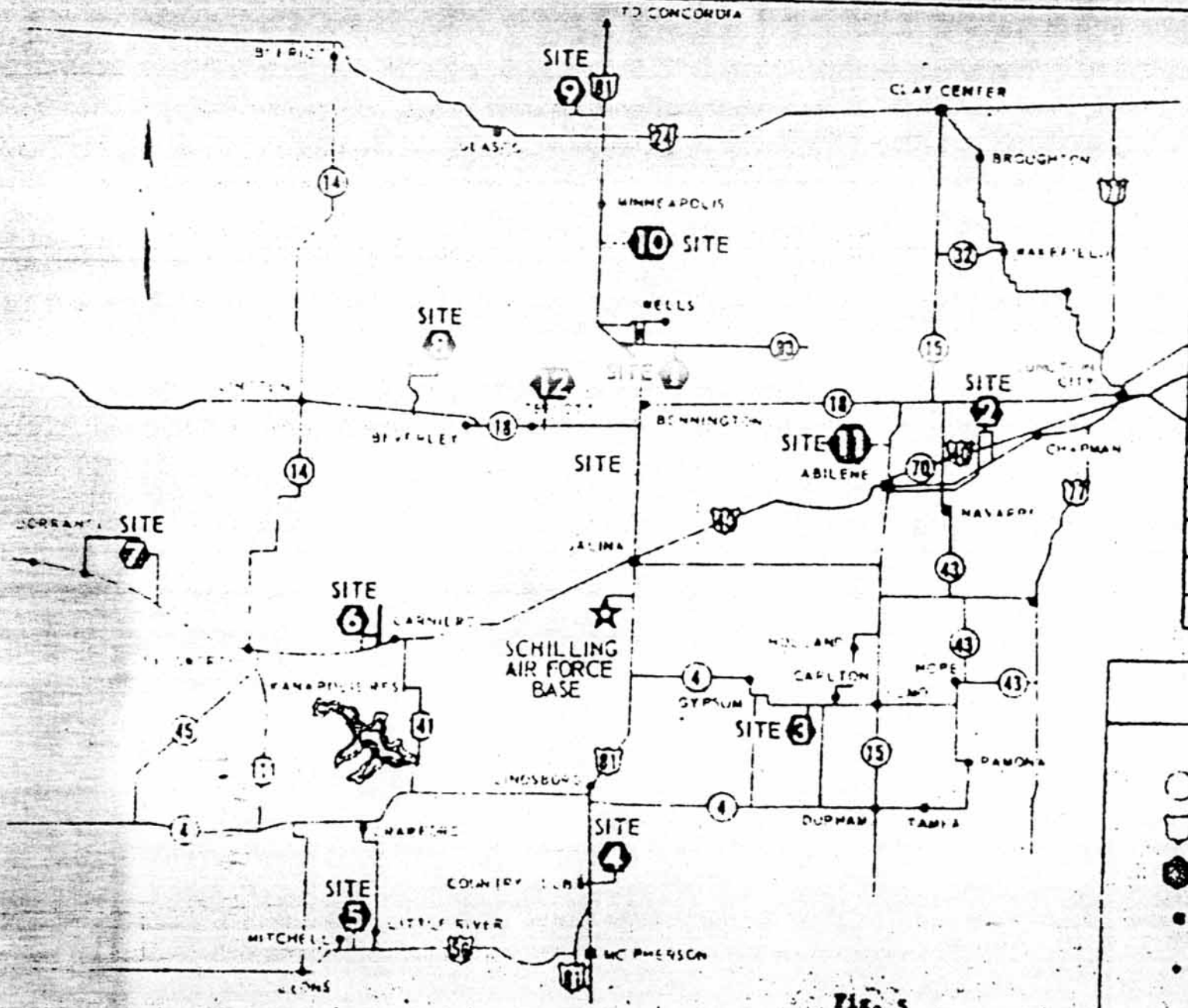
Water was hauled in from nearby towns and placed in large storage tanks which the contractor had provided for this purpose. These water storage tanks varied in size from site to site but most of them held approximately 10,000 gallons.

Mobile compressors were used for all the pneumatic tools.

TOPOGRAPHY

The topography of the areas where the missile sites are located (vicinity of Schilling Air Force Base) was in general, rolling, hilly country. In most cases it is cattle grazing land. At several sites the lands had been cultivated. On the average there was from one to fourteen feet of top soil covering the twelve (12) areas.

AREA MAP - SCHILLING AIR FORCE BASE



DISTANCE FROM SCHILLING TO SITES	
SITE	MILES
1	22
2	[illegible]
3	25
4	28
5	[illegible]
6	28
7	51
8	45.[illegible]
9	55
10	32
11	30
12	37

SYMBOLS

- STATE HIGHWAY
- GOVERNMENT HIGHWAY
- SITE
- TOWNS OVER 2000 POPULATION
- TOWNS OF 2000 POPULATION OR LESS

Fig. 5

4. GEOLOGY OF THE SITES

The geologic characteristics of the twelve sites at Schilling varied from site to site. The borings, Figures 6, 7, and 8, which were part of the contract drawing, clearly show the different materials encountered at all 12 sites. Following is a summary of each site geological characteristics.

SITE 1

This site (Fig. 6) was covered with about 3' of top soil. Ground elevation was 1392.7. Under the top soil was a deep layer of poorly cemented fine to medium grained sandstone. The deeper the shaft was excavated the coarser became the sand in the sandstone. This material (sandstone) was located between elevation 1397 and elevation 1259. At elevation 1285 the water table was encountered. There was approximately 800 gpm flowing into the silo. Since this was a poorly cemented material, the water washed the sand into the shaft. This situation presented many problems and delayed the excavation of the shaft for approximately 60 days. From elevation 1259 to the bottom of the silo, a dark bluish gray shale was encountered. Some of the shale was hard enough that it required blasting; but most of it could be ripped, with the ripper attached to the highloader. The shale was void of water. Problems encountered and solutions to those problems are more fully covered under the Excavation Section of this report.

SITE 2

This site (Fig. 6) was mantled with 9 to 14.5 feet of material composed of lean clay. Near the base of this mantle, there existed fragments of limestone and shale in a matrix of fat clay. Below this overburden there existed about 40 feet of shale of the Wellington Formation. From

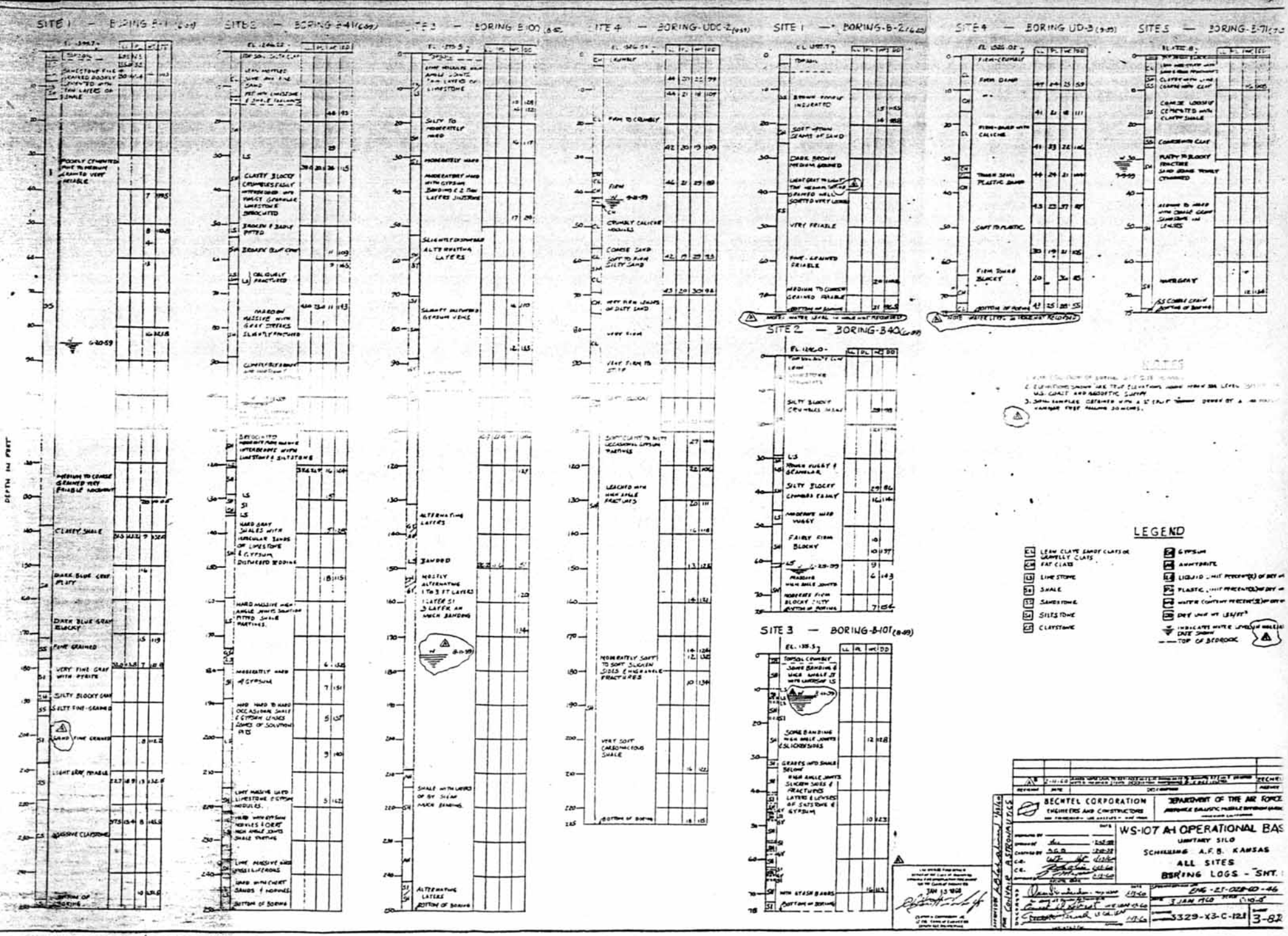

SITE 1 — BORING B-1
SITE 3 — BORING B-4
SITE 3 — BORING B-100
SITE 4 — BORING UDC-2
SITE 1 — BORING B-2
SITE 4 — BORING UD-3
SITE 5 — BORING B-7
SITE 2 — BORING B-40
SITE 3 — BORING B-101
DEPTH IN FEET
LEGEND
LEAN CLAYS SANDY CLAYS OR GRAVELLY CLAYS
FAT CLAYS
LIMESTONE
SHALE
SANDSTONE
SILTSTONE
CLAYSTONE
GYPSUM
ANHYDRITE
LIQUID LIMIT PERCENT(%) OF DRY WT
PLASTIC LIMIT PERCENT(%) OF DRY WT
WATER CONTENT PERCENT(%) OF DRY WT
DRY UNIT WT LBS/FT³
INDICATES WATER LEVEL IN HOLE AND DATE SHOWN
TOP OF BEDROCK
BECHTEL CORPORATION
ENGINEERS AND CONSTRUCTORS
DEPARTMENT OF THE AIR FORCE
WS-107 A1 OPERATIONAL BAS
UNITARY SILO
SCHRIEVING A.F.B. KANSAS
ALL SITES
BORING LOGS - SHT.
3329-X3-C-121
3-82

FIG. 6

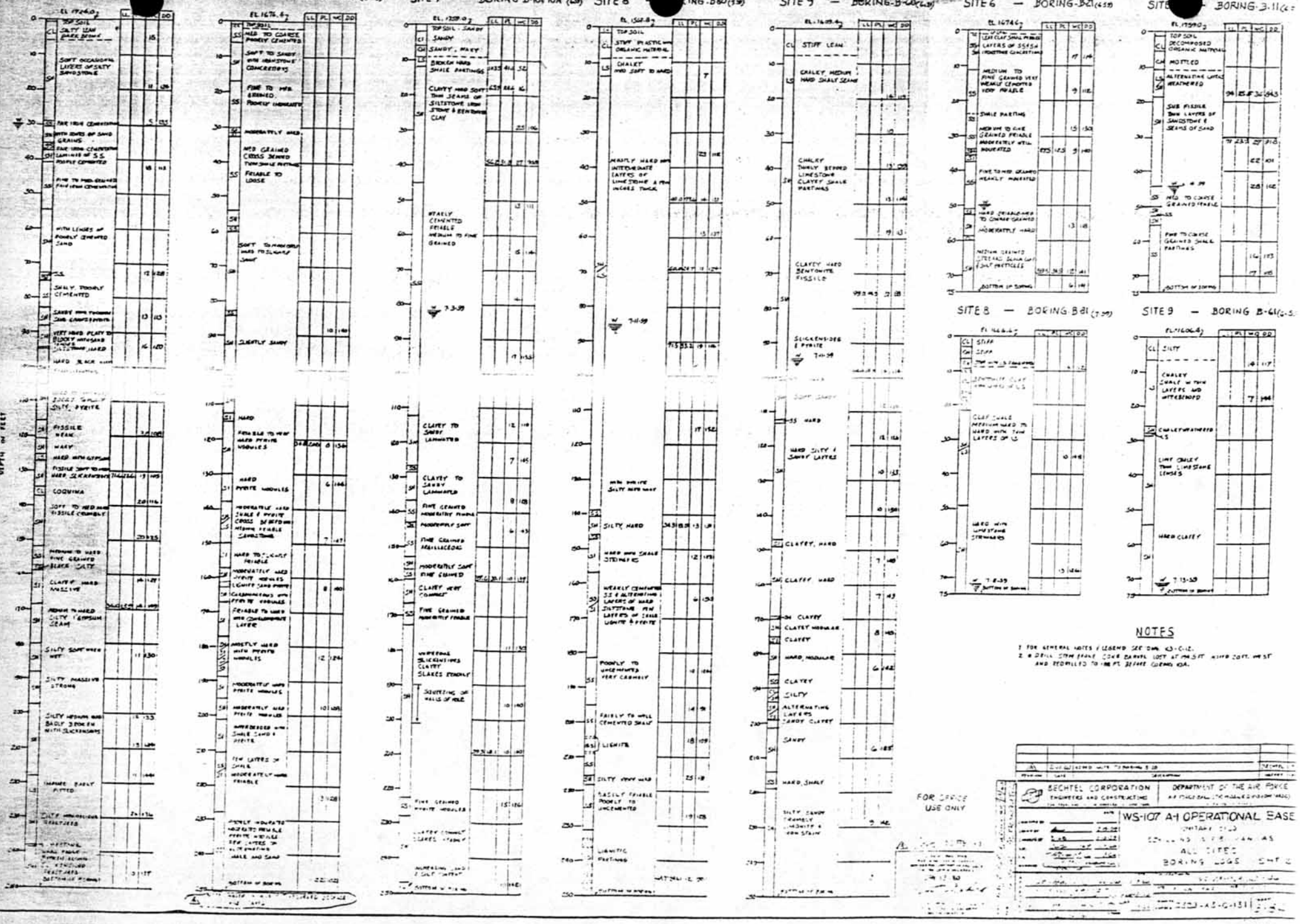
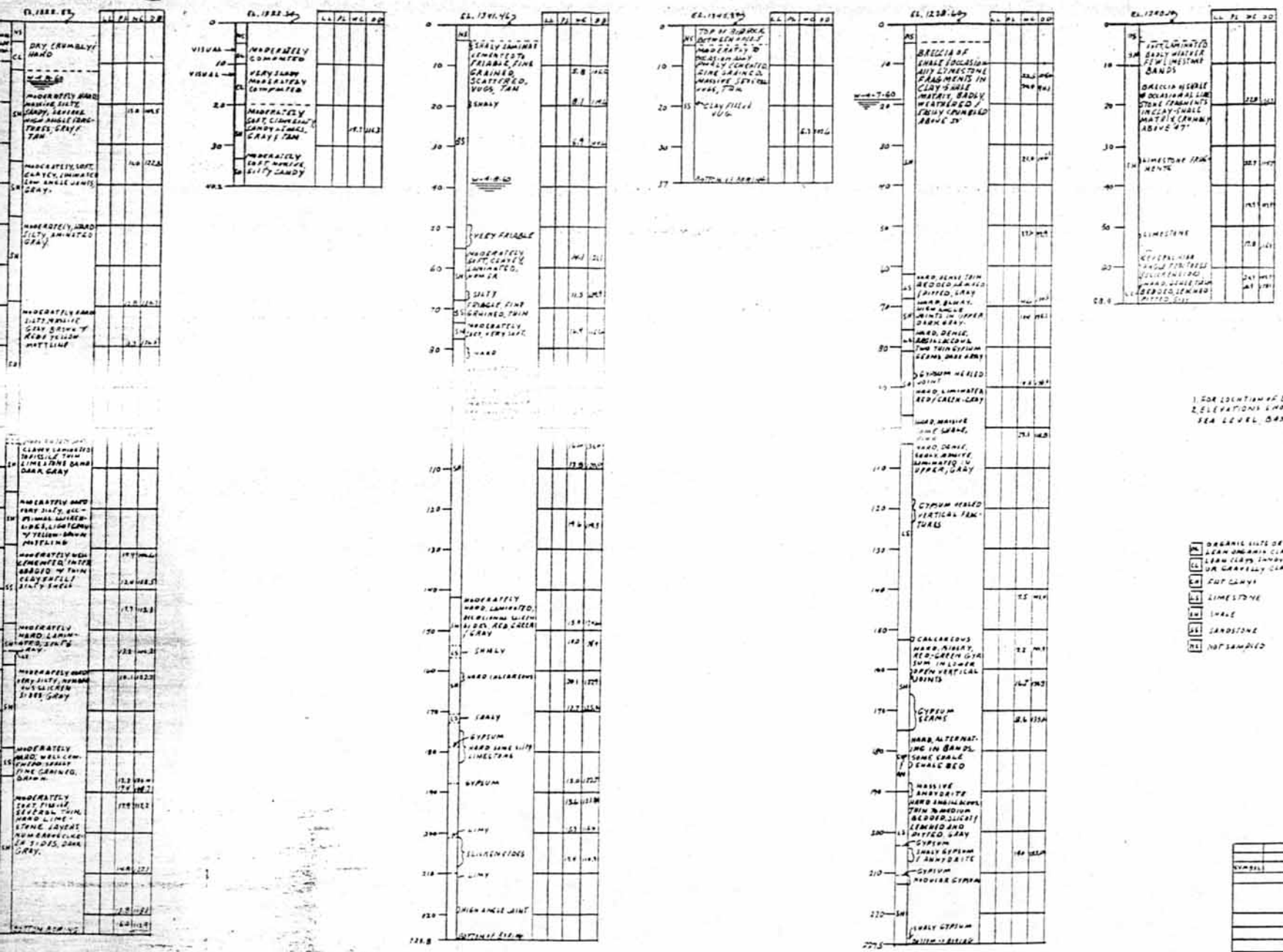

SITE 5 — BORING B-20 (7-59)
SITE 6 — BORING B-20 (6-59)
SITE 7 — BORING B-10 & 10A
SITE 8 — BORING B-80 (5-59)
SITE 9 — BORING B-60 (6-59)
SITE 6 — BORING B-21 (4-59)
SITE 7 — BORING B-11
SITE 8 — BORING B-81 (7-59)
SITE 9 — BORING B-61
DEPTH IN FEET
NOTES
1. FOR GENERAL NOTES & LEGEND SEE DWG. 43-C-12.
2. A DRILL STEM FRAME CORE BARREL LOST AT 194.5 FT AND REDRILLED TO 198 FT BEFORE CORING 10A.
FOR OFFICE USE ONLY
BECHTEL CORPORATION
ENGINEERS AND CONSTRUCTORS
DEPARTMENT OF THE AIR FORCE
WS-107 A-1 OPERATIONAL BASE
ALL SITES
BORING LOGS

FIG. 7



NOTES

1. FOR LOCATION OF BORINGS SEE PLANS.
2. ELEVATIONS SHOWN ARE TRUE ELEVATIONS ABOVE MEAN SEA LEVEL, BASED ON U.S. COAST AND GEODETIC SURVEY.

LEGEND

- OH ORGANIC SILTS OR LEAN ORGANIC CLAYS
- CL LEAN CLAYS, SANDY CLAYS OR GRAVELLY CLAYS
- CH FAT CLAYS
- LS LIMESTONE
- SH SHALE
- SS SANDSTONE
- NS NOT SAMPLED
- GY GYPSUM
- AH ANHYDRITE
- LL LIQUID LIMIT % OF DRY LIMIT
- PL PLASTIC LIMIT % OF DRY LIMIT
- WC WATER LIMIT % OF DRY LIMIT
- DD DRY UNIT WT. LBS/FT³
- WATER LEVEL IN HOLE DATE SHOWN
- TOP OF NEO ROCK

SYMBOL	DESCRIPTION	DATE	APPROVAL
	REVISIONS		

U.S. ARMY ENGINEER DISTRICT
KANSAS CITY
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

SCHILLING MISSILE SITES

SCHILLING A.F.B. KANSAS

SITES 9 11 & 12

BORING LOGS

FIG. 3

this Wellington formation to the bottom of the excavation, there was a sequence of alternating shales and limestones of the Permian Chase Group. In the lower part of this Permian Chase Group there were zones of gypsum.

The water table was encountered at about 92 feet below the surface. Ground elevation was 1246.22. The flow into the excavation was approximately 150 gpm at this depth. At 103 feet below the natural ground there was a total flow of approximately 550 gpm. Problems and their solutions are more fully covered in the Excavation Section of this report.

SITE 3

This site (Fig. 6) was covered with 2' to 7' of lean and fat clays. Under the top soil there was a layer of fractured and deeply weathered shales about 17' deep. At this point there was a 3' layer of soft blue-gray shale which prevented intense weathering below it. Below this layer there were thin beds of siltstone and some impure limestones throughout the shale, down to approximately 132'. The last 50' of this area also had layers of gypsum. Anhydrite occurred in primary beds below 132 feet. The maximum observed thickness of an individual bed was 12 feet. From the top of bedrock to a depth of approximately 132 feet, there were numerous faults and disturbed areas. From 132 feet to the bottom of the excavation the shales were less disturbed. There was no water problem at this site.

SITE 4

This site (Fig. 6) was covered with 95 feet of overburden which consisted of lean and fat clays, with lean clays predominating. From

95 to 110 foot depths, there was a shale, Kiowa, which was not much harder than the clays above. The Minnescah shale which lay from the 110 to 160 foot depths was a soft shale. The Wellington shale was encountered at 160 foot depth and extended to the bottom of excavation. Water was encountered approximately 43 feet down which caused some minor problems, mainly with the site tube excavation. The sight tube excavation had to be trenched at this site instead of tunneled as done at all other sites. The contractor had to use lagging in areas of the shaft where the material was sloughing. Weep pipes were installed to assist in eliminating the water. This problem area is covered in more detail in Excavation.

SITE 5

This site (Fig. 7) was mantled with 6 feet of lean clay. Below this overburden were beds of silty gray shales and moderately well cemented sandstone of the Dakota formation extending to a depth of approximately 76 feet. From this depth to approximately 159 feet, black shales and subordinate siltstone of the Kiowa formation were encountered. Below this formation were green, gray and red clay shales of the Minnescah formation which existed to the bottom of the excavation. Ground water caused some problem during excavation. About 30 gpm was encountered at reference elevation 932. A water ring was placed at elevation 928 to catch the water and pump it out of the silo. The ground water sometimes exceeded this amount (30 gpm) but never was excessive. Excavation was done under muddy conditions a good part of the time.

SITE 6

This site (Fig. 7) was covered with 1 to 2 feet of top soil and had

several outcrops of bedrock around the east and south side of the site. Below the top soil was a thick series of Dakota sandstone and shales which extend to a depth of 172 feet. The shale was more of a claystone than a typical shale. Below the depth of 172 feet there were gray shales and siltstones of the Niobrara formation which extended to the bottom of the excavation.

Some seepage was experienced in the open excavation. This never became a problem. At reference elevation 908 some lagging had to be used to prevent sloughing but again the water caused no special problems. At referenced elevation 832 seepage into the silo caused a slight delay in excavation because of the muddy conditions encountered. Said water was pumped out of the silo.

SITE 7

This site (Fig. [illegible]) was mantled with 9 to 10 feet of residual clay soil which changed from lean to fat clay at a depth of about 5 feet. Below the top soil there was approximately 2 to 4 feet of cretaceous limestone and shale of the Greenhorn formation. Under this layer was 30 to 40 feet of shale of the Graneros formation. The rest of the excavated area consisted of sandstones and shales of the Dakota formation.

There were some problems with ground water. At reference elevation 907 there was about 30 gpm. A water ring was used at elevation 880. This water ring was quite successful. From this elevation down, there was some water that drained to the bottom of the shaft but it did not interfer with the excavation production.

SITE 8

This site (Fig. [illegible]) was covered with 4 to 8 feet of top soil which changed from a lean clay to a fat clay at a depth of 1 to 2 feet. Below

this overburden to a depth of approximately 26 feet a layer of highly weathered, brown to yellow colored, shales and soft limestones of the Carlile formation existed. Alternatingly, hard limestones, and limey dark gray shales, of the Greenhorn formation existed from a depth of 26 feet to a depth of 125 feet. From this depth to 160 feet there was a Graneros shale and siltstone. Below 160 feet there was carbonaceous clayey siltstone and sandstone of the Dakota formation.

Ground water was not encountered during excavation at this site.

SITE 9

This site (Fig. 7) was covered with 6 to 8 feet of stiff, brown, lean clay and silt. From the base of the soil mantle to a depth of 32 feet weathered shaly limestone of the Carlile formation was encountered. The Greenhorn formation between 32 and 101 feet consists of, dark gray-limey shales to a depth of 135.5 feet. From this depth to the bottom of the excavation, the Dakota formation was encountered and this consists of massive shales with silt and sandy lenses and thin layers of siltstones and sandstones.

Ground water was not encountered at this site.

SITE 10

The overburden at this site (Fig. 8) consisted of about 10 feet of predominantly lean clays. From this depth to 129 feet the bedrock consists of shales and siltstones. For the first 35 feet the material was weathered. Below this, there were zones which were fractured and slickeided. Between the depths of 129 feet and 149 feet a layer of sandstone was encountered. Just below the sandstone to a depth of 136 feet another

layer of shale was encountered. Below this shale to the bottom of the excavation was a somewhat softer dark shale.

Some seepage was encountered at elevations 914 and 889. More water was encountered at elevation 874. At 870, sufficient water was entering the shaft excavation to require pumping, (about 15 gpm). When excavation has reached elevation 859 about 60 gpm had to be pumped from the shaft.

Two water rings were constructed during excavation to control the flow of water. The second water ring was fairly successful. During periods when the water was not successfully controlled the bottom became so slick and muddy that the high-loader would bog down. This condition slowed down excavation at several different times.

At several elevations the sides of the silo had to be supported to prevent sloughing.

SITE 11

This site (F[illegible]) was covered with 5 feet of overburden. The bedrock from the overburden shale contact, to a depth of 50 feet was a highly weathered brecciated shale, with the size of the pieces ranging from 1 to 3 inches and were surrounded by a matrix of clay. From 51 feet to 61 feet the material was also brecciated but the pieces range from 6 inches to 3 inches and were held much more lightly in the compacted clay. Below a depth of 6[illegible] feet the material alternated between shales, limestones and gypsum.

Water was encountered at elevation 1209. The source of the water was through a limestone layer. This water was located in the open excavation area. A sump was excavated off to the side of the main part of the

excavation. A trench was excavated around part of the toe to the open excavation and the water was drained into the sump via this trench. About 75 gpm was pumped from this sump. This kept the free water away from the bottom of the shaft excavation at all times. Test wells were drilled at the time the open excavation was completed. Very little water was encountered in the shaft excavation itself.

When the excavation was completed, an old boring was discovered which was leaking gas into the silo. This hole was reamed and grouted shut. This prevented the escaping gas from entering the silo proper.

SITE 12

The overburden depth at this site (Fig. 5) was less than 5 feet. From the overburden to a depth of 55 feet a layer of weathered Dakota sandstone existed. Below shale was encountered from a depth of 55 feet to a depth of 141 feet. From this depth to the bottom of the excavation the Hinnescah shale was excavated.

Seepage was present at elevation 946. A water ring was placed on the 8th ring beam and again on the 14th ring beam. Below this level little water was encountered. The water that was pumped out during most of the excavation averaged about 50 gpm.

5. EXCAVATION AND BACKFILL

GENERAL

The logs and a geologic description of each site, which has already been discussed, show the materials that were encountered during the open excavation and the shaft excavation.

The first phase of excavation, the open excavation, was done on six, ten hour shifts and was accomplished generally by DW 20's and 21's pushed by dozers as shown in figure 9. The dozers also utilized their ripper attachment to loosen the material. This operation took approximately ten to fifteen days depending on the amount of equipment used and the weather conditions.

Problems encountered during this phase of the operation consisted mostly of muddy conditions in the silo (shaft) excavation that prevailed at the first few sites (Mar, Apr. of 1960). While at Site 11 ground water was encountered at the beginning in the open excavation, causing some problems, (Geology, Site 11).

The sequence for the shaft excavation and the respective completion dates for the 12 sites was eventually stabilized as: Site 3, 9, 3, 6, 5, 7, 4, 1, 11, 10, 12 and [illegible]

SHAFT EXCAVATION

The second phase of excavation, shaft excavation, was done on an around the clock basis, seven days a week. This excavation was performed with a Cat 977 in the shaft. The Cat 977 was equipped with a front end loader and with a ripper to loosen the material at the bottom of the shaft when this was possible. The high-loader, at the bottom of shaft, is shown in figure 10. If the material became too hard to rip then some blasting was required. After the material was loosened it was scooped

Figure 9. Open excavation operation done by dozers, IW20's and 21's.

Figure 10. Highloader working in bottom of shaft. Safety fence can be seen at top of the picture.

up with the high-loader bucket, and dumped into a four cubic yard miners bucket. This bucket was hoisted to the top of the excavation by a crane and the material dumped into dumpsters which in turn hauled the material to the designated stock pile area. Figure 11 shows the crane bucket and dumpsters.

Throughout the excavation a chain link fence divided the shaft into two parts. The bucket was raised and lowered on one side of the fence. The men and equipment at the bottom of the shaft remained on the other side of the fence while the bucket was raised and lowered. This was done as a safety precaution.

At the top of the shaft excavation, a concrete pad was placed around the circumference with "I" beams imbedded within it to support the top ring beam at reference elevation 910 as shown in figure 12. This top ring beam was set accurately, by survey, so that it could be used as a template for succeeding ring beams. The ring beams were succeedingly placed as the excavation progressed. Each ring beam was placed before the excavation exceeded 1½ times the design distance between ring beams.

At both sites 8 and 9 there was a five day and four day delay respectively between placing the 4th and 5th ring beams because the beams had not been fabricated and shipped to the sites when the Contractor was ready to place them. Other this initial delay at these two sites only, there were no more delays due to a late shipment of ring beams.

The ring beams were secured in place by driving oak wedges every four feet along the circumference between the ring beam and the excavated wall as shown in figure 13. The wedges were driven so as to position the ring beam in its proper location.

Figure 11. Cr[illegible] with bucket at elevation 560. Dumpsters for [illegible]ulling excavated material are also shown.

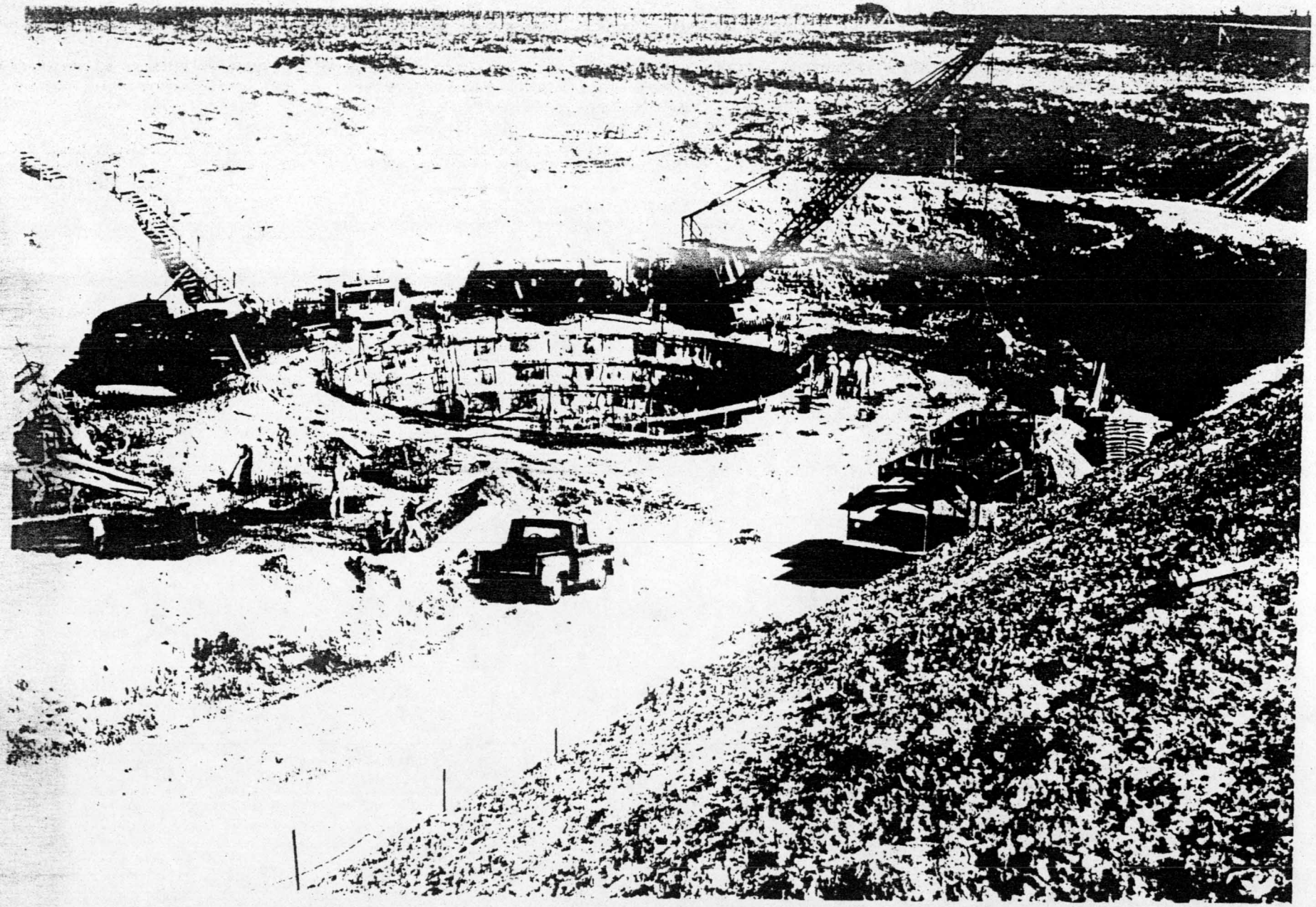
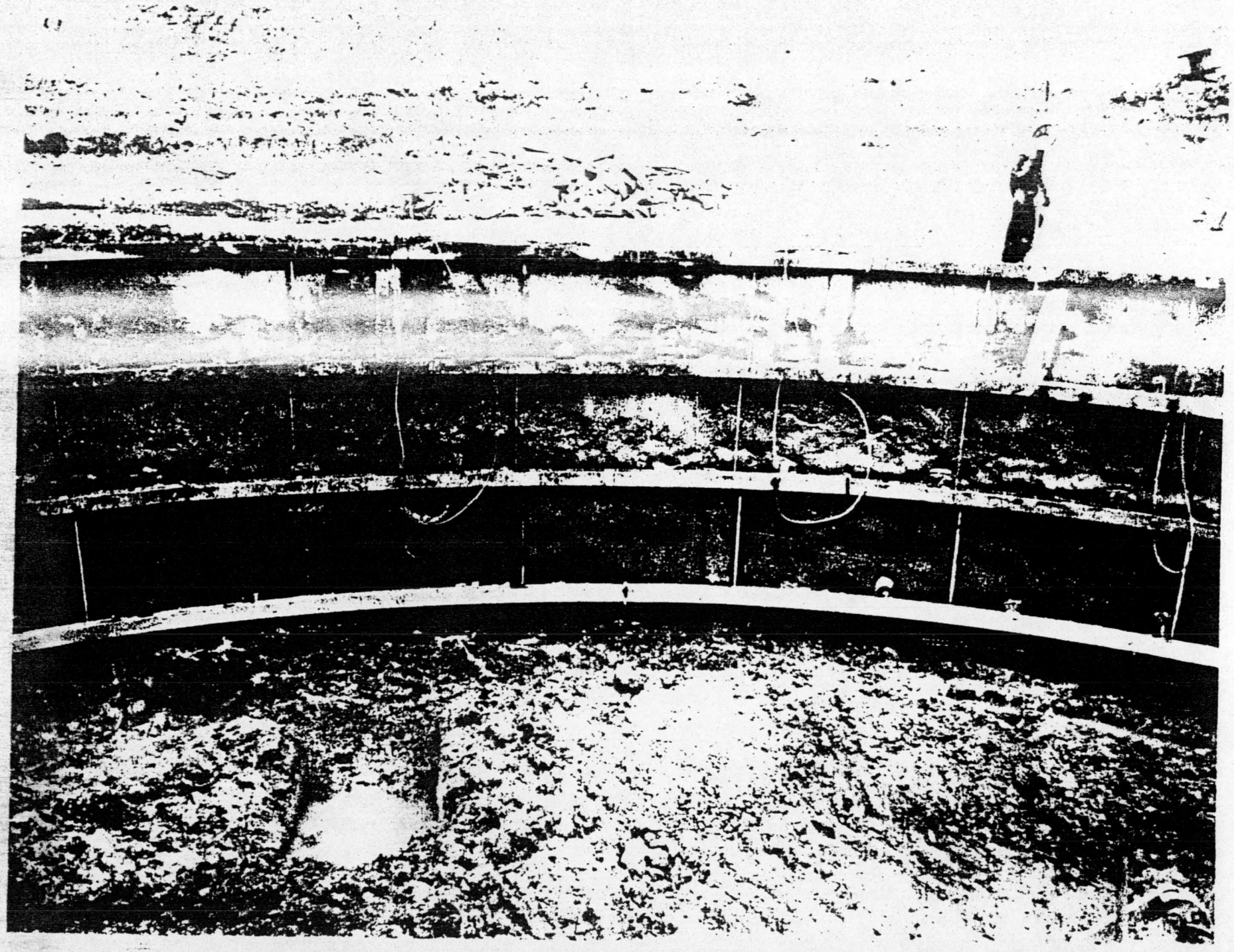


Figure 12. Concrete pad with I beams used to support Ring Beam at elevation 960.

Figure 13. Oak wedges and oak lagging used to support ring beams and excavation.



In the area of the first six ring beams a problem developed (at all sites) at the location of the fill and vent shaft. In this area you could not drive wedges between the excavated walls and the ring beams because there wasn't any excavation behind the ring beam. This left an area where the ring beams were (virtually) unsupported. To overcome this, the ring beams were supported from the ring beam below, by use of timbers. At some sites there were timbers wedged between the ring beam and the back of the fill and vent shaft excavation for additional support. Figures 14 and 15 shows the area of the fill and vent shaft and the timber supports used. Before slip forming one of the ring beams in this area had to be cut because it passed through the fill and vent shaft blockouts. (2).

Two by two wire mesh was placed along the circumference of the ring beams between the ring beams and the excavation, for reinforcement, prior to the shooting of the gunite, as shown in figure 16. Several problems developed in placing the gunite. The contractor had a difficult time trying to keep the rate of gunite placement up with the rate of excavation. The specifications required placement of the gunite on the silo walls within 24 hours after they had been exposed. This was not usually the case at the beginning, but was improved with time. Figure 17 shows the gunite operation.

Few gunite test cylinders passed the compressive strength requirements. This could have been caused by several different factors. Making the cylinders was a problem; cylinders were made both standing vertically and laying horizontally but the rebound caused trouble both ways. Making uniform cylinders was never perfected and therefore, numerous irregularities within the cylinder samples existed.

Figure 14. Supporting ring beams in the area of fill and vent shaft.

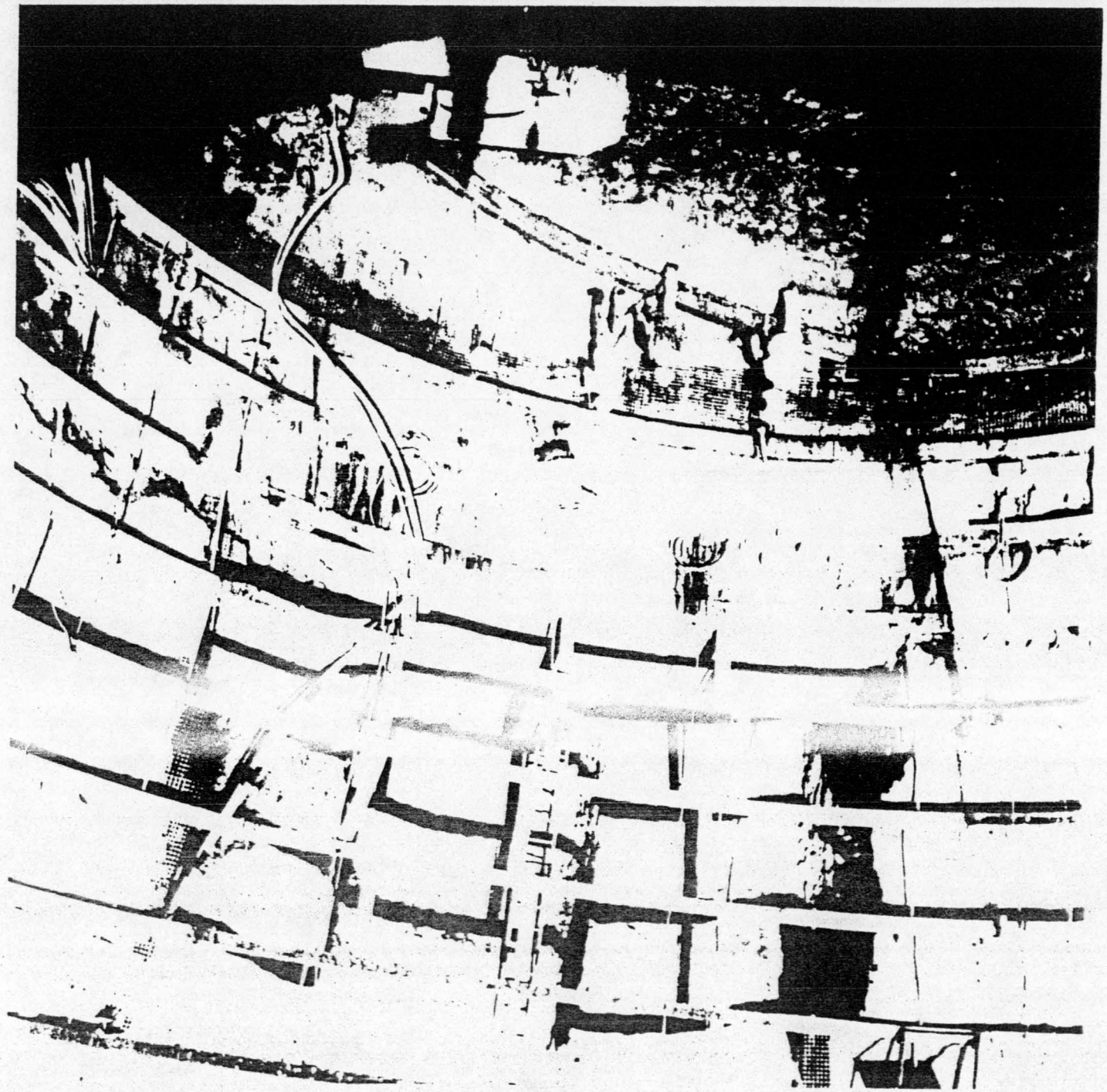


Figure 15. Supporting wing beams in the area of fill and vent shaft.

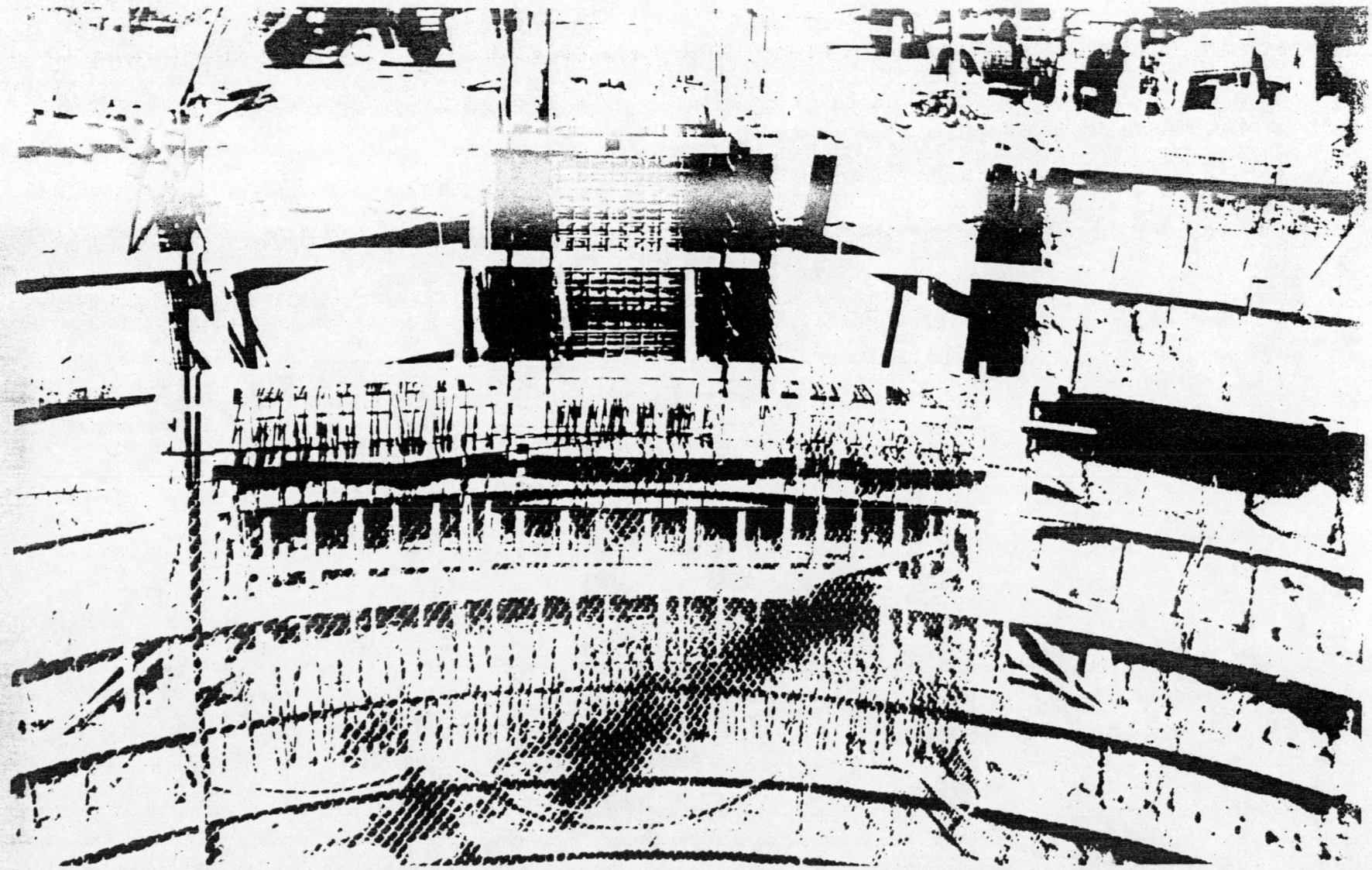


Figure 14. 2 x 2 wire mesh used between ring beams for reinforcing steel for gunite.

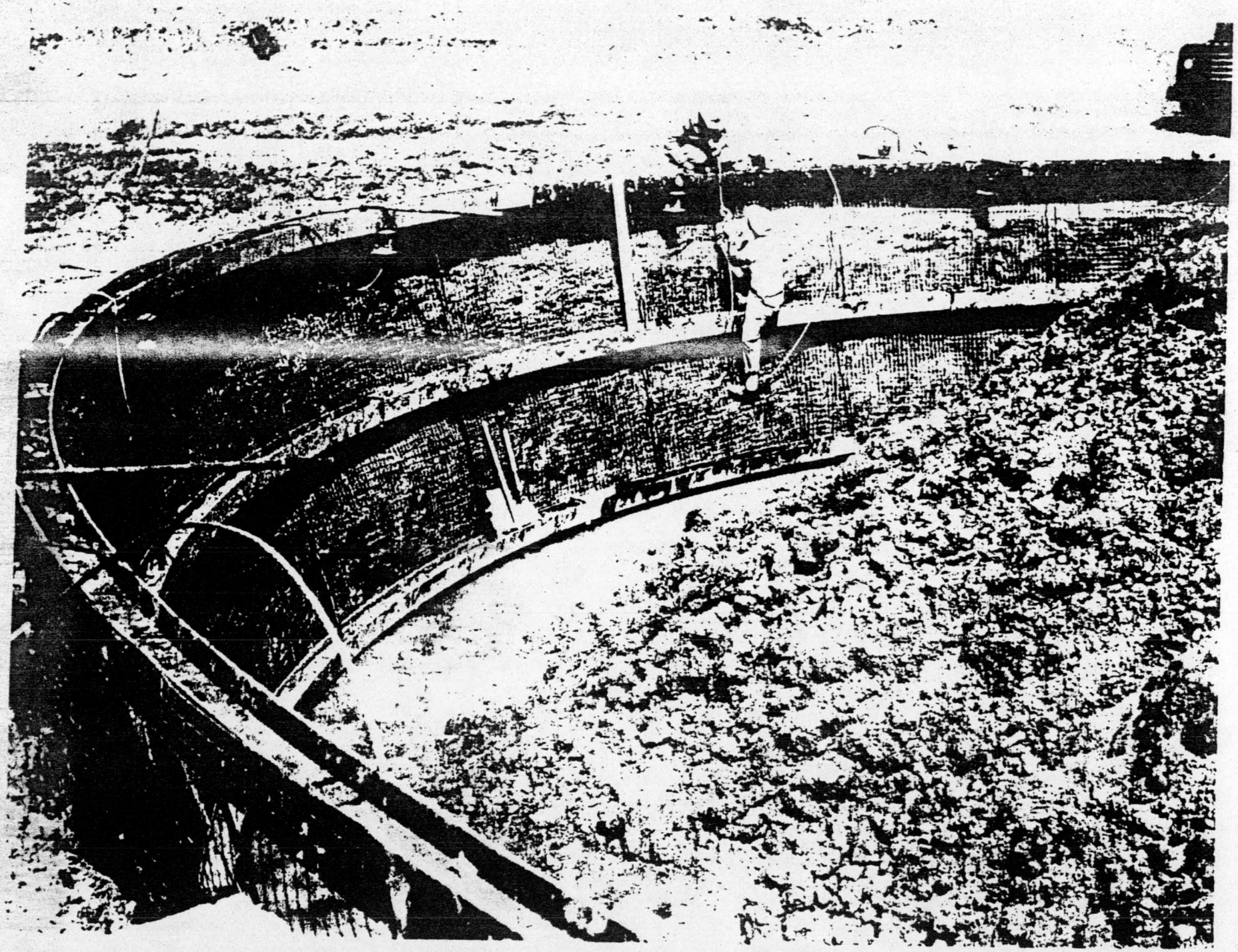
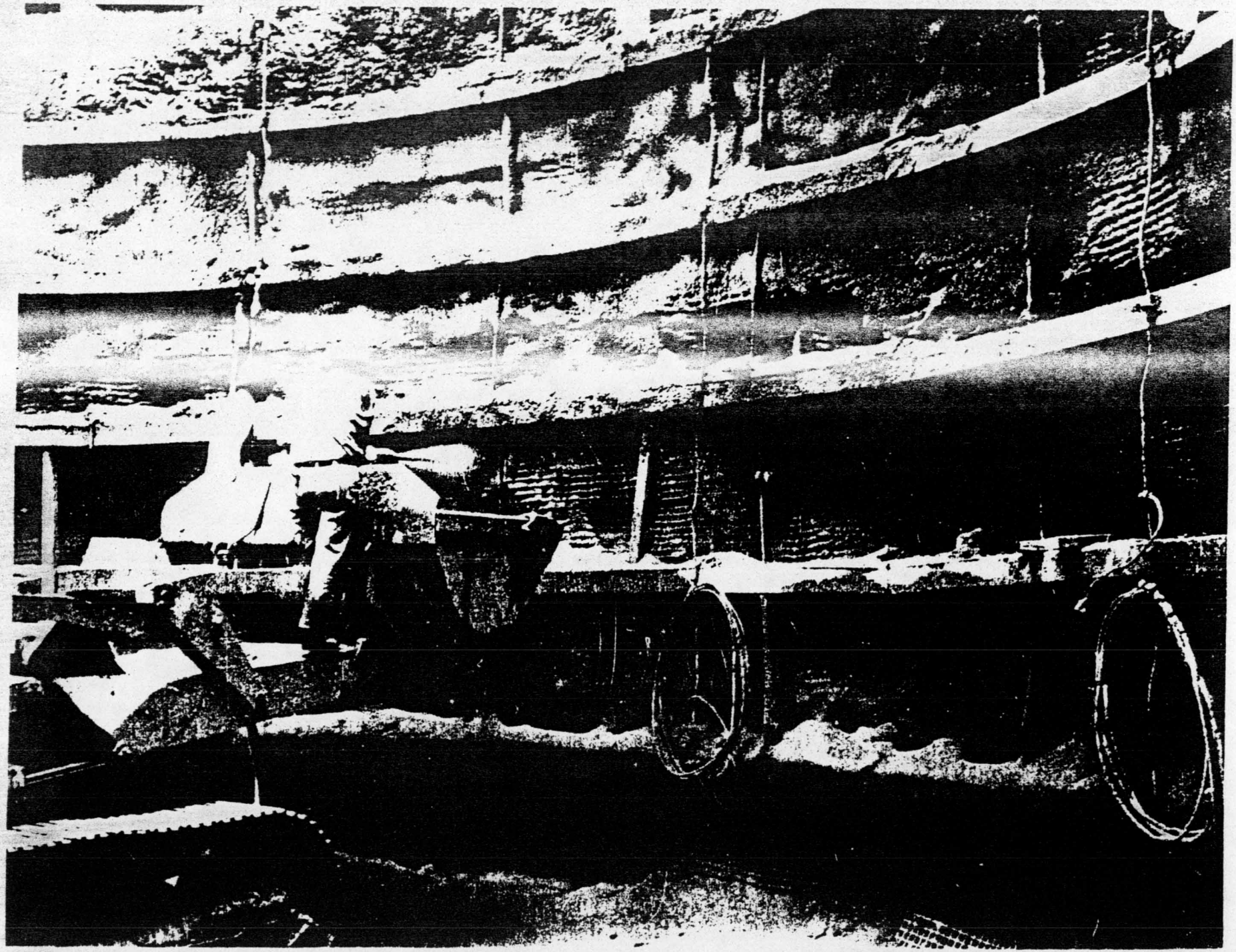


Figure 17. Gunite operation on walls of silo shaft.



In areas where there was moisture on the walls of the silo the gunite would not adhear to the excavated walls. The gunite was eliminated in these moist areas but the wire mesh was installed as required. This wire mesh did the trick in preventing slaking material from falling to the bottom of the silo. In numerous wet areas oak lagging was also used to keep the sane, clay and shale from slaking off and falling to the bottom. Figure 18 shows one of these areas.

At sites 1 and 2, which were declared changed condition sites due to excessive ground water, solid lagging of oak timber and/or corrigated sheet metal were used to prevent the walls from caving in and to assist in directing the ground water into the water rings for disposal. Figure 19 shows corrigated sheet metal used at Site No. 1. At site 4 solid oak lagging was used in the areas where the clays were wet.

At the sites where water was a problem, water rings were constructed to collect the water. This water was then channeled by a system of pipes to temporary sumps or tanks and eventually into the designed sump at the bottom of the silo. Figure 20 shows a temporary sump at Site 2. From these tanks or sumps the water was pumped to the ground elevation and disposed of through natural drainage systems.

The shaft excavation at Site 1 was accomplished mainly in loosely cemented sandstone from elevation 960 to 861. At elevation 880 water was encountered. Up until this point the contractor had excavated at a rate of approximately 4 feet a day. This water created a two month delay (covered in Contract Administration) and numerous problems. Before the start of excavation, four wells with pumps had been installed at the quarter points around the circumference of the shaft and at the toe of the open excavation. These pumps did not prove adequate to lower the

Figure 18. Oak lagging used to support sides of excavation at Site 2.

Figure 19. Corrugated sheet metal used to support sides of excavation at Site 1.

Figure 20. Temporary sump in bottom of shaft at Site 2.

water table below the point of excavation. About a week after encountering the water, holes were drilled at an angle into the sides of the shaft at the approximate elevation of the water. These holes were filled with chemical grout, but the water washed this grout back into the shaft. This solution to the problem (chemical grout) proved ineffective. Next the contractor (on his own) had planned to backfill the shaft approximately 17 feet. He had also planned on drilling holes around the shaft and grouting. This backfill would prevent the water from flowing into the shaft during the grouting operation. This plan never materialized. Instead it was decided to drill five additional wells between the four original wells and install additional pumps in order to try and draw the water table down below the excavation. It was also decided to have John W. Stang, Co., provide a well point system to assist in lowering the water table.

With nine dewatering pumps installed, excavation again was undertaken. The shaft was excavated to elevation 870 when the contractor installed the well point system. During the drilling operation for the well point system a leak developed at elevation 970. The water coming into the shaft was now carrying a considerable amount of sand. Seven pumps in the silo were used to pump the water out, with only partial success. The water was entering the silo faster than it could be pumped out. Equilibrium was eventually established at elevation 879.5. At this point there was approximately 10 feet of water in the shaft. Once again the shaft was backfilled in order to give the contractor a foundation to work on, while installing the well point system. Grout holes were also drilled from elevation 879 around the shaft and these holes

were pumped full of grout. Sixty seven well points were installed and about 100 gpm was pumped by this system. Excavation was again started. At elevation 870 the boil broke loose again. Spiling was now driven to prevent the sand from washing out. At this point about 1400 gpm was being pumped out of the silo. This quantity lasted for only a few hours and then returned to about 900 gpm. The Contractor decided to install additional well points at a little shallower depth. This was done with little effect. Solid corrugated metal sheetings were installed behind the ring beams. A sump was dug at the side of the main shaft, and as the water accumulated in this sump it was pumped out of the silo. The excavation continued slowly with sheeting being installed between each ring beam. At elevation 867 a channel was discovered in the location of the boil area. Excavation below this elevation revealed a hard layer of sandstone. The main flow of water remained above this layer of sandstone. A weep pipe was installed in this channel and about 100 gpm flowed through this pipe. This water was collected by a tank and pumped to the surface. From this point on, about 20% of the water was seeping into the bottom of the shaft. The well point system was removed and solid sheeting was continued until excavation was below the sandstone and into the shale. Grout was pumped behind the corrugated sheet metal to try and stop the water. This was not effective. Gunite could not be used on the shale because it was too wet. When the shaft was finally bottomed out there was still the problem of collecting the water and pumping it out during the concrete operation. This was done by channeling the water into pipes and piping it to the sump. From this point (sump) it was pumped to the surface.

The shaft excavation at Site 2 progressed without any unusual circumstances until elevation 903 was reached. At this elevation a flow of about 35[illegible] gpm was encountered. This water stopped any further excavation. Approximately a week after encountering the water a grouting operation was started. Forty-one primary holes were drilled on 8 foot centers, [illegible] feet from the edge of the shaft at reference elevation 960. While drilling these holes underground fractures were encountered allowing the water to seep through. The drilled holes were grouted with neat cement. These holes were drilled to reference elevation 810. The secondary holes were drilled and grouted using the same procedure as the primary holes to reference elevation 870. Both sets of holes required [illegible],367 bags of cement grout. Water still entered the shaft at approximately 300 gpm. A sump was excavated at the bottom of the silo into the Greswell limestone. Water now flowed into the sump at a rate of 550 gpm. Excavation continued, always keeping the sump ahead of the shaft. A water ring was installed at elevation 864 to collect the water from the Greswell limestone. After this water ring was completed only 20[illegible] gpm entered the sump on the silo floor. Two more partial ring beams were placed at different elevations. Another water ring was installed at ring beam 34 which was near the bottom of the shaft. This assisted in collecting the water that was running down the walls. The flat silo bottom was utilized at this silo because of the gypsum strata just below the bottom of the excavation. It was felt said strata might liquify and eventually allow settlement, if a normal (6") silo bottom was utilized.

After the foundation ring (last ring beam) was placed, the filter drain material (for the bottom of the silo) was compacted. This drain

material was lowered into the silo by the same 4 cu. yd. buckets used for removing the excavation. The material was placed in lifts and compacted by tampers.

SIGHT TUBE EXCAVATION

Soon after the silo excavation reached reference elevation 904 the Contractor started excavating for the sight tube. This operation was started at the lower elevation of the sight tube, 904'3", and was hand excavated toward the existing ground elevation, 960. A shaft approximately 8' by 6' was excavated at an angle of 49° / 50° with the horizontal. This excavation was shored approximately every four feet throughout the entire shaft. A platform was built near the lower end of the shaft for the men and equipment, and to prevent excavated materials from falling to the bottom of the silo where work was proceeding. When the material was too hard to jackhammer, some blasting was done. The sight tube was welded together and lowered into the shaft. The tube was supported in position by spiders along the length of the sight tube. Backfill of the sight tube was performed by jetting with sand.

The sight tube at site 4 was an exception. At site 4, after excavating approximately 10' of the tunnel (from elevation 904'3") the material over the excavation caved in. The Contractor cleared the cave-in and started tunneling again with the same results. In his third attempt, the Contractor chose at this site to utilize an open excavation, using 8" H piles at 4' centers with oak lagging, to install the sight tube. Oak shoring was used to hold the sight tube in position. The shoring was not stable because the material continued to shift, due to excessive moisture at this elevation. The contractor next placed

concrete around the lower end of the sight tube to hold the sight tube in position. The excavation was then backfilled with sand using a water jet for consolidation. The wood crib structure, and concrete were left in place because the excavated area was not stable enough to safely remove the material. Figure 21 shows the sight tube excavation at Site 4.

BACKFILL

The material excavated from the open cut and from the silo was used as backfill and embankment material. Large rocks were not placed close to the structures. Material was placed in approximately 6" lifts and compacted with sheep foot rollers in accessible areas and by mechanical hand tampers around all structures. The minimum distance out from all structures tamped by the hand tamper was 2'. A density of 90% minimum was required for all backfilled areas except two. The density under the utility tunnel was 95% and all base course 100%. Figures 22, 23 and 24 show parts of the backfill operation.

Sand was used under the utility tunnel and was hand tamped before setting the tunnel.

Type I material (sand) was used as backfill under the LCC slab.

Filter drain material was placed and hand tamped at the bottom of the silo. This material was placed in about 3" lifts.

Base Course was placed on the roads and the parking areas in approximately 6" lifts. The embankment just below the base course was compacted to a 95% density.

Figure 21. Site [illegible] excavation at Site 4.

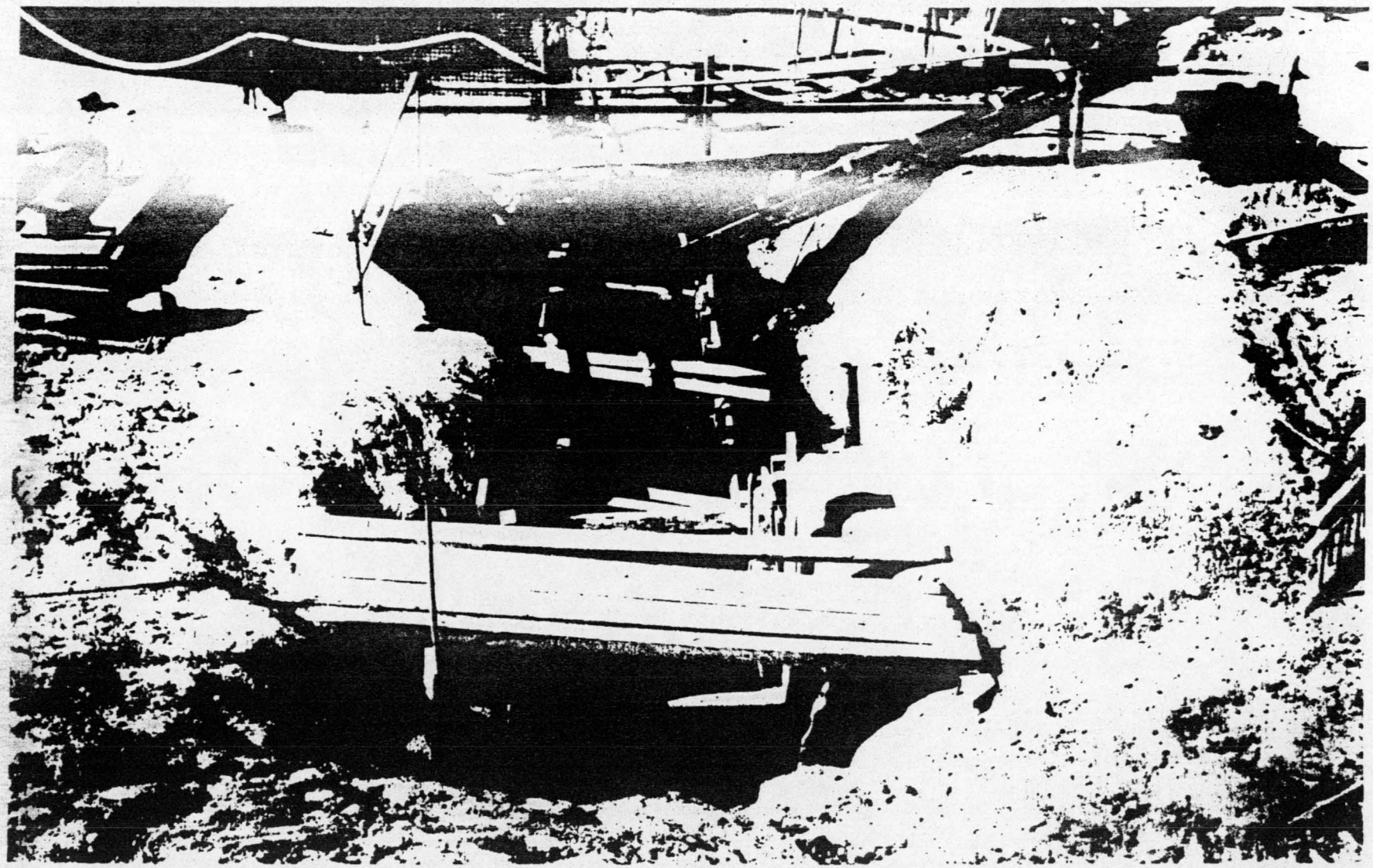


Figure 22. Backfill operation around silo.

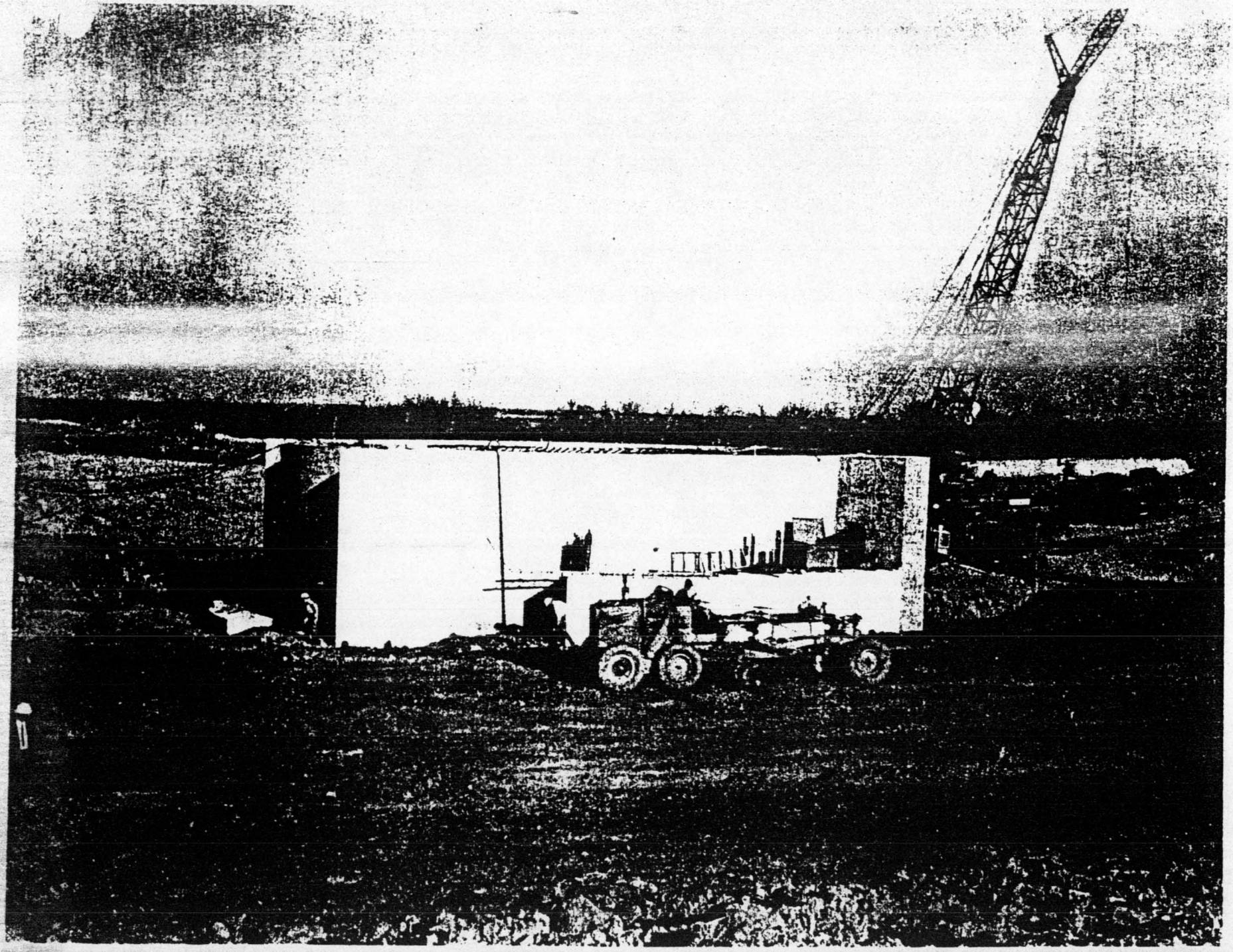


Figure 23. Backfill operation around LCC and silo.

Figure 24. Backfill operation around LCC.

6. CONCRETE PLACING

FORM

Forms for the LCC, vestibule and stairway were made of 3/4" plywood. Supports for the plywood varied from 2" x 4" to 8" x 8" clear, straight grained timbers; sizes depended on whether the material was to be used for supports for ceiling forms, bracing, or framing for forms. Metal scaffolds (with screw feet, allowing forms to be lowered from position upon removal) were used to support the roof slab of the LCC. The walls of the LCC were formed by double form wall. Construction she-bolts were used to hold the forms in their set position during placing of concrete. Three sets of exterior forms and four sets of interior forms were used to build the walls of the twelve LCCs. Figure 25 shows form work inside the LCC and figures 26 & 27 show form work outside the LCC.

Forms for the outside of the silo from reference elevation 960 to 1000 were also made of 3/4" plywood. These forms were supported by metal scaffolding and by cables which enclosed the circular form work at 1 foot centers. Figure 28 shows part of the silo form work. Four sets of silo forms were used in building the twelve sites; this includes both slip forms and the exterior forms utilized from elevation 960 to the top of the silo, a distance of forty feet.

The slip forms were constructed of tongue and groove wood. These forms were supported by cables, solid metal rods and aluminum adjustable tubing. A working and finishing platform was incorporated on the slip form (located directly under the slip form). Struts were not used originally across the slip form. When it was discovered that the silo was

Figure 25. Inside frame work for LCC.

Figure 26. Outside form work for the LCC. Silo outside forms are shown laying on the berm.

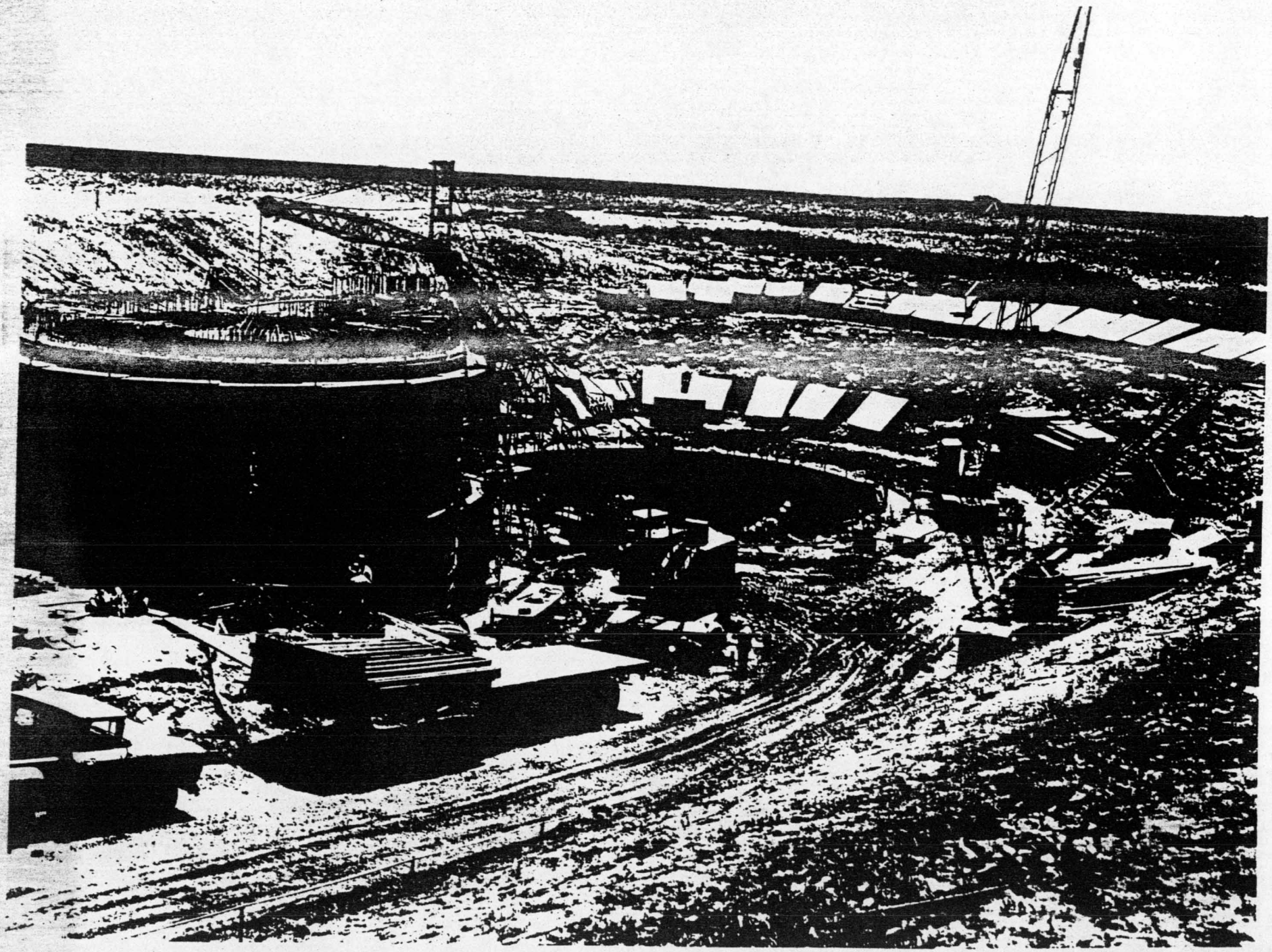


Figure 27. Outside form work for the LCC

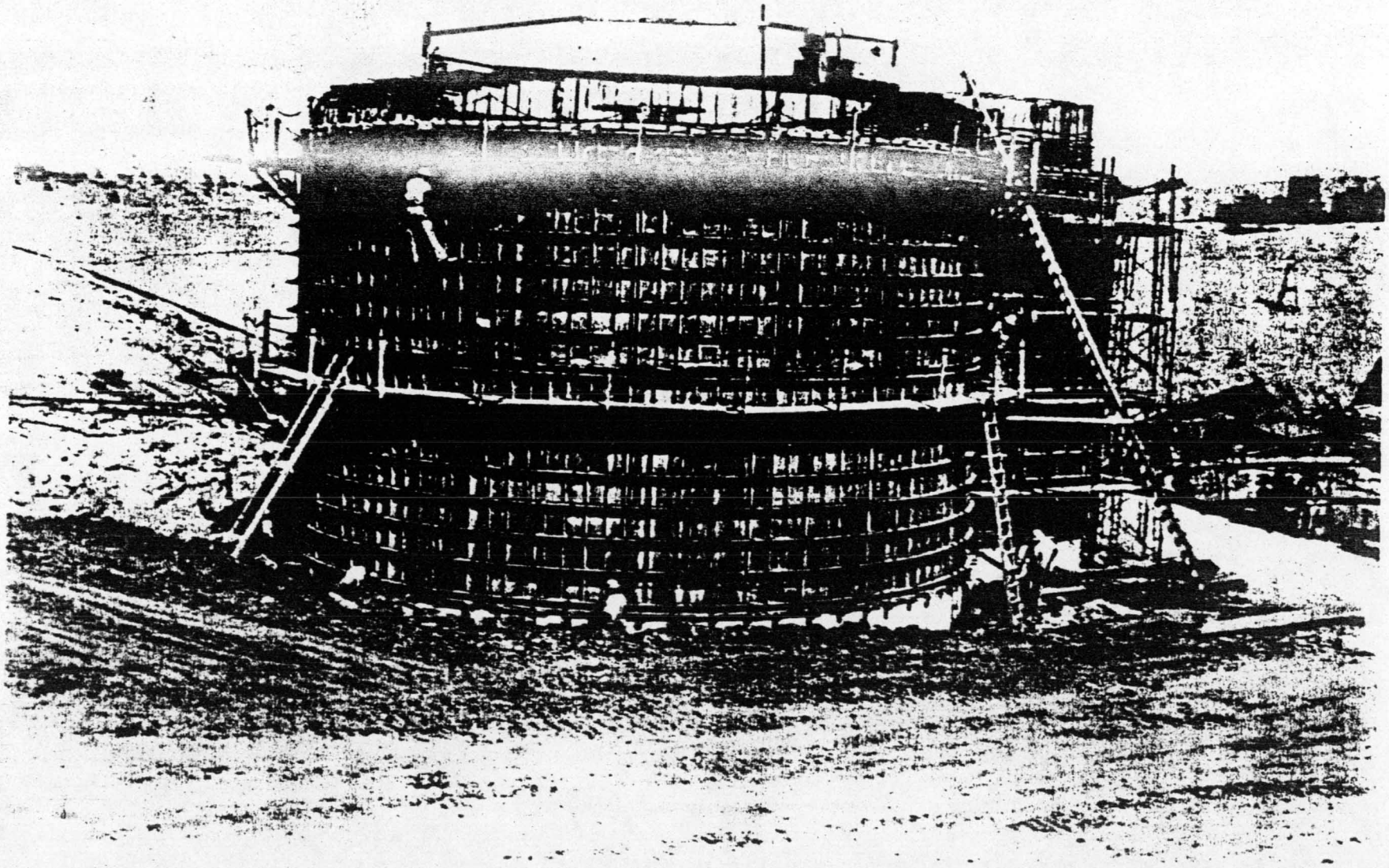
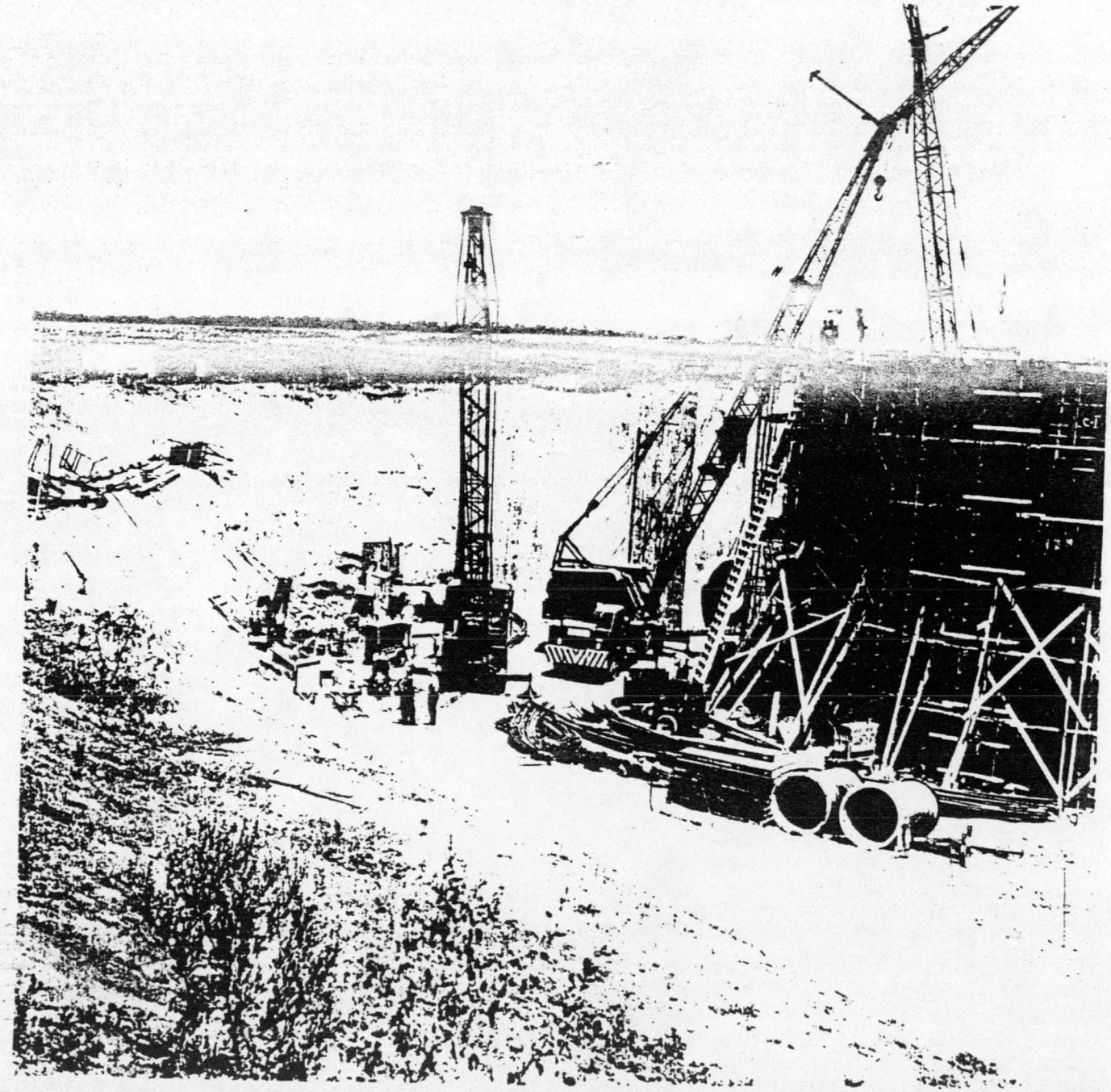


Figure 28. Outside forms for silo from reference elevation 960 to reference elevation 1000.



taking an oval shape, struts across the diameter were installed to keep the final configuration of the silo circular. At the locations of embedded material, sections of the (tongue and groove) slip form were removed as the form passed by the embedded protruding item. This (removed) section was later replaced when the embedded item was passed over. Figure 29 and figure 30 show slip forming during placement of concrete in the silo. The slip form was raised by pneumatic rod jacks. The slip form was constructed to provide a runway on which concrete buggies were able to roll and place the concrete as needed around the silo wall. The pneumatic jacks were manually operated from a central control station. The slip form was operated so as to keep it about 1" higher than the freshly placed concrete. The form had a vertical face, four feet in length. At a rate of one foot per hour it took the form four hours to pass by the concrete after it was placed. This allowed the concrete time to set. The rods on which the pneumatic jacks operated were supported by a cable and the cable in turn was attached to a structural ring beam which was made out of "I" beams as was shown in figure 30. This ring beam was attached to a number of wide flange beams which were located equa-distant around the circumference of the silo. The wide flange beams were supported in two different ways. The first method was used for the lower slip form operation (excludes upper forty feet). In this method, the beams were laid on the ground at elevation 960. They were extended out over the silo excavation and the metal jack ring rested on them. The end which was on the ground was held in position by a concrete counter-weight. Figure 31 shows these counter-weights. The second method of support for the wide flange beams used

Figure 79. Slip form during placement of 2'6" portion of silo walls.

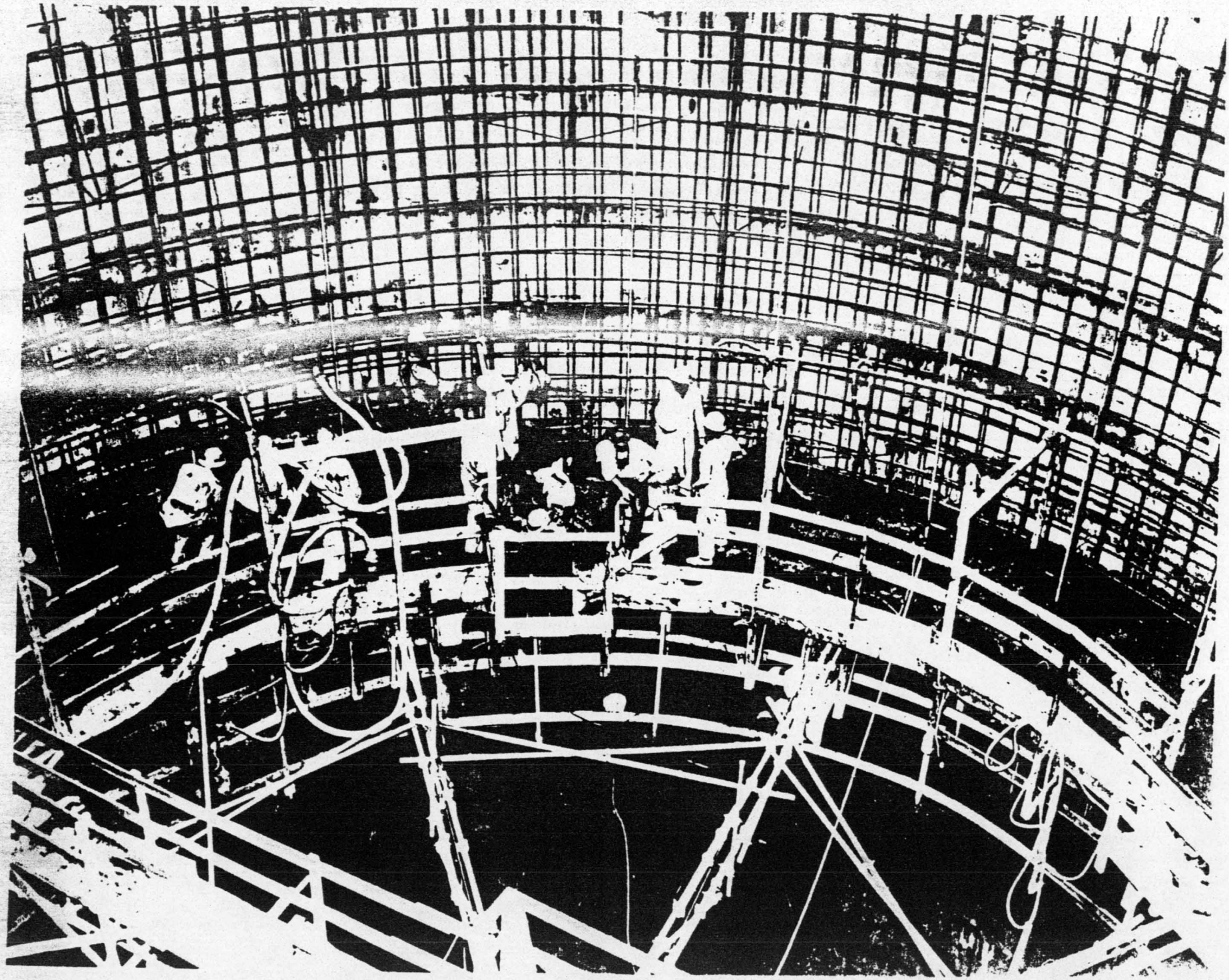


Figure 30. Slip form operation showing supporting ring beam made of I Beams and also wide flange beams which were used to support the ring beam.

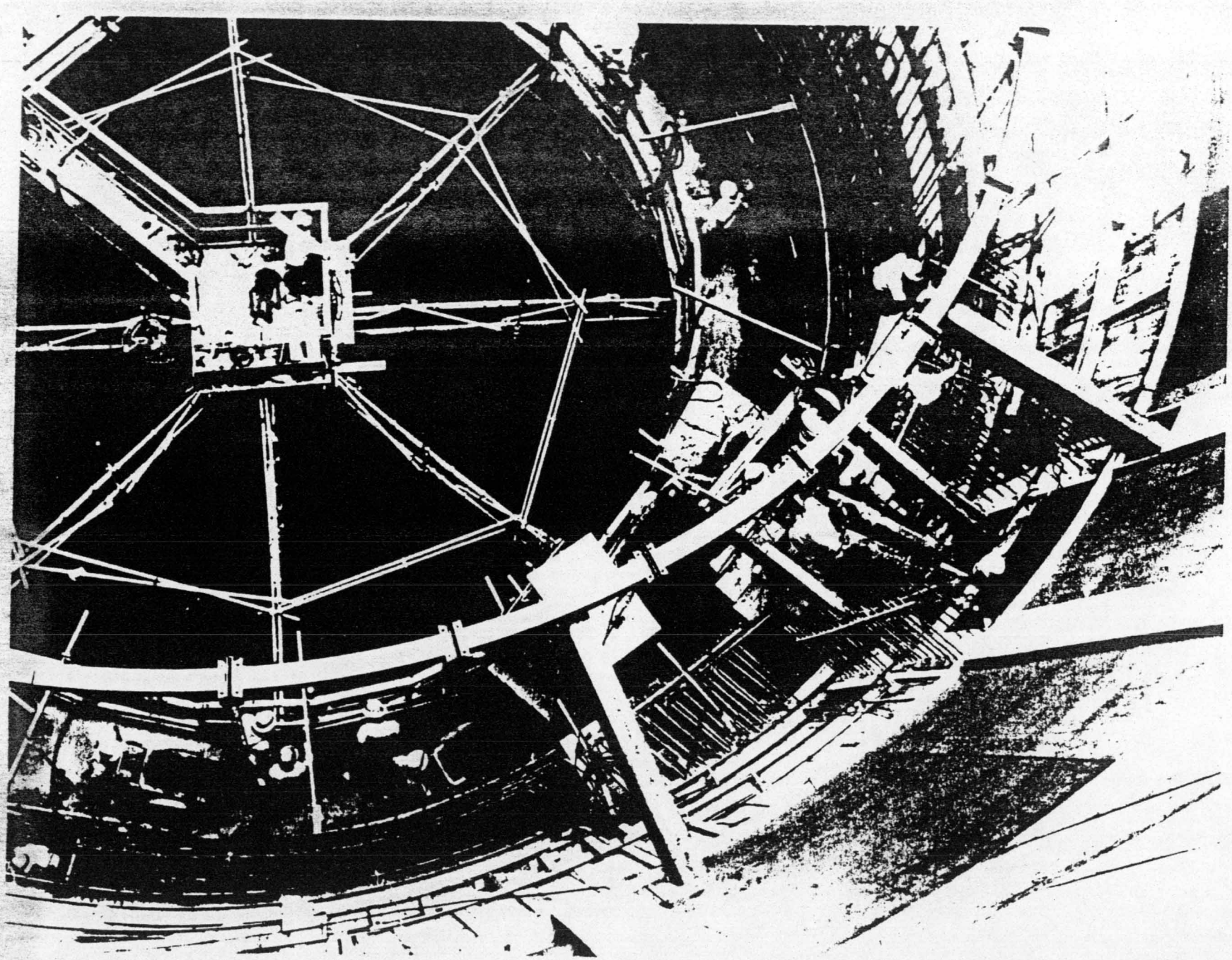
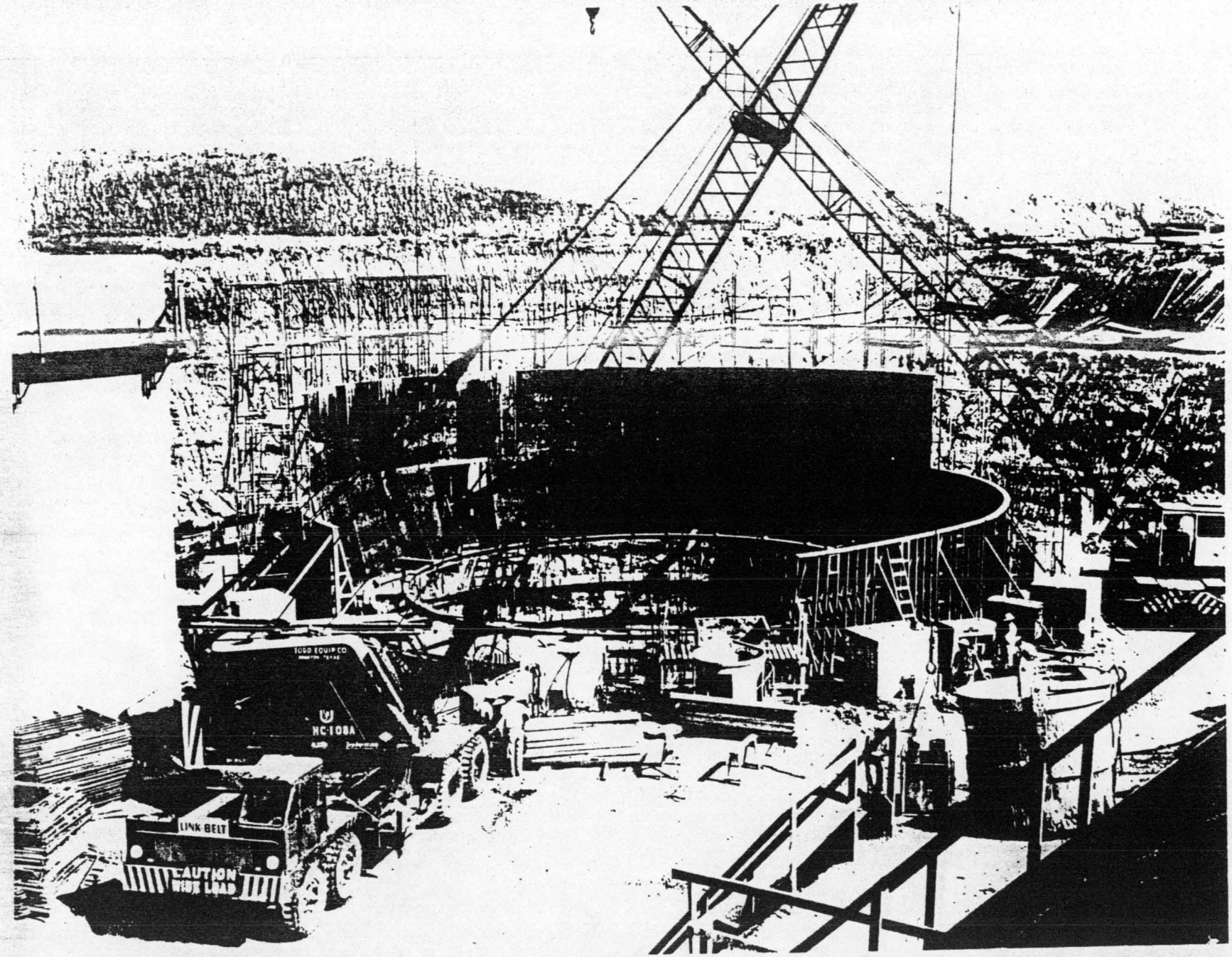


Figure 31. Concrete blocks equidistant around the silo used as counterweights to support the slip form.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CAUTION
WIDE LOAD

during the upper (40') slip form operation consisted of welding the W/F beam to the No. 18 rebars at elevation 1000. This method had the advantage of not requiring the forms from elevation 960 to 1000 to be in position when concrete was being placed during the lower (first) slip form operation.

Prior to the support of the slip form as described above, a method was used at the first site (site C) that did not prove satisfactory. Trees, shown in figure 32 were used which eventually gave way. In this tree method, the forms for the outside of the silo from elevation 960 to 1000 were constructed before any slip forming was started. Outside the form, trees made of 10 x 8 timbers ran from elevation 960 to an elevation above 1000. From this member another member run out perpendicular over the silo to which the structural ring beam was attached. The cables for the jacking rods were attached to this ring beam. These trees were then supported by cables which were anchored to dead man and the form work. This method proved unsatisfactory and was abandoned.

The forms for the silo cap were made of 60" plate girder beams as shown in figure 33 and 34. The beams rested on the 18" parapet walls at reference elevation 1000. From these beams, rods were hung which in turn supported a structural steel platform under the cap. On this platform, 6 inch wood decking and plywood was placed which served as the bottom form for the silo cap. The cap was, also, supported from the crib steel as shown in figure 35. Camber was built into the forms because of the thickness and quantity of concrete placed. It was believed (correctly) that there would be a tendency for the forms to deflect. Originally a 1" camber was used, but was later reduced to 3/4".

Figure 32. Trees used to support slip form at first site. These trees gave way and this system of support was abandoned.

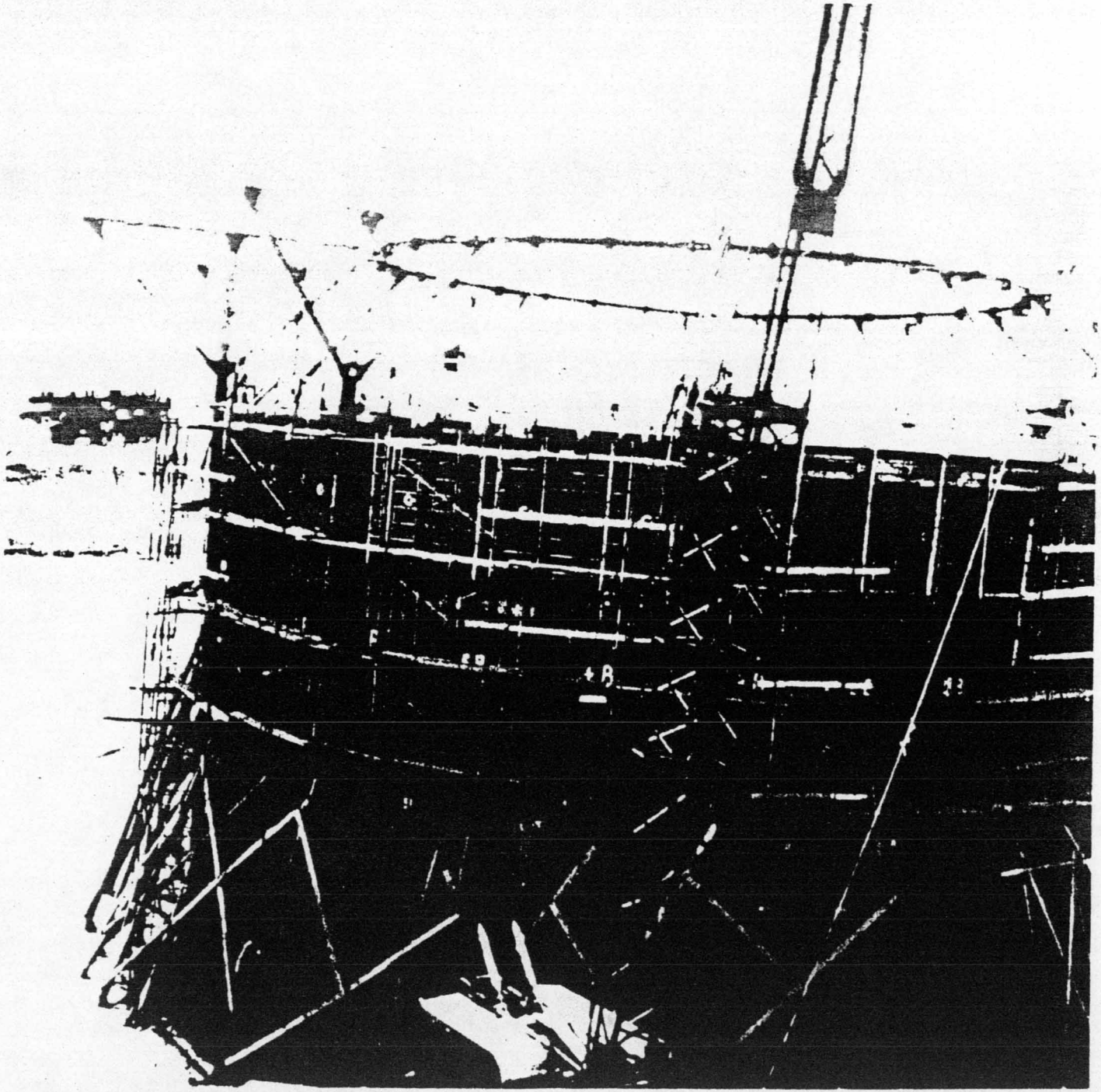

Figure 33. Girders used to support cap concrete.

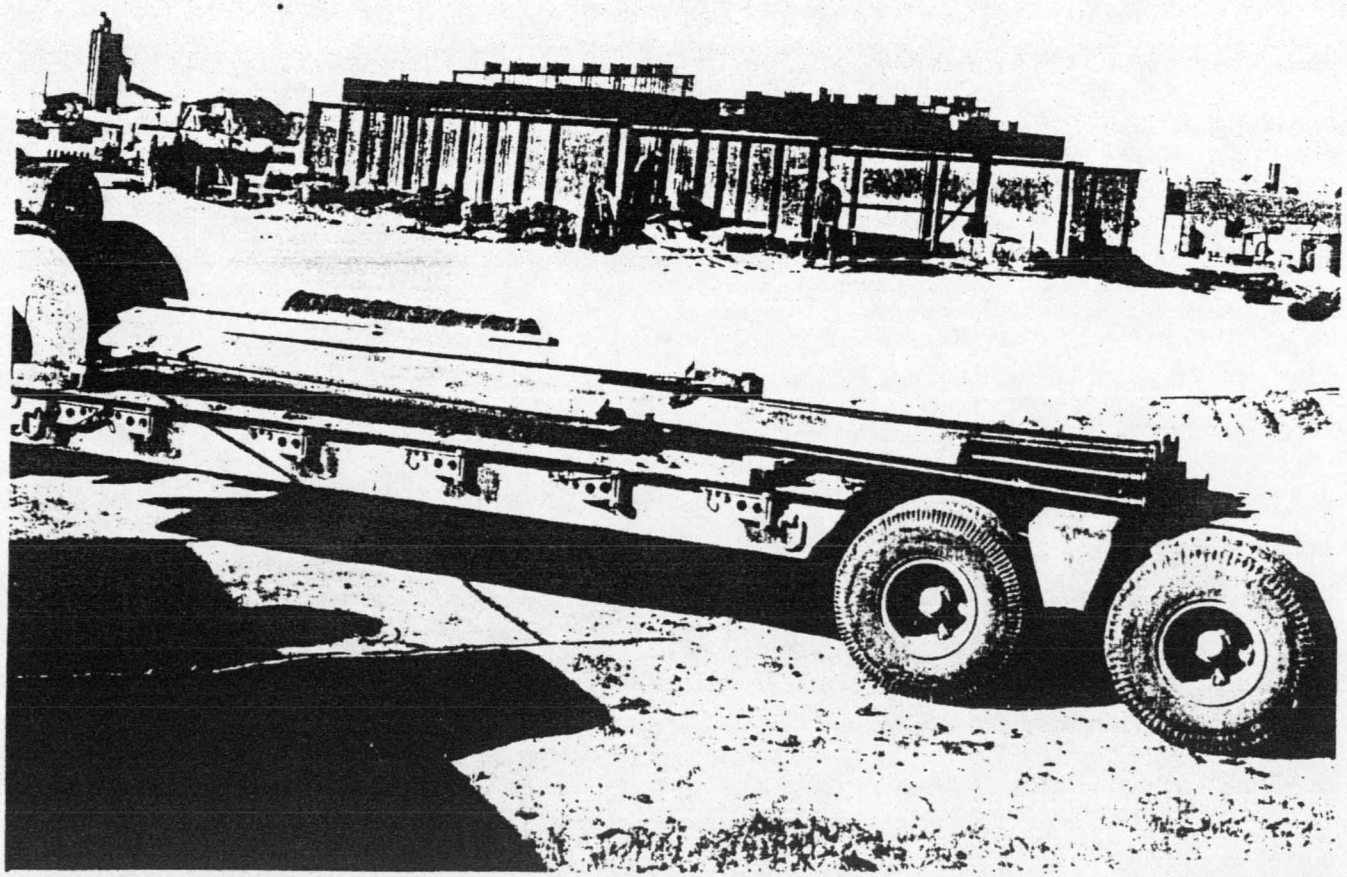

Figure 14. [illegible] place used to support the cap.

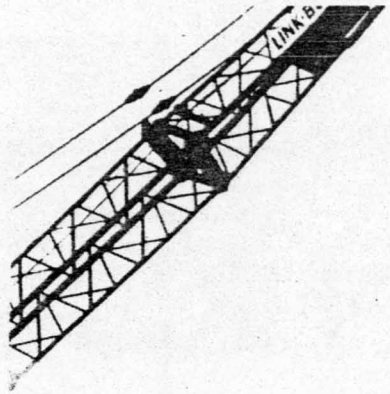
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Figure 35. Supports on Level 1 used to help support the cap.


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STEEL REINFORCEMENT

The LCC and silo were both constructed with reasteel from sizes No. 4 to No. 18. There were several places that contained so much steel that it was quite difficult to place the concrete. Figure 36 shows the steel and form section of the LCC.

The re-steel was placed in the LCC slab by normal construction practices. The steel was placed in the walls of the LCC after the inside forms were erected. After all the steel was placed, the outside forms of the wall were erected. The steel in the roof slab was placed without any unusual difficulties.

The re-steel for the portion of the silo wall which was 2'6" thick (from the bottom of the silo to reference elevation 945) consisted of two mats of No. [illegible] rebar on one foot centers as shown in figure 37. This rebar was erected from a steel and plywood platform which was just slightly smaller than the interior diameter of the silo itself. This platform was raised and lowered by two cranes. The outside vertical steel was placed with a jig holding 13 rebars at one time and secured to the ring beams by Nelson studs. The outside horizontal rebars were then secured to the vertical rebars. The inside mat was also jig placed and secured to a framework of [illegible] which were welded along the inner circumference of the ring beams.

The concrete was placed up to reference elevation 945 during the first (lower) slip. From this elevation to the top of the silo, No. 14 and No. 18 bars were used as reinforcing as shown in figure 38. These bars were extremely heavy and were placed individually by crane. The lower end of the vertical bars rested on the previously placed concrete

Figure 36. Reinforcing steel and form work in the LCC wall

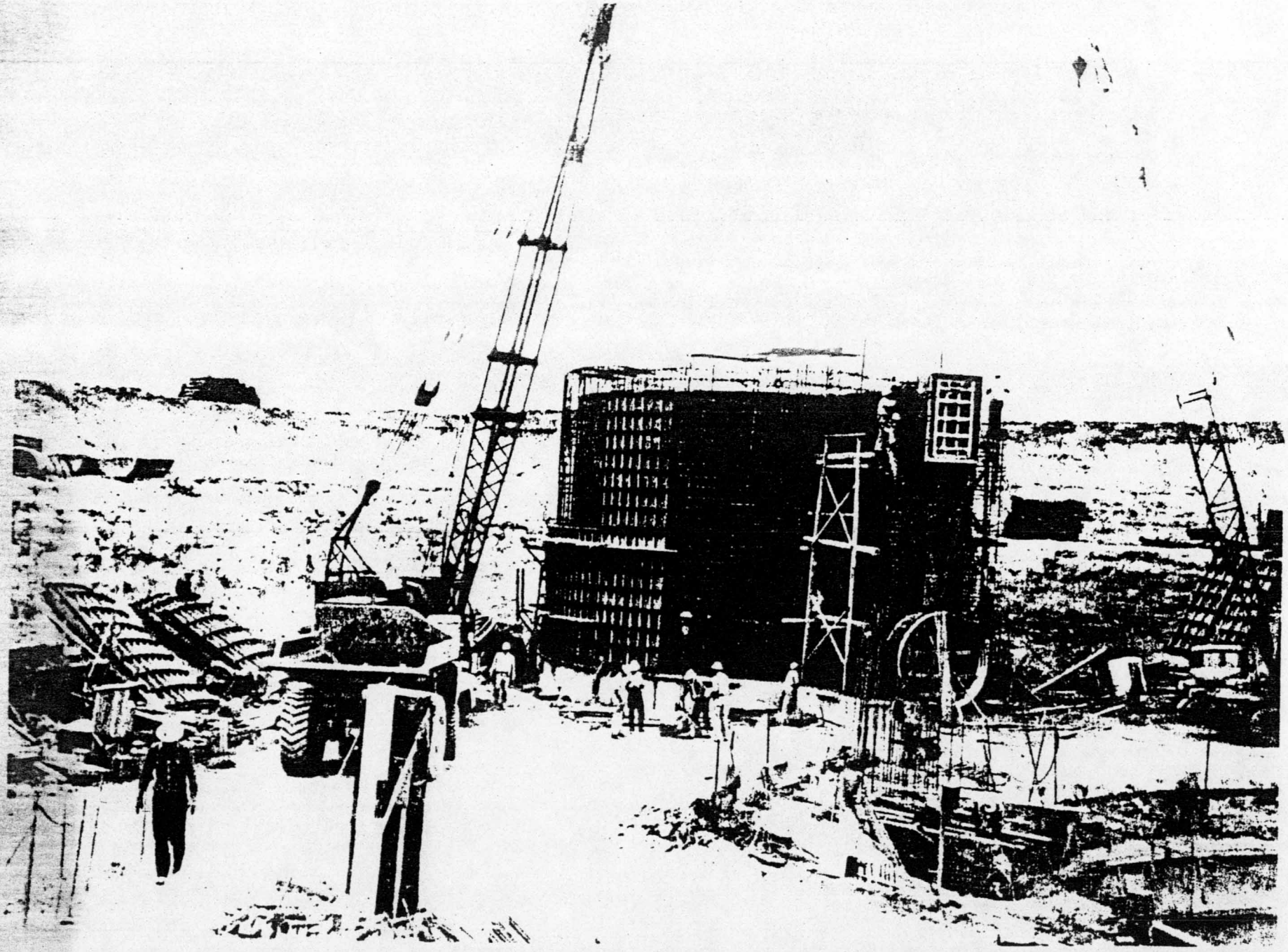


Figure 37. Reinforcing Steel in the lower portion of the pile.

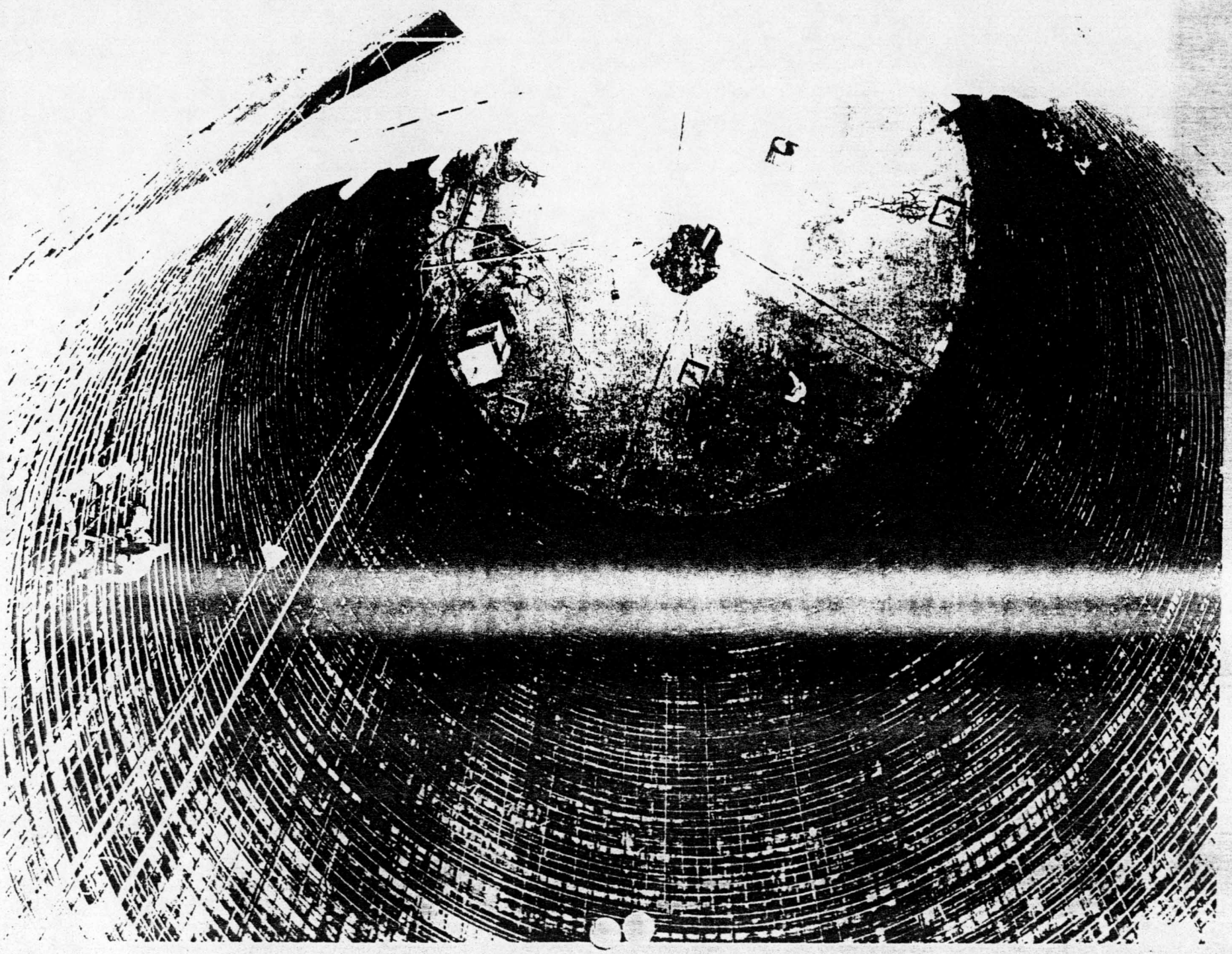
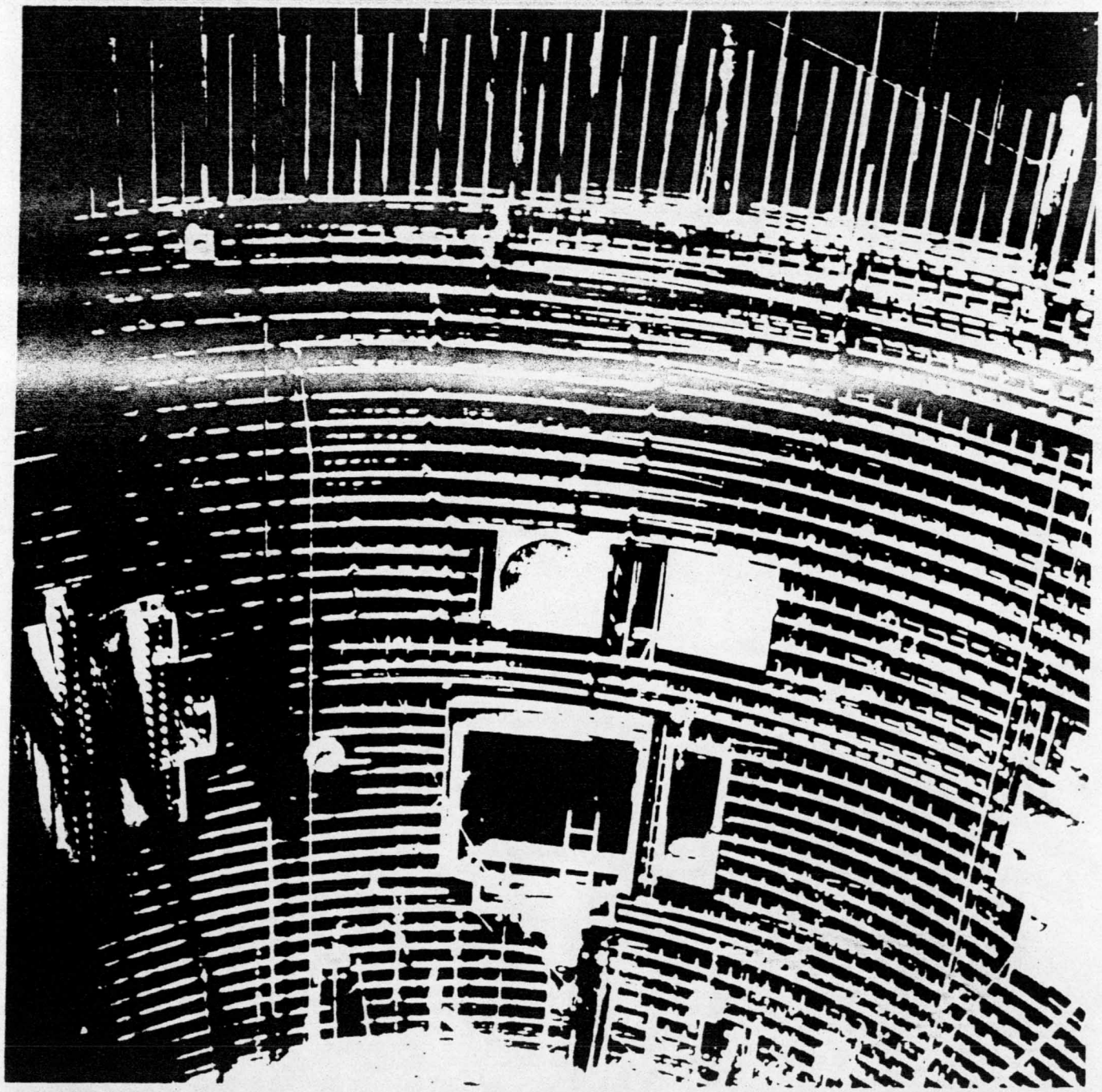


Figure 3B. Re[illegible]orcing steel in the upper portion of the

[illegible]al



for vertical support. Three mat layers existed. The outside mat was secured in position by a ring attached to the forms until it became self-supporting. The inside mat was supported from the outside mat of steel until it became self-supporting. The intermediate steel was supported from the inside and outside mats. The slip form was tied in place at elevation 945 so that the ironworkers could use it as a scaffold for erecting the reinforcement above elevation 945.

Three cranes were used to set these rebars in place. No. 14 and No. 18 rebar were field fabricated (bent).

Heavy embedded items for the upper pour such as the shock hanger insert plates were supported with angle and wide flange beams from the previously placed concrete. Lower embedded items were suspended from the ring beams with angles and WF sections.

After the forms had been erected for the silo cap, the cap reinforcements were placed. The top mat of No. 18 bars were butt welded by a thermite welding process to the previously placed No. 18 bars. Other than this welding process there were no unusual difficulties in placing the steel in the cap.

CONCRETE MATERIALS

Each of the twelve sites required approximately 8,000 cubic yards of concrete (total). There were several classes of concrete required. Requirements for strength were 5,000 psi, 3,750 psi and 2,500 psi. Most of the concrete was made with 1½" top size aggregate. Several areas in the structures were specified to have a top size aggregate of only 3/4"; i.e., the silo cap, LCC floor slab and LCC roof.

The source of aggregate and sand depended upon the location of the individual sites. Aggregate was furnished from Walker Stone Company.

Milford, Kansas; Quartzite Stone Co., Inc., Lincoln, Kansas and Concrete Materials, Moline, Kansas. Sand was furnished by Fyfe Sand, Concordia, Kansas; Moore Sand Co., Junction City, Kansas; Salina Sand Co., Salina, Kansas; and Lyons Sand Co., Lyons, Kansas.

The mix designs used were:

3/4" Aggregate

3/4	6 Sacks/cu yd
Sand	47% by Vol.
Course	53% by Vol.
Air	4.5% by Vol.
Water	5.5 gals/sack

1 1/2" Aggregate

1 1/2	5.5 Sacks/cu yd
Sand	40% by Vol.
Course	60% by Vol.
Air	4.5% by Vol.
Water	5.5 gals/sack

The actual batch weights varied from site to site because the sources of aggregate and sand differed for each site, each source having a different specific gravity.

Aggregate and sand was hauled from the quarries to each site and stock piled until it was used.

Cement suppliers were: Universal Atlas Cement Co., Independence, Kansas; The Monarch Cement Company, Humboldt, Kansas and the Dewey Portland Cement Company, Dewey, Oklahoma.

The cement was shipped in by rail via freight cars. Cement trailers were used to haul the cement from the rail head to each site. Water was

hauled by trucks from the surrounding towns and stored in storage tanks near the batch plant. At some sites, pumps were installed to reduce the amount of ground water that was seeping into the silo during excavation. At these sites, water was also obtained from the de-watering pumps.

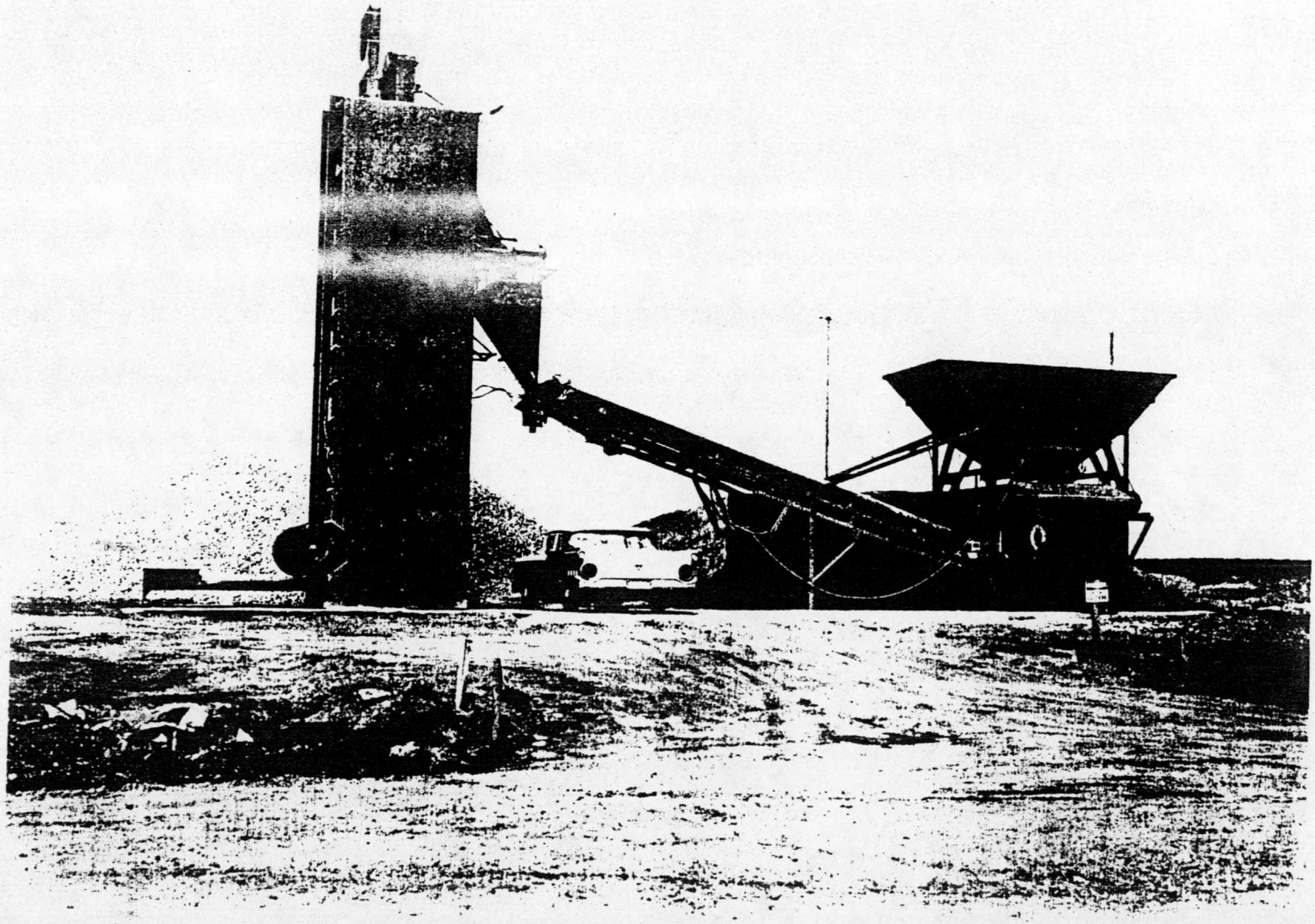
CONCRETE PLANT

The concrete plant that was used was a Ross portable batch plant with portable cement silos. Six separate plants were used and they were moved from site to site as required. Each site had a concrete pad on which the batch plant was erected. It required about three, 8-hour shifts to move the plant from one site to another. Each plant was capable of producing approximately 60 cubic yards per hour. Also available was a standby batch plant which could produce 20 to 30 cubic yards if necessary. This would have only been used if the main batch plant failed while the job was at an area where a construction joint was not allowed by the plans and specifications.

The cement was stored in a silo which in turn batched the cement into the transit mix trucks as required. The sand and aggregates were dumped into the weighing batch hoppers by use of a highloader from the stockpiles. From the batching hopper an elevating belt carried the material to the concrete mixing truck. Figure 39 shows the batch plant. The water was metered by a fluse into the mixing truck. The air intraining agent was measured into a marked glass tube and in turn was dumped into the mixing truck.

During each concrete operation there were two to six, 6 cubic yard transit mix trucks used. From the batch plant the trucks mixed the concrete and hauled it to where it was to be placed utilizing the aid of cranes, chutes and concrete buckets.

Figure 39. A typical batch plant set up.



CONCRETE PLACEMENT

The concrete was placed in the LCC floor slab, LCC roof slab, silo pedestals, silo floor slab and silo cap with a crane and a concrete bucket. It was then vibrated by air vibrators.

To place the concrete in the LCC walls and column, tremmies were used. As the concrete was placed, the lower sections of the tremmies were removed allowing 3 feet of clearance at all times. About twelve to fifteen vibrators were used. The vibrator operators could not move around the wall very freely (usually only 20 feet). Their inability to move was due to the large amount of reinforcing steel located within this 2' 3" thickness of wall.

The silo walls were placed by the use of slip forms. The thickness of the silo wall was 2'6". This thickness was from the bottom of the silo to reference elevation 945, a distance of 119 feet. The 2'6" part of the silo wall was placed in one continuous operation. The concrete was dumped from a concrete bucket into a concrete hopper. Said hopper was then lowered to the elevation of the slip form via a double cable pully system. At this elevation concrete buggies were rolled under the hopper and filled. The buggies were then rolled around the slip form to the spot where the concrete was to be placed. After dumping the concrete, the laborers continued around the slip form until they reached the concrete hopper where their buggy was again refilled. After the concrete was dumped in place, it was vibrated by an air vibrator. The slip form moved up on an average rate of 10 to 12 inches an hour.

The second slip form operation (the upper section of the silo) was also a continuous operation. It went from reference elevation 945 to 991.

This operation was performed somewhat differently. A platform was built at reference elevation 1000. The buggies operated at this elevation throughout the entire second slip form operation. Because these walls were 9 feet thick (at their maximum) there was a need for considerable more concrete in a given amount of time. Therefore, two cranes and two hoppers were used. The hoppers were located at the opposite sides of the silo at reference elevation 1000. Concrete was placed in each hopper continuously. The buggies filled up at each hopper. This allowed them to dump twice, during a single trip around the platform. Holes were provided in the platform at elevation 1000 and tremmies were attached to the platform through these holes. When the operation first started, these tremmies were about 60' long. The concrete was dumped into these tremmies (elevation 1000) falling to the elevation of the previously placed concrete. At this (lower) elevation which varied as the slip form moved up, the concrete was vibrated. There were about fourteen vibrator operators working continuously around the circumference of the silo as the concrete was being placed. Progress was 6 inches per hour during this second slip.

The top 9' of the silo was the cap pour. It was placed in two operations. The first operation consisted in placing an 18" parapet wall around the outside top of the silo. This 18" wall was then used to help support the forms for the silo cap. The last operation was the placing of the cap. The cap was placed utilizing normal concrete placing operations. The contractor was set up for winter conditions and did place some concrete in the winter.

FINISHING AND CURING

The 2nd floor slab, roof slab and top of tunnel were trowel finished.

No difficulties were encountered during this operation. Burlap was placed on the exposed surface and kept wet by a canvas soap hose at all times. Figure 40 shows burlap on the LCC.

The floor slab of the silo was steel trowel finished. For the silo walls, there was a scaffold attached below and to the slip form, from which the finishers (approximately four hours after the concrete was placed) were able to float the silo walls. Little difficulty was encountered in finishing the walls from this platform. Curing of the walls was done by attaching a perforated hose to the bottom of the finishers scaffold and keeping a fine spray of water on the concrete wall at all times as the slip form moved up.

Burlap was placed on the joints and kept wet during the curing period.

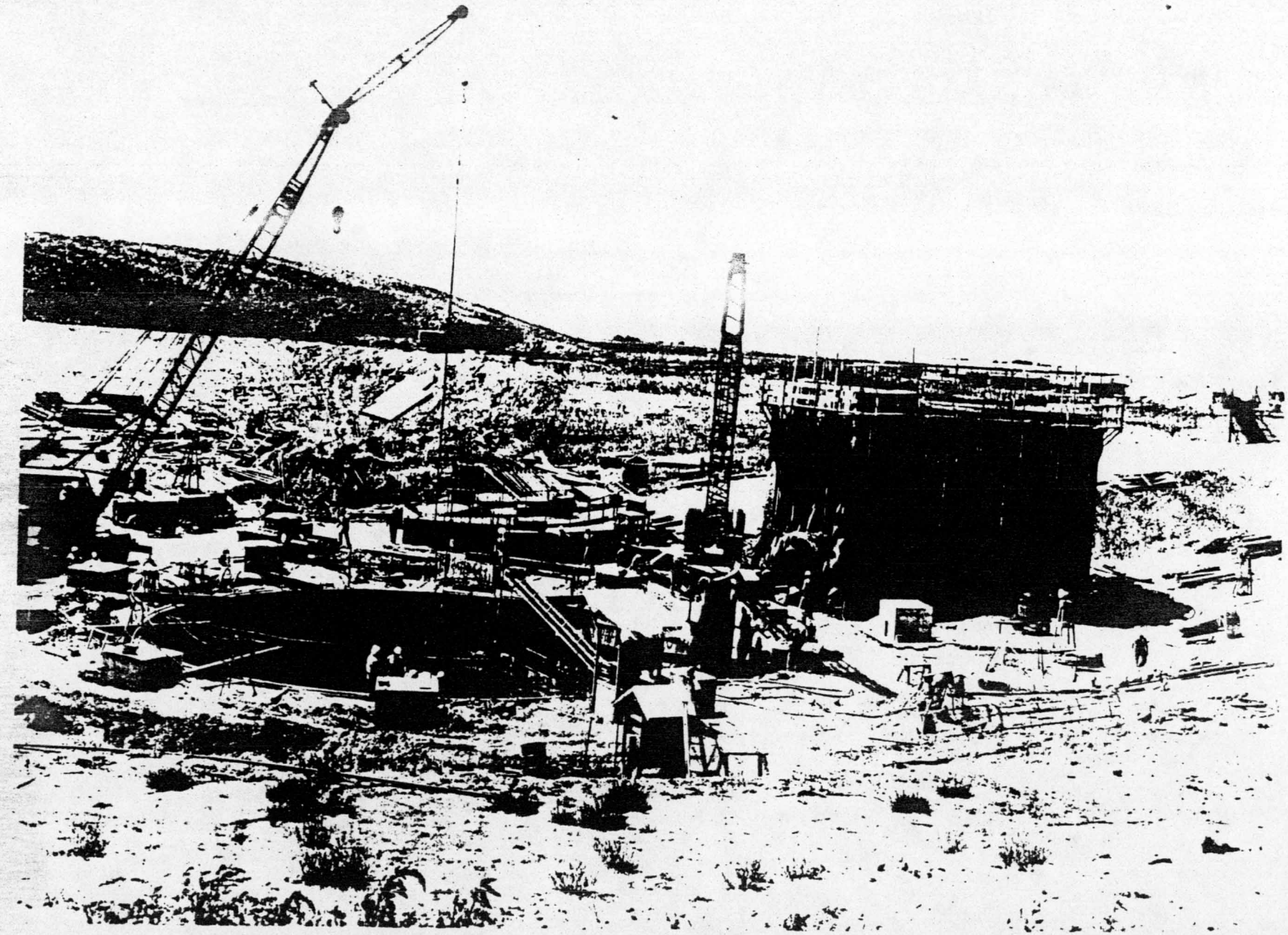
The joint at the top of each slip form operation was water cut and sandblasted to provide a good clean joint on which to place the new concrete.

Most of the caps were placed in cold weather. A tent was built over the concrete during the curing period. Under the tent the concrete was covered by canvas and bales of straw (for curing).

Bottle gas heaters were used when the cap was steel trowled. It was discovered that in some areas there was more than 1/8" irregularity (low spot) per ten foot length. This was corrected by grinding channels in the cap to drain these low spots.

All of the silo caps cracked at the corner of the overhead door block-outs and ran to the outside edge of the caps. The Air Force requested that these cracks be sealed. The cracks were sawed about 1½"

Figure 40. Curing the LCC with burlap.



deep and ½" wide and filled with a LOX compatible sealant. Products Research sealant compound PR-1540 was used for this purpose.

The overhead doors were positioned in the cap, with the re-steel already placed within them. Then the forms for the bottom of the door frame were set in place. The concrete was placed in the door frame with the doors in the closed position. After the concrete in the doors had set, the doors were raised and lowered three times and remained in the open position.

7. CRIB STEEL ERECTION

SHOCK HANGERS, SILO AND LCC

The silo crib is constructed of structural steel. There are eight levels in the crib and all the equipment involved in the silo is located on one of these levels. The entire crib is suspended within the silo by four pairs of shock hanger springs. The springs are designed to [illegible]ize any shock (natural or man made) from reaching the equipment within the silo.

The LCC crib is constructed of structural steel also. This crib is suspended on four air cylinder supports. These supports are also designed to [illegible]ize any shock from reaching the equipment in the LCC. There are four limit switches directly below the air cylinders (1 each) that work in unison with the cylinders in order to control the air pressure to the cylinders. This maintains the crib in a level position. There are two levels to this (LCC) structure. The four air cylinders are attached to sections embedded in the roof. The roof of the LCC in turn is supported by the walls and a center column.

Figure 41 is an isometric view of the launch complex. From this figure, it is possible to see the LCC crib and the silo crib. Also, this figure shows the relative position of the LCC to the silo.

COMPRESSION OF SHOCK HANGER SPRINGS

The shock hanger springs are government furnished property. These springs had to be preloaded (compressed) before they were hung into position. A safety problem arose in the compressing of the shock strut springs. The problem became apparent when the hose

Figure 41. Isometric view of launch complex.

to a 300 ton jack (furnished by the Air Force) ruptured, thus releasing the pressure on the jack and the compression on the shock strut springs. As a result of this failure a man was injured by the broken hose and the shock strut was damaged to the extent that a complete replacement was required. At time of failure, the springs were being compressed while in a horizontal position; this allowed the strut to move horizontally when the compression was suddenly released from the springs.

To correct the above situation the contractor was required to provide a check valve on the hydraulic connection of the jack, to compress the springs in a vertical position and to shim the jack as compression of the springs progressed. The compression of the springs in the vertical position was a radical departure from the method recommended by AMP but proved more efficient and safer than the recommended procedure, see Figure 42. Compression therefore of the remaining shock strut springs was accomplished in this (vertical) manner. The sequence was: the bottom section of the main center support rod was removed and three temporary outer rods were attached by couplings to the three spacer rods; a temporary plate was then installed as a support for the hydraulic jack; the hydraulic jack was set on this plate and with the aid of steel shims the inner and outer coil springs were compressed. At this point three temporary stiff legs were set in place and clamped to the spacer rods. The hydraulic jack was then removed. The bottom section support rod was replaced and secured again by the use of a threaded coupling. With the springs compressed they were connected to the wall brackets in the silo.

Figure 42. Compressing the shock hanger springs.

ERECTION

The structural members of the crib were shop fabricated and transported to each site. Upon arrival at the site this material was stockpiled in order of erection so that it would be accessible, as it was needed in the structure.

Concrete pedestals were poured at the bottom of the silo. These pedestals protruded upthrough the silo floor 9", and contained imbedded studs to provide foundation supports for the crib during erection. Temporary members were used between these pedestals and the main vertical crib steel members. These temporary members were removed, when the crib was hung.

Structural members were lowered into the silo by a crane in their order of erection. Each member was fastened in place by an erection crew. A second crew followed and completed the bolting operation.

There was little difficulty in erecting the crib steel although the silo walls limited the working area. It became evident that the upper suspension crib brackets, the shock hanger springs and lower suspension crib bracket would have to be installed before the crib could be erected above the fifth level. The fifth level was where the lower suspension crib brackets fastened to the crib. Figure 43 shows the upper bracket and springs and Figure 44 shows the springs and lower bracket (at level 5). Figure 45 shows the upper suspension crib bracket, shock hanger springs and part of the crib steel at levels 2 and 3. Late spring delivery caused some delay at the first few sites.

Figure 43. Upper suspension crib bracket and shock hanger springs.

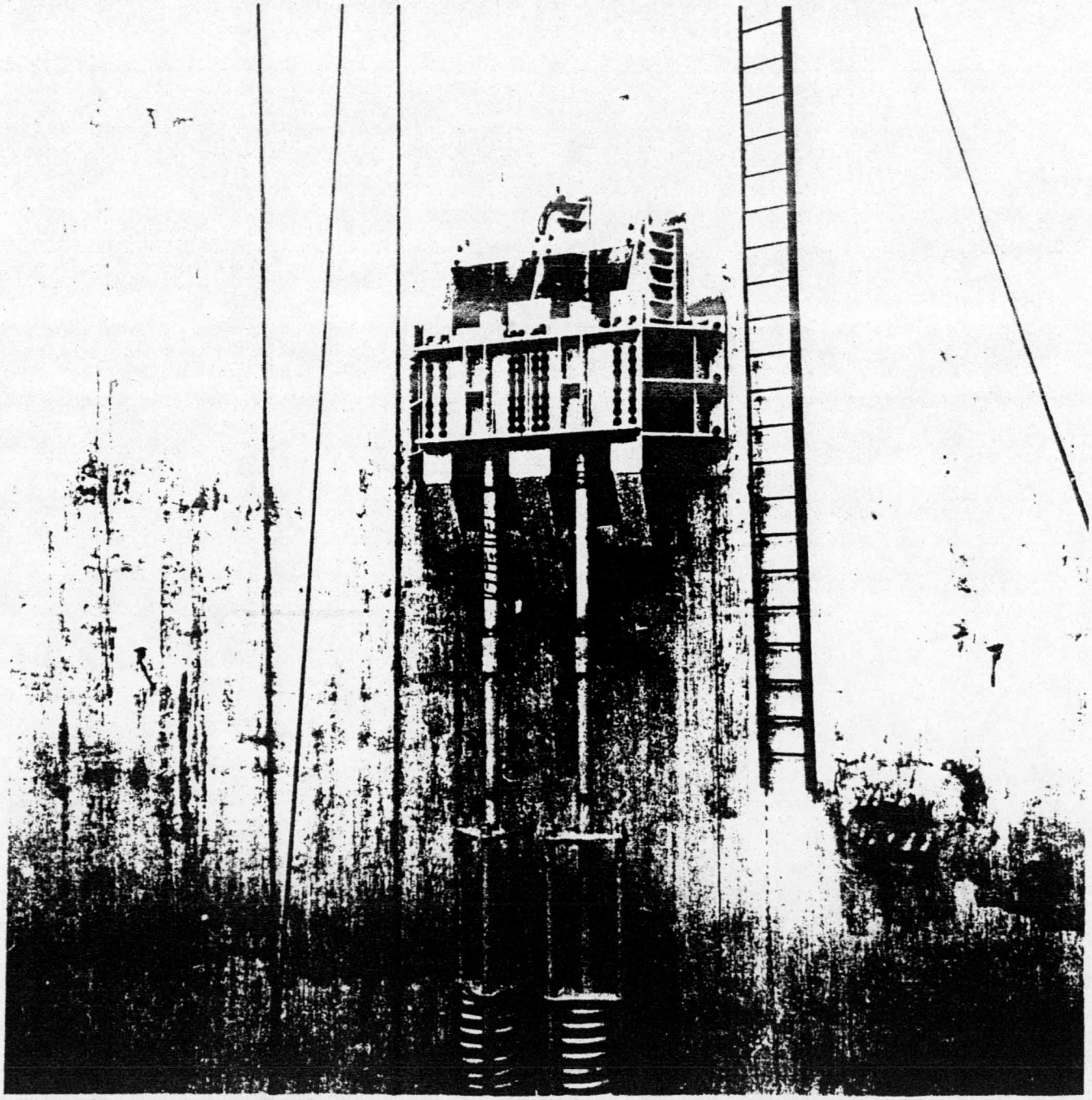


Figure 44. Shock hanger springs, lower suspension crib bracket and part of the crib steel.

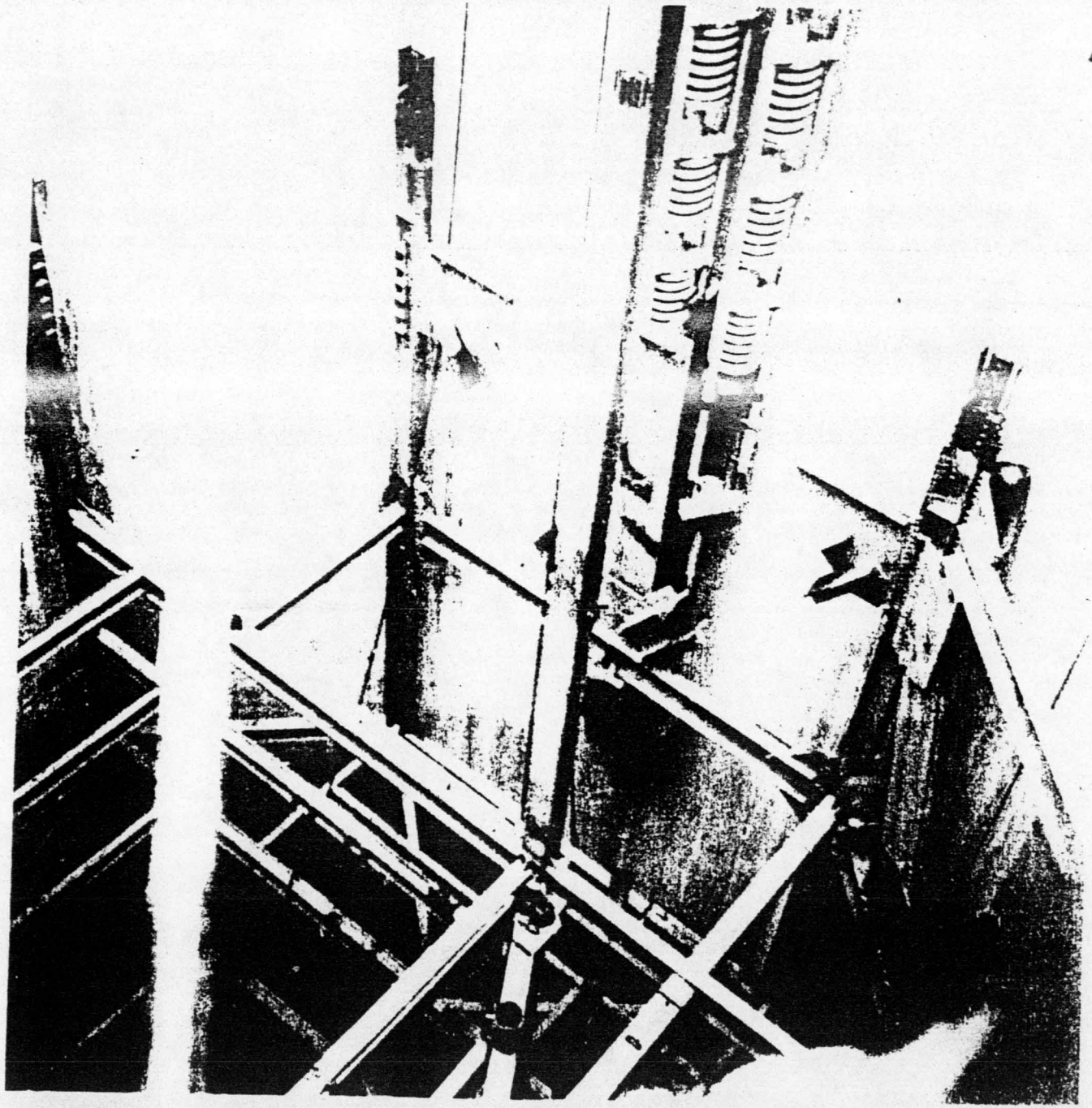
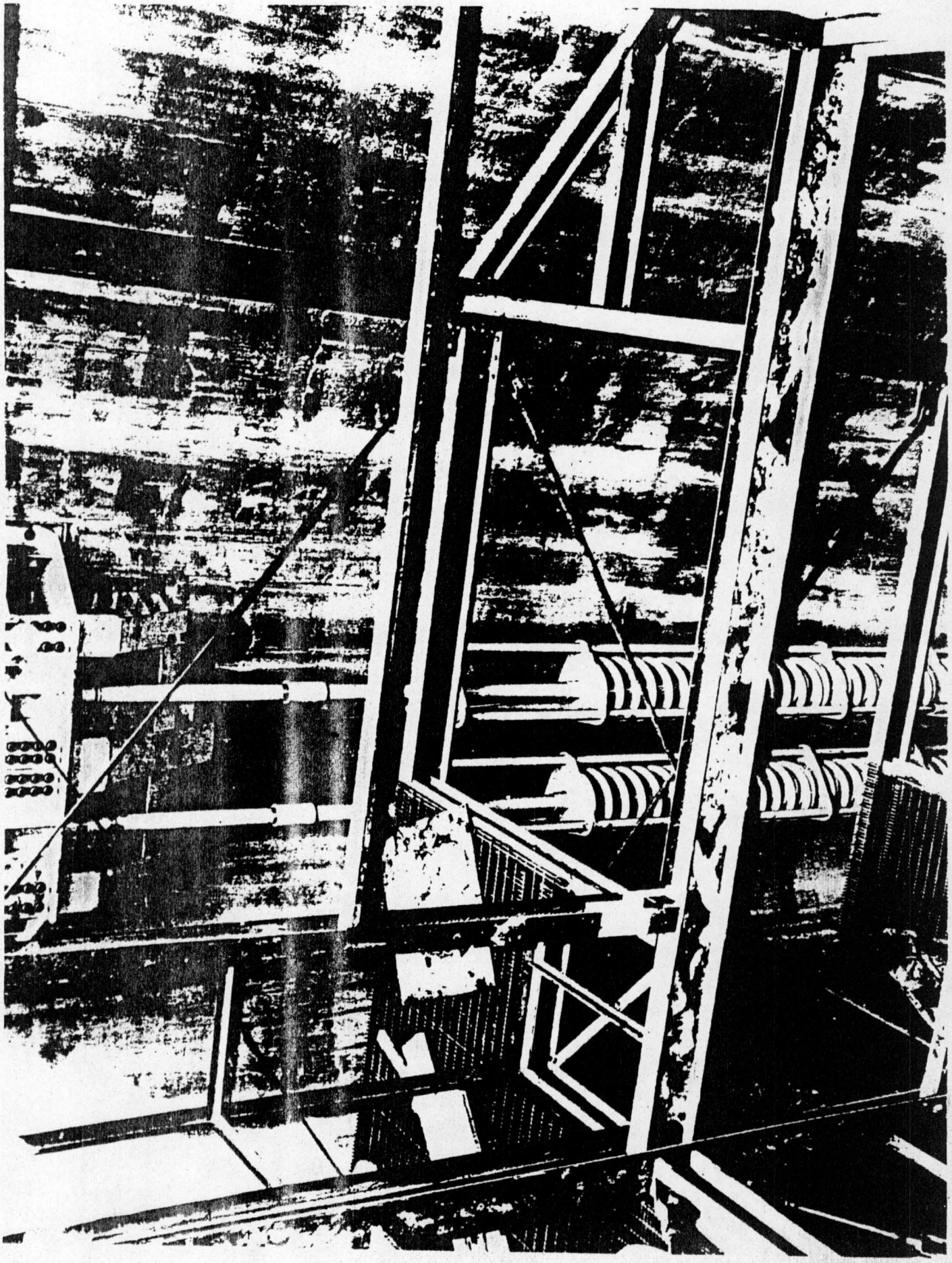


Figure 45. Upper suspension crib bracket, shock hanger springs and part of crib at Level 2 and 3.



After the installation of the 8 shock hanger springs, the crib was erected up to the third level. At this point hydraulic jacks were used at the bottom of the silo to raise the crib up high enough to remove the temporary crib supports and secure the crib to the shock hanger assemblies. When the crib was secured, the hydraulic jacks were slowly and evenly lowered until the crib was entirely supported by the shock hangers. All temporary support members, jacks, cribbing, and blocking was removed from the silo. The crib was completed up to and including the floor members of level number 1.

When the main members of the crib had been erected, the floor grating and the spiral stairway were installed so that all crafts could start installing their equipment.

The LCC crib steel was erected in about two days. There were no problems encountered during this erection. Four concrete pedestals were placed monolith with the floor slab. The two main beams of the LCC crib were set on these four pedestals. The rest of the crib was erected from these two members.

Throughout the erection of the crib steel (silo and LCC) the contractor had to do some field fabricating in order to make some members fit in there proper location:

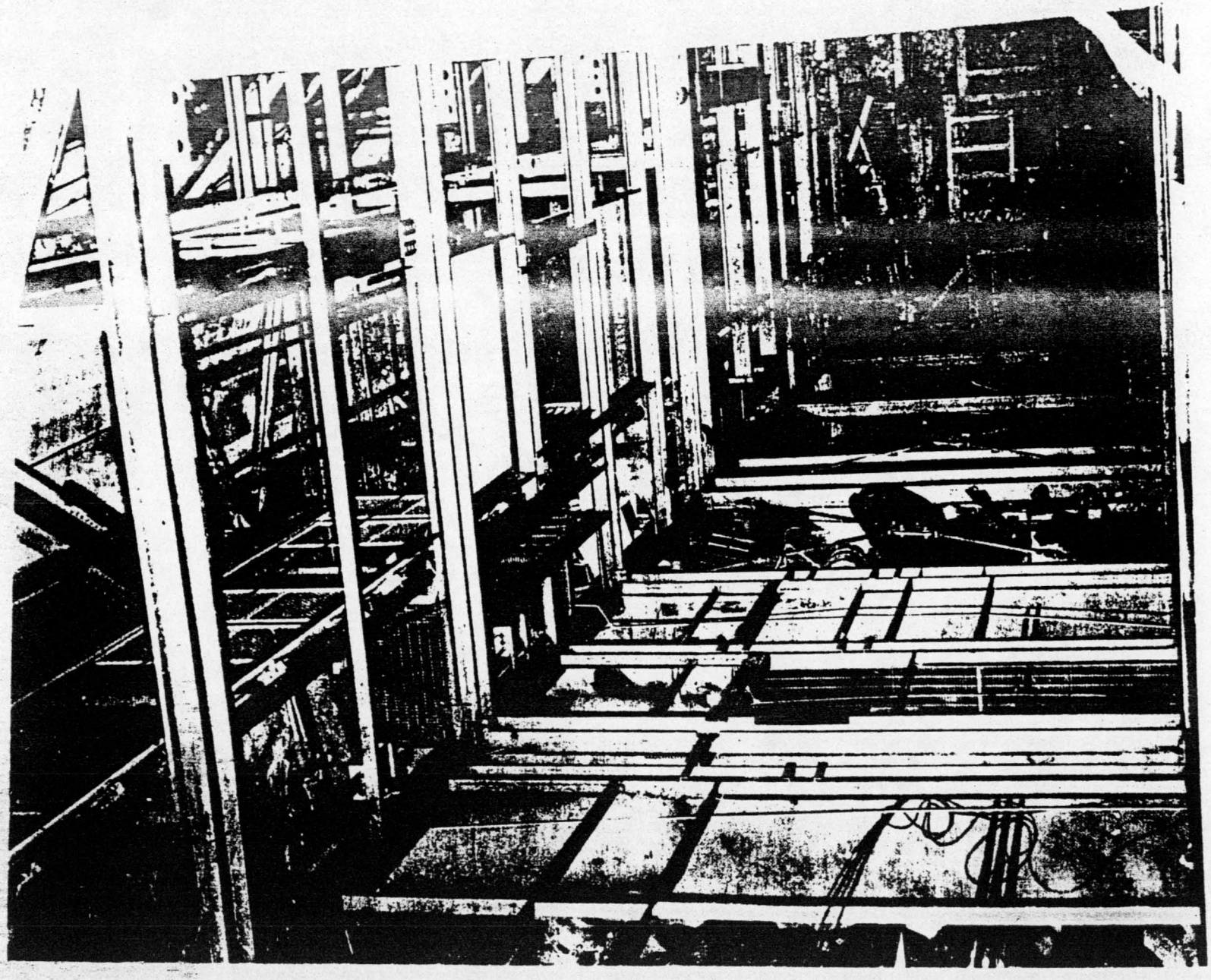
Figure 46 is a picture of the silo crib from top to bottom.

There were numerous changes to the crib steel before and after it was erected. Those changes that came after the crib had been erected were made while other work processed as scheduled.

PROCESS VESSELS

The cryogenic vessels (large vessels) were utilized for the

Figure 46. View of the crib looking from top to bottom.



storage of liquid oxygen and liquid nitrogen. These vessels are located on level 8. The vessels were not fabricated in time to install them as had been planned (during erection). This posed a very serious problem because if the crib erection was delayed, all work which depended upon the completion of the crib would also be delayed. It was decided to continue the erection of the crib and set the vessels at a later date. Several members were left out between level 7 and 8 including some of the members of level 8 proper so that the vessels could be set, when they arrived. When they finally did arrive, the vessels were lowered down the launch platform shaft (see Figure 46). The nitrogen helium heat exchanger tank was set first because of its location in the silo. This tank was constructed with four legs which bolted to similar legs on the liquid nitrogen tank. The liquid nitrogen storage tank was set in position under the heat exchanger and both were secured. Next the seven GOX and GN2 tanks were set in place one on top of the other. At the last three sites, a set of 3 vertical tanks were installed instead of the 7 horizontial tanks. After the GOX and GN2 tanks were installed the LOX topping tank was lowered into the silo and placed into position.

All the tanks were lowered into the silo by crane. Then with the aid of 2 cranes, an air, winch, a cable, and pully blocks, the tanks were raised into position under level 7, and secured there. The LOX Topping Tank was supported by 4 main rods secured to the bottom level 7; it also had 8 guy rods to hold it in position. Because of the weight and size of the LOX Storage Tank it was handled in a somewhat different manner. Temporary rails were set on the silo

floor and a carriage was installed to carry the vessel approximately 40' horizontally. This carriage was set at the correct elevation for the final positioning of the tank. Three cranes were used to raise the tank. It was then lowered (by 2 cranes) through the missile shaft to the carriage. Figure 47 shows how the liquid oxygen vessel was lifted by three cranes just prior to being set into the silo. The carriage was moved into position by a crane, and air wench, and cable and pully blocks, with the aid of the crib to secure the pully blocks. The LOX tank was then supported by four 2½" diameter rods and 8 guy rods secured to the bottom of level 7. After the LOX Storage Tank was positioned and the major crib steelmembers that had been left out previously were now installed. Several minor members of the crib were not installed between levels 7A and 8 until the two inflight tanks and the one ground support tank were placed into position. Figure 48 shows several vessels secured in place between level 7 and level 8 of the crib.

ELEVATOR, FACILITY AND LAUNCH PLATFORM

There are two elevator shafts within the crib steel. The smaller shaft is for the facility elevator and the larger shaft is for the launch platform elevator on which the missile rides. The counterweights for the launch platform were lowered to the bottom of the shaft during the erection of the crib steel. The guide rails were temporarily hung in place to guide the weights to the bottom. The counterweights were set on cribbing. Said cribbing rested on a previously poured thick concrete beam, deisgned for this purpose.

Figure 47. Three cranes lifting the Liquid Oxygen Vessel into position to lower it into silo.

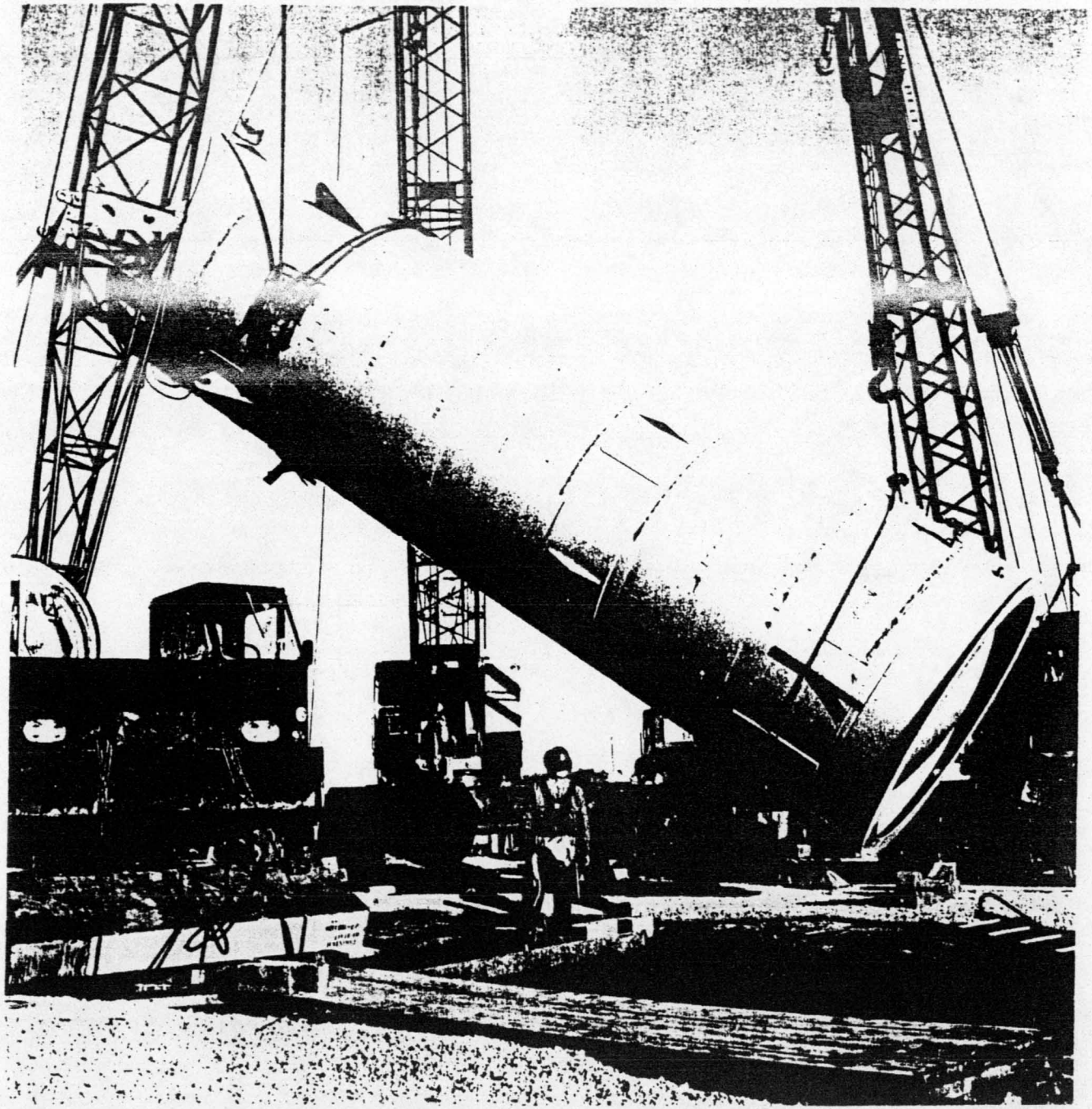
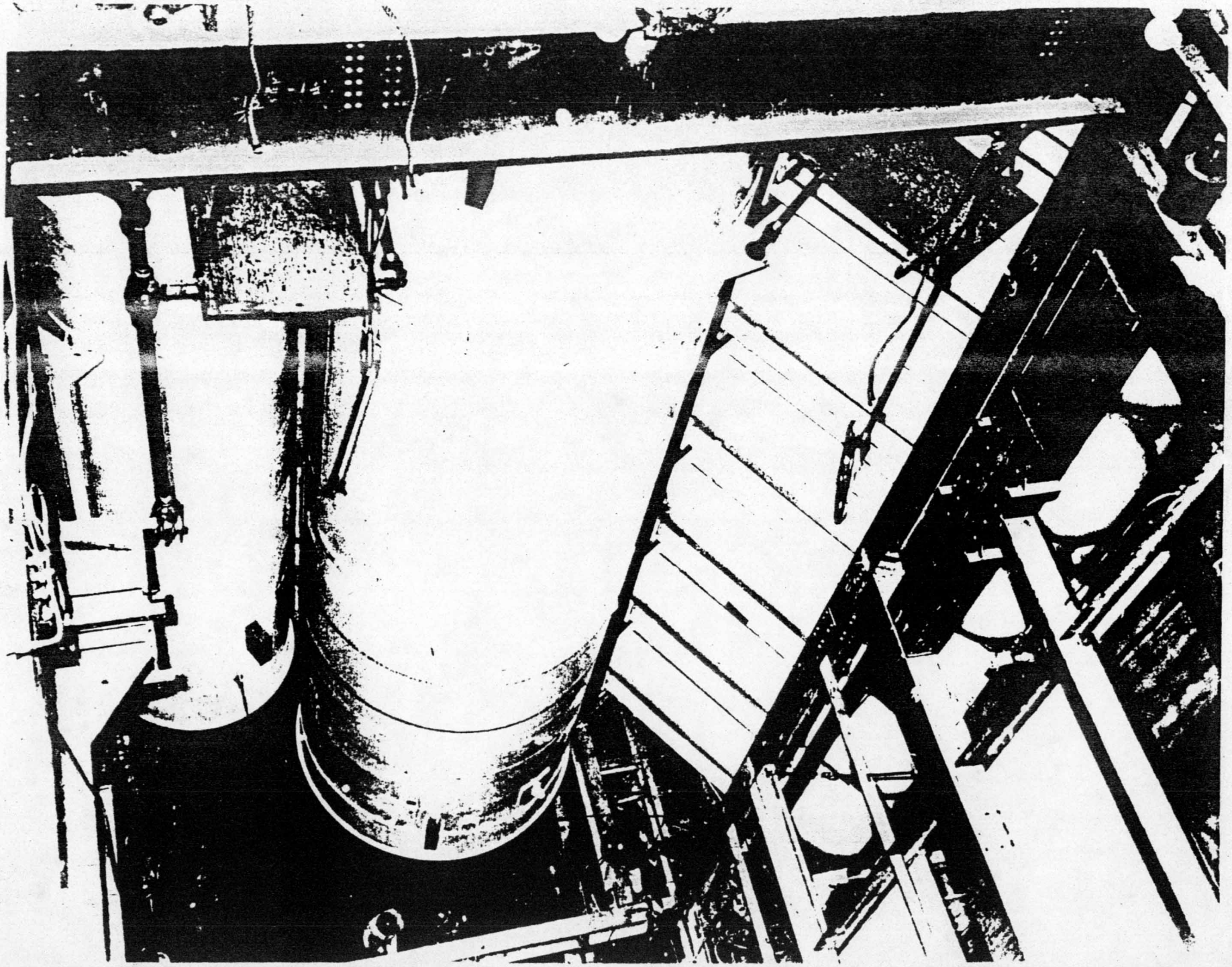


Figure 48. Vessels between Level 7 and 8 used for the storage of Liquid Oxygen and Nitrogen Gas.



The counterweight consisted of 29 leaves weighing better than one half million pounds. Twelve 2½" rods pass thru the weights which will be used to secure the weights to the pully blocks that will be utilized in the operation of the launch platform elevator.

8. [illegible] POWER SYSTEM

GENERAL

The purpose of the PLS was to transfer and store the propellants and auxiliary fluids from the supply source to the missile. This system started at grade level with fill lines and vents and terminated at the elevator disconnect assemblies. The propellants consisted of liquid oxygen and JP-4 fuel. The auxiliary fluids are liquid nitrogen, gaseous nitrogen, gaseous helium, and compressed air.

It was extremely important to keep this system clean at all times. The cleanliness that was required was far beyond the requirements of any normal construction in the field. For this reason, this system was designed necessitating fabrication of all parts at the factory, cleaning them there and shipping the prefabricated parts to the sites. These prefabricated skids and spools were then assembled in the silo.

Two of the liquids that flowed through this system were liquid oxygen at -297° F and liquid nitrogen at -320° F. Stainless steel piping was used because of the extremities in temperature.

[illegible] was composed of six prefabricated skids on which most of the gages, valves, and controls for the various systems were centralized. Several filters and other components originally installed on the prefabs however were later noted to be incorrect and were replaced after the installation of the prefab. The rest of the system consisted of the prefabricated spools, almost 400 for each site, which carry the propellants and auxiliary fluids to the storage vessels from the point of filling, and from the storage vessels to the missile.

The storage vessels were already installed when the PLS piping

were connected to them. Correct location of these vessels was therefore essential. The [illegible] vessel location was especially critical. The main LO2 fill line to the plants emerged from the top of this vessel. The second pipe section from the vessel consisted of a contraction joint. This joint was designed to contract and expand axially only, and was not designed to allow for misalignment. A great deal of care was also necessary in locating both the [illegible] vessel from the LO2 control trailer to which the LO2 fill line was connected. It was necessary to make final adjustments at the time of plant installation.

[illegible]:

The six prefab units were lowered into the silo were:

(1) Liquid Oxygen Fill Prefab

(2) Liquid Oxygen Control Prefab

(3) Liquid Nitrogen Prefab

(4) Pressurization Prefab

(5) Instrument Air Prefab

(6) Fuel Prefab

Figure [illegible] shows a typical pressurization prefab.

The first five of the above mentioned prefabs were lowered intact to level 7 where they were secured to the crib steel. Figure 50 and 51 show two views of the equipment on level 7. The sixth prefab was lowered at a later date to level 6. Those prefabs were all supposed to have a positive purge of 15 psi of dry nitrogen within them when they arrived from the plant. The purge was to be maintained until final connection of the prefab into the system. Virtually all prefabs arrived at the contractor's warehouse with less than the specified purge pressure. Also

Figure 49. Pressurization Prefab.

Pressurization
Panel

Figure 50. Propellant Loading System prefabs and piping on Level 7.

Figure 51. Propellant Loading System prefabs and piping on Level 7.

the pressure or many of the prefabs dropped to zero at one time or another before being connected into the system. Because of these conditions plus the fact that the purge pressure was introduced into the prefabs through rubber hoses with no filters, the cleanliness of the prefabs was questioned. In order to determine the extent of contamination, if any, due to improper purge on the prefabs an inspection was held at one site where the prefabs had been placed into the silo, but had not been connected into the system. In this inspection various components were opened and inspected visually and a wipe test made, which was analyzed by the government laboratory. Some particles over the specified limit of 150 microns were discovered. The majority of these contaminates were gasket material and thread lubricants. It was decided that these particles would be removed by shutdowns during testing, and, were not sufficient to warrant re-cleaning of the prefabs. As a result of this inspection it was decided that prefabs would not be rejected solely because of a lack of purge pressure, lack of filters in the purge line or the use of rubber hoses on the purge lines. However, the contractor was required to maintain a purge pressure of 3 to 15 psi on all prefabs after arrival to the area and to provide 10 micron filters on the purge lines. The use of 100% clean rubber hoses was permitted.

The major problems encountered with the prefab equipment centered around the control panel of the pressurization prefab, the Worthington air compressor on the instrument air prefab and the air dryer on the instrument air prefab.

The pressure prefab control panel had fabricated holes, through

which the stems of the control valves extended. Many of these holes were not in line with the valve stems, causing the stem to bind. This was noted on the first prefabs to arrive, and it was requested that it be corrected. The contractor neglected to correct this however, and the binding resulted in breakage of several valve stems during the test phase. This was later corrected and provided for free operation of all the valve stems.

The air compressors developed malfunctions, including excessive oil pumping, high or low interstage pressures, low oil pressure and failure to unload. These conditions were all traced primarily to failure of seats in the interstage valves and in the dump valve. Failure was apparently due to the action of the lubricating oil on the seats. This was remedied by changing both the seat material and the type of oil, resulting in a compatible combination.

After a short period of operation, it was discovered that oil was passing through the air drier assembly. The air drier consisted of silicagel elements and a heater. It was found necessary to install an oil separator unit upstream of the drier unit. Many compressor units ran a considerable length of time before discovering that oil was passing the drier equipment. Piping between the drier and the air receiver was found contaminated in several instances and in one case evidence of oil was found in the receiver. All contaminated parts were disassembled (as required) and cleaned on the site with trichlorethylene. The components were then inspected with the air of "black light" and reassembled.

Two problems were encountered with gages on the prefabs. The bourdon tube of the differential pressure gage on the cryogenic filters

(installed after testing) were found to be rated for less than the operating pressure of the system. Correct gages were therefore furnished by the contractor. It proved to be extremely difficult to calibrate the liquid level indicators within the limits required by specification. Actually it was nearly impossible to read the instrument itself closely enough to determine if the requirements were met. After several attempts with greatly differing readings, the majority of the gages were brought within limits.

It was necessary in most cases to raise the specified operating pressure for pneumatic control valves on the pressurization prefab from 35 psi to 45 psi in order to obtain specified closing times.

Some difficulty was also encountered with the teflon seats in the air pressure regulators. The teflon became rough after a few operations and failed to seat properly, thus allowing excessive pressure to build up.

FIELD INSPECTION:

The prefabricated spools were shipped in by truck. These spools were stored on saw horses as they arrived. The spools were sealed with blind flanges, taped, and covered with polyethylene. The polyethylene and tape on many of the spools was scuffed and broken at the time of arrival. To determine the results of the damage to the packaging, several spools with badly damaged wrapping were selected and inspected by the above mentioned prefab inspection method (visual, wipe test, micron size, etc.). The cleanliness of those examined was found to conform to the specification requirements.

All spools that could be bolted together before they were lowered

into the silo were so done. These spools were bolted together underneath a tent which had been erected as a clean room. Each spool had a purge on it and a continuous flow was passed through the piping as it was being bolted together. A "black light", "white light", visual inspection and a smear test (if necessary) were used at each connection to make sure that there was no fluorescence material in the spools or on the teflon gasket which was installed between the flanges of each spool. Spools were rejected because of dents and also because they did not meet cleanliness requirements. When blind flanges were removed from the ends of spools the open ends of the spools were always kept under a plastic bag, besides maintaining a flow of dry nitrogen through both spools which were to be bolted together.

The installation operation required an inspector with the (installation) crew at all times. Besides the government inspector, the government hired an independent laboratory service. This laboratory provided a man on each site for analyses of all tests. It was found necessary to divide one spool that was originally designed as a single unit in order to install it in the fill and vent shaft.

This same procedure was used when the connections were made in the silo except that in some instances there wasn't any clean room. All high pressure lines were tightened with a hammer wrench prior to testing.

A problem that arose was the fact that the storage vessels and the propellant loading system had two different criteria for cleanliness. The piping contractor was reluctant to connect piping to the pressure vessels until the vessels met the same cleanliness requirements (maximum particle size 150 microns) as those specified for the piping. The vessels and piping were to be checked for cleanliness at a later time as a

complete system, with the system required to meet the cleanliness requirement as indicated for the piping alone. To bring the vessels to the cleanliness standards desired, they were cleaned by blowing with GH_2. For the first several sites, the vessels were pressurized individually through a common fill connection at the top of the fill and vent shaft. Blow down pot tests (as described later) were then installed on this connection, and the vessel blown back through this connection. An attempt was made to assure that the fill line, through which the vessel was filled and blown, was in itself clean, before beginning the cleaning process. This was accomplished by blowing the line prior to the cleaning operation. This procedure was apparently not completely successful, as the first few vessels blown through this line invariably required more blowing than subsequent vessels. Later it was decided that the cleaning process would be more effective if the vessels were charged as previously explained, but blown down through a special test valve installed in place of the blind flange located at the end of the vessels (opposite the fill and vent). This procedure was followed at approximately one half of the sites with the used GH_2 discharged directly out of the vessel and into the silo.

When the analysis of the blow down pad showed no particles over 150 microns the final connection of the piping to the vessels was made.

[illegible]

The location of guides and anchors for the GLS piping was also more critical than normally is encountered in construction. Because of the contraction of cryogenic lines and the high pressures involved on the gaseous lines, it was important not to deviate from the designed location

of the pipe supports. A portion of the PLS piping was anchored to inserts imbedded in the silo wall and a portion to the crib steel itself. Some of the insert plates in the silo wall were not in the correct location. A few of the discrepancies were due to errors in the drawings which were utilized to set the plates; the majority were due strictly to errors in setting the plates. Because of these errors in insert plates, it was necessary to relocate a few of the plates and, to re-work many of the hangers in the fill and vent shaft. Also, the block-outs for the blast plates and frames, where the piping passes from inside the silo to the fill and vent shaft, were mislocated on several plates. This caused considerable delay while relocating the block-outs, (for the blast plates). Problems arose also in locating the supports on the crib steel. At the time the supports were installed, the crib steel had not been aligned, and the crib was not necessarily suspended in a true vertical position. This created a problem in selecting a reference point from which to locate the supports. This was never completely resolved during the installation of the hangers. It appears that the hangers should have been located with reference to structural members on each level even though this may not have provided alignment of the hanger at the time of installation.

Several instances were encountered where there occurred an interference between flanges and fittings on the pipe and the supports, as designed. In most instances the support was notched as required to provide the necessary clearance. In others, shims placed under the piping provided the required clearance.

[illegible]:

Most of the systems had to be checked to insure that they would hold a proof pressure, that they did not leak and that they were clean. All gages throughout the system had to be calibrated before any tests could be run.

The proof pressure was a pressure specified for each system and was a pressure in excess of the working pressure. If the system held a proof pressure for five minutes then the pressure was reduced to working pressure. At working pressure the entire system was checked for deformation due to the proof pressure, and for leaks. In checking for leaks, a tape was placed over the joint. A hole was punched in the tape and leak-tek was placed over the hole to see if there was any nitrogen escaping. It appears that this might not be as good a method for checking, as placing leak-tek around the entire exposed flange.

A blow horn was installed in each complete line of each system to check the partical size and also to detect any evidence of hydrocarbons. The specifications required that no particle, larger than 150 microns, remain in the system and that there should be no hydrocarbons. This blow horn was designed so that a gauze pad could easily be placed in or removed from it, without removing the blow horn itself, from the system.

There was quite a bit of difficulty in designing a blow horn that itself would not contaminate the system. Before the one explained above was discovered, a blow horn which had to be removed after each blow, was used. This type introduced brass particles into the system which made it impossible to get a clean pad. Contamination was also traced to gaskets used on some designs of blow horns. The gaskets would not withstand

the high pressures and velocities within the blow horn. Eventually a horn was developed utilizing a metal to metal seat. This eliminated gasket failure. It was important with this type of horn however, to assure that there was no leakage around the seat in order that all of the blow-down gas pass through the filter pad to achieve a valid test. Further, it was necessary that the back-up screen which held the test pad be soldered completely around the edge. This not only insured all the gas passing through the pad but helped prevent the pad from being damaged. Early blow horn designs tore pads because the length of the horn was less than the specified 18". Test valves were used at the ends of the systems during testing. These valves had stainless steel seats which introduced numerous stainless steel particles into the system. The valves when new were not as prone to emite particles as the valves which had been used for some period of time.

The system to be tested for cleanliness was pressurized with nitrogen up to the working pressure, or brought down from proof pressure to the working pressure of each particular system. Then, according to the respective test procedure, the nitrogen was blown off through the blow horn for a certain amount of time, or through a certain pressure drop. The test pad was then removed from the blow horn and placed under a microscope to determine the number of particles and the size of each particle retained on the pad. This procedure continued until the Air Force PIO Control room stated that, "that particular line of the system passed". In those cases where successive blow down pads showed no improvement or it appeared that an excessive amount of blowing would be necessary to produce a clean pad, an attempt was made to locate the

source of contamination and remove it. Filter housings and dead end pipes were prime areas of suspect and often proved to be contaminated upon inspection. Contaminants were removed by trychlorethylene, by directly blowing the contaminated part, or a combination of methods. The components were then reassembled and the blow downs continued. The reason that the Air Force make the final decision on whether a system was clean or not was because their criteria for cleanliness was not as strict as our own specification. The Air Force criteria was developed after our specification had been written. Some of these systems took many blows before they were satisfactory. In all, there were 24 lines (at each site) that had to be blown clean. A room was provided at each site which was kept clean and pressurized. All pads were prepared, pre-read and read again after each blow, in this room.

Nitrogen for these tests was provided by the Air Force. The major portion of the liquid nitrogen was produced at Schilling Air Force Base. The contractor hauled the liquid nitrogen from Salina to each site in Air Force tank trucks. The liquid nitrogen was then pumped into a government furnished recharger where it was transformed into the gaseous state and then while in the gaseous state, used for testing the systems. There were some problems involved in getting the liquid nitrogen to the site when needed. The rechargers also had a tendency to break down which often delayed the work.

There were eleven distinct tests run on the PLS. Following is the list of the tests:

1. Instrument Air System
2. Continuity and Valve Actuation

3. Gaseous Oxygen System

4. Gaseous Nitrogen System

5. Liquid Oxygen System

6. Liquid Nitrogen System

7. Helium System

8. Fuel Loading System

9. Cold Flow Test - LOX System

10. Cold Flow Test - LN_2 System

11. Standby

Test 1, 3, 4, 5, 6 and 7 of the above tests were essentially run to check for retention of proof pressure, for leaks at the flanges and for cleanliness as already explained.

Test 7 provided proof that, the helium system would hold a vacuum (beside the afore mentioned requirements).

Test 2 was a check to see that all the electrical valve actuation equipment functioned properly.

Test 8 required a proof pressure and leak test on the fuel system. Fuel had to be circulated through this system to check the system's cleanliness and to prove that the system was capable of functioning as designed.

Test 9 and 10 was a check to see that the liquid oxygen and liquid nitrogen system would remain in tact when the systems were subjected to the extreme cold of the liquid nitrogen with particular attention to the action of the contraction joints.

Test 11 was utilized to leave the entire system in its final configuration.

In performing test 9 and 10 it was necessary to pull a vacuum of 190 microns on all the four cryogenic vessels. These vessels, used for the storage of liquid oxygen and nitrogen, were constructed of an inner and outer shell. Between these two shells is an area in which a vacuum is maintained to provide insulation for the cold liquid which is stored in the inner vessel. There was no problem in maintaining this vacuum at most sites. One noticeable exception was the LN_2 tank at site 12. The vacuum could not be pulled down to 150 microns, as it had been done on all other vessels. This vessel was checked for leaks and none were found. The annular space was purged with dry nitrogen in the hopes that, if there was moisture in this space, it could be dried out. Eventually it became evident that there had been moisture in this annular space. The vacuum was finally pulled down to 150 microns. This was finally accomplished by drying out the annular space with dry nitrogen although this was a very slow process.

9. MECHANICAL EQUIPMENT

GENERAL:

The mechanical system consisted of a substantial amount of piping, tanks, and duct work, connecting the different pieces of equipment together so that they would function as designed. The various systems incorporated in the complex were:

a. Supply and Distribution System.

(1) Condenser Water Supply and Return

(2) Chilled Water Supply and Return

(3) Hot Water Supply and Return

(4) Diesel Fuel Supply and Return

(5) Diesel Lube Oil Supply and Return

(6) Diesel Exhaust

b. Water Storage and Distribution System.

c. Sewers; Sanitary, Gravity and Sewage Treatment Facilities.

d. General Plumbing.

e. Ventilating System.

f. Air-Conditioning System.

g. Fuel Oil Storage and Underground Piping.

h. Gas Detection System.

i. Compressed Air System.

j. Blast Closure System.

k. The controls for all of the systems.

All the piping for the above systems was prefabricated and then shipped to each site. Shipping of this material to the right site at the proper time, was one of the contractor's major problems. He handled

it well and the installation proceeded smoothly.

PROBLEM AREAS :

The biggest problem encountered in the installation of the piping was the numerous changes that were made in design. These design changes reached the contractor after the piping had been fabricated and in many instances, after the pipe had already been installed. Modification No. 71 was issued to the contractor when he had fabricated approximately 85% of all the piping to be installed. This caused a delay and in some instances confusion at the sites.

There were numerous interferences encountered during installation. This Area Office issued 127 SCMW (Sandilling Area Military) sketches which corrected these interferences. As each interference was discovered in the field, it was brought to the attention of the area office. The problem was then reviewed, a solution reached, and a SCMW sketch issued. Each site received a copy of this sketch and in this way, all twelve sites had the same change to the system. This assisted in keeping all the sites as similar as physically possible.

The number and location of hangers used to support the piping as shown in the design drawings was not adequate to provide stability for the piping. After the piping and hangers had been installed at several sites, a survey was made to determine where additional hangers were required. From the results of this survey, a change order was issued, adding approximately fifty hangers at each of the twelve sites.

The contractor, according to the specifications, had the option of pneumatic automatic or electronic automatic controls for the ventilating and air conditioning system. He choose pneumatic automatic controls

which were installed by the Powers Regulator Company.

The diesel shock mounts had to be re-adjusted after the diesels had been completely checked out. This necessitated rechecking the diesels once again to make sure that the shaft and various other parts were level. The shock mounts were originally adjusted when the diesel was being prepared for checkout. This adjustment was hurriedly done, so that the testing of the diesels could begin. There was also discovered, sagging in the beams which supported the diesel generators. Because of these two reasons, it was necessary to readjust the shock mounts a second time. Before this second adjustment, a modification was issued to the contract which provided additional beams to support the diesel generators.

Under the provisions of the contract, the contractor was required to install equipment which was furnished by others (ASC) and see that it operated properly. In several cases the ASC equipment which was provided, did not fit properly to the parts fabricated by the local contractor according to his plans and specifications. The silo submersible pumps furnished by Winthrop Pump Company, (a government furnished Assigned Service Contract) caused considerable problems. The seal and the wiring insulation deteriorated, because of foreign liquids other than water which eventually made their way into the sump. These pumps were modified by the I and C contractor.

The Launch Control Center Sewage Sump Pumps as originally installed failed to operate satisfactorily owing to the leakage of air from the air column of the liquid level control. The contractor was directed to provide a dependable liquid control in accordance with the contract

specifications. This was accomplished by sealing all threaded pipe connections with teflon tape, sealing the pores in the aluminum alloy pressure switch mounting block with a sealant while the block was under a partial vacuum, and installing new diaphragm pressure switches.

VALIDATION:

After completing the installation of a system at each site, the contractor ran a validation test on the system in accordance with a procedure set up by the Corps of Engineers, Air Force and OR/A. These procedures were revised several times, before all parties were generally satisfied with them. All systems which had been previously validated by an earlier different procedure had to be partly or totally revalidated. As each system was validated a representative of the Corps of Engineers, the Air Force and OR/A was required to witness the validation and sign that the system satisfactorily passed the procedure. There was a total of twenty-one validations at each site.

During the validation procedures some systems were found to be deficient in one respect or another. Some of the deficiencies were in design while others were in construction or operation. In the instance of the silo submersible pumps and the sewage pumps, it was discovered that the equipment had been tampered with prior to final validation, and therefore would not operate as designed.

The design inadequacy of the blast closure systems (16" and 42") was discovered when an attempt to validate them was made. The 16" blast closures did not meet the specification requirements as to the air leakage rate at -200° F. temperature and required a factory test at Henry Pratt Company's plant. They also failed this test. The 42" blast

closures would not withstand the closing shock created when they had to close. The nozzle was usually the first thing that failed. Re-design of the 12" blast closure was necessary and several other changes had to be made also as a result of the validation tests.

The gas detection system functioned as designed but did not completely satisfy the needs of the Using Agency (U. S. Air Force). A change order was initiated which provided for the additional requirements of the Air Force. This change order delayed the validation of the system for several months.

Most of the systems required some adjustment before they functioned properly.

10. [illegible] FACILITIES

[illegible]

The electrical work for each complex included diesel generators, [illegible] distribution lenders, motor controls, lighting, communication [illegible]ceiver, grounding and alarm systems.

The diesel generators, low switchgears, essential and non-essential switch gear, interface cabinet, facility remote control [illegible] (FRCP) and the power remote control panel (PRCP) were fabricated at various shops throughout the country. They were then shipped [illegible] and lowered into the silo, or placed in the ICC, in their respective locations.

[illegible]

One of the main problems that was encountered during the installation was the great number of conflicts that arose between equipment of other crafts and the electrical facilities [illegible] conduits and cable trays. Some examples of these conflicts [illegible]:

[illegible]. Level No. 1 - Several lights on Level 1 interfered with [illegible]lled equipment; i.e. - with the door to the air intake blast [illegible]

Level No. 2 - Cable trays on Level 2 had to be raised, [illegible]ifted to one side in order to clear water pipes, eliminate the diesel exhaust from coming into contact with the [illegible] provide clearance to the water control centers.

Level No. 3 - Lights had to be raised on Level 3 to avoid [illegible], and some conduits had to be re-located to avoid

interferring with other apparatus that was given the same elevations and dimensions on the drawings.

d. Level No. 4 - On level 4 the door on the lighting panel had to be eliminated because it could not be opened when the chiller unit was installed.

e. Level No. 5 - Lights conflicted with equipment on level 5.

f. Level No. 6 - Lights also conflicted with equipment on Level 6. Conduit had to be re-routed on Level 6 to bypass the I beam of the hoist, and to allow the doors to the missile enclosure to open.

g. Level No. 7 - Conduit sizes had to be altered for a junction box on a HLS skid at Level 7. Telephone riser had to be relocated around HLS piping below Level 7.

h. Level No. 8 - Installing explosion proof fitting in their proper place on Level 8 was a problem. It was not very clear which areas were included.

i. The 4 x 4 wire way from the lighting panel on Col. K was re-located to allow for installation of I and C equipment.

j. Emergency lights throughout the silo had to be shifted to obtain the maximum light from them.

At the start of the electrical, mechanical, HLS installation, etc. the craft which was first to install their pipes or conduits did not run into the problem of interferences. As the job progressed every craft realizing the situation, worked with each other so that all the equipment would be installed at the right location. Since the mechanical piping was already prefabricated, it became apparent that it was

easier in most instances to relocate or rework the electrical installation.

Protection (from the weather) of the electrical equipment as it arrived at the site and until it could be placed into the silo was a problem. Even after installing the electrical equipment into the silo protection from the weather was necessary.

After the complexes were turned over to the Air Force the contractor discovered that the bus bars in all three control centers did not meet the specifications. These bus bars were covered at cost. Changing them required that the power be cut off, and this could be last handled at night.

The blast detection conduit markers at grade elevation were generally not installed. When installed in numerous instances they were not at the correct location. It became necessary for the contractor to use a mine detector (or similar device) to locate the ends of these (blast detection) conduits. Without the ends of the conduit, the I and C contract could not connect up the blast detection system.

Grounding became quite a problem, because of a difference of opinion on exactly what had to be grounded. All the ring beams and re-steel were grounded by 4/0 copper wire to copper rods which were driven into the earth at several different elevations. Grounding plates were imbedded in the concrete silo walls and were also connected to the 4/0 copper wire. Every piece of equipment was grounded to the crib steel and in turn the crib was ground to the aforementioned grounding plates in the concrete wall. Bonding straps were placed across flanges and

valves throughout the silo and LCC. All flexible joints on ducts and cable trays were also bonded.

Several relays had to be changed because they would not function properly (i.e. - the RCP relay). The exciter relay air gap spacing was not correct in the equipment that was shipped to the sites from General Electrical. This air gap spacing had to be corrected before the diesel generator tests could be run. The incorrect spacing in the exciter relay was discovered at the factory from a relay that was shipped back for a checkout. The spacing for the remaining relays was corrected at the sites.

Another problem involving the generators was the correct rating required for the diesel generator exciter. The Air Force wanted a 9 horsepower exciter instead of the 7½ horsepower exciter furnished and would not sign off the test procedures. This problem was a matter of interpretation of the National Electrical Manufacturer's Association Standards. The diesel generators were finally accepted as furnished (7½ HP).

Florescent lights could not be furnished according to specifications because there aren't any lights manufactured that would meet the specifications.

The doors on the back of the 480V Switchgear had to be altered in order to open them. There existed a conflict between the doors and members of the crib steel.

Air Force demands concerning the Emergency Lights and the batteries required considerable correspondence with the contractor and delayed validation for quite a long time.

VALIDATION

When all the electrical equipment was installed and completely hooked up, validation tests had to be run on each system. This was done in a manner similar to, and, in conjunction with, the mechanical equipment.

11. [illegible] FACILITIES

[illegible] - (Contract No. [illegible]):

Operation began [illegible] April 196[illegible].

The sequence of construction was as follows: Laying out of the site, constructing the access road, and locating and establishing the limits of the borrow pit. This was followed by stripping of the site, excavation for the building and storage tank foundations, and excavation for the utilities.

The water table was hit during the excavation for the sewer discharge lines and required use of dewatering pumps. The sewer, water and gas lines were installed by being jacked under the existing road. The electrical supply line was then installed and the building and storage tank foundations placed. Structural steel erection, roofing, and insulated siding followed. The interior mechanical and electrical installation was accomplished along with the rest of the construction. Painting then followed.

The oxygen and nitrogen tanks and piping were then installed and the system was tested and purged. The access road had a portion made of bituminous and a portion made of concrete. A [illegible] compatable joint sealer was used with the concrete portion.

This contract with its modifications was completed on schedule. A supplemental agreement was issued for the installation of an overhead crane. This crane was also installed on schedule.

[illegible] - (Contract No. [illegible]):

Operations began [illegible] June 1960.

The first phase required removing the existing partitions, the

electrical and mechanical facilities and the concrete floors. After this demolition was accomplished, drainage material and the underground utilities were placed and the new concrete floor was poured. Construction of the electrical supply line and transformer station began on 23 June 1961.

The erection of the new partitions, the installation of electrical facilities and the installation of the mechanical fire detection system was next. The drainage material, underground utilities equipment pads and cement floors were then placed in the missile area. Forming and placing of concrete for utility trenches followed. The erection of the structural steel for the overhead crane and the installation of the crane, the installation of the battery station and the installation of the mechanical and electrical equipment were next in sequence, for the missile area. The mechanical and electrical installations in the equipment room were made simultaneously with the other construction.

The removal work began on the technical supply building on 12 July 1961. This was followed by the erection of the partitions for the offices and the installation of the mechanical and electrical facilities. The painting and finish work was interpreted into the construction progress. The fire protection for the technical supply building was via an overhead sprinkler system. Said building was completed on schedule.

The installation of the underground communications duct from the Missile Assembly Building to the Base Communications Building was accomplished during the building construction phase. Base re-routing

of lines was required because of interferences.

The installation of the tank farm and the helium line to the rail siding was accomplished during the last stage of construction. The helium line was installed by being jacked under the existing 17" pavement.

Construction on the Missile Assembly building was completed with modifications, ahead of schedule; however, considerable difficulty was experienced with the placement of the missile pod and IGS (Inertial Guidance System) cooling systems. These are high pressure systems and errors were discovered in the design, the specifications and the construction. The contractor did correct the construction errors.

CONVERSION OF BUILDINGS - (Contract No. 4091):

Operations began 12 July 1960.

The sequence of construction was as follows: Removal of the existing partitions, and the existing electrical and mechanical facilities.

As this work progressed, the construction of the new work followed. The new work consisted mainly of new partitions, some electrical wiring, electrical fixtures, changes in existing mechanical installations and painting. Several buildings were completed at a time, and upon request from the "Using Agency", NASA, they were turned over to them. A total of 15 buildings were rehabilitated.

One of the original buildings was deleted from the contract, and two others added. Building #113, one of the added (two) buildings, required one 5-ton air conditioning unit (government furnished) and one new 10-ton air conditioning unit. Construction with modifications was

completed on schedule.

REACTOR [illegible] FACILITY - (Contract No. 4497):

Operations began 2 August 1960.

The sequence of construction was as follows: Demolition of the existing concrete pavement for new addition to [illegible] I Building, excavation for footings, forming and placing of concrete for footings, forming and placing of concrete for grade beam, erection of the structural steel, forming and placing of concrete for the blast wall followed by the installation of the roofing and siding.

Modification of the existing [illegible] I Building was accomplished simultaneously with new construction. This consisted in part of installing a new boiler in the equipment room and modifying the existing heating and air conditioning system and extending these two systems into the new portion. The existing electrical system was modified and extended into the new addition also. An overhead crane was also installed. It was found, after installation, that the crane, and the ceiling lighting supports conflicted. A change order, modifying the structural steel bracing and the lighting supports corrected this conflict.

The modifications of the Base Spares Building and Storage Igloo were accomplished simultaneously with the work on the [illegible] I Building. The designed overhead door for the storage igloo could not be used because of inadequate overhead clearance. A modification was issued for the installation of a steel, exterior roll-up type door. Construction with modification was completed on schedule.

A supplemental agreement was issued for the installation of an

Air system.

MODIFICATIONS MISSILE ASSEMBLY BUILDING - (Contract No. 1066):

After the Missile Assembly Building was constructed, several modifications were deemed necessary.

The operations of these modifications began 3 April 1961.

The sequence of construction for these modifications was as follows: Removed existing partitions, and some electrical and mechanical work; installation of temporary partitions for dust protection; cutting out the existing concrete floor for the installation of a new cleaning pit, (room 106); removal of a monorail and hoist (from room 109); back-fill the (old) pit and place a concrete slab in room 109. While excavating for the new cleaning pit (in room 106), the contractor encountered conduits not shown on the drawings. A modification was issued to re-route these conduits. The contractor then placed the concrete for the (new) cleaning pit and installed the new partitions.

An air lock (110) had to be shifted because of a conflict with existing electrical panels. The mechanical and electrical work was accomplished while the rest of the work was being done.

Due to the short period allowed for the completion of this contract, much expediting was required on several critical items. The electric oven (an architect design from Air Force criteria) had no prototype requirements, and no factory test requirements. Much expediting was done on the oven so that it could be installed in time to meet contract completion date. When the oven was installed, and the operational tests run, the oven would not function as required. A modification was issued,

returning the oven to the manufacturer for re-design work. There was a considerable delay in getting the oven re-designed. The oven was not re-delivered (to the job) until 2 October 1961. Additional changes were still required at the job, in order for the oven to comply with the requirements of the specifications.

The deadweighter also caused some delay because of manufacturer fabrication errors.

The contract with modifications was (finally) completed on schedule.

WATER SUPPLY SYSTEM - (Contract No. 4386):

While the aforementioned support facilities were all located on base (Schilling Air Force Base) the water supply system was solely an off base support facility.

The wells had previously been established by contract under the Kansas City District Office at all sites, except at Site #3 and #11 where the water supply was obtained from the city of Gypsum, Kansas for Site #3, and from the city of Abilene, Kansas for Site #11.

Operations began at Sites #3, #4, and #6 on 3 June 1960; at Site #2 on 20 June 1960; at Site #5 on 5 July 1960; at Site #1 on 20 July 1960; at Site #8 on 28 July 1960; at Site #7 on 4 August 1960; at Site #9 on 23 August 1960; at Site #12 on 7 October 1960; at Site #11 on 1 November 1960 and at Site #10 on 7 November 1960.

Site #3 required the construction of a pump station in the city of Gypsum to supply the site with water. The well house and water softener building were located at the site. The supply line ran from the city (Gypsum) to the site.

Site #1 didn't require a pump station (in the city of Abilene). The supply line was connected to the existing city main.

The well houses at sites #4, #5 and #6 were located off the site, and, the evaporation pond at site #6 (only) was located adjacent to the (off site) well house. Tee fences were constructed around these off site facilities.

Installation of the mechanical and electrical equipment started when the buildings were completed.

The construction of the evaporation ponds was carried on simultaneously with other construction and all were located on the site with the exception of Site #6. The water storage tanks (4 each) were installed by the complex contractor.

The testing of the systems revealed that the water supply at several of the sites was barely sufficient. But only at Site #12, was a new (No. 2) well required. After several drillings, a good supply of water was found at this site. A new manhole for this well was constructed and the pump from the old existing (No. 1) well was removed and installed in the new (No. 2) well. The new well was then connected to the existing well house.

Roadways were constructed to all the off site wells; the seeding and sodding then proceeded.

There was conflict between the contract specifications and design on some of the electrical systems with reference to special relays. These conflicts were corrected.

The construction with all modifications was completed on schedule.

PART III

CONTRACT ADMINISTRATION

12. A BRIEF HISTORY OF EACH CONSTRUCTION CONTRACT

A brief history of each construction contract with original and final contract cost exclusive of unsettled claims, the total number of modifications and claims exceeding $100,000 each together with their description and comments concerning their settlement. The information provided concerning the modifications is current as of 1 December 1961

WS-107 A-1 OPERATIONAL BASE

MISSILE LAUNCH COMPLEXES

SCHILLING AIR FORCE BASE

Contract Number:	DA-23-028-ENG-4281
Date of Contract:	7 March 1960
Contractor:	Utah-Manhattan-Sundt, Joint Venturers 100 Bush Street San Francisco 4, California
Construction:	WS-107 A-1 Operational Base Missile Launch Complexes near Schilling Air Force Base Salina, Kansas
Notice to Proceed:	7 March 1960
Original Contract Amount:	$17,209,000 for nine sites 6,174,000 for three sites (See TAB 1a) $23,383,000 for twelve sites
Modifications:	To date, of 267 modifications Proposed, 45 have been cancelled 219 have been combined into 53 modifications and 3 remain open. (See TAB 1f)

Of these 53 modifications, the following resulted in increases in the contract amount over $100,000:

Mod No.	Amount	
24	6 138,735.00	(See TAB 1b)
35	1,000,473.00	(See TAB 1b)
36	143,214.80	(See TAB 1b)
52	107,255.00	(See TAB 1c)
56	131,624.00	(See TAB 1a)
63	238,779.00	(See TAB 1c)
65	1,733,533.00	(See TAB 1d)
125	17,588,344.00	(See TAB 1g)
139	500,000.00	(See TAB 1h)

Claims: To date, of 91 claims by the Contractor,

11 have been allowed

75 have been withdrawn by the Contractor, based on negotiations of Modification No. 125 and

5 remain open.

Of these 11 claims which were allowed, four resulted in modifications over $100,000.00. (See TAB 1g)

Final Contract Amount, exclusive of unsettled claims	$45,678,965.00 (See TAB 1n)

TAB 1a

ATLAS "F" SCHILLING

Contract No.:	DA-23-028-ENG-4281
Contractor:	Utah-Manhattan-Sundt, Joint Venturers
Modification No.:	15 - Supplemental Agreement
1. Description:	Provide for the construction of three additional launch sites.
2. Source:	Air Force Construction Directive
3. Received by Contracting Officer:	4 May 1960
4. Presented to Contractor:	13 May 1960
5. Negotiations Completed:	24 May 1960
6. Notice to Proceed:	26 May 1960
7. Cost Estimate:	
a. Government estimate at start of negotiations:	$3,718,000.00
b. Contractor's initial proposal:	$6,975,954.00
8. Negotiated Amount:	$6,174,000.00

TAB 1b

Contract:	DA-23-028-ENG-4281
Modification No.:	24 - Change Order
Date of Modification:	22 June 1960
Description:	Assignment of Contract No. DA-23-028-ENG-4323, for furnishing Blast Closures
Amount of Modification:	$139,735.00

Contract:	DA-23-028-ENG-4281
Modification No.:	35 - Change Order
Date of Modification:	22 July 1960
Description:	Assignment of Contract No. DA-23-028-ENG-4253, for furnishing Diesel Generators
Amount of Modification:	$1,080,473.00

Contract:	DA-23-028-ENG-4281
Modification No.:	36 - Change Order
Date of Modification:	22 July 1960
Description:	Assignment of Contract No. DA-23-028-ENG-4246, for furnishing Switchgear and Panels
Amount of Modification:	$143,214.00

Note: For complete list of Assigned Contracts, see Page

TAB 1c

Contract:	DA-23-028-ENG-4281
Modification No.:	52 - Change Order
Date of Modification:	2 September 1960
Description:	Assignment of Contract No. DA-41-443-ENG-5711, for furnishing Package Water Chiller Units and Rotary Pumps
Amount of Modification:	$107,255.00

Contract:	DA-23-028-ENG-4281
Modification No.:	58 - Change Order
Date of Modification:	2 September 1960
Description:	Assignment of Contract No. DA-41-443-ENG-5746, for furnishing Air Washer Dust Collector Units.
Amount of Modification:	$131,624.00

Contract:	DA-23-028-ENG-4281
Modification No.:	63 - Change Order
Date of Modification:	9 September 1960
Description:	Assignment of Contract No. DA-23-028-ENG-4360, for furnishing Over-Head Door Hinge Assemblies.
Amount of Modification:	$238,779.00

TAB 14

ATLAS "F" SCHILLING

Contract:	DA-23-020-ENG-4281
Modification No.:	63 - Change Order
Date of Modification:	8 September 1960
Description:	Assignment of Contract No. DA-41-443-ENG-5760 Bid Item No. 3, "Install and test prefabs and interconnecting piping"
Final amount of modification:	$1,733,533.48

The PLS Contractor, Paul Hardeman, submitted a claim to the Government based on the fact that the silos at Schilling were not in the state of readiness indicated by his contract at the time the work under Contract No. ENG-5760 was to begin. This claim was allowed under Corps of Engineer's Board of Contract Appeals Decision No. 1944.

The Contractor's Original Claim:	$1,370,961.80
Government's Original Estimate:	$ 478,054.00
Amount Allowed:	$ 469,027.00

This amount is included in the final amount of modification shown above.

TAB 1e

Contract Number:	DA-23-[illegible]-ENG-4281
Modification Number:	125
Date of Modification	31 May 1961
Description	Modification No. 125 grouped the following modifications into one modification to facilitate negotiations:

22	83	128	RI-144	RI-190	RI-221
25	94	RI-[illegible]	RI-147	RI-192	RI-222
27	95	RI-[illegible]	RI-153	RI-193	RI-227
31	96	RI-[illegible]	RI-154	RI-194	RI-228
34	97	RI-[illegible]	RI-157	RI-195	RI-230
42	98	RI-[illegible]	RI-158	RI-196	RI-231
43	99	RI-[illegible]	RI-160	RI-197	RI-232
46	100	RI-[illegible]	RI-161	RI-198	RI-235
47	101	RI-[illegible]	RI-162	RI-199	RI-236
48	102	RI-[illegible]	RI-163	RI-201	RI-237
49	103	RI-[illegible]	RI-169	RI-202	RI-238
64	109	RI-[illegible]	RI-172	RI-203	RI-239
67	110	RI-[illegible]	RI-175	RI-204	RI-240
68	111	RI-[illegible]	RI-177	RI-207	RI-241
71	113	RI-[illegible]	RI-180	RI-210	RI-246
72	114	RI-[illegible]	RI-182	RI-212	RI-247
79	115	RI-[illegible]	RI-183	RI-213	RI-248
81	118	RI-[illegible]	RI-187	RI-214	RI-249

82	120	MI-134	MI-188	MI-219	MI-251
83	122	MI-143	MI-189	MI-220	MI-254

These 120 change order packages were initiated and issued to the Contractor separately throughout the contract performance period.

The number, complexity and the effect of change upon change, and change upon unchanged work made fair and reasonable estimating and negotiating for each of the change orders impractical.

Modification No. 125 was estimated and negotiated on a subcontractor work feature basis.

As each subcontractor or work feature was successfully negotiated, a supplement to Modification No. 125 was issued which increased the contract amount.

Twenty-two supplements were issued.

The following modifications included in Modification No. 125 provided interim payments prior to final settlement:

Modification No.	Amount
22	$ 16,371.00
23	471,720.00
27	7,930.00
31	9,590.00
34	4,029.00
43	61,346.00
47	16,980.00
48	1,100,000.00
49	799,750.00

TAB 1e

Modification No.	Amount
64	$ 500,000.00
67	4,785.00
71	1,413,000.00
82	59,460.00
83	4,633.00
94	1,300,000.00
95	9,242.00
96	32,300.00
97	9,700.00
98	3,031.00
99	6,782.00
100	38,568.00
101	40,070.00
102	1,654.00
103	21,770.00
109	12,250.00
110	2,657.00
111	8,760.00
113	35,748.00
114	17,476.00
115	26,349.00
118	40,000.00
120	5,980.00
122	5,875.00

TAB 1e

Modification No.	Amount
125 (Part 01)	$ 2,803,000.00
Total Interim Payments:	$10,180,236.00

Modification No. 125 was negotiated for $17,204,817.00. Of this amount, $10,180,236.00 has previously been paid as interim payments.

Equipment No.	Amount of Increase
1	$ None
2	49,494.65 (See TAB 1e1)
3	1,532.34 (See TAB 1e2)
4	11,452.25 Credit (See TAB 1e3)
5	226,988.67 Credit (See TAB 1e4)
6	69,586.98 (See TAB 1e5)
7	435,743.99 (See TAB 1e6)
8	265,214.89 (See TAB 1e7)
9	631,315.64 (See TAB 1e8)
10	None
11	155,993.62 (See TAB 1e9)
12	431.96 Credit (See TAB 1e10)
13	184,938.87 (See TAB 1e8)
14	9,601.91 (See TAB 1e9)
15	20,438.56 (See TAB 1e11)
16	171.82 (See TAB 1e12)
17	632.41 (See TAB 1e13)
18	95,225.94 (See TAB 1e9)
19	107,192.71 (See TAB 1e14)

TAB 1e

Supplement No.	Amount of Increase	
20	$2,697,125.48	(See TAB 1e15)
21	40,202.93	(See TAB 1e16)
22	2,324,190.63	(See TAB 1e17)
	$7,024,581.34	

TAB lel

ATLAS "F" SCHILLING

Contract No.:	DA-23-028-ENG-4231
Contractor:	Utah-Manhattan-Sundt, Joint Venturers
Modification No.	Supplement 2 to Modification 123
1. Description:	This supplement provides an adjustment in the contract amount for all changes in Modification 123 pertaining to the furnishing of all reinforcing steel for the twelve Missile Launch Sites.
2. Negotiations Completed:	3 June 1961
3. Cost Estimates:	
a. Government estimate at start of negotiations:	$103,515.00
b. Contractor's initial proposal:	$104,446.00
4. Negotiated Amount:	$ 90,376.00
5. Remarks:	The amount of Supplement 2 of $49,494.00 is the negotiated amount ($90,376.00) less interim payments made, $40,882.00.

TAB 1e2

ATLAS "F" SCHILLING

Contract No.:	DA-23-028-ENG-4281
Contractor:	Utah-Manhattan-Sundt, Joint Venturers
Modification No.:	Supplement 3 to Modification 125
1. Description:	This supplement provides for an adjustment in the contract amount for all changes in Modification 125 pertaining to the furnishing and installation of all water proofing membrane.
2. Negotiations Completed:	17 June 1961
3. Cost Estimates:	
a. Government estimate at start of negotiation	$7,118.00
b. Contractor's initial proposal:	$9,165.00
4. Negotiated Amount:	$2,741.00
5. Remarks:	The amount of Supplement No. 3 of $1,532.00 is the negotiated amount of $2,741 less prior interim payments ($1,209).

TAB 1e3

ATLAS "F" SCHILLING

Contract No.:	DA-23-028-ENG-4781
Contractor:	Utah-Manhattan-Sundt, Joint Venturers
Modification No.:	Supplement 4 to Modification 125
1. Description:	This supplement provides an adjustment in the contract amount for all changes in Modification 125 pertaining to furnishing and installing the barbed wire fence and the chain link fence and gates.
2. Negotiations completed:	18 July 1961
3. Cost Estimates:	
a. Government estimate at start of negotiations:	$24,449.00
b. Contractor's initial proposal:	$25,232.00
4. Negotiated Amount:	$20,625.00
5. Remarks:	The amount of Supplement No. 4, $11,432 credit is the negotiated amount ($20,625.00) less prior interim payments, $32,077.00.

TAB 1a4

ATLAS "F" SCHILLING

Contract No.:	AF-23-028-ENG-4281
Contractor:	Utah-Manhattan-Sundt, Joint Venturers
Modification No.:	Supplement 5 to Modification 125
1. Description:	This supplement provides an adjustment in the contract amount for all changes in Modification No. 125 pertaining to the furnishing and installation of the Silo Structural Steel for Missile Launch Complex Nos. 3, 8 and 9.
2. Negotiations completed:	19 June 1961
3. Cost estimates:	
a. Government estimate at start of negotiations:	$977,409.00
b. Contractor's initial proposal:	$963,383.00
4. Negotiated Amount:	$952,583.00
5. Remarks:	The amount of the Supplement No. 5 of $224,989 credit in the negotiated amount ($952,583) less prior interim payments made, of $1,142,572, less a $35,000 adjustment in unit price Item No. 10.

TAB 1a5

ATLAS "F" SCHILLING

Contract No.:	DA-23-028-ENG-4281
Contractor:	Utah-Manhattan-Sundt, Joint Venturers
Modification No.:	Supplement 6 to Modification 123
1. Description:	This supplement provides an adjustment in the contract amount for all changes in furnishing and installing the facility elevators.
2. Negotiations completed:	12 June 1951
3. Cost estimates:	
a. Government estimate at start of negotiations:	$80,166.00
b. Contractor's initial proposal:	$90,163.00
4. Negotiated amount:	$69,587.00
5. Remarks:	Supplement No. 6 is for the amount of settlement $69,587.00.

TAB 1a6

ATLAS "F" SCHILLING

Contract No.:	DA-23-026-ENG-4281
Contractor:	Utah-Manhattan-Summit, Joint Venturers
Modification:	Supplement 7 to Modification 125
1. Description:	This supplement provides an adjustment in the contract amount for all changes in Modification 125 pertaining to the furnishing and installation of the Silo Structural Steel for Missile Launch Complex Nos. 1, 2, 4, 5, 6, 7, 10, 11 and 12, and all miscellaneous for all twelve sites.
2. Negotiations Completed:	10 June 1961
3. Cost Estimates:	
a. Government estimate at start of negotiations:	$2,170,617.00
b. Contractor's initial proposal:	$3,147,861.00
4. Negotiated amount:	$2,332,017.00
5. Remarks:	The amount of the Supplement No. 7 of $435,744 is the negotiated amount ($2,332,017) less prior interim payments made, of $1,896,273.

TAB 1a7

ATLAS "F" SCHILLING

Contract No.:	DA-23-028-ENG-4281
Contractor:	Utah-Manhattan-Summit, Joint Venturers
Modification:	Supplement 8 to Modification 123
1. Description:	This supplement provides an adjustment in the contract amount for all changes in Modification 123 pertaining to excavation and backfilling for building above silo elevation 960.5, clearing and grubbing, and excavation, embankment and subgrade preparation for roadways.
2. Negotiations completed	12 July 1961
3. Cost estimates:	
a. Government estimate at start of negotiations:	$409,929.00
b. Contractor's initial proposal:	$516,987.00
4. Negotiated amount:	$405,813.00
5. Remarks:	The amount of the Supplement No. 8, of $265,215 is the negotiated amount ($405,813) less prior interim payments of $140,598.00.

TAB 1e3

ATLAS "F" SCHILLING

Contract Number:	DA-23-028-ENG-4281
Contractor:	Utah-Manhattan-Sundt, Joint Venturers
Modification:	Supplement No. 9 to Modification 125
1. Description:	This supplement provides an adjustment in the contract amount for installation of all reinforcing steel resulting from changes in Modification No. 125.
2. Negotiations completed:	27 May 1961
3. Cost Estimates:	
a. Government estimate at start of negotiations:	$769,039.00
b. Contractor's initial proposal:	$762,423.00
4. Negotiated amount:	$717,523.00
5. Remarks:	The amount of the Supplement No. 9 of $631,316.00 is the negotiated amount ($717,523.00) less prior interim payments made, of $86,207.00.

TAB 1e9

ATLAS "F" SCHILLING

Contract Number:	AA-23-021-ENG-42[illegible]
Contractor:	Utah-Manhattan-Sundt, Joint Venturers
Modification:	Supplements 11, 13, 14 and 15 to Modification No. 125.
1. Description:	These four supplements provide for adjustments in the contract amount for additional work in furnishing and installing all mechanical items except those furnished under the Assigned Service Contracts resulting from changes in Modification No. 125.
2. Negotiation completed:	18 August 1961
3. Cost Estimates:	
a. Government estimate at start of negotiations:	$2,433,073.00
b. Contractor's initial proposal:	$3,502,640.00
4. Negotiated amount:	$2,411,664.00
5. Remarks:	The amount of the supplements, $445,980.00, is the negotiated amount $2,411,664) less prior interim payments made, of $1,965,684.00.

TAB 1a10

ATLAS "F" SCHILLING

Contract Number:	DA-23-028-ENG-4281
Contractor:	Utah-Manhattan-Sundt, Joint Venturers
Modification:	Supplement No. 12, Modification No. 125
1. Description:	This supplement provides an adjustment in the contract amount for all changes in Modification No. 125 pertaining to furnishing and installing piping as required to manifold the vessels and furnishing and delivering pressure vessels.
2. Negotiations completed:	1 August 1961
3. Cost Estimates:	
a. Government estimate at start of negotiations:	$19,617.00
b. Contractor's initial proposal:	$19,804.00
4. Negotiated amount:	$13,983.00
5. Remarks:	The amount of Supplement No. 12, $432.00 credit is the negotiated amount $13,983.00 less prior interim payments $14,415.00.

TAB 1e11

ATLAS "F" SCHILLING

Contract No:	DA-23-028-ENG-4281
Contractor:	Utah-Manhattan-Sundt, Joint Venturers
Modification No:	Supplement No. 13 to Modification No. 125
1. Description:	This supplement provides an adjustment in the contract amount for all changes in Modification 125 pertaining to furnishing all filter drain material, and furnishing and delivering all base course material and accomplishing all paving and performing the required access maintenance.
2. Negotiations completed:	29 July 1961
3. Cost Estimates:	
a. Government estimate at start of negotiations:	$101,708.00
b. Contractor's initial proposal:	$205,484.00
4. Negotiated amount:	$97,019.00
5. Remarks:	The amount of Supplement No. 13, $20,651.00 is the negotiated amount $97,019.00 less prior interim payments, $76,368.00.

TAB 1e12

ATLAS "F" SCHILLING

Contract Number:	DA-23-028-ENG-4231
Contractor:	Utah-Manhattan-Summit, Joint Venturers
Modification No:	Supplement No. 16 to Modification No. 125
1. Description:	This supplement provides an adjustment in the contract amount for all changes in Modification 125 pertaining to furnishing and installing t the Safety Platforms.
2. Negotiations Completed:	9 August 1961
3. Cost Estimates:	
a. Government estimate at start of negotiations:	$58,553.00
b. Contractor's initial proposal:	$57,553.00
4. Negotiated amount:	$57,553.00
5. Remarks:	Supplement No. 16 to Modification 125 is written in the amount of $57,553.00.

TAB 1e13

ATLAS "F" SCHILLING

Contract No.:	DA-23-026-ENG-4281
Contractor:	Utah-Manhattan-Sundt, Joint Venturers
Modification No.	Supplement No. 17 to Modification No. 125
1. Description:	This supplement provides an adjustment in the contract amount for all changes in Modification 125 pertaining to furnishing twelve cooling towers.
2. Negotiations Completed:	9 August 1961
3. Cost Estimates:	
a. Government estimate at start of negotiations:	$ 635.00
b. Contractor's initial proposal:	$1,432.00
4. Negotiated amount:	$633.00
5. Remarks:	The amount of Supplement No. 17, $1,942 credit is the negotiated amount $633.00 less prior interim payment, $2,575.00.

ATLAS "F" SCHILLING

Contract No.	DA-23-026-ENG-4281
Contractor:	Utah-Manhattan-Sundt, Joint Venturers
Modification:	Supplement No. 19 to Modification No. 125
1. Description:	This supplement provides for adjustment in the contract amount for additional work in installing the PLS Prefabs and Piping resulting from the changes in Modification No. 125.
2. Negotiations Completed:	15 August 1961
3. Cost Estimates:	
a. Government estimate at start of negotiations:	$134,950.00
b. Contractor's initial proposal:	$352,647.00
4. Negotiated amount:	$132,741.00
5. Remarks:	The amount of the supplement, $107,193.00, is the negotiated amount ($132,741.00) less prior interim payments made, of $25,548.00.

TAB 1e15

ATLAS "F" SCHILLING

Contract No:	DA-23-023-ENG-4281
Contractor:	Utah-Manhattan-Sundt, Joint Venturers
Modification:	Supplement No. 20 to Modification No. 125
1. Description:	This supplement provides for adjustment in the contract amount for additional work on the part of the prime contractor in furnishing, installing, placing and performing the fencing, concrete, reinforcing, embedded items, seeding and sodding, electrical, paving, changed conditions at Site No. 1 and changed conditions at Site No. 2.
2. Negotiations completed:	19 September 1961
3. Cost Estimates:	
a. Government estimate at start of negotiations:	$6,540,000.00
b. Contractor's initial proposal:	$8,662,153.00
4. Negotiated amount:	$6,314,026.00
5. Remarks:	The amount of the Supplement, $2,697,125.00 is the negotiated amount ($6,314,026.00) less prior interim payments made of $3,616,901.00.

TAB 1e16

ATLAS "F" SCHILLING

Contract No:	DA-23-023-ENG-4281
Contractor:	Utah-Manhattan-Sundt, Joint Venturers
Modification No:	Supplement No. 21, Modification 125
1. Description:	This supplement provides an adjustment in the contract amount for all changes in Modification 125 pertaining to performing all painting.
2. Negotiations Completed:	27 November 1961
3. Cost Estimates:	
a. Government estimate at start of negotiations:	$ 96,189.00
b. Contractor's initial proposal:	$189,189.00
4. Negotiated amount:	$ 94,189.00
5. Remarks:	The amount of Supplement No. 21, $40,203.00 is the negotiated amount ($94,189.00) less prior interim payments, $53,986.00.

XAB 1e17

ATLAS F SCHILLING

Contract No:	DA-23-028-ENG-4281
Contractor:	Utah-Manhattan-Swadt, Joint Venturers
Modification:	Supplement No. 22 to Modification No. 123
1. Description:	This supplement is the final part of Modification No. 125
2. Negotiations Completed:	19 September 1961
3. Cost Estimates:	
a. Government estimate at start of negotiations:	$43,632,780.00
b. Contractor's initial proposal:	$51,008,506.00
At one time, it reached:	$54,276,035.00
4. Negotiated Amount of Job as built:	$45,153,374.00
5. Remarks:	The amount of the supplement, $2,524,191.00, is the negotiated amount less original contract, less completed modifications and less prior interim payments made.

NOTE: As of the date of this report, this supplement has not been issued due to the fact that the Government is attempting to negotiate a settlement on Supplement No. 21, dealing with painting. It was originally planned to issue this Supplement No. 21 unilaterally.

TAB 1f

ATLAS "F" SCHILLING

Three Modifications Remain Open:

1. Area Control 81-215

By letter dated 17 May 1961, the Contractor was directed to install a proto type modification kit on one blast closure at Site No. 10 and conduct several operational tests.

The Contractor completed the prescribed tests 21 August 1961. By letter dated 19 October 1961, the Contractor was advised that the test results were accepted and no further testing would be required. It was requested that the Contractor submit a proposal of cost so that an agreement can be reached.

2. Area Control 81-266:

This modification number has been established and funds committed in order to cover possible settlement of the Wintroath Pump Claim. (See Tab 1g).

3. Area Control 81-257: (See Tab 1h) Modification No. 139

Struthers Wells has submitted a claim for extra cost due to expediting production to overcome excusable delays. The Contracting Officer has determined that some of the delays were indeed excusable. This modification, will provide fair and reasonable compensation for the extra cost incurred. The first part of this modification provides a $300,000.00 interim payment.

TAB lg

ATLAS "F" SCHILLING

To date, the Contractor has submitted 87 claims which have been reported on the claim report:

Of the 87, there are five claims remaining open.

		Contractor's Claim
1.	C-16 - Appeal of unilateral Mod. No. 51	Time
2.	C-20 - Appeal of unilateral Mod. No. 12	Time
3.	C-26 - Appeal of unilateral Mod. No. 44	Time
4.	C-29 - Kintroath Pump Claim	$10,000.00
5.	C-82 - Strutbern Wells Claim	3.8 million (See Tab lh)

Of the 87, there were seven claims allowed:

			Claimed:	Allowed:
1.	C-53, Mod 125, Supp 21	Flourney Paint	$19,000.00	$16,193.00
2.	C-79, Mod 132	Southwest Welding	64,520.00	31,630.00
3.	C-84, Mod 130	A. N. Lockett	1,782.00	1,782.00
4.	C-81, Mod 135	Paul Hardeman	54,202.00	25,542.00
5.	C-85, Mod 136	White Motors	1,615.00	1,615.00
6.	C-46, Mod 125, Supp 20	Bonding, Bolts	49,020.00	49,020.00
7.	C-19, Mod 118	Time on Mod 71		

There were four claims allowed which were not recorded on the claim report:

		Claimed:	Allowed:	
1.	Power for PLS testing (C-7)	$ 215,166.00	$140,914.00	(See TAB li)
2.	Changed Conditions at Site 1	1,566,229.00	547,522.00	(See TAB lj)
3.	Changed Conditions at Site 2	1,302,325.00	435,656.00	(See TAB lk)
4.	Paul Hardeman Assignment Charges	1,370,961.00	469,027.00	(See TAB ll)

All other claims have been withdrawn by the Contractor based on the settlement of Modification No. 125.

TAB Ih

ATLAS "F" SCHILLING

17 November 1961

1. Contract No: DA-23-028-ENG-4281

2. Contractor: Utah-Manhattan-Sundt, Joint Venturers

3. Source: Contractor

4. Received by Contracting Officer: 22 July 1960

5. Description: Contractor's supplier of pressure and cryogenic vessels for 9 sites, Strother-Wells, claims additional costs occasioned by not being granted time to cover excusable delays, and also additional costs for work performed not in the contract. U-M-S claims the same excusable delays and costs in accomplishment of work under his contract. The tentative decision recognizes 43 to 46 days (varies with individual sites) of the 157 days claimed delay in installation of cryogenic vessels, and 15 days (concurrent with those recognized above) of the 270 days claimed delay in installation of pressure vessels. It further recognizes some compensable extras in installation of cryogenic vessels. Because the recognized delays occurred during a time when the contractor was under Government direction to exercise extraordinary measures to recoup time lost (GCSb action), a condition of certain acceleration costs are implicit in the decision.

The Contractor's claim is itemized in 10 specific areas, with time claims against each area. The times specified are in many cases partially concurrent. His claim did not relate his total dollar claim to the 10 areas.

ATLAS "F" SCHILLING

6. Status: The Contracting Officer has acknowledged that there is some merit to the contractor's claim. A tentative decision has been drafted; the contractor's comments have been solicited prior to issuance as a final decision. Dollar value of the recognized portion of the claim is now being estimated. A $500,000.00 interim payment has been provided in Modification No. 139.

7. Contractor Value of Claim: $3,530,677.00

8. Expected Settlement Cost: $1,000,000 (Order of Magnitude)

TAB 11

1. Contract No.:	DA-23-02B-ENG-4281
2. Contractor:	Utah-Manhattan-Sundt, Joint Venturers
3. Source:	Contractor
4. Received by the Contracting Officer:	15 September 1960
5. Description:	The Contractor claimed that he had been directed to furnish electrical for the purpose of testing the FLS prefabs and piping and the facility elevators which was not required under the contract. The Contracting Officer, on 12 April 1961 recognized the Contractor's Claim. The adjustment in the contract amount for this settled claim is included in Supplement No. 20 to Modification No. 125.
6. Status:	Claim settled.
7. Contractor's original value of claim:	$215,166.00
8. Negotiated amount:	$160,814.00

TAB 1j

ATLAS "F" SCHILLING

1. Contract No.:	DA-23-026-ENG-4261
2. Contractor:	Utah-Manhattan-Bundt, Joint Venturers
3. Source:	Contractor
4. Received by the Contracting Officer:	4 May 1960
5. Description:	The Contractor, by letter dated 4 May 1960 claimed changed conditions under Clause 4, due to the excessive ground water encountered during excavation at Site No. 1. The Contracting Officer recognized the changed conditions on 6 June 1961. The adjustment in the contract amount for this settled claim is included in Supplement No. 20 to Modification 125.
6. Status:	Claim Settled
7. Contractor's original value of claim:	$1,568,229.00
8. Negotiated Amount:	$547,522.00

TAB 1h

ATLAS "F" SCHILLING

1. Contract no.:	DA-23-029-ENG-6281
2. Contractor:	Utah-Manhattan-Summit, Joint Venturers
3. Source:	Contractor
4. Received by the Contracting Officer:	9 May 1960
5. Description:	The Contractor, by letter dated 9 May 1960 claimed changed conditions under Clause 4 due to the excessive ground water encountered during the silo excavation at Site No. 2. The Contracting Officer recognized the Changed Conditions on 17 August 1960. The adjustment in the contract amount for this settled claim is included in Supplement No. 20 to Modification 125.
6. Status:	Claim Settled
7. Contractor's original value of claim:	$1,302,325.00
8. Negotiated Amount:	$435,656.00

TAB 11

ATLAS "F" SCHILLING

1. Contract No:	DA-23-026-ENG-4281
2. Contractor:	Utah-Manhattan-Sundt, Joint Venturers
3. Source:	Contractor
4. Received by the Contracting Officer:	
5. Description:	The FLS Assigned Contractor, Paul Bardemac, by his letter dated 4 January 1961 protested the Assignment of his contract to the construction contractor, and claimed that the status of construction under the Contract No. 4281 was not to the point described in his contract and that this was causing him to incur additional cost. The Contracting Officer denied the Contractor's claim. This decision was appealed and claim was allowed under Corps of Engineers Board of Contract Appeals Case No. 1944. The adjustment in the contract amount for this settled claim is provided in Supplement No. 3 to Modification No. 65.
6. Status:	Claim Settled

TAB 11

ATLAS "F" SCHILLING

7. Contractor's original value of claim: $1,370,961.00

8. Negotiated Amount: $469,027.00

TAB 1m

ATLAS "F" SCHILLING

The final contract amount is composed of the following cost:

1. Original Contract Amount for 9 Sites:	$17,209,000.00
2. Original Contract Amount for 3 Sites: (Mod 15)	6,174,000.00
3. Assigned Service Contracts:	3,712,773.00
	$27,095,773.00
4. Modifications 1 through 136, except Mod 15:	18,083,192.00
	$45,178,965.00
5. Modification No. 137 (Interim Payment)	500,000.00
	$45,678,965.00
6. Modification No. RI-21[illegible] open (See Tab 1f)	
possible settlement	20,000.00
7. Struthers Wells Claim (See Tabs 1n and 1f)	
possible settlement	1,000,000.00
8. Wintroath Pump Claim (See Tab 1f)	
possible settlement	10,000.00
TOTAL POTENTIAL COST:	$46,708,965.00

SUPPORT FACILITY FOR
WS-107 A-1 OPERATIONAL BASE
MISSILE LAUNCH COMPLEXES
SCHILLING AIR FORCE BASE

Contract Number:	DA-23-028-ENG-4361
Date of Contract:	13 April 1960
Contractor:	Marvin W. Mills Construction P. O. Box 1035 Salina, Kansas
Construction:	Liquid Oxygen Facilities at Schilling Air Force Base, Salina, Kansas
Notice to Proceed:	14 April 1960
Original Contract Amount:	$379,900.00
Modifications:	A total of 15 Modifications were proposed:

1. 325.00	9. 790.00
2. 845.00	10. Cancelled
3. 1,811.00	11. 306.00
4. 418.57	12. -250.00
5. 5,280.00	13. Cancelled
6. N/C	14. 2,878.00
7. -750.00	15. 559.64
8. 2,671.57	

Claims: The Contractor submitted four claims, which were all less than $100,000.00, denied by the Area Engineer, and withdrawn by the Contractor.

Final Contract Amount: $394,694.78

SUPPORT FACILITY FOR
WS-107 A-1 OPERATIONAL BASE
MISSILE LAUNCH COMPLEXES
SCHILLING AIR FORCE BASE

Contract Number:	DA-23-028-BNO-4186
Date of Contract:	5 May 1960
Contractor:	Carrothers Construction Co., Inc. P. O. Box 350 Paola, Kansas
Notice to Proceed:	13 May 1960
Original Contract Amount:	$469,800.00 for nine sites
(Modification No. 9)	285,000.00 for three sites (See Tab 2a)
	$754,800.00 for twelve sites
Modifications:	A total of 32 Modifications were proposed

1 was cancelled
31 were combined and issued as
28 Modifications:

1.	No Cost	13.	1,400.00
2.	109.55	14.	99.00
3.	436.36	15.	No Cost
4.	8,962.00	16.	3,221.00
5.	632.90	17.	470.00
6.	285,000.00 (See Tab 2b)	18.	17,144.69
7.	13,142.00	19.	10,653.00
8.	No Cost	20.	3,993.00
9.	285,000.00 (See Tab 2a)	21.	1,761.90
10.	No Cost	22.	4,044.32
11.	310.10	23.	3,611.01
12.	1,992.75	24.	4,986.10

25.	4,906.10	27.	4,736.44
26.	- 550.55	28.	7,500.00

Claims: The Contractor submitted six claims, of which four were denied and two allowed. The two allowed were paid for in Modification No. 25.

Final Contract Amount: $1,131,334.55

TAB 2a

ATLAS "F" SCHEDULE

Contract No.:	DA-23-026-ENG-4356
Contractor:	Carrothers Construction Co., Inc.
Modification No.:	9 - Supplemental Agreement
1. Description:	Provide for the construction of the water facilities for three additional launch sites.
2. Source:	Air Force Construction Directive
3. Received by Contracting Officer:	8 September 1960
4. Presented to Contractor:	8 September 1960
5. Negotiations Completed:	29 September 1960
6. Notice to Proceed:	6 October 1960
7. Cost Estimate:	
a. Government estimate at start of negotiations:	$288,549.00
b. Contractor's initial proposal	$301,357.00
8. Negotiated Amount:	$285,000.00

TAB 2b

ATLA[illegible] SCHILLING

Contract No.:	DA-23-02[illegible]-ENG-4366
Contractor:	Carrolbera Construction Co., Inc.
Modification No.:	6 - Change Order
1. Description:	Revise Water Treatment Facilities to provide for automatic operation.
2. Source:	AFBMC
3. Received by Contracting Officer:	
4. Presented to Contractor:	
5. Negotiations Completed:	
6. Notice to Proceed:	
7. Cost Estimate:	
a. Government estimate at start of negotiations:	$285,000.00
b. Contractor's initial proposal:	$291,490.00
8. Negotiated Amount:	$285,900.00

SUPPORT FACILITY FOR
WS-107 A-1 OPERATIONAL BASE
MISSILE LAUNCH COMPLEXES
SCHILLING AIR FORCE BASE

Contract Number:	DA-23-028-ENG-4974
Date of Contract:	18 July 1961
Contractor:	Meeks and Westbrook P. O. Box 795 Abilene, Texas
Construction:	Fuel Catchment Tank System at Schilling Air Force Base, Salina, Kansas
Notice to Proceed:	13 July 1961
Original Contract Amount:	$186,396.00
Modifications:	Three modifications were proposed. Two have been issued. One remains open. 1. $1,805.83 2. No Cost
Claims:	No Claims
Current Contract Amount:	$188,201.83 This contract remains open.

SUPPORT FACILITY FOR
WS-107 A-1 OPERATIONAL BASE
MISSILE LAUNCH COMPLEXES
SCHILLING AIR FORCE BASE

Contract Number:	DA-23-028-ENG-4921
Date of Contract:	26 May 1961
Contractor:	Shea Construction Co., Inc. R.F.D. #2 Salina, Kansas
Construction:	Installation of an addition to existing Communication Ducts System.
Notice to Proceed:	26 May 1961
Original Contract Amount:	$29,506.40
Modifications:	Only one modification was proposed. 1. $340.45
Claims:	No Claims.
Final Contract Amount:	$29,846.45

SUPPORT FACILITY FOR
WS-107 A-1 OPERATIONAL BASE
MISSILE LAUNCH COMPLEXES
SCHILLING AIR FORCE BASE

Contract Number:	DA-23-028-ENG-4497
Date of Contract:	15 July 1960
Contractor:	M. W. Mills Construction P. O. Box 944 Salina, Kansas
Construction:	Re-Entry Vehicle Facility at Schilling Air Force Base, Salina, Kansas
Notice to Proceed:	15 July 1960
Original Contract Amount:	$92,900.00
Modification:	A total of 9 Modifications were proposed:

1. 626.40	6. 1,479.43
2. No Cost	7. No Cost
3. Cancelled	8. 3,202.00
4. 1,050.00	9. -1,652.00
5. 378.40	

Claims:	The Contractor submitted one claim, which was denied by the Area Engineer and withdrawn by the Contractor.
Final Contract Amount:	$102,984.23

SUPPORT FACILITY FOR
WS-107 A-1 OPERATIONAL BASE
MISSILE LAUNCH COMPLEXES
SCHILLING AIR FORCE BASE

Contract Number:	DA-23-028-ENG-4491
Date of Contract:	7 July 1960
Contractor:	General Air Conditioning & Electric Co. 113 South Fifth Salina, Kansas
Construction:	Conversion of Buildings at Schilling Air Force Base, Salina, Kansas
Notice to Proceed:	12 July 1960
Original Contract Amount:	$128,844.00
Modifications:	A total of four modifications were proposed. 1. 16,400.00 2. 28,050.60 3. - 809.03 4. 1,500.00
Claims:	The Contractor submitted eight claims, which were settled and paid for in Modification No. 4.
Final Contract Amount:	$173,985.57.

SUPPORT FACILITY FOR
WS-107 A-1 OPERATIONAL BASE
MISSILE LAUNCH COMPLEXES
SCHILLING AIR FORCE BASE

Contract Number:	DA-23-028-ENG-4451
Date of Contract:	13 June 1960
Contractor:	Swanson & Youngdale 737 France Avenue, North Minneapolis 22, Minnesota
Construction:	Missile Assembly Building at Schilling Air Force Base, Salina, Kansas
Notice to Proceed:	17 June 1960
Original Contract Amount:	$637,500.00
Modifications:	A total of 18 Modifications were proposed:

1.	828.53	9.	266.02
2.	760.00	10.	No Cost
3.	860.68	11.	50.47
4.	No Cost	12.	374.20
5.	-160.00	13.	103.92
6.	65.09	14.	126.23
7.	2,910.00	15.	Not Issued
8.	932.42	16.	62.35

Three proposed modifications were cancelled.

Claims:	The Contractor submitted three claims, all were denied by the Area Engineer.
Final Contract Amount:	$644,716.93

SUPPORT FACILITY FOR
WS-107 A-1 OPERATIONAL BASE
MISSILE LAUNCH COMPLEXES
SCHILLING AIR FORCE BASE

Contract Number:	DA-23-028-ENG-4366
Date of Contract:	31 March 1961
Contractor:	General Air Conditioning 113 South Fifth Salina, Kansas
Construction:	Modification of Missile Assembly Building at Schilling Air Force Base, Salina, Kansas
Notice to Proceed:	31 March 1961
Original Contract Amount:	$71,500.00
Modifications:	A total of two modifications were proposed: 1. $1,404.89 2. $3,311.81
Claims:	The Contractor has submitted one claim, which is currently being considered. A claim for extra cost incurred in working extra hours and more men in complying to a directive to speed up his operations to overcome an excusable delay. Expected cost: $1,926.67.
Final Contract Amount Excluding Claim:	$76,716.70

for in modification estimates had mounted to high proportions and were easily apparent to the Contractor through his mounting costs but not nearly so obvious to the C of E estimators nor justifiable even when known to exist. These intangible costs were not identifiable with any specific modification or specific item of work but were the cumulative result of the many modifications, crowded working conditions, and the urgency requiring completion of construction in less than adequate time.

From the start of Contract No. DA-23-022-ENG-4281 until November 1961, modifications and negotiations were handled by the Modification Section, which consisted of three men. Estimates were prepared by the Engineering and Technical Branch, which had no qualified estimating personnel. These estimates required reviewing and often reworking by the Modification Section prior to negotiations. By the fall of 1960, a large backlog of unestimated and unsettled modifications existed (106) in November 1960, a separate Estimating Section was formed. This section consisted of four permanent estimators, plus four additional estimators on TDY. Four additional TDY estimators were added to the section during December and January. Although the individuals were not the same, the Estimating Section remained at about this size until May and June, at which time it reached a peak of twenty estimators. These twenty men included nine from Builders Estimating Service, Inc., a commercial firm specializing in providing estimating services. The Modification Section was likewise increased in size during December and January to ten people, by the assignment of temporary duty personnel. It was gradually reduced in size to a total of five by midsummer. Much of the work performed by the Modification Section during this period was in connection with

acceleration cost computations and work on claims. During the life of the contract a total of about 82 man months were expended by the Modification Section. There were approximately 118 man months of work performed by the Estimating Section. This latter figure does not include time for estimating effort by the Modification Section, by the Engineering and Technical Branch, or by estimating talent borrowed from CPMSCO prior to formation of the Estimating Section. After a decision was reached on the method used for final settlement of the contract, approximately 22 man months for the Modification Section and 56 man months for the Estimating Section were required to complete the contract. It is noted that the man months discussed above were made up almost entirely of 60 hours or more per week.

During the first six months of the contract life, negotiations were conducted as required. In the fall of 1960 the effort to negotiate was increased and an attempt was made to negotiate weekly. Following this, an attempt was made to establish a schedule for negotiations on specific modifications. By this time, however, the Contractor no longer had a clear picture of his costs for individual modifications, nor a clear picture of the eventual effect that an individual modification settlement might have on the final settlement. Negotiation attempts were thus completely unsuccessful during the fall of 1960 and the winter of 1960-61. Except for token efforts, negotiations on individual modifications were suspended during the spring of 1961, pending the development of a method of settlement satisfactory to both the Government and the Contractor. When a proposal was requested the Contractor would only submit direct costs without impact, overhead & applicable profit. When

the method was agreed upon, about 1 May 1961, negotiations were resumed and by mid-August were being conducted on almost a continuous basis until 19 September 1961, when agreement was reached on the final negotiable item.

Probably because of its size, the variety of work affected and the time of its arrival, Request 82 which became Modification 71 was the most difficult of all. The notice to proceed on "The Big Mod" was issued to the Contractor on 15 September 1960. The first part of the two-part modification was issued on 26 September 1960. This modification involved 17 drawings and made drastic changes in the electrical, the air piping, the diesel exhaust system, and the crib steel. The effect of this modification through disrupted schedules, disorganized work programs, the lifting work already completed, etc., was tremendous. An estimate was originally prepared by the Engineering and Technical Branch and then redone by a joint team from the Kansas City District of the Corps of Engineers and from the Bechtel Corporation. A conference on this estimate was held in Dallas, Texas on 18 October 1960, and was attended by representatives of C&EMCO, AFNEC, Corps of Engineer's Area Offices, two Division Offices, and three District Offices. Another conference was held at CEMCO on 5 December 1960. The estimate was reviewed and re-reviewed but agreement was never reached on its value between the SATAF and the Area Office. It was finally forwarded to higher headquarters for resolution. Negotiations with the Contractor were carried on informally for several months, and a formal effort covering a period of five days in late March, was conducted. This conference did

not result in final agreement. The amount of the Contractor's proposal and the Government Estimate were so far apart as to make further negotiation impractical.

Inasmuch as the work performed on structural steel by Kaiser and American Bridge could be more easily segregated and was not closely interwoven with other work, it was decided to make an independent calculation of the reasonable cost due each and to attempt a separate settlement of these costs. An estimating team averaging three men was established for this purpose. Conferences with other areas were conducted in order to utilize cost information experienced elsewhere. Work was started on this approach about 1 January 1961 and agreement was reached on a final settlement amount in mid-June 1961. The settlement included shop and field acceleration costs.

METHODS OF SETTLEMENT THAT PROVED UNSUCCESSFUL

As previously stated, the negotiations on individual modifications proved successful only as long as the costs could be separately identified and charged to an individual item of changed work. When modifications were issued so frequently that they overlapped and intangible costs started mounting, negotiations could no longer be successfully completed on the normal basis.

Attempts were then made to compute acceleration and so-called "impact" costs. Acceleration costs could be computed, based on actual work-weeks versus an estimated normal work-week. Acceleration costs on materials, where applicable, were generally obtainable. Impact costs, while much more difficult, could also be estimated in total to a reasonable degree of accuracy. However, assignment of these costs to a specific

modification, or even justifying these costs by assignment to the amount of work added proved an insurmountable obstacle.

On the theory that practically all the acceleration and "impact" costs applied to labor, an attempt was made to graphically solve the problem in the following manner:

a. The estimated number of manhours per week of original contract work for each major item was plotted against the scheduled weeks for that item.

b. The estimated total manhours for modified work affecting that item was plotted as an addition to the original work for the length of time required to complete the modification.

c. A third line representing the actual manhours experienced as reflected by the payroll records and daily construction logs was plotted on the chart.

d. The difference between the last two lines represented acceleration, impact, inefficiency, etc.

It was planned to deduct from this result the known instances of inefficiency, repeat work, etc., for which the Government had no obligation, and assign the remainder to the modification or modifications completed during the same period as shown by the chart. This method, however, proved time consuming, difficult to manage, and generally unsatisfactory.

FINAL METHOD OF SETTLEMENT

The method finally adopted as most feasible was similar to that employed in the American Bridge and Kaiser settlements. It was decided to subdivide the contract work into features corresponding to

the work performed by the principal subcontractors. The work performed by the prime contractor was then further divided into its principal features. An estimate was prepared for each of these subdivisions representing a fair value of all work under the contract as-built. From this value was subtracted the estimated value of the original contract work. The difference represented a fair value of the cost of added work. All but two negotiations were conducted on this basis. This method had the advantage of being able to estimate the cost of a complete operation in a fashion parallel to the way the work had to be performed. It was possible to readily identify intangible costs and their causes with a particular operation. For the most part the modification estimates previously prepared, or the portions of them applicable to a specific item of work, could be used as prepared. It became obvious from this approach that much of the cost in dispute was represented by an increase in the cost of performing the original contract work that resulted from the impact of the modifications. This method did have two disadvantages. The first was the large amount of extra work required to completely re-estimate the job. The second was the inability to negotiate any of these items until the item was nearly 100% complete.

OTHER CONTRACTS

As previously indicated the modifications required for all other contracts were negotiated in the normal fashion. Each modification was estimated and negotiated separately, as it occurred.

14. ACCELERATION, PREMIUM RATES, INCREASED COST AND REASON THEREOF

CONTRACT NO. ENG-4497, RE-ENTRY VEHICLE FACILITY

This contract increased from an original amount of $92,900 to a final amount of $102,98[illegible]. Of the $10,08[illegible] or 11% increase, $8,202 was the cost of the Phase II work added by Supplemental Agreement. This accounts for nearly [illegible]% of the increase, which otherwise would have been a separate contract.

CONTRACT NO. E[illegible]-4466, MODIFICATION OF MISSILE ASSEMBLY BUILDING

This contract increased from an original amount of $71,500 to an estimated final amount of $80,405. The $8,905 increase is approximately 12% of the original. Modifications amounting to $5,405 primarily result from the redesign of the electric vacuum oven. The remaining $3,500 represents a claim covering additional costs experienced by the Contractor due to the oven changes, which have not been covered by modifications.

CONTRACT NO. E[illegible]-44[illegible]1, CONVERSION OF BUILDINGS

This contract increased from an original amount of $128,844 to a final amount of $17[illegible]. Of the $45,142 or 35% increase, $16,400 resulted from adding another building to those being converted to use under the ICBM Program and making miscellaneous changes in three others. Another $23,050 resulted from deleting the conversion of one building and substituting another in which the work to be accomplished was considerably greater.

CONTRACT NO. E[illegible]-43[illegible]6, WATER SUPPLY

This contract increased from an original amount for the twelve sites of $754,300 to an estimated final amount of $1,141,246. The 51%

increase of $386,446 results primarily from the following:

a. $235,000 for an extensive revision in the water treatment facilities at seven of the sites.

b. $22,457 for additional requirements for Operational and Maintenance Manuals.

c. $17,147 for cleaning sand from wells which resulted from the design and location of the wells.

d. $10,683 for miscellaneous electrical and mechanical changes.

e. $8,962 for providing fully automatic operation of the water softeners, permanent draw-down gages and hand pump at wells, etc.

f. $42,197 for remaining twenty-three modifications, the largest of which is $7,500.

CONTRACT DA-23-028-ENG-4231, WS-107 A-1 OPERATIONAL BASE, MISSILE LAUNCH COMPLEXES

GENERAL

The Notice to Proceed was given and acknowledged 7 March 1960. Final completion dates for the nine sites covered in the original contract were from 15 February 1961 to 12 April 1961, at one week intervals.

By Supplemental Agreement, Modification No. 15 dated 25 May 1960, three additional sites were added to the contract in the amount of $6,174,000.00. Final completion dates for the additional sites were from 12 June 1961 to 26 June 1961 at one week intervals.

The Schilling WS-107 A-1 Operational Base was the first of six similar bases in the United States and was assigned the shortest construction period of all.

Uppermost in the minds of all who were responsible for the ICBM Construction Work at CEESCO, Schilling Area, was the necessity of meeting the Air Force need dates established in the National Defense Program, regardless of the handicaps during construction.

The Specifications of the various contracts emphasized the importance of getting each contract, each part of the national preparedness effort, completed on time.

At the Prebidding Conference for the Missile Launch Complexes, held in Kansas City, Missouri, 11 February 1960, Colonel Lawrence E. Laurion, District Engineer and Contracting Officer, stated in his opening remarks:

"I am sure that you gentlemen all know that this project is connected with the Inter-Continental Ballistic Missile Program, and is vital to the national defense of this country. Consequently, a date has

been set by which these missile launching bases must be operational. From that date are determined the dates that other things have to happen, such as the date of completion of this contract that we are discussing today, the date for installation of other technical equipment that will be installed by others and so on; therefore, although I recognize full well that the time for completion of the work under advertisement in this project is woefully short, that is the basis on which the bids are being received. I have no authority to change those dates, and I will do everything in my power that is given to me under the terms of the contract to enforce those authorities given me in the contract, and to ensure that the completion dates are met. We are not interested in collecting liquidated damages. We are interested in getting the construction work completed by the date specified. You should understand from the beginning that I will most certainly invoke the provisions of paragraph 00-5 of the contract at any time I think the completion dates are in jeopardy."

Again, in the Pre-Construction Conference held at Schilling Air Force Base, 11 March 1960, Colonel Laurion pointed out the urgency of the project in his first comment to the construction contractor's key personnel on the job by saying "We will live up to the completion dates."

Essentially the increase in the Current Working Estimate of Costs for the Schilling Area Missile Launch Complexes and Support Facilities resulted from the necessity of overcoming an endless number of changes without benefit of additional time in which to accomplish them.

The changes resulted in two types of additional cost, which might be termed direct and indirect. The direct were those costs easily

discernible and readily estimated, in general. The indirect were those resulting from the "impact" or "ripple effect", such as were occasioned by delays, the additional cost in the work not changed by the modification, and the acceleration costs involved in maintaining scheduled progress in spite of the changed or additional work and the many delays.

The broad aspect of cost increases for the Missile Launch Complex Construction is shown by Exhibit "E". Increased costs fall into three main categories, i.e., Changed Conditions, Required Modification and Impact and Acceleration.

CHANGED CONDITIONS

Changed conditions (excessive water) encountered at Sites 1 and 2 necessitated the resequencing of all sites, and a shortening of the construction period for six sites. The construction period for one site was shortened by 67 days. It is considered that these changed conditions had a more adverse effect on the contractor's progress than any other factor at the Schilling project. The acceleration required to offset the delay was costly.

It was not so much the volume of water encountered, as the fact that the water was entering the excavation in a manner that could not be readily controlled by cement and/or chemical (American Cyanamid AM-9) grouting. At Site 1, the presence of carbonaceous remains and partially petrified trees appeared to act as a collector and conductor system concentrating an unusually large flow of water into the shaft. A crash program was instituted to control the water, because it was feared that it might be necessary to abandon the shaft and sink a new shaft at a different location. Manpower and equipment were pressed into service by

the Contractor to stem the flow of water. However, when manpower and equipment are added piecemeal to a specific job on an "as needed" basis, rather than being carefully programmed in advance, it results in inefficiency of operations and abnormally high costs result.

The changed conditions demanded larger and more equipment than was on hand in order that the excessive water could be handled. This obtaining of equipment resulted in some delays during which other equipment, already on the job, was on a standby basis until excavation could be resumed.

The Contractor was put to added delays and expense in obtaining additional rights-of-way from adjacent landowners in order to dispose of the large flow that followed as dewatering operations got underway.

Due to the delay at Sites 1 and 2 caused by the excessive water and other items which had varying effects on progress, it became necessary to reschedule the sequence of site completion. Although Site No. 1 moved backward 5 weeks in the completion schedule and Site 2 moved backward 15 weeks, the sequencing position was partially determined by the progress of the remaining ten sites. As previously stated, six sites moved up in the schedule, but also it must be noted that one moved backward and three held the same position. A glance at the revised sequence shows that some sites had gained and others lost irrespective of the changed conditions. Sequence changed from 8, 9, 1, 2, 3, 4, 5, 6, 7, 10, 11, 12 to 8, 9, 3, 6, 5, 7, 4, 1, 11, 10, 12, 2. It is obvious that the resultant resequencing was not completely the result of changed conditions at Sites 1 and 2, yet a determination of the proper portion of an unknown acceleration cost with each site having different problems presented an imponderable problem for the estimators.

After reviewing the facts surrounding the changed conditions at Site 2, it has been estimated that 47 days should be allowed for shaft excavation under normal conditions and an additional 20 days for excavation under the changed conditions. In addition to increased cost of labor and equipment for these 20 days, delays were estimated at 52 days during which equipment was on a standby basis.

Charts showing history of Changed Conditions at Sites 1 and 2 are among those at the end of this report.

DESIGN CHANGES

During the advertising period from 23 January 1960 to 4 March 1960, when the bids were opened, eight addenda were issued, the last being dated 26 February 1960. These addenda re-issued 248 drawings of the total of 290, revised 250 of the 524 pages of specifications, and provided 29 additional pages of specifications. Those changes demonstrated that although all possible efforts had been expended to produce a final set of bidding documents, this was impossible. While the issuance of such revising addenda undoubtedly increased the risks inherent in the preparation of a bid, and indirectly increased the cost, the designing agency is to be commended for its efforts in attempting to keep the bidding documents current with the design activities. Field Changes and Design Changes are listed under Exhibit "C". The estimated amounts shown, in general, contain very little impact costs.

a. Revision to Contract Drawings: Revisions in design continued after the construction contract was awarded on 7 March 1960. This is demonstrated by the fact that 263 contract drawings had been revised by contract modifications, 52 drawings of which were revised at least four

or more times. This number does not include the 30 drawings of site work for the three sites added to the contract by supplemental agreement. Changes that were of particular significance are discussed in other portions of this report.

The delay to the overall completion of the job occasioned by these many changes contributed substantially to the difficulty of maintaining schedules and minimizing slippages. Only by an accelerated construction was completion accomplished within the contract time.

b. Shock Hanger Insert Plates: The Shock Hanger Bracket Insert Plate Drawings were revised three times after the original schedule of shop drawings had been sent to the Contractor with the comment, "No Action", owing to pending changes which were known at that time to be on the way.

Even after the last set for revision of the drawings had been made, the fabricator was unable to obtain the large size wide-flange beams and type of steel specified. The Kansas City District Office, as well as the Schilling Area Office, assisted the Contractor in attempting to locate a possible source of supply for these items. It was finally necessary to utilize 36" wide flange beams instead of 33" wide flange, as called for by the drawings. This substitution resulted in a delay and numerous telephone calls, etc., to obtain approval from all agencies concerned.

On the final revision of the drawings for this item, a tolerance limitation was placed by the designers which was more stringent than that allowed by mill tolerances under the AISC. In order to meet these in-plane tolerances, it was necessary to mill the assembly after fabrication.

c. Collimator Insert Plates: The design drawings for this item had been revised four times since the original approval of shop drawings and start of fabrication.

After the first Collimator Insert Plates had been imbedded in concrete in the first silos, errors were found in the design and some adaptations were necessary to properly utilize this installation.

Prior to imbedment of the second silo plates, much time and effort was expended with AFBMD personnel and Bechtel Corporation in an effort to resolve all questions and problems. For a considerable period, some question remained as to whether or not the installation and details of the individual plates were correct.

Anchor bolts, shown on Drawing AFBMD-1-16, on several of the insert plates, reference Sections "G" and "H", were omitted until Revision "E". In the interim, plates were fabricated and installed in the first several silos.

The Key Plan showing Basic Work Points, 1, 2, 3, and 4, was subjected to question as to the correctness of derivation of the locations of Work Points 1 and 4. It is apparent from the drawing layout that Work Points 1 and 4 were points of tangency to the silo wall at 26'-1" radius on tangent lines from Work Points 2 and 3. Location dimensions (X and Y coordinates) of Work Points 1 and 4 were discrepant with the apparent method of derivations. This matter was referred repeatedly to Bechtel Corporation and AFBMD since the 13 June 1960; however, no action of clarification resulted.

d. Fill and Vent Line Shaft Insert Plates: These imbedded plates occur in the wall of the fill and vent line shaft of the silo walls and are for the purpose of supporting PLF piping. Revised drawings reflecting

changes in the design and the location of these imbedded plates occurred twice after the plates had been fabricated.

In addition, certain plates were changed from carbon steel to stainless steel after carbon steel had been fabricated.

During the installation of these plates in the fill and vent line shaft, errors in the design drawings were encountered which necessitated a resolution promptly to avoid delaying construction. A solution was arrived at by the Schilling Area Office with the cooperation of AFBMD Schilling Field Office without much loss of time. However, later changes in the design drawings requiring answers to problems were not so prompt.

Examples of lack of clarity and omissions from contract plans concerning the subject plates were as follows:

1. Alterations of pipe supports in Fill and Vent Shaft at the time the concrete was ready to pour and again after the concrete at some sites had been poured.

2. Interference between Pipe Support Plates and concrete.

3. Change in type of steel after the support plates had been procured.

c. Grib Steel Changes. To avoid lost time resulting from preparation of shop drawings by the fabricator followed by a checking at the hands of the Architect-Engineer, the Air Force decided to furnish the Contractor a standard set of shop details or Supplemental Design Drawings. Paragraph 22-06 of the specifications was accordingly revised by addendum.

It was hoped that the cost of the crib steel might be reduced by the amount of the standard price for making detailed shop drawings and that a possible further reduction might result from relieving the Contractor of the responsibility for error in detailing this steel.

The detail drawings for the LCC crib and floor plates were issued as part of the original contract. Those bidding were notified that the Supplemental Design Drawings would be furnished at a later date.

Fabrication could not proceed prior to the issuance of the Supplemental Design drawings (Specification Paragraph 22-06a); however, milling of the main members could be accomplished based on the information given on the contract drawings. Due to this, milling of some of the members was under way when the Supplemental Design drawings were released. It was necessary to reorder from the mill as a result of redesign. This increased the direct costs and the indirect costs due to lost time.

Although a major overall resizing of the floor members was made by addendum and so should have been reflected in the contractor's bid, subsequent resizing of these and other members was brought about in the release of the Supplemental Design drawings. These changes included:

1. Redesign of the crib suspension bracket.
2. Minor floor member changes.
3. Diesel generator support members on levels 5 and 6.
4. Structural steel for elevator guide rails.
5. Revise crib spring hangers.
6. Change four cover plated beams to plate girders.
7. Many minor items.

The bulk of the 167 Supplemental Design drawings were issued by the Architect-Engineer, Sechtal, in two packages; the first 11 May 1960 and the second two days later.

The fabricator, American Bridge, subcontractor for the steel work, contended shortly after the work started that his original schedule of fabrication was based on having the LCC drawings by 6 April 1960 and

those for the silo by 15 April 1960. One-hundred sixty two (162) Supplemental Design drawings were delivered to the prime contractor 16 May 1960.

It is normal in the industry for each fabricator to develop the shop design details in his own shop and for a "lead time" of several months to be given the mills. This is necessary for efficient scheduling of rolling and proper sequencing of fabrication and shipping to the job.

Assuming that a delay of approximately one month resulted from late receipt of Supplemental Design drawings, this could only have been overcome by acceleration prior to delivery to the job site and/or in erection upon receipt.

Although a total of 167 Supplemental Design drawings were transmitted to the contractor, revisions were made to 361 Supplemental Design drawings. This resulted from a series of changes as follows:

33 drawings revised 27 May 1960

133 drawings revised 23 June 1960

101 drawings revised 25 July 1960

46 drawings revised 5 September 1960

7 drawings revised 7 October 1960

23 drawings revised 21 October 1960

9 drawings revised 14 November 1960

7 drawings revised 25 November 1960

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It can be assumed that the Contractor received the changes some two to three weeks after the date of the revision. The number of major changes and spacing of the revisions, frustrated any attempt at rescheduling. The

resultant inefficiencies and the accelerated effort to fabricate the steel, resulted in very considerable cost increases to the steel fabricator.

Normally, changes of design up to 10% can be handled in a fabrication shop without serious delays in scheduled shipping. In this case, however, better than 1500 tons of scrap steel was developed due to the changes on top of changes, whereas 3165 tons of fabricated steel was shipped to the job. The 1500 tons of scrap was later reduced, as subsequent changes made use of a large portion of it. Finally, 609 tons of scrap steel resulted and 265 tons of steel for which a partial credit was allowed.

The changes were of such magnitude that a complete shutdown occurred at the fabrication shop. When work could proceed, acceleration was required. Through a trip to the shops and considerable research, it was estimated that shop acceleration brought back 54 days of lost time. The overtime work was not an economical nor efficient operation. To provide shipment of pieces in proper sequence, special handling was necessary. These items of additional work caused much additional costs.

Several of the changes made in the crib steel affected Schilling alone, as it was possible to work them into the bid plans for the remaining areas.

After making the first issue, Bechtel was directed by the Air Force to have the Supplemental Design drawings checked by an outside agency. This check was undertaken by American Bridge 16 May 1960. When the review of the Supplemental Design drawings was complete about 10 June 1960 it was necessary to revise the 146 drawings.

Because of the many changes in the steel design and their effect on fabrication a cutoff date of 31 May 1960 was established for changes

in the fabrication plant and subsequent changes were handled as field changes. Although this prevented further slippage of crib steel delivery to the sites, it increased the cost of the changes which were subsequently required.

Pressure brought to bear through the Expediting Department of the Chief of Engineers improved American Bridge's schedule by approximately six weeks; however, it still remained about 15 days behind the original schedule.

It was then that Maisir Steel was contacted and delivery of crib steel for the first three sites was obtained at premium price in order to maintain the schedule.

f. Schilling Modification No. 71: This modification pertained to multitudinous changes in facility piping, electrical wiring, H.V. and A.C. ductwork, structural steel, and equipment location to meet the variations in the assigned service contract equipment. This modification issued to the Contractor, 26 September 1960, came at a time when a considerable amount of mechanical and electrical material was on hand and a large percentage of off-the-job prefabrication had been accomplished. The initial modification resulted in changes to 121 contract drawings. This modification was issued at a time when the Contractor was already under ordered acceleration due to lagging progress resulting from the many prior changes, and it was ordered (by higher Headquarters) that no additional time would be allowed for Modification No. 71.

A comparison of the estimates prepared by A/E, the Air Force, this office and the Contractor, given below shows the wide variance of opinion as to the value of the modification:

Rechtel	$ 386,760.00
AEC (Bechtel personnel)	434,630.00
C of E original estimate	506,224.55
C of E final estimate	1,413,515.93
Contractor's original proposal	2,776,911.92
Contractor's final proposal	4,314,956.34

Representative of the immeasurable effect of the modification was the added cost to the facility piping prefabricated by the mechanical sub-contractor, Stanley Carter, for installation in the silos. Not only was it necessary to return the spools from the various sites to the fabrication shop in Salina, but some of the installation that had been made at Site No. 8, had to be removed. It was found necessary by Stanley-Carter to employ an architect-engineer firm (Wilson and Co., Salina, Kansas) to make a complete study of the fabricated spools to determine which were affected and which of these could be economically reworked for reuse. It was determined that of the 2200 spools fabricated, 1300 were changed, of which 691 could not be reworked.

Not only was there added expense and delay to make the necessary study of the pipe spools described above but the rework was more costly in time and money than the original fabrication had been.

The Contractor could not tell just what the work amounted to, the credit obtainable for the deleted material, nor could he determine quantities of new material required until he had gathered, surveyed and completed a study of the changed material. Obviously the Contractor was in no position to provide a reasonable proposal for the work until considerable money and time had been expended in obtaining the data, and this office was in no better position to evaluate the change.

Most of these conferences were initiated by the Schilling Area Office when it appeared that the submittals were behind schedule. However, in spite of expediting assistance given by the Schilling Area Office, delays were experienced in obtaining approved shop drawings, calculation requirements, etc.

Because of the various delays in ultimate vessel production, it was necessary to resort to an accelerated schedule in order for deliveries to be made in time to avoid serious delay in the overall progress. Even so, it was necessary to place these pressure vessels after the crib steel had been erected above the crib level on which the vessels occur, rather than at the correct level as originally planned.

All possible steps were taken to expedite procurement of material, plant fabrication and shipment to the job site. This accelerated program was necessary from the standpoint of maintaining scheduled progress and was costly to accomplish.

Struthers-Wells is currently claiming approximately $3.3 million for additional costs due to delay in approval of shop drawings, and the wording of the specifications with respect to the materials used and the applicable test procedures.

PROPELLANT LOADING SYSTEM PREFABS

The Propellant Loading System Prefabs were furnished under Contract No. DA-41-643-ENG-5700, awarded Paul Hardeman (28 February 1960) by Fort Worth District Engineer, who was responsible for the manufacture, shop testing, and delivery of the units for the Atlas "F" program. The respective Atlas "F" Areas were responsible for the installation and field testing of the system. The cost of design changes was handled by Fort Worth District, the cost of field changes by the Area Office.

Like other phases of this program, the prefabs sustained many design changes during manufacturing and revisions that caused replacements after installation. From 29 February 1960 to 1 August 1960, there were 139 revisions that reflected on 61 contract plans. By the time the prefabs for Schilling Air Force Base were completed, there were a total of 309 plan revisions and many clarification sketches issued.

Due primarily to the delayed delivery of the Process Vessels, resultant and very costly delays occurred in the installation of the PLS prefabs and interconnecting piping. Through a Changed Conditions Claim successfull, prosecuted by Paul Hardeman over $469,000 was added to the cost of this work.

PLS VESSEL BLOWDOWN

Paragraph 13-03c, Section 13 of the specifications for Contract No. DA-23-028-ENG-4281, originally stated in part: "Prior to installation of the piping and components, the Contractor shall check to his satisfaction that the facility vessels and interconnecting piping and components are clean, and free of foreign material."

The Contractor who furnished and installed the prefabs and interconnecting piping did not furnish the vessels. Furthermore, the cleanliness requirements for the prefabs and interconnecting piping was much more restrictive than those for the vessels. The contractor was therefore able to disclaim any responsibility for the vessels other than that necessary to satisfy himself either that they were clean or that they were not. Because of the difference in cleanliness requirements for the vessels and for the system, he was able to establish in all cases, that the vessels were not clean. He therefore refused to connect to the vessels until they were cleaned.

Cleaning the vessels in place would have been not only time consuming but the cost would have been prohibitive. To remove the vessels from the site and return to the plant for cleaning would have resulted in a serious delay to construction. After careful consideration it was decided to blow down the vessels repeatedly until no particles were present on the inspection pad of greater size that that permitted in the system.

To avoid any further delay, a modification was issued to provide payment for and to outline the method of cleaning the vessels. The net result of the modification to cost was an addition to the contract amount of approximately $84,000, as agreed upon in the final settlement.

DIESEL GENERATOR OPERATION

The specifications prescribe that the diesel generators supplied under Contract No. DA-23-0[illegible]-ENG-4263 and installed after assignment under Contract No. DA-23-0[illegible]-ENG-4281, would be used to supply the electric current required for final facilities checkout. There were two advantages to this arrangement; first, the diesel generators would receive a complete check out and, secondly, the initial contract amount should have been substantially lower through not requiring the Contractor to furnish special generators to supply the 240/480 Volt, 3 Ø power for final testing.

Due to Modification No. 71 the permanent power system could not be completed as early as the electricity was required for the start of final testing.

It was necessary for the Contractor to provide special generators to produce the 480 V. power necessary for the operation of the facility elevators. This 480 V. power was also required to operate the Government

furnished rechargers used so extensively in the Vessel blowdowns and final testing of the F.L.S. prefabs and interconnecting piping.

Due to the incremental and progressive testing required in the F. L. S. installation, the start of final testing was very shortly after the start of installation. Following the start of final testing, power was needed continuously until the sites were turned over to the Air Force. In most instances the final testing was put into effect on FLS items, however at the last site or two, final testing of Stanley Carter's mechanical items were ready for testing ahead of Paul Hardeman.

Additional costs developed when, after placing a diesel generator, it was found that a design change was necessary to revise beam sizes and add an extra beam for support of the generators.

Modification No. 71 revised all piping to the diesel generator exhaust system.

Additional funds were required to provide the cable between the generators and the main switch panel, as same was not covered by Contract No. ENG-4281, nor was wiring external to the diesel generator itself, required under the White Motor Company Contract No, ENG-4263, by which the generators were furnished:

During the various delays in the diesel generator installation, a revised testing procedure was received at the end of January 1961, which was required to prove the generators prior to being put into use. It was not until 17 February 1961 that the generators were accepted for operational use.

At Site No. 8, from the initiation of final testing 23 January 1961 until 17 February 1961 when the generators were ready for use, it was necessary for the Contractor to furnish the electrical power from

his temporary generators. An average of thirteen days of testing with the Contractor's generators applied to the remaining sites. A large portion of the testing had to be done on an overtime basis or with the added costs of night differential applied to the wage rates.

After the diesel generators were in use, it was necessary for the Contractor to operate them. A modification to the contract was made to cover the furnishing and operation of generators by the Contractor during final testing until the diesel generators were ready for use. The modification also covered operation of the diesel generators after they had been test run.

The Government estimate in connection with furnishing power was $140,514.00.

GOVERNMENT FURNISHED PROPERTY

a. Counterweight: The counterweight for the launch platform consists of 29 leaves stacked and laid together by 12, 2½" rods and nuts. The total weight of the counterweight is listed as 565,000 pounds and posed no small problem in unloading and handling.

The counterweight delivery schedule had been moved up from the initial date of 23 November 1960 to 12 July 1960 with delivery to be made to the railhead nearest each site. Although the Contractor requested several days delay in delivery, the first shipment of our gondolas arrived 14 July 1960 at Schilling Air Force Base instead of the railhead at Beverly, Kansas, where delivery was scheduled. Four more gondolas arrived 15 July 1960, also at Schilling Air Force Base, and it was learned that approximately one and a half counterweights had been received minus the necessary tie rods. The first set of tie rods were rejected prior to

shipment because of error in thread cutting. These rods were later shipped for temporary use and subsequently replaced when new rods were fabricated. The reprogramming for earlier delivery of the counterweights, the subsequent delay in delivery to the first site and the extra handling of the bolts, all increased the contractor's costs.

b. Silo Crib Suspension System and Wall Brackets: These items, briefly known as shock hangers, consist of four pairs of supports of the spring loaded suspension rod type, installed at quadrant points inside the silo. The upper end of the rod is hung from Government furnished brackets fastened to Contractor furnished insert plates in the silo walls. Each spring capsule has a listed weight of 23,700 pounds and, together with the rods attached to each end totals 25,500 pounds with an overall length of 68 feet.

The Contractor pointed out shortly after the start of crib erection by Kaiser Steel, 2 August 1960, that Kaiser Steel's experience dictated that the shock hangers must be suspended before crib steel erection progresses past their location; otherwise chipping of the concrete would be necessary to get the hangers in place. For this reason, this office requested that delivery for the first site be 9 August 1960 to avoid delay in the crib steel erection. AFBMD was confident that the 9 August date would be met.

On 4 August 1960 the wall brackets only were received, and Kaiser Steel, performing the crib erection, was ready for the remainder of the shock hangers on 5 August 1960.

AFBMD arranged to air lift the shock hangers, which improved the delivery dates; however deliveries to the first five sites were 5, 16,

14, 13, and 6 days, respectively, behind schedule. At the first site Kaiser Steel, performing the crib erection, was actually ready for the complete shock hangers four days ahead of scheduled delivery.

The original plan to ship the spring capsule portion of the support hanger in a compressed state ready for installation was reconsidered due to the safety hazard resulting from possible release of compression blocking during shipment. At the request of AFBMD, the contract was modified to provide for the spring compression to be accomplished at the job site by the construction contractor. AFBMD was to furnish large jacks for the compression; however there was a delay in obtaining jacks of proper capacity. One of the jacks furnished was not equipped with a proper safety device to guard against unexpected release of compression during the jacking operation. An accident which occurred due to the use of the unsafe jack, resulted in a broken limb to one operator and damage to the spring capsule, requiring its replacement.

RELOCATION OF ACCESS ROAD

a. Site No. 6 Access Road: In order to comply with State of Kansas law to provide proper visibility for the entrance of a side road into a Federal Highway, it was necessary to change the location of the access road from that shown on the contract plans. The resurvey, redesign and real estate acquisition delayed construction of the access road from 14 April 1960 to 6 July 1960.

Through a private agreement with an adjacent property owner the construction contractor arranged for a separate access to the launch site proper. As a result, only a relatively small portion of the 83 day delay in access road construction affected the launch facilities proper.

The resurvey, redesign and requirement for additional real estate were items which raised the overall cost of the Schilling program, although they did not result in an extensive increase to Contract No. DAC-4281.

b. Site No. 12, Access Road: Except for the fact that the site access road enters a main State Highway rather than a Federal Highway, the reason for the relocation and manner in which it was accomplished was almost identical with the need for redesign experienced at Site No. 6.

Although the construction of the access road was only delayed 29 days at Site No. 12, from 26 May 1960 to 24 June 1960, more delay resulted in the launch facilities construction as the contractor experienced more problems in obtaining and establishing a temporary access until the redesigned location could be officially provided.

The increased costs to the Contractor for this change became a larger percentage of the total increase than in the case of Site No. 6.

DIFFERENCES IN TOLERANCES

Another item which increased costs under Contract No. DA-23-028-SMC-4281 was the difference in tolerances between the Propellant Loading System piping requirements, the concrete work, the embedded items, and the crib steel. Because these did not have the same tolerances, it was most difficult to have an agreement in fitting up. Even had the work not been conducted on an accelerated basis, the tolerances in the concrete were unusually severe considering the type of construction involved and the method by which the concrete was placed. With embedded items placed in concrete having a tolerance of plus or minus one inch, it was most difficult to attach brackets to hold PLS pipe having a tolerance of

plus or minus one sixteenth inch. Corrections and adjustments required were delaying and costly. These difficulties were further aggravated by the layout of piping with measurements from the X and Y axis to be in with items measured from the crib steel where locations varied daily.

OTHER DELAYING FACTORS

Each delay to the construction under Contract No. EMC-4261 added to the cost of the work, some to a greater extent that others. Obviously any delay to pacing items such as excavation, concrete work, and crib erection delayed all follow on work day for day. Delays to other than actually pacing items were frequently costly in the impact or ripple effect on other items closely associated with the delayed item. In either case the cost of overcoming delays through accelerated effort with its innate inefficiency was a very appreciable item. It is seen by Exhibit "B" that acceleration and impact amounted for a little over $5,678,000 in the total contract cost. In addition to the delays resulting from Changed Conditions, Modifications to the Contract, and other items previously mentioned the following also caused delays with their attendant cost increases, although to a lesser degree.

a. Adverse Weather: The heaviest snow storm recorded for this area affected the sites at the outset of the contract, making it necessary to revise the sequence of sites at which construction would be started in order that a minimum of delay would result. Because of less difficulty in access, Sites 8 and 9 were put ahead of No. 1.

Even with the shift in construction sequence, the removal of snow to clear for the start of operations caused the loss of two days at Site 8 and two days at Site 9.

The excessive moisture in the soil following the thaw resulted in three more days of lost time at Site 9 due to the access road becoming impassable for rubber-tired construction equipment.

Excessive rainfall without drying spells began occurring at critical phases of excavation, resulting in two to three weeks loss of time at both Sites 7 and 9.

Total lost time due to weather on Contract No. DAO-4281 for the construction of Missile Launch Complexes was estimated at twenty days.

b. Ring Beams: Eight days delay at the first site only was chargeable to late delivery of ring beams. Delay was caused by the compressed construction schedule, time lost in transit, and time to repair shipment damage.

c. Hardened Bottom, Site No. 2: The possibility of the need for a hard bottom was the subject of considerable conjecture by representatives of the C of E, AFBMD and the construction contractor for several days before excavation reached the original bottom elevation.

On 5 August 1960 after the excavation was completed (Reference Elevation 823) an inspection was made by representatives of the C of E, AFBMD Field Office and Bechtel. It was agreed that the sump should be excavated and then at that time another inspection would be made to reach a decision as to the type of bottom to be constructed.

During the evening of 9 August 1960 the representatives mentioned above inspected the shaft and sump. After a conference at the job site it was determined that the so-called hard or pressure type bottom construction would be required at this site.

This change was necessary to insure the integrity of the silo structure. Although some delay resulted from this change, through

expediting and acceleration, the overall delay was probably reduced to between 7 to 10 days.

d. Number of Drawings: The volume of drawings involved at the outset, complicated by change upon change, resulted in a very real problem of record keeping of receipt and distribution to thirty-six subcontractors and suppliers. For each modification, the Contractor received and made distribution of 166 copies of each drawing. There is no question but that the volume of drawings and, at times, the rapidity of changes caused misunderstanding, delays and often costly mistakes. The cost of reproduction alone was tremendous. There were:

Original Contract Drawings	290
Revised by Addenda	248
Revised by Modification	560
Original Grid Steel Supplemental Design Drawings	167
Revised Grid Steel Supplemental Design Drawings	361
Schilling Area Sketches	127
Basic Prefab and Piping Drawings	66
PLS Drawings Revised by Modification	309

The ill effects of the "Theory of Concurrence" i.e., the simultaneous planning, fabrication and construction were probably more noticeable at Schilling than any other Atlas "F" Complex. The number of drawing revisions at Schilling speak mute testimony to the fact that at the head of the six Atlas "F" Areas, the learning curve was sharp and costly.

SUMMARY

The one item which was most representative of the cost was the labor, which is the common denominator for all trades. In addition to cost it

reflects the acceleration and contains the inefficiencies of overtime work by adding still further hours. Impact to was included in the added manhours of labor, though an hour of impact cannot be separately distinguished from any other hour of work.

Two charts in Section 22 of this report show the comparison of Contract No. EWG-4281 manhours "As Planned" versus "As Built", one chart being in monthly totals, the other showing the accumulative results. It will be noted in the latter that the total man hours "As Built" shows an 83% increase over the total man hours "As Planned". Exhibit "A" shows a 93% increase in dollars.

Other charts showing a comparison of Crib Steel erection, scheduled versus actual, and a site by site portrayal of scheduled versus actual construction of pacing items are also located in Section 22.

EXHIBIT "A"
CONTRACT COST INCREASES, SCHILLING AREA

Abbreviated Contract No.	Short Title	CONTRACT AMOUNT ORIGINAL	CONTRACT AMOUNT ULTIMATE	Percent Increases	Status of Contractor Earnings
4281	Missile Launch Complexes (12)	23,383,000	45,153,853	93%	100%
4361	LOX Facilities	379,900	394,695	4%	100%
4386	Water Supply (12)	754,800	1,131,835	51%	100%
4451	Missile Assembly Building	637,500	644,719	1%	100%
4491	Conversion of Buildings	128,844	173,986	[illegible]	100%
4497	Re-Entry Vehicle Facility	92,900	102,984	11%	100%
4866	Modification of MAB	71,500	80,405	12%	95%
4921	Communication Ducts	29,506	29,847	1%	100%
4974	Fuel Catchment Tanks	186,396	188,202	1%	0%
5862	Blast Detection System	100,860	101,380	1%	0%
		25,764,406	48,010,969	86%	

EXHIBIT "B"
COST INCREASE - CONTRACT NO. ENG-4281

Description	Basic Contract	Modifications, Impact and Acceleration	Changed Conditions	Totals
Basic Contract (9 Sites)	$17,209,000	$	$	$17,209,000
Modification No. 15 (3 Sites)	6,174,000			6,174,000
Changed Conditions, Site 1			519,300	519,300
Changed Conditions, Site 2			413,200	413,200
Hard Bottom, Site 2 (Mod. 44)		59,437		59,437
Assignment Contracts				3,712,773
Safety Platform, Modification 112		74,899		74,899
Diesel Generator Power for Testing			239,262	239,262
Remaining Design ~~Changes~~ Definitization (Pad)		2,845,000 ~~4,577,359~~ * 376,000 279,000		4,577,359
Remaining Field Changes Des Changes		~~122,638~~ *		122,638
GFP (extra costs incidental thereto)		26,359		26,359
Remaining Acceleration and Impact		5,678,199 1,000,000 *		5,678,199
Overhead				4,014,675
Profit				2,141,055
Bond				191,218
TOTAL				$45,153,374

*Contains some items having partial acceleration and impact.

EXHIBIT "C"

FIELD CHANGES, SCHILLING

REQUEST No.	DESCRIPTION	AMOUNT
4	Remove existing fence & replace with New Fence at Sites 3, 4, & 5. LI00-001 C, D&E	$ 3,303.00
5	Add 12" x 18" CMP Drainage at Site No. 1 - Line Item 00-001A	155.00
39	Relocation of certain Material Stock Piles - Line Item 00-001 D & E	2,341.00
47	Install Grout Pipes & Grout at Site #1 Line Item 00-001A	16,769.00
60	Block Gas Hole at Site No. 11 Line Item 00-001 E	3,770.00
66	Provide Grout at Site 10 & Grout as necessary LI 00-001 J	3,000.00
70	Add 6" Angle Valve in 6" Waterline to Tunnel	4,948.00
87	Construct Headwall Site No. 6 Line Item 00-001 F	4,732.00
89	Add Grout Pipes Site No. 2 & Grout as necessary Line Item 00-001 B	4,487.00
90	Provide a collimator insert Plate Survey	1,480.00
101	Provide 40 Rubber Gaskets for Blast Closures	13,140.00
110	Erect Radio Towers at all Sites	2,155.00
168	Misc. Field Changes 14 thru 26 Jan 61	26,349.00
177	Provide Drain Pumps Level 4, Sites 3, 5 & 9 all Sites provide Shut-off Valve Air Receiver LI 00-001 C, H & I Q-29	20,060.00
187	Provide temporary service at Sites 8 & 9 for Mallum Compressors Q-39	634.00
190	Replace Heat Recovery Silencer Gaskets Sites 7 & 8	2,051.00

REQUEST NO.	DESCRIPTION	AMOUNT
196	Replace Pressure Safety Valves PSV60 & PSV61	$ 1,634.00
199	Provide Electrical Service for Alternators on Submersible Pumps	12,374.00
222	Revise Junction Box Rack to hold Telephone Cabinet	968.00
231	Relocate Outlet Line Site #12	921.00
232	Re-letter & Re-locate Signs S-2 & S-3 - Delete Access Road Signs Sites 6, 10 & 12	931.00
237	Check Gas Detection Wiring (Par. 9c)	1,000.00
240	Furnish American-made lens with 1/2" Focal length on TV Camera in lieu of Japan made with 1" Focal length	1,476.00
	TOTAL - FIELD CHANGES	$122,638.00

DESIGN CHANGES

7	Misc. Changes, Blast Closures, Elec., Metal Instrum. - 9 Sites	26,572.00
8	Misc. Changes, Electrical & Mechanical	18,721.00
13	Misc. Changes, HV & AC Facility Piping & Gas Detection System	44,152.00
15	Revise Water Wells & Service Roads LI 00-001 A, B & G	1,002.00
25	Revise Valve Pockets, Plumbing, Compressed Air System to LOC	16,371.00
26	Add Switch Gear Supports, Disconnect Brackets - Revise Conduits & Cable Size	7,930.00
30	Relocate Access Road at Site No. 6 Line Item 00-001 F	36,439.00
31	Misc. Structural, Electrical & Mechanical Changes	4,029.00
32	Relocate Access Road Site No. 12 Line Item 00-001 L	1,408.00

REQUEST NO.	DESCRIPTION	AMOUNT
36	Revise Crib Floor Framing Plan	$ 9,590.00
41	Pressure Switches LH_2 & LO_2 Storage & Heat Exchanger Nozzle Orientation	1,479.00
46	Revise Steel for Facility Elevator Guide Rails & Other Misc. Changes	61,346.00
53	Revise Requirements for Operation & Maintenance Manuals	8,665.00
61	Revise Parking Areas Line Items 00-001 A thru 00-001 I	64,950.00
65	Relocate Tile Fields Sites 10 & 12 - Line Items 00-001 J & L	4,588.00
67	Alternate Piping Arrangement between Gaseous Vessels & Piping	26,492.00
82	Revise Standard Equipment, Package Interim Fmt. COC Nos. 226, 260B, 270B, 285, 333E, 342, 368, 381A & 396	1,413,000.00
83	Revise Collimator Plates	4,755.00
86	Provide Prime Coat for Asphalt	15,983.00
92	Extend Ground Grid to Fuel Tanks	4,747.00
100	Revisions of Entrance Security System	160,814.00
106	Provide Screw Fasteners in lieu of Hinge Pins on 480 Volt Panel	5,875.00
107	Revise Polaris Site Tube, Revise TCD Cooling System & Other Changes	22,628.00
108	Revise Flexible Connections	92.00
109	Field Changes to Crib Steel	9,375.00
111	Install 2 Elbows on Each Heat Recovery Silencer	9,242.00

REQUEST NO.	DESCRIPTION	AMOUNT
114	Extend Water Well Access Road at Site Nos. 1, 3, 5, 6, 7 & 9	$ 4,433.00
115	Revise Horizontal Crib Locks (Bubble Space)	5,309.00
117	Impulse Screen, Fire Protection Wiring & Misc. Changes	50,460.00
124	Add Diesel Generator Support Steel	9,440.00
125	Blockouts for FLS Lines in Mill & Vent Shaft	9,780.00
127	Cut Hole in Silo to Install 3 FLS Line	2,638.00
131	Revisions to Pipe Support Insert Plates	40,670.00
132	Revision to Elect. Conduit at Water Chiller	3,031.00
134	Correct Pump Mounting Studs - Level 4	10,429.00
138	Pipe Sleeves for Removable Handrail at Silo Doors & Misc. Changes	38,563.00
142	Revisions to Security Fence, to Provide 10' Frangible STOP ORDER ISSUED U-5	32,300.00
143	Revisions to Overhead Cylinder Bracket U-6	21,739.00
144	Structural & Electrical Changes U-9	146,062.00
147	$1\frac{1}{2}$ Blockouts, Enlargement U-14	4,633.00
148	Guide Rail Supports, Newloads on L/F to Crib Locks & Bracing U-15	40,800.00
149	Provide Frame for Seven Grating Openings U-1	1,664.00
150	Correction to the Installation of the Launch Platform Drive Base Assemblies U-2	21,770.00

REQUEST NO.	DESCRIPTION	AMOUNT
153	Revise Emergency Shower Splash Pan & Drain Below Level 7 Q-5	11,434.00
156	Correct Interference between Wireway & Climatizer Level 2 & Relocate Battery Operated Emergency Lamp Q-6	18,921.00
157	Corrections to Crib Steel Drawings Q-9	863.00
158	Relocation of Hanger, re-route Drain Line From Floor Drain Q-10	16,035.00
159	Misc. Changes thru 31 Dec 60 Q-11	8,760.00
163	Turnish Motorized Damper VB 21 Q-15	1,855.00
16.	Misc. Changes 1 Jan thru 14 Jan 61 Q-17	12,250.00
169	Revisions to Electric Power, LCC at Site 5	4,593.00
170	Misc. Changes to Site Crib Steel & Acceleration Q-22	1,500,000.00
173	Misc. Field Changes 20 Jan thru 11 Feb 61 Q-25	17,476.00
178	Miscellaneous Hangers Q-30	35,746.00
179	Certain Changes to Pressure Gage Dial Ranges Q-31	5,980.00
180	Seal Welding Level No. 6	34,755.00
184	Misc. Changes 11 Feb thru 17 Mar 61 Q-36	68,090.00
192	Relocation of Elect. Fixtures, Sites 3, 4, 5, 6, 8 & 9 Q-44	2,289.00
193	Field Changes from 20 Mar 61 Q-45	19,990.00
194	Motor Starter Heaters for ASC Contract No. 4739 Q-46	1,651.00
195	Change Spec. Req. for Safety Platform	100.00
197	Re-work Crib Frame to Accomodate Safety Platform	8,271.00

REQUEST NO.	DESCRIPTION	AMOUNT
202	Delete Specifications Requirements for Finish Painting (Underside of Gratings)	$ 224,400.00
204	Bonding Across High Strength Bolted Joints	49,265.00
213	Misc. Changes from 24 Apr 61	3,397.00
215	Modification to Blast Closures	70,000.00
217	Modification to Safety Platform	1,082.00
227	Revise Limit Switch Safety Platforms	3,507.00
241	Seal Cracks in Silo Caps, All Sites	7,011.00
246	Revisions to Safety Platform	500.00
249	Modification to S1-C Submersible Pumps P-81 & P-82	500.00
258	Revisions to MLS Cable	0.00
	ESTIMATED DESIGN CHANGES	$4,577,359.00

Fld -179,000
Dsch 376,000
To Df 4,241,000
Need 1,000,000
4,700,000

376,000

123,000
4,577,000
4,700,000

15. LIST OF PRINCIPAL SUBCONTRACTORS, SCOPE OF WORK, COST AND EFFECTIVENESS OF SUBCONTRACTORS' OPERATIONS.

CONTRACT NO. DA-23-028-ENG-4281
PRIME CONTRACTOR: STAM-MANHATTAN-SUMDT

NAME - SUB CONTRACTOR	SCOPE OF WORK	INITIAL COST	FINAL COST	COMMENT ON EFFECTIVENESS
Walt Keeler Co., Inc. P. O. Box 1972 Wichita, Kansas	Furnished & Mixed Concrete	$ 379,905	$ 379,905	Average
General Engineering Const. Co. 5642 E. Speedway Tucson, Arizona	Seeding & Sodding	94,891	108,153	Unsatisfactory
Struthers Wells Corporation Warren, Pennsylvania	Furnished PLE Vessels	2,701,344	*	Average
Ryerson, Joseph T & Son, Inc. P. O. Box 80004, Chicago, Illinois	Furnished Rebar	1,714,282	1,800,000	Excellent
Premier Roofing Co. 936 S. Greenwood Montebello, California	Installed Water Proofing Membrane	74,460	77,060	Above Average
Cyclone Fence Co. 13600 S. Brandon Chicago, Illinois	Fencing & Gates	118,439	132,000	Above Average
Kaiser Steel Corp. P. O. Box 6997 Los Angeles, California	Crib Steel	0	1,178,603	Excellent
Otis Elevator 260 Eleventh Ave., New York, New York	Furnish & Install	342,107	408,107	Excellent

NAME-SUB CONTRACTOR	SCOPE OF WORK	INITIAL COST	FINAL COST	COMMENT NO. EFFECTIVENESS
American Bridge Co. P. O. Box 340 Orange, Texas	Crib Steel Erection	$2,544,702	$4,486,425	Excellent
George Bennett 3300 N. 91st St., Bethel, Kansas	Open Excavation & Backfill	698,060	1,103,260	Above Average
Camblin Steel Service Co, Inc. 1655 ElCamino, N. Sacramento, California	Installed Rebar	547,422	1,240,000	Excellent
A. O. Smith Co. Milwaukee, Wisconsin	Furnish PLS Vessels	444,991	458,253	Above Average
Harry Henery, Inc. Ottawa, Kansas	Grading & Paving	530,482	622,500	Above Average
Missouri Valley Steel, Inc. P. O. Box 89 Leavenworth, Kansas	Furnish & Install Safety Platforms	0	54,587	Average
Water Cooling Equipment Co. 8601 New Hampshire Rd., St. Louis, Mo.	Furnish & Install Cooling Towers	40,786	41,388	Average
Stanley Carter 13540 Linwood Ave., Detroit, Mich.	Mechanical Work	2,639,206	4,972,444	Excellent
Paul Bardeman, Inc. 10579 Dale Ave., Stanton, California	PLS Installation & Testing	1,275,849	1,895,000	Above Average

NAME-SUB CONTRACTOR	SCOPE OF WORK	INITIAL COST	FINAL COST	COMMENT ON EFFECTIVENESS
Wintroath Pumps 1100 S. Heridan Ave., Alhambra, California	Furnish Submer-ible Pumps	$ 20,400	*	Above Average
Sempco Corporation 347 W. 16th Street Salt Lake City, Utah	Furnish Sewage Pumps	9,160	9,225	Average
Henry Pratt Co. 319 W. Van Buren St., Chicago, Illinois	Furnish Blast Closures	138,735	**	Average
Boeing Airplane Co. 3801 S. Oliver Wichita, Kansas	Furnish Air Spring Cylinder Supports	85,089	85,089	Average
Boeing Airplane Co. 3801 S. Oliver Wichita, Kansas	Furnish Overhead Door Hinge Assemblies	236,052	236,052	Average
General Electric Co. P. O. Box 2331 Denver, Colorado	Furnish Switch	143,600	162,809	Average
Clarage Fans Co. 619 Roctor St., Kalamazoo, Michigan	Furnish Centrif-ugal Fans	27,069	27,208	Average
White Motor Company 1401 Sheridan Ave., Springfield, Ohio	Furnish & Install Diesel Generators	1,000,428	1,019,776	Excellent
A. M. Lockett & Co., Ltd. 1701 Mercantile Dallas Bldg Dallas, Texas	Furnish & Install Water Chiller Units & Rotary Pumps	107,255	111,108	Excellent

NAME-SUB CONTRACTOR	SCOPE OF WORK	INITIAL COST	FINAL COST	COMMENT ON EFFECTIVENESS
Dean Hill Corporation 4000 E. 16th St., Indianapolis, Indiana	Furnish Centrifugal Fans	52,299	52,299	Average
The Trane Company 2nd & Cameron Ave., LaCrosse, Wisc.	Furnish Air Conditioning Fan Coil Units	38,460	38,460	Average
Joy Manufacturing Co. 742 S. Harry Hines Blvd. Dallas, Texas	Furnish Air Washer Dust Collectors	130,962	130,962	Average
Cook Paint & Varnish Co. 116 N. Santa Fe, Salina, Kansas	Floor Tile	3,087	3,087	Average
Elmer's Furniture 1815 S. Ninth Salina, Kansas	Floor Covering	22,812	22,812	Average
Globe Sheet Metal Works Walnut & Broadway, Salina, Kansas	Heating & Ventilating in Silos	367,608	527,000	Excellent
Layne-Western Co. 1011 W. Harry Wichita, Kansas	Drill 4 Water Wells	42,210	42,210	Excellent
Lionel Robbins Minneapolis, Kansas	Furnish Equipment & Hauling	8,185	8,185	Average
Selby Drilling Co. P. O. Box 450 Boise, Idaho	Chemical Grouting -	35,425	35,425	Average

NAME-SUB CONTRACTOR	SCOPE OF WORK	INITIAL COST	FINAL COST	COMMENT ON EFFECTIVENESS
Woods Bros. Const. Co. P. O. Box 145 Salina, Kansas	12 C of E Office Buildings	$ 44,568	$ 44,568	Average
Johns Manville Sale Corp. 2010 McGee Kansas City, Missouri	Insulation	252,925	420,000	Above Average
Powers Regulator Co. 216 E. Waterman, Wichita, Kansas	Install of Controls Valve on Piping, Heating & Vent.	266,600	275,000	Excellent
L. J. Wing Manufacturing Co. N. Stiles St., Linden, New Jersey	Furnish Supply & Exhaust Fans	27,240	27,240	Average
Harvey Bertram Company 2225 Bogen St., Cincinnati, Ohio	Furnish Supply Fans	2,640	2,640	Average
Flournoy Painting Co. 2403 Mandelier Rd., Colorado Springs, Colorado	Painting - All Sites	160,666	250,000	Average
Southwest Welding & Mfg Co. 3201 W. Mission Rd., Alhambra, California	Furnish PLS Vessels	424,380	454,380	Average

* These subcontractors have open claims.

** There is an open Modification (R-218) which will effect this subcontractor's final cost.

CONTRACT NO. DA-23-026-ENG-4361
PRIME CONTRACTOR: MARVIN W. HILL CONSTRUCTION

NAME-SUB CONTRACTOR	SCOPE OF WORK	AMOUNT OF SUB CONTRACT	COMMENT ON EFFECTIVENESS
R. R. Ballou Const. Co. R.F.D. #2 Salina, Kansas	Excavation	$ 32,639.00	Excellent
E. K. Jenkins, Inc. 730 N. Main Wichita, Kansas	Heating, Mechanical Setting Tanks, Piping & Plumbing	231,054.00	Excellent
Mckee Gardens Abilene, Kansas	Seeding & Sodding	225.00	Excellent
York Electric Company 1227 Clay, N. Kansas City, Missouri	Electrical	24,461.00	Above Average
Globe Sheet Metal Walnut & Broadway Salina, Kansas	Placed Galvanized Sheet Steel on Building	2,219.00	Above Average
Ed Serrault Roofing Company 527 S. 5th St., Salina, Kansas	Roofing	4,200.00	Average
Belger Cartage 418 N. Osage Wichita, Kansas	Erected Structural Steel	1,455.00	Excellent
Reno Painting Co. P. O. Box 632 Salina, Kansas	Painting	3,820.00	Above Average

NAME-SUB CONTRACTOR	SCOPE OF WORK	AMOUNT OF SUB CONTRACT	COMMENT ON EFFECTIVENESS
Eckley-Morris Masonry 357 Jewell Salina, Kansas	Masonry	$ 1,550.00	Average
Crawford & Son 623 So. 4th Salina, Kansas	Plastering	669.00	Average

CONTRACT NO. DA-23-028-ENG-4386
PRIME CONTRACTOR: CARROTHERS CONSTRUCTION CO., INC.

NAME-SUB CONTRACTOR	SCOPE OF WORK	AMOUNT OF SUB CONTRACT	COMMENT ON EFFECTIVENESS
Braymen-Heinking Co. P. O. Box 145 Topeka, Kansas	Laying of Water Lines, Excavation & Backfill	$ 172,209	Average
Martin & Ade 617 Maple Gypsum, Kansas	Dirt Work	535	Average
E. K. Jenkins, Inc. 730 No. Main Wichita, Kansas	Erection of Buildings 1 - 9	15,420	Excellent
Kansas Steel Bldg Company 148 North Street Topeka, Kansas	Erection of Buildings, 10-11-12	29,775	Average
Minneapolis Honeywell Regulator Co. 2601 S. Madison Wichita, Kansas	Installation of Pneumatic Controls	37,250	Excellent
McKee Gardens Abilene, Kansas	Dirt Work	165	Excellent
Skiles Plumbing & Heating Co. Kearney, Nebraska	Plumbing & Mechanical	31,250	Average
Wilson-Deere Electric Co. 1813 Harrison Kansas City, Mo.	Interior & Exterior Electrical Work	97,564	Average
Wilson & Co. P. O. Box 28, Salina, Kansas	Testing & Developing Wells	9,287	Average

NAME-SUB CONTRACTOR	SCOPE OF WORK	AMOUNT OF SUB CONTRACT	COMMENT ON EFFECTIVENESS
General Engineering Const. Co. 5642 E. Speedway Tucson, Arizona	Seeding & Sodding	$ 11,060	Satisfactory
Harry Henery, Inc. Ottawa, Kansas	Dirt Work	5,269	Average

CONTRACT NO. DA-23-028-ENG-4451
PRIME CONTRACTOR: SWANSON & YOUNGDALE CONSTRUCTION CO.

NAME-SUB CONTRACTOR	SCOPE OF WORK	AMOUNT OF SUB CONTRACT	COMMENT ON EFFECTIVENESS
Baker Drywall Co. 1726 S. Minneapolis Wichita, Kansas	Drywall All Joints & Cracks	$ 6,062	Above Average
Belger Cartage Co. 418 N. Osage Wichita, Kansas	Installation of Structural Steel for Bridge Crane	5,360	Excellent
Bohn Co., Inc. Greeley, Kansas	Process Piping & Cleaning	5,600	Above Average
Birch Construction Co. 514 E. Beloit Salina, Kansas	Excavation, Fill & Backfill	10,600	Average
Cyclone Fence Co. 2820 Roe Lane Kansas City, Kansas	Fencing	1,770	Average
Diamond Engineering Co. Grand Island, Nebraska	Underground Communication Ducts	20,600	Above Average
M. W. Hills P. O. Box 944 Salina, Kansas	Concrete Work	50,300	Above Average
Insulation Service, Inc. P. O. Box 4695 Tulsa, Oklahoma	Insulating All Corrugated Zinc Siding	11,700	Average

NAME-SUB CONTRACTOR	SCOPE OF WORK	AMOUNT OF SUB CONTRACT	COMMENT ON EFFECTIVENESS
Ed Serrault Roofing Co. 527 S. 5th Salina, Kansas	Roofing & Sheet	$ 6,600	Average
Universal Engineering & Const. Co. P. O. Box 5473 Tulsa, Oklahoma	Plumbing, Heating & Air Conditioning	185,800	Average
W. M. Wood Painting Co. 801 S. Santa Fe Salina, Kansas	Painting	7,900	Average
York Electric Co. 1227 Clay St., N. Kansas City, Mo.	Interior & Exterior Electrical	114,250	Above Average
Overhead Door Company P. O. Box 2254 Wichita, Kansas	Vertical Door Lift Installation	1,730	Average
Abell-Howe Company 7747 Van Buren Forest Park, Illinois	Bridge Crane & Monorail Hoist	19,400	Average
Pittsburgh Plate Glass Co. 204 East Iron, Salina, Kansas	Glass & Glazing	950	Above Average
Kilpatrick Brothers P. O. Box 3658 Oklahoma City, Oklahoma	Carpentry & Millwork	4,500	Average
Taylor Forge & Pipe Works Paola, Kansas	Process Vessels, Manufacture, Test & Deliver	46,500	Average

CONTRACT NO. DA-23-028-ENG-4497
PRIME CONTRACTOR: M. W. HILLS CONSTRUCTION

NAME-SUB CONTRACTOR	SCOPE OF WORK	AMOUNT OF SUB CONTRACT	COMMENT ON EFFECTIVENESS
E. R. Jenkins, Inc. 730 North Main Wichita, Kansas	Mechanical Work	$ 9,199.00	Excellent
Birch Construction Co. 514 East Beloit Salina, Kansas	Excavation	1,780.00	Average
Ed Serrault Roofing Co. 527 South Fifth St. Salina, Kansas	Roofing	1,500.00	Average
General Air Conditioning & Electrical Co. 113 South Fifth St. Salina, Kansas	Electrical Work	9,670.00	Above Average
Reno Paint Company P. O. Box 632 Salina, Kansas	Painting	2,173.00	Above Average
McKee Gardens Abilene, Kansas	Seeding & Sodding	300.00	Excellent
Abell-Howe Co. 7747 Van Buren Forest Park, Illinois	Bridge Crane	13,351.00	Above Average

CONTRACT NO. DA-23-028-ENG-4491
PRIME CONTRACTOR: GENERAL AIR CONDITIONING & ELECTRICAL CO.

NAME-SUB CONTRACTOR	SCOPE OF WORK	AMOUNT OF SUB CONTRACT	COMMENT ON EFFECTIVENESS
Robertson Plumbing & Heating Co. 321 N. 12th St. Salina, Kansas	Plumbing & Pipe Fitting	$ 9,522	Above Average
Woods Bros. Const. Co. 415 E. Prescott Salina, Kansas	Carpentry, Cement Work Roofing, Painting, Security Fence, Excavation	93,443	Average
Jayhawk Electric Co. Topeka, Kansas	High Voltage	9,295	Average

CONTRACT NO. DA-23-028-ENG-4866
PRIME CONTRACTOR: GENERAL AIR CONDITIONING & ELECTRICAL CO.

NAME-SUB CONTRACTOR	SCOPE OF WORK	AMOUNT OF SUB CONTRACT	COMMENT ON EFFECTIVENESS
David E. McDaniel Co., Inc. 7719 Cottontail Avenue Wichita, Kansas	Insulation Duct Pipes Walls	$ 1,969	Average
Woods Bros. Const. Co. 415 E. Prescott Salina, Kansas	Carpentry, Cement, Roofing & Painting	19,374	Average
Robertson Plumbing & HeatingCo. 321 North 12th Salina, Kansas	Plumbing & Pipe Fitting	12,628	Above Average
Minneapolis-Honeywell 2801 South Madison Wichita, Kansas	Pneumatic Controls	1,475	Excellent

CONTRACT NO. DA-23-028-ENG-4974
PRIME CONTRACTOR: UTAH-MANHATTAN-SUNDT

NAME - SUB CONTRACTOR	SCOPE OF WORK	INITIAL COST	FINAL COST	COMMENT ON EFFECTIVENESS
General Air Conditioning & Electrical Company 113 S. 5th St. Salina, Kansas	Electrical Work	Approx. $ 24,000	Pending	Pending Completion of Job

16. THE RACE AGAINST TIME - - -

SHOWING CONSTRUCTION PERIOD AND

STATEMENT OF LIQUIDATED DAMAGES.

16. THE RACE AGAINST TIME -
SHOWING CONSTRUCTION PERIOD AND STATEMENT ON LIQUIDATED DAMAGES

SITE NO.	LAUNCH SITES - CONTRACT NO. DA-23-028-ENG-4281				BAKER WELLS - CONTRACT NO. DA-23-028-ENG-4386	
	SCHEDULED COMPLETION DATES		STARTING DATE	COMPLETION DATE	STARTING DATE	COMPLETION DATE
	ORIGINAL	MODIFIED				
1	2/15/61	6/5/61	3/25/60	5/16/61	7/20/60	4/9/61
2	2/22/61	6/30/61	3/30/60	6/26/61	7/1/60	4/9/61
3	3/1/61	4/17/61	4/4/60	4/3/61	6/3/60	4/3/61
4	3/8/61	5/17/61	4/6/60	5/4/61	6/7/60	4/9/61
5	3/15/61	5/28/61	4/11/60	5/1/61	7/5/60	4/9/61
6	3/22/61	5/6/61	4/14/60	4/10/61	6/9/60	4/9/61
7	3/29/61	5/29/61	4/14/60	5/6/61	8/4/60	4/9/61
8	4/5/61	4/4/61	3/18/60	3/20/61	7/28/60	1/10/61
9	4/12/61	4/12/61	3/24/60	3/27/61	8/23/60	3/24/61
10	6/12/61	6/25/61	5/27/60	6/12/61	11/7/60	5/1/61
11	6/19/61	6/5/61	5/29/60	5/16/61	11/7/60	5/1/61
12	6/26/61	7/8/61	6/17/60	6/19/61	11/7/60	5/1/61

Certain minor work contained in Modification No. 125 to Contract No. ENG-4281 had a scheduled completion date of 4 September 1961.

The work authorized by Modification 28 to Contract No. ENG-4386 had a scheduled completion date of 9 October 1961.

The work under both contracts, 4281 and 4386 was accepted on or prior to the scheduled completion dates. No liquidated damages were assessed.

	Contract	Scheduled Date	Actual Date
LIQUID OXYGEN FACILITY	No. 4361	4/20/60	6/10/61
MISSILE ASSEMBLY BUILDING	No. 4451	6/23/60	12/31/60
CONVERSION OF BUILDINGS	No. 4491	7/12/60	10/31/60
RE-ENTRY VEHICLE	No. 4497	7/25/60	6/1/61
MODIFICATION TO MAB	No. 4866	4/3/61	6/15/61
COMMUNICATION DUCTS	No. 4921	6/7/61	8/7/61

FUEL CATCHMENT TANKS, NO. 4974

SITE NO.	SCHEDULED COMPLETION DATE	ACTUAL COMPLETION DATE
1	12/4/61	
2	1/1/62	
3	11/6/61	11/11/61
4	11/27/61	11/27/61
5	11/13/61	11/22/61
6	11/6/61	11/11/61
7	11/20/61	11/24/61
8	11/3/61	11/7/61
9	11/5/61	11/15/61
10	12/18/61	
11	12/11/61	
12	12/25/61	

All contracts on this page were accepted on or prior to the scheduled completion dates except Contract No. DA-4974, which remains open. Liquidated damages in the amount of $3700 have been assessed against Contract No. ENG-4974

17. ADMINISTRATIVE PROBLEMS

The staffing of qualified estimating personnel was extremely late in the life of the Area office. This caused a great backlog of work to build up as explained in both the sections of this report entitled "History of Estimating and Negotiations" and "Discussion of Acceleration". It is believed that had the qualified estimating personnel been staffed from the beginning of the project, the Government would have been in a much better position to force negotiation action on the part of the Contractor.

The frequency and scope of the many modifications to Contract No. LNG-4231 seriously affected the controlling features of work. The net increase of construction work to be performed under the contract was large, but even more serious was the modification of previously modified work. Construction work was almost constantly being performed that resulted in no progress toward completion because it had to be redone due to further changes. This condition created confusion as well as tremendous scheduling problems. This problem was part of a condition which became known as "impact". The impact factors were extremely difficult to visualize and evaluate.

The Area did not establish a claims file until January 1961. Until the establishment of this claims file, no one person knew the status of all of the Contractor's claims. Generally, each time the Contractor wrote a letter concerning a claim, a search of the main file was made for all prior correspondence pertaining to the subject. This proved to be time consuming and not always fruitful.

The Area did not establish a systematic method of obtaining information necessary for preparation of Government Estimates for Change

Orders at the time such changes were put into effect. This opened the door for much uncertainty and variance in the initial Government Estimates.

Change of command from the Kansas City District Office to CEEMCO created for a short while confusion of responsibilities of the new Headquarters and the Service District.

This office has experienced numerous delays effecting the receipt of guarantee documents in accordance with CEEMCO Circular 61-3, which requires that "name of prime contractor with complete address and telephone number, and the names, addresses and telephone numbers of all subcontractors and/or equipment suppliers or manufacturers specifically designated in writing by the prime contractor for direct contact."

This circular was issued on 9 January 1961 fully ten months after the contract award and beginning of construction.

This meant that the majority of the guarantees were in the possession of the Government and it was then necessary to request the Contractor to furnish the information as required by the above mentioned CEEMCO Circular.

After receipt of all guarantee documents and the information required by CEEMCO Circular 61-3, this office prepared a spread sheet and an index of suppliers and/or manufacturers with names, addresses and telephone numbers. A sample exhibit is attached to the section of this report entitled "Conclusions and Recommendations."

18. CONCLUSIONS AND RECOMMENDATIONS

Estimating personnel should be staffed early in the life of the Area, if the Area is to be responsible for estimating and negotiating Change Orders.

Change Orders should be issued to the Contractor only after all sections concerned with the changed work have reviewed the Change Order for effects and completion.

Prior to negotiations with the Contractor if a Notice to Proceed has not been issued or at the time a Notice to Proceed is issued, a blank reporting form should be given to a Government Engineer at each missile site. This form should be filled out and returned to the Area Office so that information can be used in Estimating and Negotiations. This report should ask particular questions concerning the status of the work to be changed, unusual factors affecting cost of change, material on hand, etc. These questions should be about particular facts rather than in generalities. This would insure that the report from each site would give comparable information.

The following was suggested in the Atlas F Manual No. 61-1, Section III, Paragraph 3-01a, but has never been incorporated into the modification procedure at the Schilling Area Office. To facilitate comparison between the Contractor's proposal and the Government Estimate, and to insure that the Contractor and the Government are in agreement with the items of work and quantities involved, a particular change should be furnished the Contractor (preferably by the use of DD Form 1107, Change Order Price Analysis) at the time his proposal is requested with an itemized list and quantities of the items involved in the change. This list should be as complete as practicable, and should include any required additions

on the part of the Contractor with the price of each item left blank for insertion by the Contractor. The individual or section initiating the modification should be responsible for the preparation of the list.

In most cases, modifications involve the changing of sentences and paragraphs in the original contract. The practice has been, in such cases, merely to write into the modification a statement which says: "Delete the following.." or "Add the new sentence or words".. etc. It is then necessary for all persons concerned with the contract specifications to post these changes in order to keep a set of current specifications for reference, by striking out the applicable portions and adding in pencil the new wording. This presents quite a problem and is so much trouble that in most cases it is ignored or is done at the beginning of a job and is not kept up. In copying the new wording into the specifications, mistakes are sometimes made and one can never trust the marked out or added portions. This results in a considerable amount of lost time looking back to the modifications involved to check entries. It is recommended that all such changes in the future we handled in the same manner as used for an addendum to the contract, i.e., issue a complete new page with the changes incorporated at the time such changes are made in the contra contract. These new pages can then be inserted in the contract and the old one either destroyed or marked through for future reference.

To improve the submission of RFIE material it is recommended that a paragraph be included under the Special Conditions portion of the specifications substantially as follows: "The Contractor shall include the provisions of subparagraph entitled 'Equipment - Operation and Maintenance Data' above in all contract agreements, and include this requirement in all

purchase orders for equipment and components identified on the Master Equipment List for incorporation in the subcontract item or items."

To assist in the timely submittal of all necessary guarantee documents and to provide desirable information for use when the guarantees are invoked, it is recommended that the attached form showing the items involved be prepared and included at the end of the Special Conditions.

GUARANTEE SPREAD SHEET INFORMATION

CONTRACTOR:
CONTRACT NO.:

Specification Reference			Item Guaranteed	Responsibility for: A. Installation B. Supplier C. Manufacturer	Starting Date for Implementation of Guarantee Period
Title	Page	Par. No.			Site No. 1 2 3 4 & etc
Security Fencing	2-9	2-11	All moving equipment, motor, gear drive, sprockets, pinions	A. Cyclone Fence Co. B. 2 * C. 3 *	5/1 5/6 5/11 5/16 **

* See Index for Information Required

**Date determined by system test completion if applicable, otherwise this date governed by contract spec. guarantee paragraph.

INDEX
of
SUPPLIERS AND/OR MANUFACTURERS

INDEX NO.

1 Cyclone Fence Co.
2820 Roe Lane
Kansas City, Mo.

Tele. No. KE 2-2472 H. Sennott

* 2 Roe Constructors
317 Adams Street
Badlands, Texas

Tele. No. WI 6-2183 John Roe

* 3 American Steel Works
West 27th Street
Kansas City, Missouri

Tele. No. WA 1-8900 A. S. Rowe

(This index to be separate from the tabulation)

19. LIST OF CONTRACTS ASSIGNED TO THE CONSTRUCTION CONTRACTOR UNDER CONTRACT NO. DA-23-028-ENG-4281

CONTRACT	CONTRACTOR	ITEM
4333	Boeing Airplane Co.	Air Cylinder Supports
4325	Henry Pratt Co.	Blast Closures
4263	White Motors	Diesel Generators
4246	General Electric	Switch Gear & Panels
5711	A. M. Lockett & Co.	Waterchiller Units & Rotar Pumps
5718	Water Cooling Equip. Co.	Cooling Towers
5725	Dean Hill Corp.	Centrifugal & Turbine Pumps
5732	Sempco Corp.	Sewage Pumps
5733	Trane Co.	Fan Coil Units
5739	Wintroath Pump	Submersible Pumps
5746	Joy Mfg. Co.	Air Washer Dust Collectors
5783	Clarage Fan	Centrifugal Fans
5790	Wing Mfg. Co.	Axial Flow Fans
5797	Bertram Co.	Propeller Type Fans
4340	Boeing Airplane Co.	Overhead Door Hinge Assembly
5760	Paul Hardeman	FLS
4239	Otis Elevator	Elevators

20. LIST OF ALL CONTRACTS ADMINISTERED BY CERMCO, SCHILLING AREA

CONTRACT NUMBER	DESCRIPTION
CONSTRUCTION CONTRACTS:	
4281	Missile Launch Complexes
4361	LOX Facility
4386	Water Supply
4451	MAB Building
4497	FEV. Bldg.
4866	Clean Room
4921	Comm. Duct
4974	Fuel Catchment
4491	Conversion Field Office
5160	GOX Sleeves
ASSIGNED SERVICE CONTRACTS:	
3760	Assignment of PLS Part 3
4333	Air Cylinder Spring Support
4325	Blast Closures
4263	Diesel Generators
4246	Switchgear & Panels
4239	Elevators
5711	Water Chiller & Rotary Pumps
5718	Cooling Towers
5725	Cent. Pumps
5732	Sewage Pumps
5753	Fan Coil Unit
5739	Submersible Pumps

CONTRACT NUMBER	DESCRIPTION
ASSIGNED SERVICE CONTRACTS (CONTD):	
5746	Air Washer & Dust Coll. Units
5783	Cent. Fans
5790	Axial Flow Fans
5797	Prop. Fans
4340	O. H. Door Hinge Assembly
PROCUREMENT	
5760	PLS Part 1 & 2
4439	CBR Filters
6062	A/C Fan Coil Units
6063	Water Booster Pumps
6070	Missile Inclosure
4260	Kansas City Power & Light
6097	GOX Vent Fans
4964	GOX Vent Blast Closure
5862	Sam Fran. Blast Det. Sys.
7378	Gaseous Helium N_2 Trailer
7379	LN_2 Trailer & Chargers
7430	LN_2 Rechargers
6172	N_2 Rechargers
7424	Rental of Tube Bank Trailers
4464	Infra Red Analyzer with Recorder
4601	Surface Moisture & Density Gauge (Misc)
ARCHITECT ENGINEER CONTRACTS:	
4804	Revise drawings & Specs for MAB Cleaning Room

CONTRACT NUMBER	DESCRIPTION
ARCHITECT ENGINEER CONTRACTS (CONTD):	
4735	Design, prepare contract dwgs, Specs & cost estimate & prepare record dwgs, Re-Entry Vehicle Facility, Phase II
4598	Physical Status Reports
4322	Surveys to establish horizontal & vertical controls
4541	Engineering investigations & mapping for design of communications facilities
4448	Technical advise, check shop dwgs, MAB
4442	Water Supply Facilities Design & prepare MEL
4363	Design, preparation of contract dwgs, specs, bidding documents, cost estimates, with option for checking shop dwgs & preparation of record dwgs.
4304	Seismic investigations & studies & prepare a refraction profile for 6 sites
4299	Prepare topographic & planimetricmaps
4277	Check shop dwgs on construction of complexes; services of r resident representative; check shop dwgs on process vessels; check & validate shop dwgs & computations for pressure vessels, A. O. Smith; investigate & determine cause of failure during testing of pressure vessels at Plant. Check revisions to LOX Storage Tanks. Compile data on shop dwgs. submissions for pressure vessels fabricated by Struthers Wells
4260	Relocate a 34.5 KV transmission line.
4258	Check shop dwgs for items of standardized equipment to be procured by the CE
4140	Design, preparation of contract dwgs, specs, bidding documents, etc., cost estimate for LOX Facility & Re-Entry. Revise dwgs to include a LN Storage Tank, LOX Facility. Revise dwgs & specs Re-Entry. Revise to include utilities, LOX Facility & more revisions to dwgs, Re-Entry.
4139	Make surveys, investigations & maps, supervise necessary test borings for Water Supply. Water Softening equipment
4115	Same as 4139, except for Water Treatment Plant.
4942	Engineering Investigations & Studies, Schilling Missile Complex (Site No. 12)

21. LIST OF ALL MODIFICATION NUMBERS FOR EACH CONSTRUCTION CONTRACT

CONTRACT NO. DA-23-028-ENG-4281

MOD. NO.	DESCRIPTION
1	Revise Site Signs S-1, S-2, S-3 to read 550 in lieu of 531.
2	Revise the Numbers and Dates on Drawings.
3	Revise Sequence of Completion.
4	Remove existing fence and replace with New Fence at Sites 3, 4, & 5.
5	Add 12" x 18" CMP Drainage at Site No. 1.
6	Remove and replace unsuitable material for Access Road, Site 6.
7	Miscellaneous Changes LO_2 and LN_2 Topping Tanks.
8	Miscellaneous Changes, Blast Closures, Elec., Metal Ductwork, 9 sites.
9	Omit the placement of gunite in lower flanges of ring beams Sites 1-9.
10	Miscellaneous Changes.
11	Miscellaneous Changes, Electrical and Mechanical.
12	Miscellaneous Changes, HV & AC Facility Piping & Gas Detection System.
13	Revise Delivery Dates - ASC Contracts.
14	Revise Blast Door Rubber Seals
15	Add Sites Nos. 10, 11 and 12 to Contract.
16	Revise Termination of Access Roads with County Roads.
17	Omit the Placement of Gunite in Lower Flanges.
18	Revisions to H_2O Pumps, Elec. Trays and Water Proofing Tunnel.
19	Revise Crib Suspension Brackets.
20	Revise Delivery Dates, Government Furnished Property.
21	Revise Culvert at Access Road, Site No. 10.
22	Revise Valve Pockets, Plumbing, Compressed Air System to LCC.
23	Assignment of Supply Contract No. 4333 (ASC)
24	Assignment of Supply Contract No. 4325 (Blast Closure)

MOD. NO.	DESCRIPTION
25	Water Control, Site No. 1, Changed Conditions.
26	Repair Fence at Site No. 8.
27	Add Switch Gear Supports, Disconnect Brackets, Revise Conduits and Cable Size.
28	Revise Pipe Support Insert Plates.
29	Relocate Access Road at Site No. 6.
30	Relocate Access Road at Site No. 12.
31	Revise Crib Floor Framing Plan.
32	Correction to Pipe Support Plates.
33	Relocation of Certain Material Stock Piles.
34	Miscellaneous Structural, Electrical and Mechanical Changes.
35	Assignment of Supply Contract 4263 (Diesel Generators).
36	Assignment of Supply Contract 4246 (Switchgear & Panels).
37	Revise Water Wells and Service Roads.
38	Delete the requirement for Curing of Cunite.
39	Changes in Crib Steel, Sites 3, 8 and 9.
40	Assignment of Supply Contract No. 4239 (Elevators)
41	"Car Rider" for Critical Items.
42	Install Grout Pipes and Grout at Site No. 1.
43	Revise Steel for Facility Elevator Guide Rails and other misc changes.
44	Revise Hard Bottom, Site No. 2.
45	Revise Pipe Support Insert Plates.
46	Revise requirements for Operation Maintenance Manuals.
47	Revise Counterweight Supports and Crib Spring Hangers.
48	Acceleration (U-M-S) Prime Contractor.
49	Acceleration (Steel @ Sites 3, 8 and 9), Kaiser

MOD. NO.	DESCRIPTION
50	Foley added to Joint Venturers.
51	Block Gas Hole at Site No. 11.
52	Assignment of Supply Contract No. 5711 (Pkg H_2) Chiller Units).
53	Assignment of Supply Contract No. 5718 (Cooling Towers).
54	Assignment of Supply Contract No. 5725 (Centrifugal & Turbine Pumps).
55	Assignment of Supply Contract No. 5732 (Sewage Pumps).
56	Assignment of Supply Contract No. 5753 (A/C Fan Coil Unit).
57	Assignment of Supply Contract No. 5739 (Submersible Pumps).
58	Assignment of Supply Contract No. 5746 (Air Washer Dust Collector).
59	Assignment of Supply Contract No. 5783 (Centrifugal Fans).
60	Assignment of Supply Contract No. 5790 (Axial Flow Fans).
61	Assignment of Supply Contract No. 5797 (Propeller Type Fans).
62	Revise the Area Engineer's Authority to $500,000.
63	Assignment of Supply Contract No. 4340 (Overhead Door Hinge).
64	Water Control Site No. 2.
65	Assignment of Supply Contract No. 5760 (Installation and Test PLS).
66	Not Issued.
67	Revise Collimator Plates.
68	Provide Grout at Site 10 and Grout as necessary.
69	Provide Sleeves in Wills, LCC.
70	Provide a Collimator Insert Plate Survey.
71	Revise Standard Equipment Package.
72	Add Grout Pipes, Site No. 2 and grout as necessary.
73	Revise Requirements for Torsiograph Test.
74	Substitution of a Pressure Gage for a Safety Valve.

MOD. NO.	DESCRIPTION
75	Add 6" Angle Valve in 6" Waterline to Tunnel.
76	Revise Sequence of Completion CANCELLED.
77	Revise Performance Test on Blast Closure.
78	Erect Radio Towers at All Sites.
79	Revisions of Entrance Security System.
80	Not Issued.
81	Revise Installation & Testing Phases to PLS Prefabs.
82	Impulse Screen, Fire Protection Wiring and Miscellaneous Changes
83	Extend Water Well Access Road at Sites Nos. 1-3-5-6-7 & 9.
84	Not Issued
85	Revise Sequence of Completion.
86	Revise Parking Areas.
87	Provide Prime Coat for Asphalt.
88	Change Specifications to Defer Paving Until Spring.
89	Revise Flexible Connections.
90	Pressure Switches LN_2 & LO_2 Storage & Heat Exchanger Nozzle Orientation.
91	Relocation of Sand Filter Effuelent Line and Headwall Site No. 3.
92	Not Issued.
93	Not Issued
94	Miscellaneous Changes to Silo Crib Steel and Acceleration.
95	Install 2 Elbows on each Heat Recovery Silencer.
96	Revisions to Security Fence, to provide 10' Frangible.
97	Blockouts for PLS lines in Fill and Vent Shaft.
98	Revision to Electrical Conduit at Water Chiller.
99	Remove and Replace Three Broken Springs, Sites No. 6 and No. 7.

MOD. NO.	DESCRIPTION
100	Pipe Sleeves for Removable Handrail at Silo Doors and Misc. Changes.
101	Revisions to Pipe Support Insert Plates.
102	Provide Frame for Seven Grating Openings.
103	Correction to the Installation of the Launch Platform Drive Base Assemblies.
104	Increase Mandays ASCO of SVC Contract 4263 to 252 days.
105	Not Issued.
106	Not Issued.
107	Not Issued.
108	Not Issued.
109	Miscellaneous Changes, 1 January thru 14 January 1961.
110	Furnish Demineralized H_2O for Air Conditioning System.
111	Miscellaneous Changes from 31 December 1960.
112	Furnish & Install Safety Platform to be complete by 1 November 1961.
113	Miscellaneous Hangers.
114	Miscellaneous Field Changes 28 January thru 11 February 1961.
115	Miscellaneous Field Changes 14 thru 28 January 1961.
116	Time Adjustments.
117	Not Issued.
118	Guide Rail Supports, Newloads on L/P to Crib Locks and Bracing.
119	Increase Number of Mandays of Manufacturer's Representatives required on Contract KRG-4246.
120	Certain Changes to Pressure Gage Dial Ranges.
121	Not Issued.
122	Provide Screw Fasteners in lieu of Hinge Pins on 480 volt panel.
123	Not Issued
124	Not Issued.

MOD. NO.	DESCRIPTION
125	Consolidation of Modifications.
126	Not Issued.
127	Not Issued.
128	Implement Item No. 3 of Contract 5760 for modifications issued by Fort Worth No.s. 21, 24 and 34.
129	Adjust Unit Price Item No. 11.
130	Settlement of Lockett Claim
131	Surplus Diesel Fuel after Testing.
132	Settlement of Southwest Welding Claim.
133	Adjustment for Manufacturer's Representative, Joy Manufacturing Co.
134	Adjustment for Manufacturer's Representative, A.M. Lockett
135	Settlement of 3 Claims with Paul Hardeman.
136	Adjustment for Manufacturer's Representative, White Motor Company.
137	Modification to Blast Closures.
138	Wintroath Pump Claim.
139	Struthers-Wells Claim

CONTRACT NO. DA-23-028-ENG-4386

1	Change in Size of Aggregate.
2	Installation of Reinforcing Steel in Equipment FDN.
3	Add set of contacts and new line voltage thermostat.
4	Arrange Softeners for Automatic Controls and provide draw down gage at each well.
5	Revise Water Line at Site No. 4.
6	Revise Water Treatment Facilities at Certain Sites.
7	Add requirements for Operation and Maintenance Manuals.
8	Revise Paragraph 10-05 to allow the use of standard products.
9	Addition of three water supply systems.

MOD. NO.	DESCRIPTION
10	Revise the Contracting Officer's Authority to $375,000.00.
11	Install Air Release and Riprap.
12	Provide Ground on the Transformer.
13	Revise Size of Conduit at Sites Nos. 1, 2, 7, 8, 9, 10 and 12.
14	Revise Size of Water Meter.
15	Clean Sand From Wells.
16	Relocate Water Line at Site No. 4.
17	Install Air Release Valve and new Electric Pole, Sites 3 and 6.
18	Clean Sand from Wells, Lower Pumps 15 feet at Site 9.
19	Miscellaneous Electrical and Mechanical.
20	Change Alternator from 25 to 50 KW on Emergency Generator.
21	Lower pump at Site 7; reset pneumatic controls and re-run final tests, Site 3.
22	Provide a filter at the effulent water meter, all sites.
23	Miscellaneous changes resulting from design deficiencies.
24	Electrical Connections, Sketch 123 & 124.
25	Settlement of 18 Claims.
26	Delete Paving inside the security fence at Sites 10, 11 and 12.
27	Miscellaneous Electrical & Mechanical Changes, Sites 7 and 12.
28	Relocate main well pump and new manhole.

CONTRACT NO. DA-23-028-ENG-4361

1	Revise Requirements for Joint Reinforcing.
2	Installation of Heating Coils for FDN Pan, Number 6.
3	Add Air Inlets & Revise Emergency Shower and Eye Wash Fall.
4	Revisions to Vacuum Piping.
5	Install Utility Lines Under Avenue "C" Pavement.

MOD. NO.	DESCRIPTION
6	Substitute Liquid Nitrogen for Liquid Oxygen.
7	Revise the Test Procedure.
8	Relocate Purge Tank.
9	Paint Interior of Insulated Vessels.
10	Time Extensions, CANCELLED.
11	Miscellaneous Hardware and Bracing.
12	Delete Sand Blasting of Storage Vessels.
13	CANCELLED
14	Provide 1-1/2 ton Bridge Crane.
15	Revise Bridge Crane.

CONTRACT NO. DA-23-028-ENG-4451

1	Remove and replace damaged interior door trench wall.
2	Remove and replace portions of the concrete floor in Room 226.
3	Miscellaneous Changes.
4	Revise Safety Valves.
5	Revise method of supporting heating pipes and heaters.
6	Relocate Fire Hydrant.
7	Relocate Cooling Tower.
8	Remove lights and wiring from high bay area.
9	Furnish two new water closets and five new flush valves.
10	Revised Area Engineer's authority to $315,000.00.
11	Revisions to power panel LB, MAB Building.
12	Provide Light Bracket in High Bay Area.
13	Provide new sump pump.
14	Revise certain electrical connections.
15	Not Used.

MOD. NO.	DESCRIPTION
16	Correction to Electrical Conduit
	CONTRACT NO. DA-23-028-ENG-4491
1	Miscellaneous changes to Buildings 209, 610, 638 and add Bldg. 405.
2	Add Building No. 313, Delete Bldg No. 266 from contract.
3	Miscellaneous Changes.
4	Regulating Valves - Cast Iron Outlet Boxes remove Range HOOD.
	CONTRACT NO. DA-23-028-ENG-4866
1	Revisions to Specifications requirement for Electric Oven.
2	Return Vacuum Oven to Manufacturer and Re-work Door.
3	Settlement of Claim for Extra Labor and Transportation Costs.
	CONTRACT NO. DA-23-028-ENG-4497
1	Revise type of door on Storage Igloo.
2	Revise Area Engineer's Authority to $45,000.00.
3	CANCELLED
4	Painting Concrete Wall.
5	Additional Painting.
6	Interference between Light Fixture and Bridge Crane.
7	Revise Size of Hoisting Drum from 15" to 12" Diameter.
8	Phase Number 2.
9	Delete Manuals and 1 day Factory Representative Instructions.
	CONTRACT NO. DA-23-028-ENG-4921
1	Miscellaneous changes to Manholes 21 and 24.
	CONTRACT NO. DA-23-028-ENG-4974
1	Substitute 10S Stainless Steel Pipe for 5S

MOD. NO.	DESCRIPTION
2	Revise Paragraph 6-06d(1) & 6-06d(2)(n).
3	Revise system flush requirements.

CONTRACT NO. DA-23-028-ENG-4491

1	Miscellaneous Changes to Bldgs 209, 610, 638, and ADD Building 405.
2	Add Building No. 313, Delete Bldg. No. 266 from Contract.
3	Miscellaneous Changes
4	Regulating Valves - Cast Iron Outlet Boxes remove Range HOOD.

CONTRACT NO. DA-23-028-ENG-4866

1	Revisions to Specifications Req. for Electric Oven.
2	Relocate Duct and One Sensing Head (Combined under R-1).
3	Relocate & Reroute Conduits, Install Wire and Remove 4" G.I.P. (Combined under R-1).
4	Relocate Door No. 114 (Combined under R-1).
5	Delete Heat Exchanger in Refrig. System (Combined under R-1).
6	Relocate 1 sensing head & add 5 doctors (Combined under R-1).
7	WDFC-17 CANCELLED
8	WDFC-16 CANCELLED
9	Return Vacuum Oven to Manufacturer & Re-work Door.
10	Settlement of Claim for extra labor & transportation costs.

22. CHARTS

GENERAL

The charts in this section give a graphic representation of the changed conditions that occured at Sites 1 & 2. They provide a monthly manhour and an accumulative manhour comparison of "As Planned" vs "As Built". They also include a graphic representation for each site depicting the construction phases with respective start, completion, planned and actual dates.

There are 16 charts in all, some of which have been refered to in previous sections of this report:

a. Graphic History Changed Conditions, Site 1.

b. Graphic History Changed Conditions, Site 2.

c. Monthly Manhours Contract No. ENG-4281.

d. Accumulative Manhours Contract No. ENG-4281, Construction Phases, Starts, Completions, Planned & Actual.

e. Site 1

f. Site 2

g. Site 3

h. Site 4

i. Site 5

j. Site 6

k. Site 7

l. Site 8

m. Site 9

n. Site 10

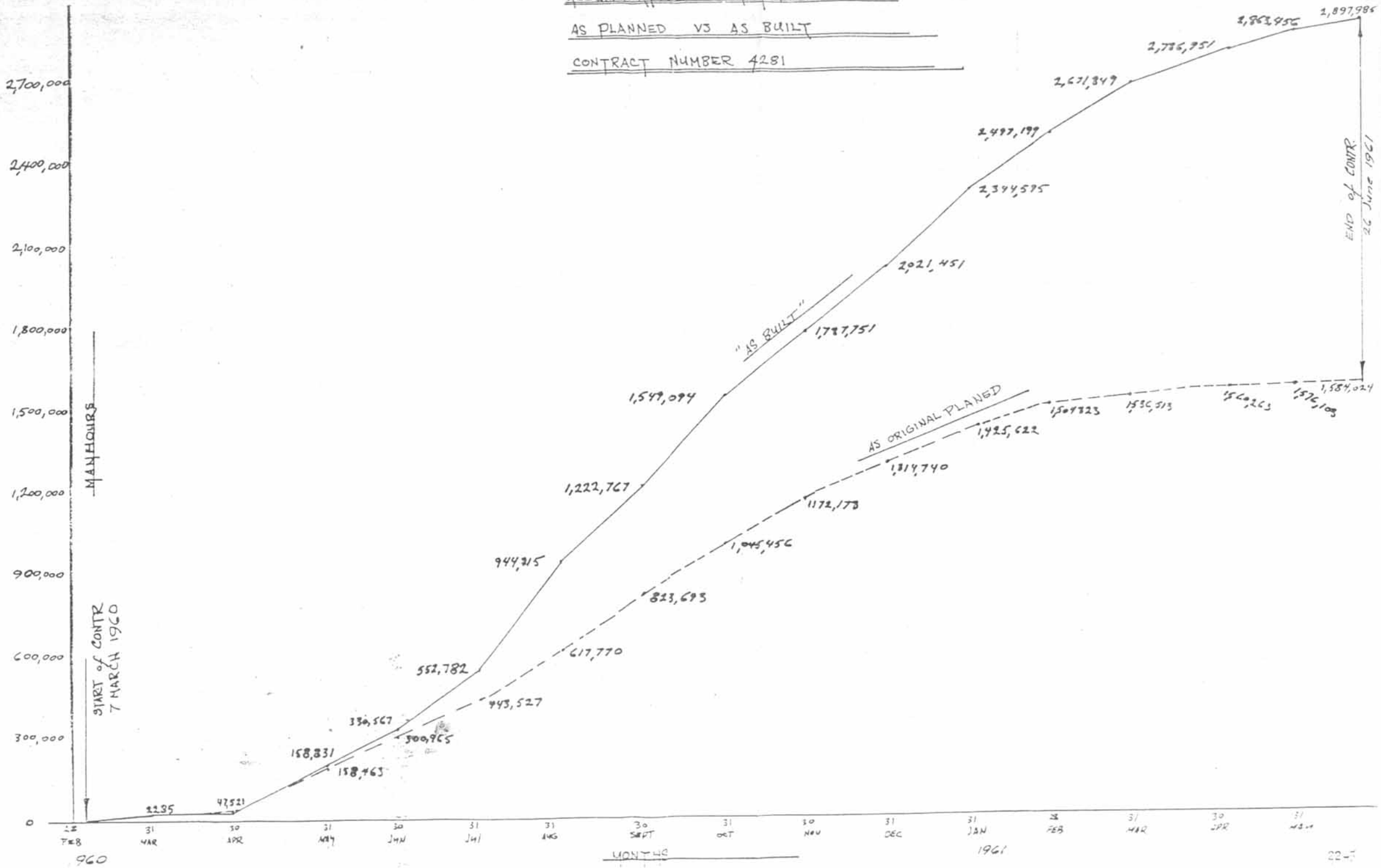
o. Site 11

p. Site 12

ACCUMULATIVE MANHOURS

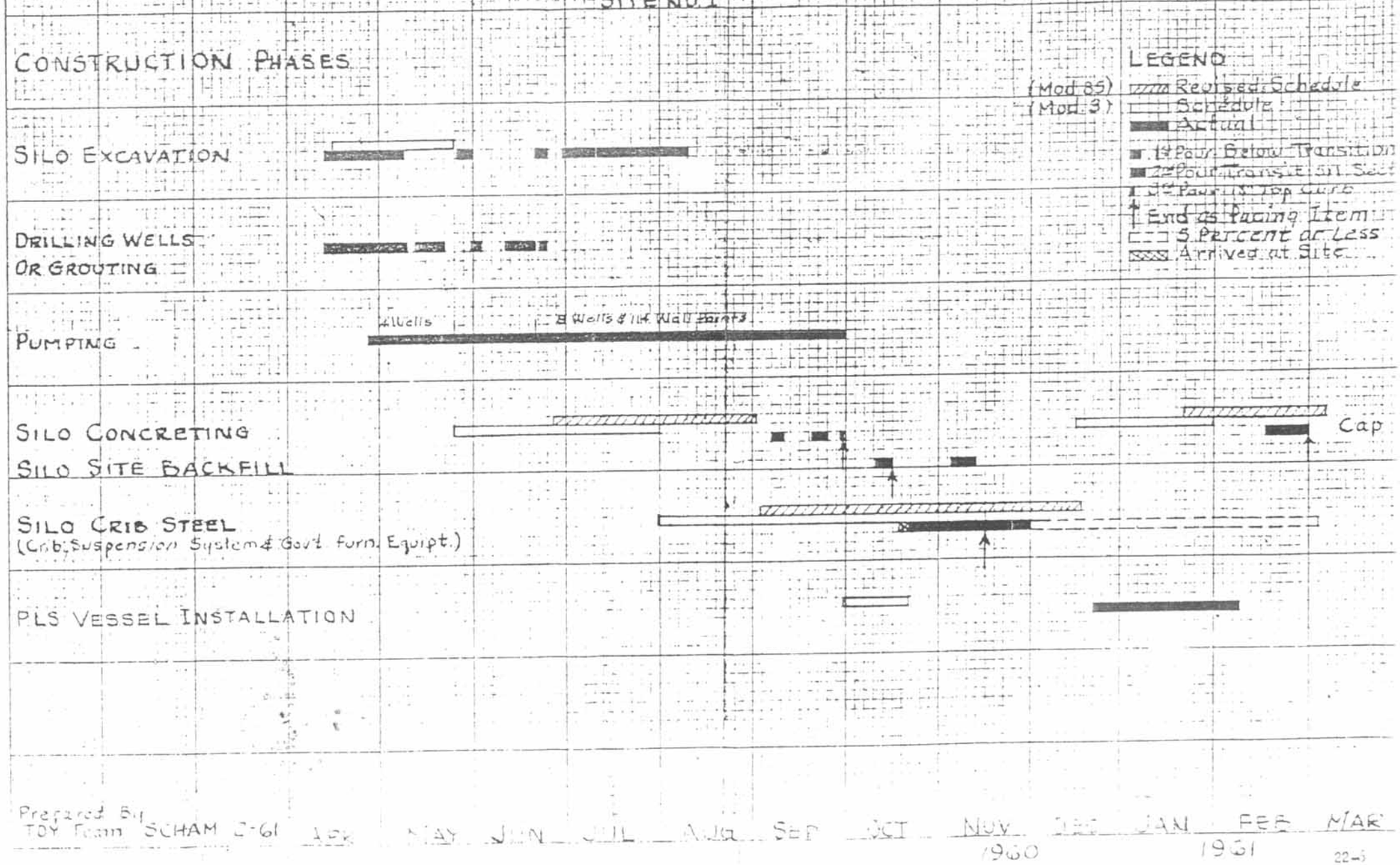
AS PLANNED VS AS BUILT

CONTRACT NUMBER 4281



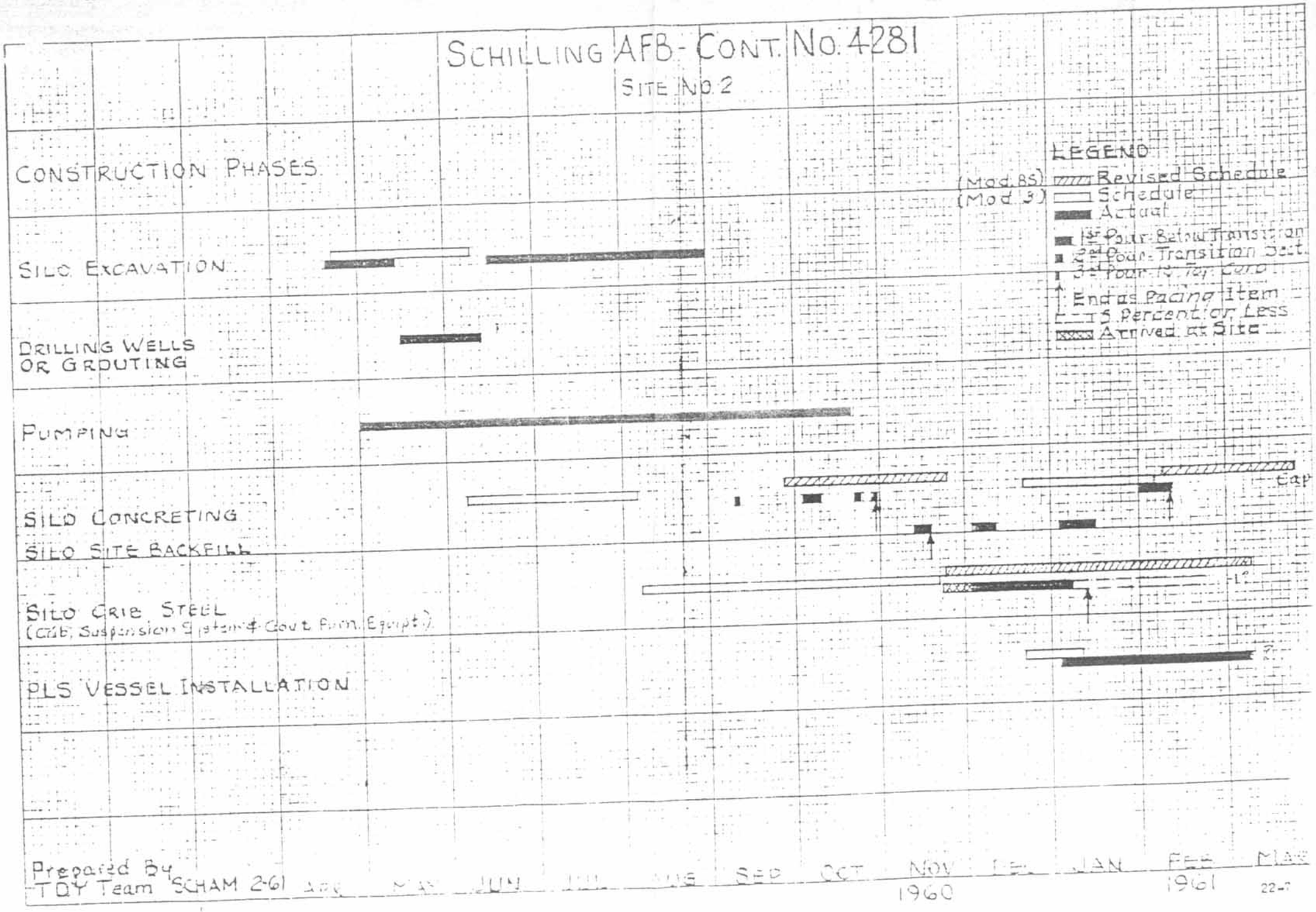
SCHILLING AFB - CONT. NO. 4281

SITE NO 1



SCHILLING AFB - CONT. No. 4281

SITE No. 2



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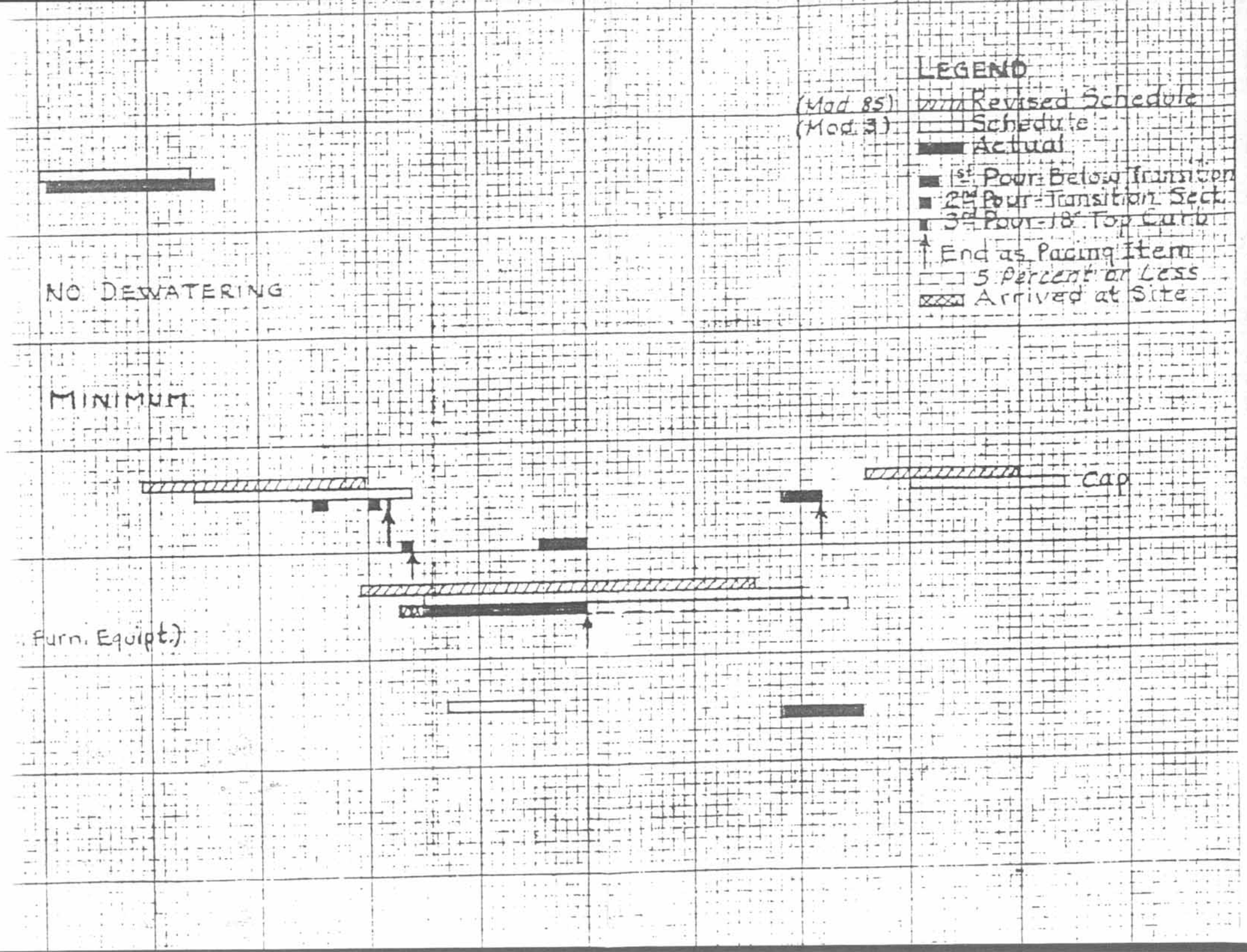
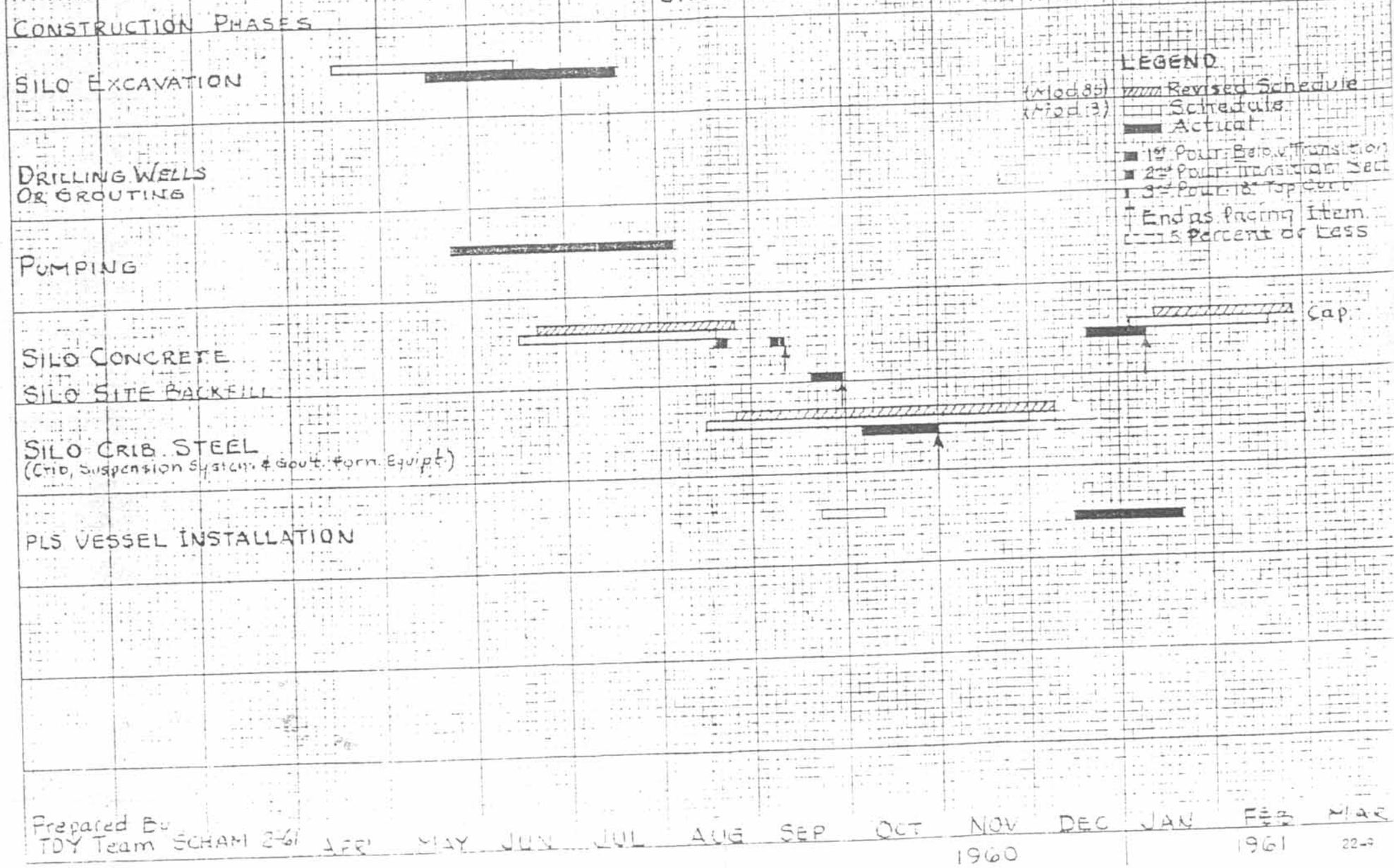
TQY Team SCHAM 2-61

22-7


LEGEND
(Mod 85) Revised Schedule
(Mod 3) Schedule
Actual
1st Pour Below Transition
2nd Pour-Transition Sect.
3rd Pour-18" Top Curb
End as Pacing Item
5 Percent or Less
Arrived at Site
NO DEWATERING
MINIMUM
Cap
furn. Equipt.)

SCHILLING AFB - CONT. No. 4281

SITE No. 4



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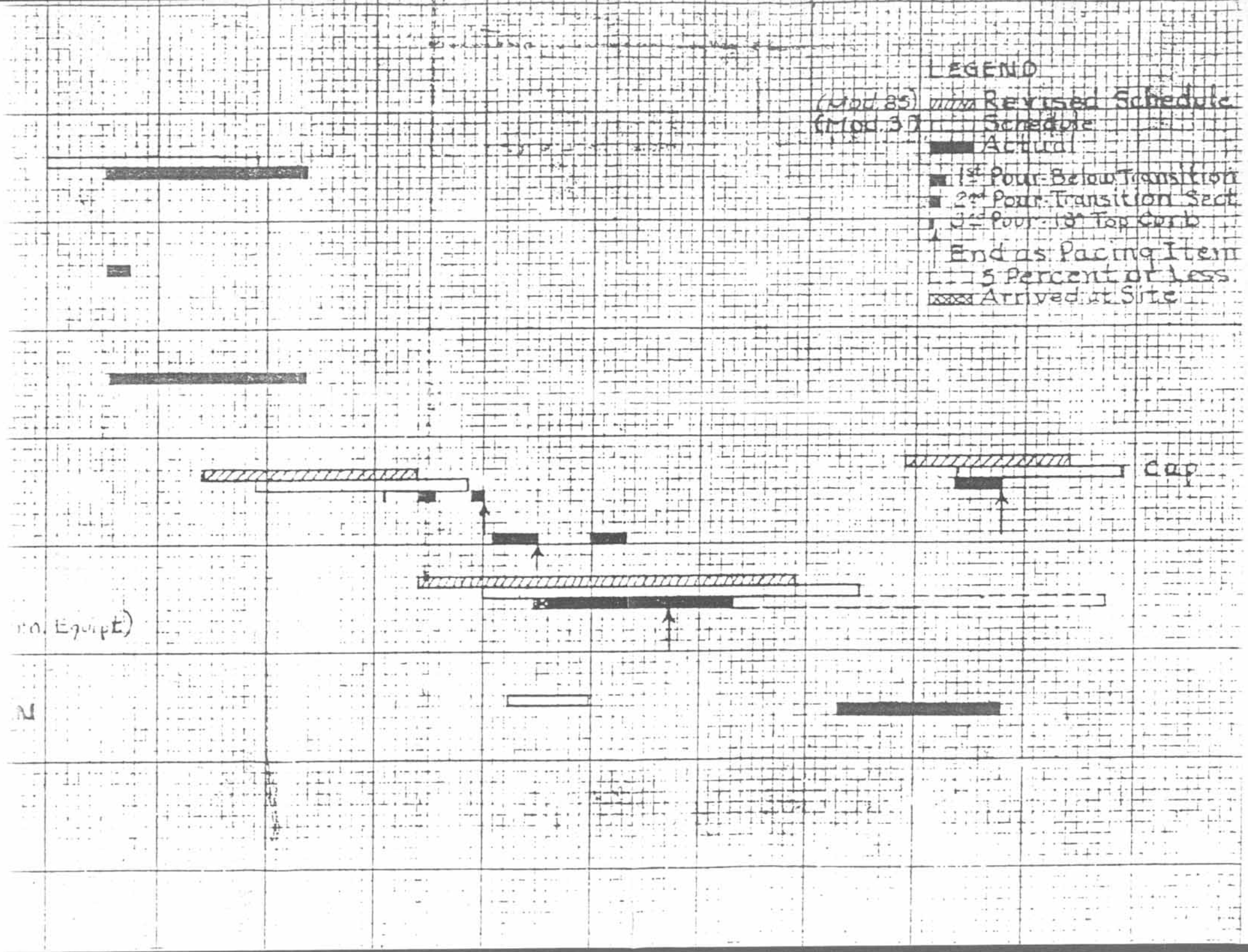
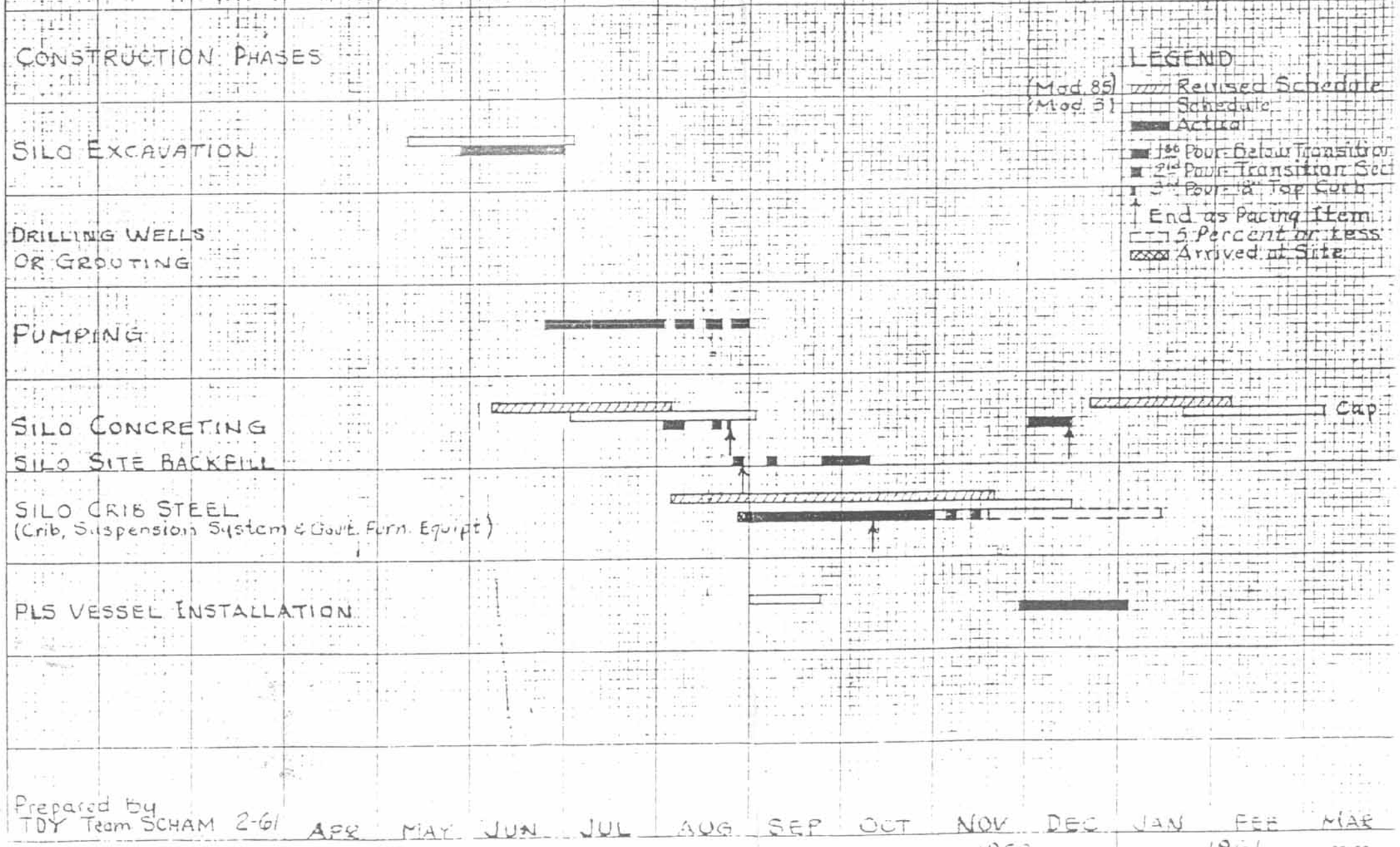
TDY Team SCHAM 2-61

22-9


LEGEND
(Mod. 85) Revised Schedule
(Mod. 3) Schedule
Actual
1st Pour-Below Transition
2nd Pour-Transition Sect.
3rd Pour-1st Top Comb.
End as Pacing Item
5 Percent or less.
Arrived at Site
Cap
n. Equipt)
N

SCHILLING AFB-CONT. No. 4281

SITE NO. 6



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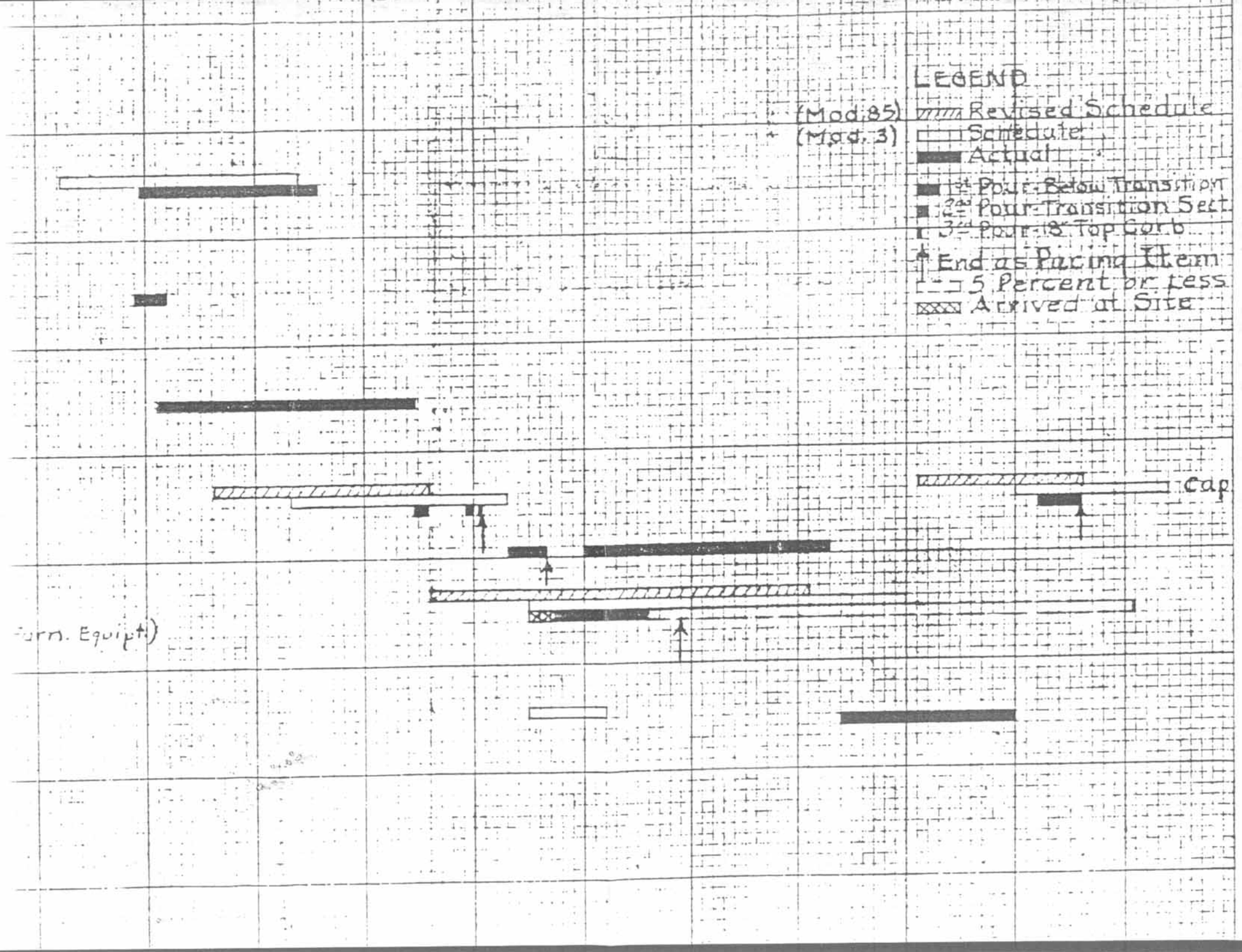
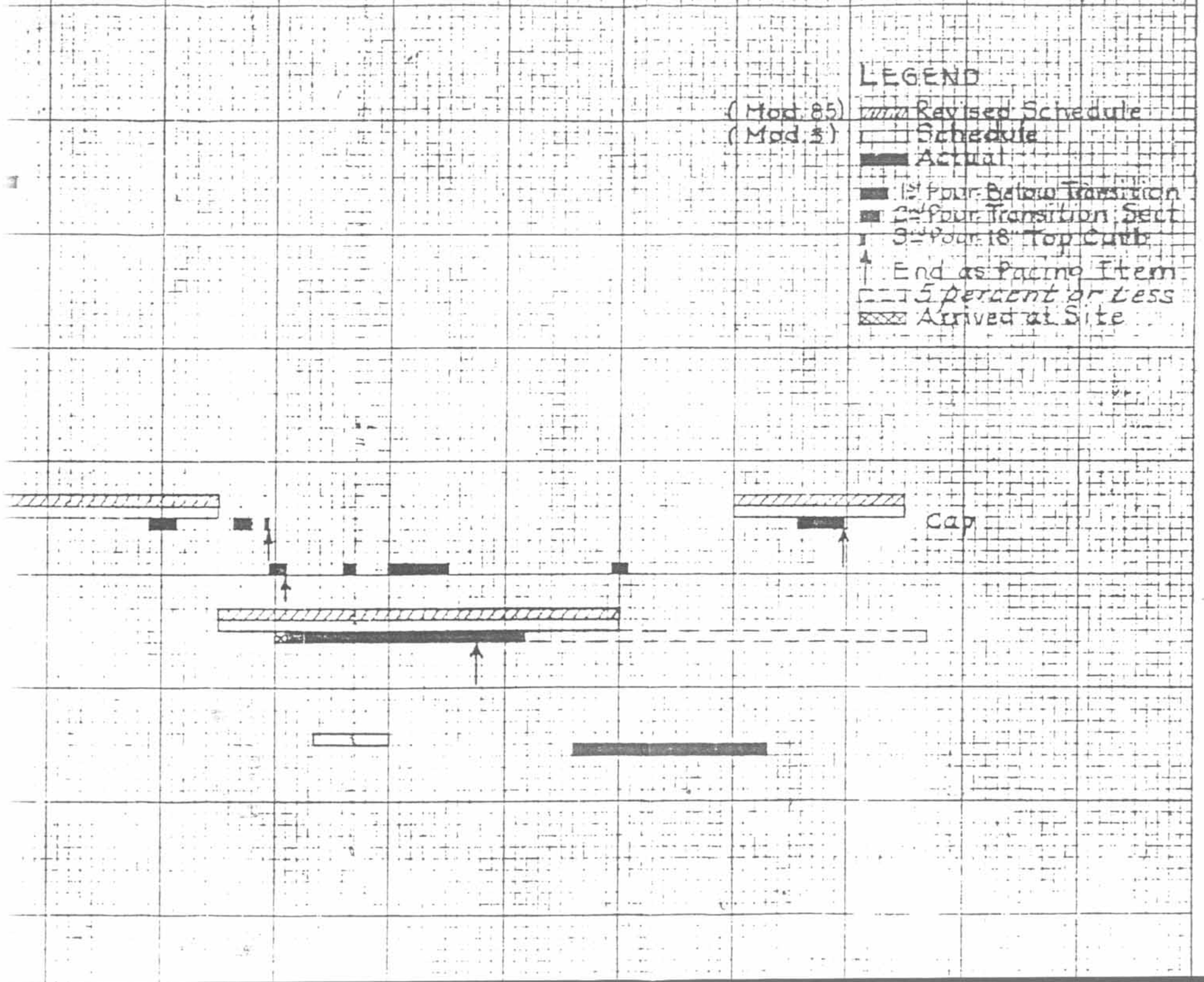
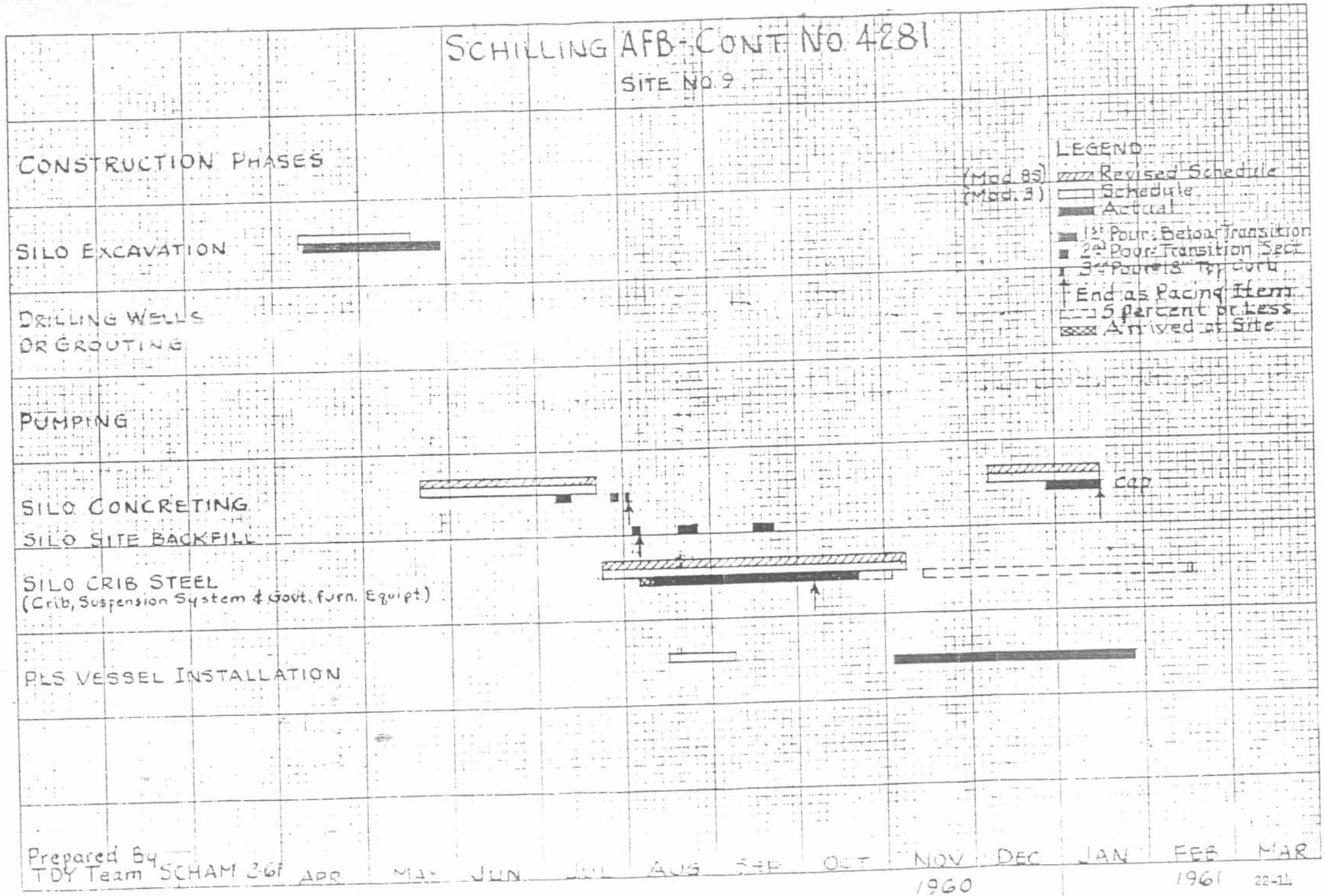
22-11

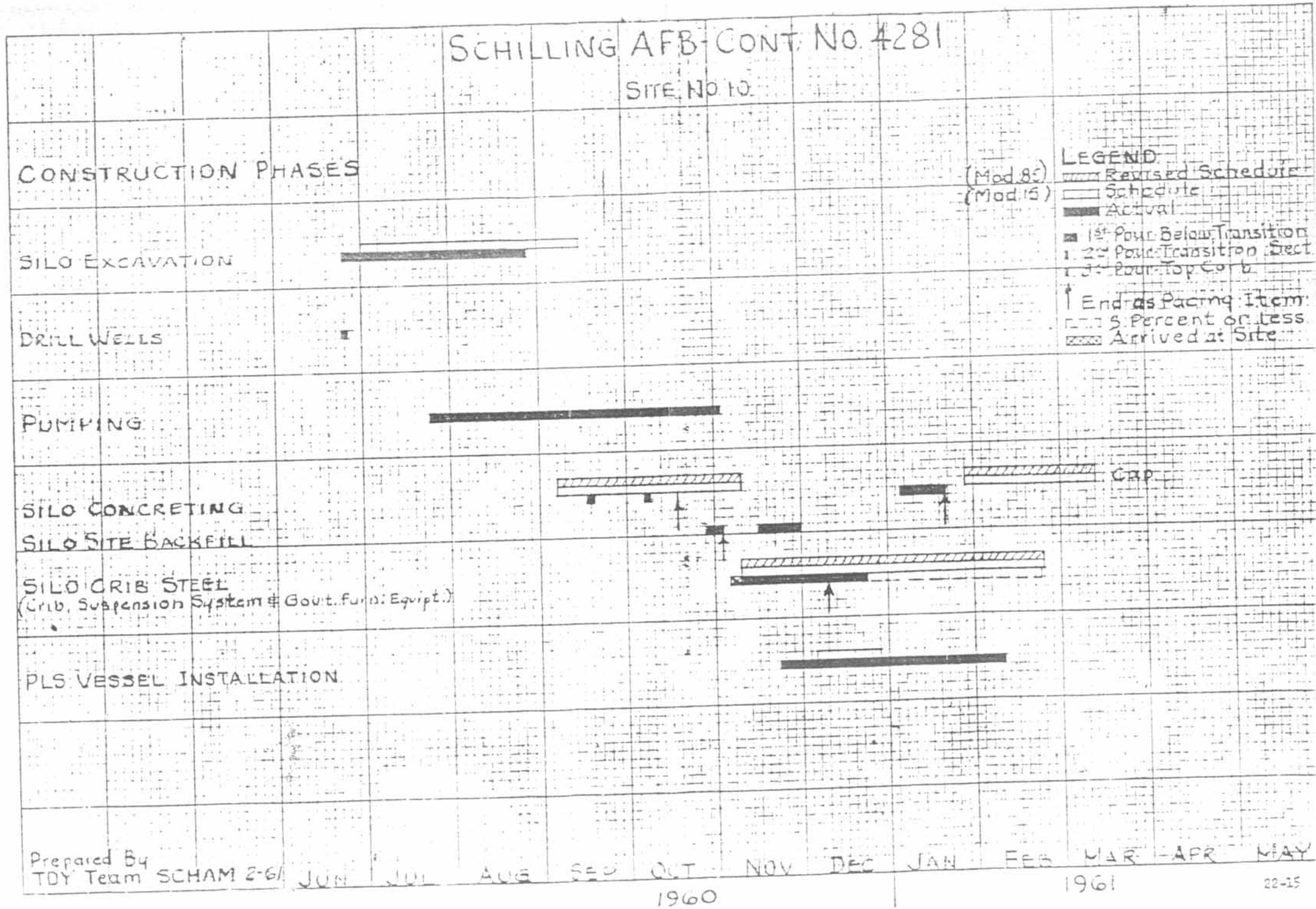

LEGEND
(Mod. 85) Revised Schedule
(Mod. 3) Schedule
Actual
1st Pour-Below Transition
2nd Pour-Transition Sect.
3rd Pour-& Top Curb
End as Pacing Item
5 Percent or Less
Arrived at Site
Cap
urn. Equipt.)


LEGEND
(Mod. 85) Revised Schedule
(Mod. 5) Schedule
Actual
1st Pour Below Transition
2nd Pour Transition Sect
3rd Pour 18" Top Curb
End as Pacing Item
5 percent or less
Arrived at Site
Cap


SCHILLING AFB - CONT. No. 4281
SITE NO. 9
CONSTRUCTION PHASES
SILO EXCAVATION
DRILLING WELLS OR GROUTING
PUMPING
SILO CONCRETING
SILO SITE BACKFILL
SILO CRIB STEEL
(Crib, Suspension System & Govt. furn. Equipt.)
PLS VESSEL INSTALLATION
(Mod. 85)
(Mod. 3)
LEGEND
Revised Schedule
Schedule
Actual
1st Pour: Below Transition
2nd Pour: Transition Sect.
3rd Pour: 18" Top Curb
End as Pacing Item
5 percent or less
Arrived at Site
Cap
Prepared By
TDY Team SCHAM 2-61
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
1960
1961
22-11

SCHILLING AFB CONT. No. 4281

SITE NO 10



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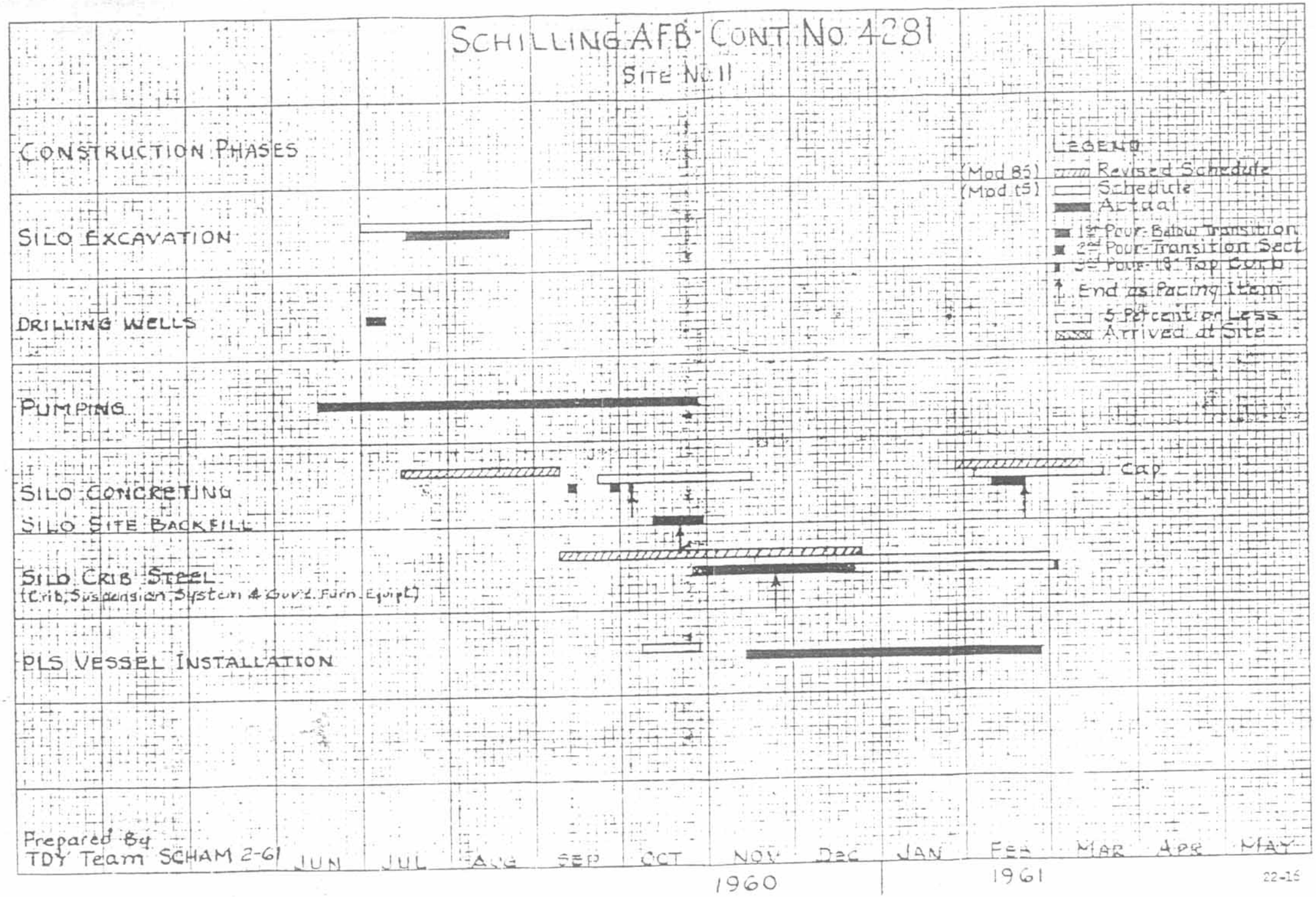
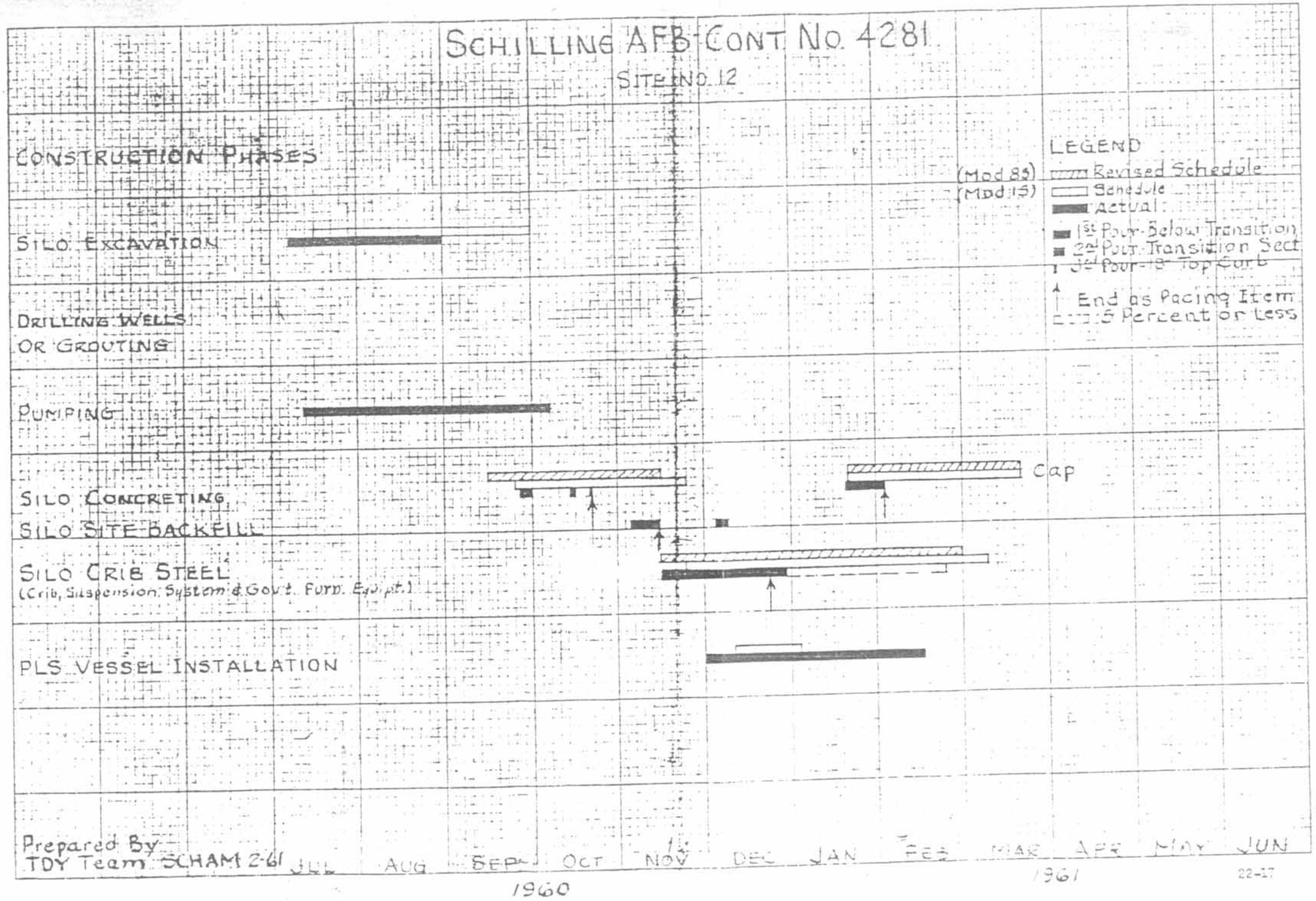
22-15


SCHILLING AFB CONT No. 4281
SITE No. 11
CONSTRUCTION PHASES
SILO EXCAVATION
DRILLING WELLS
PUMPING
SILO CONCRETING
SILO SITE BACKFILL
SILO CRIB STEEL
(Crib, Suspension System & Const. Form Equipt)
PLS VESSEL INSTALLATION
Prepared By
TDY Team SCHAM 2-61
(Mod 85)
(Mod 15)
Cap
LEGEND
Revised Schedule
Schedule
Actual
1st Pour-Below Transition
2nd Pour-Transition Sect
3rd Pour-1st Top Cone
End as Pacing Item
5 Percent or Less
Arrived at Site
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
1960
1961
22-15


SCHILLING AFB CONT No. 4281
SITE NO. 12
CONSTRUCTION PHASES
SILO EXCAVATION
DRILLING WELLS OR GROUTING
PUMPING
SILO CONCRETING
SILO SITE BACKFILL
SILO CRIB STEEL
(Crib, Suspension System & Gov't. Furn. Equipt.)
PLS VESSEL INSTALLATION
Cap
(Mod 85)
(Mod 15)
LEGEND
Revised Schedule
Schedule
Actual
1st Pour-Below Transition
2nd Pour-Transition Sect
3rd Pour-18" Top Curb
End as Pacing Item
5 Percent or Less
Prepared By
TDY Team SCHAM 2-61
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
1960
1961
22-27

CEBMCO – SCHAM

CHANGED CONDITIONS (BENNINGTON) SITE # 1

Contract No: DA-23-028-eng 4281

(Y)

1 Silo Shaft Excavation was started at EL. 960 11 April 1960 (101)

2 24-Days later they had Excavated to EL. 878 ⊖ 84 ft. for an average of 3½ ft. of Excavation/day ... at this rate of 3½ ft/day it could have been expected that they could have "Bottomed-Out" @ EL. 823 ⊖ 55 ft deeper ⊖ 3½ ft 16 days later or 21 May 1960 9

3 6 June 1960 ... It was the C.O. decision that "Changed Conditions" existed @ Site # 1 Effective 7-14-46

4 1 July 1960 ... 57-Days later ... the Contractor placed Ring-Beam # 25 @ EL 864 ... It is

5 Considered that, the Contractor is entitled to Equipment "Stand-By" Time of 52 days.

5 1 July 1960 to 19 August 1960 ... it took

6 the Contractor 40-days to Shaft 40 ft

7 because of wet materials (1 ft/day avg)

CONCLUSION:

1. That 47-days be used as average excavation time in-lieu of 40-days 9
2. That "actual" Shaft excavation time is 2 ⊕ 10 ⊖ 6 ⊕ 1-day ⊖ 69-days.
3. Contractor is entitled to:

	EXCAVATION ADDITIONAL
(a) Equipment Stand-By	52-days
(b) Additional Excavation:	
(1) Labor	22-days
(2) Equipment	22-days

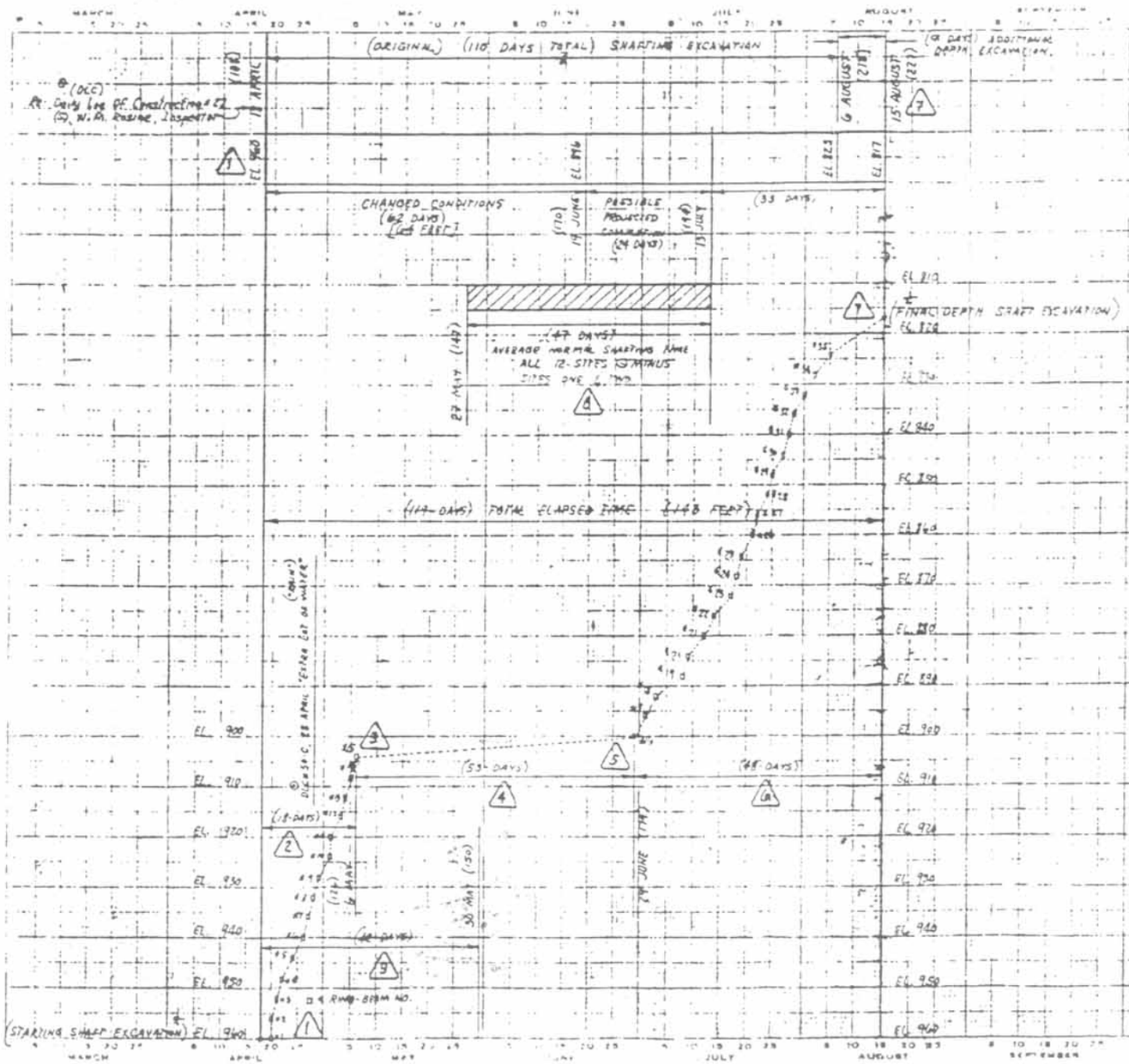
SITE # 1

22-2

CEBMCO – SCHAM

CHANGED CONDITIONS (CHAPMAN) SITE #2

Contract No. DA-23-028-eng-4281



1. Silo Shaft Excavation was started at EL. 960 18 April 1960. (108)

2. 18-Days later they had Excavated to EL. 904 @ 56 ft for an average of 3 ft. of Excavation/day... at this rate of 3 ft./day it could have been expected that they could have "Bottomed-Out" @ EL. 823 @ 71 ft. deeper @ 3 ft. 24 days later or 30 May 1960. (9)

3. 17 Aug 1960... It was the C.O. decision that "Changed Conditions" existed @ Site #2 effective date: 7 Aug 1960

4. 29 June 1960 53-Days later ... the Contractor

5. placed Ring-Beam #1 @ EL. 900 ... ft 15' Considered that the Contractor is entitled to Equipment "Stand-By" Time of 52 days.

6. 29 June 1960 to 15 August 1960 ... it took the Contractor 48 days to Shaft 85 ft.

7. because of wet-materials (1.7 ft/day avg)

CONCLUSION:

1. That 47 days be used as average excavation time in-lieu of 42 days (9)
2. That "actual" Shaft excavation time is (2) @ (6) +11 days @ 67-days.
3. Contractor is entitled to:

	EXCAVATION ADDITIONAL
(a) Equipment Stand-By	52-days
(b) Additional Excavation:	
(1) Labor	20-days
(2) Equipment	20-days

SITE #2

22-3

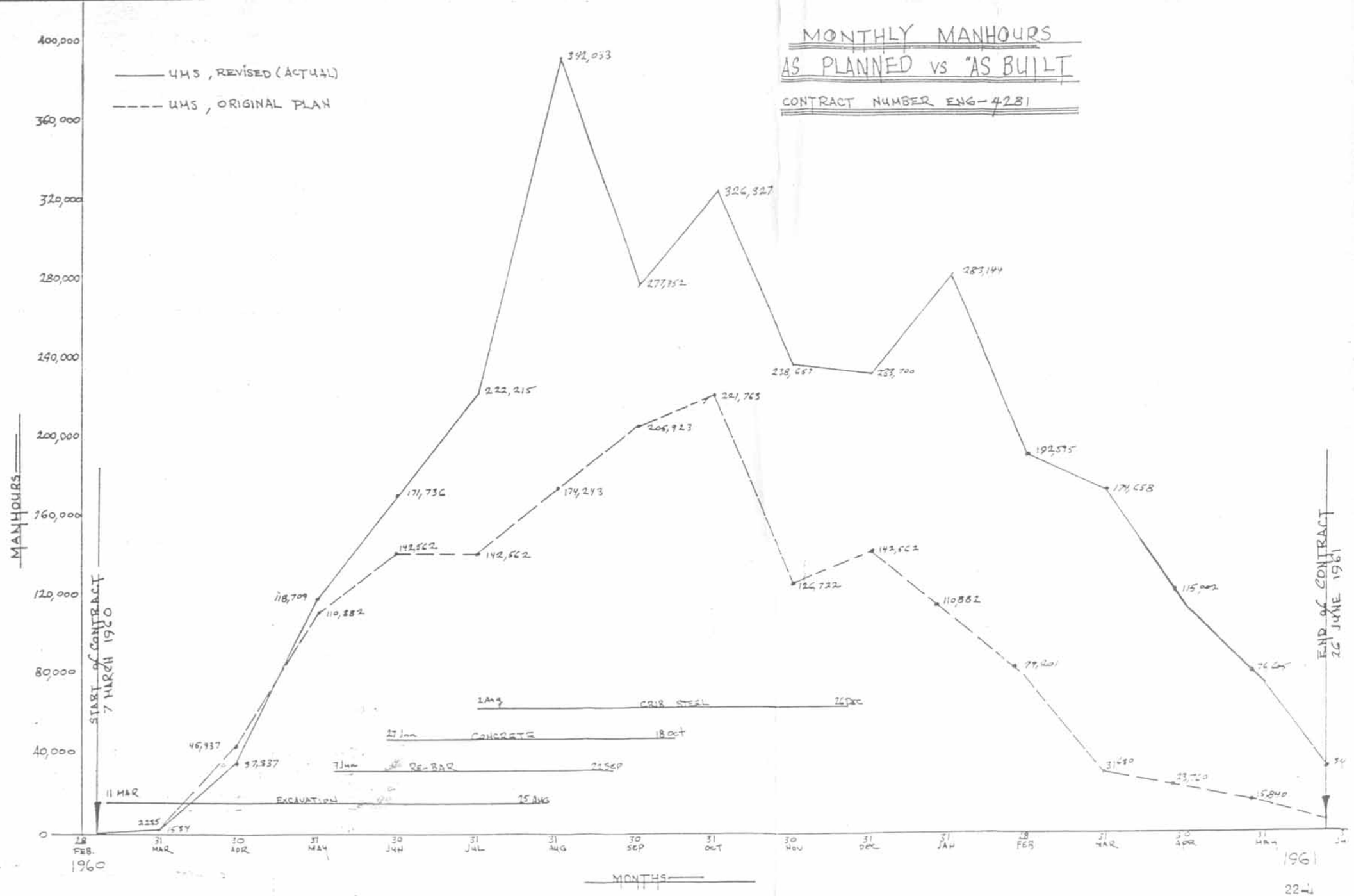

MONTHLY MANHOURS
AS PLANNED vs "AS BUILT
CONTRACT NUMBER ENG-4281
UMS, REVISED (ACTUAL)
UMS, ORIGINAL PLAN
MANHOURS
MONTHS
START of CONTRACT 7 MARCH 1960
END of CONTRACT 26 JUNE 1961
11 MAR
EXCAVATION
25 AUG
7 Jun
RE-BAR
21 SEP
27 Jun
CONCRETE
18 Oct
1 Aug
CRIB STEEL
26 Dec
400,000
360,000
320,000
280,000
240,000
200,000
160,000
120,000
80,000
40,000
0
28 FEB. 1960
31 MAR
30 APR
31 MAY
30 JUN
31 JUL
31 AUG
30 SEP
31 OCT
30 NOV
31 DEC
31 JAN
28 FEB
31 MAR
30 APR
31 MAY
1961
342,053
326,327
283,144
277,352
238,657
233,700
222,215
221,763
206,923
192,575
179,658
174,243
171,736
142,562
142,562
142,562
126,722
118,709
110,882
110,882
115,002
79,201
76,695
46,937
37,337
31,680
23,760
15,840
2225
1584
34

Figure 52. Lt Gen Wilson (Chief of Engineers) being greeted at Schilling AFB on 6 June 1961, left to right: Lt Gen Wilson, Chief of Engineers; Col W. W. Wilson, Director Atlas F; Col E. B. Jennings, Area Engineer, Col Arthur W. Cruikshank, Jr. SATAF Commander; Col Julius B. Summers, Base Commander.

Figure 53. Lt Gen Wilson (Chief of Engineers) signing the official register at Site 2, 6 June 1961.

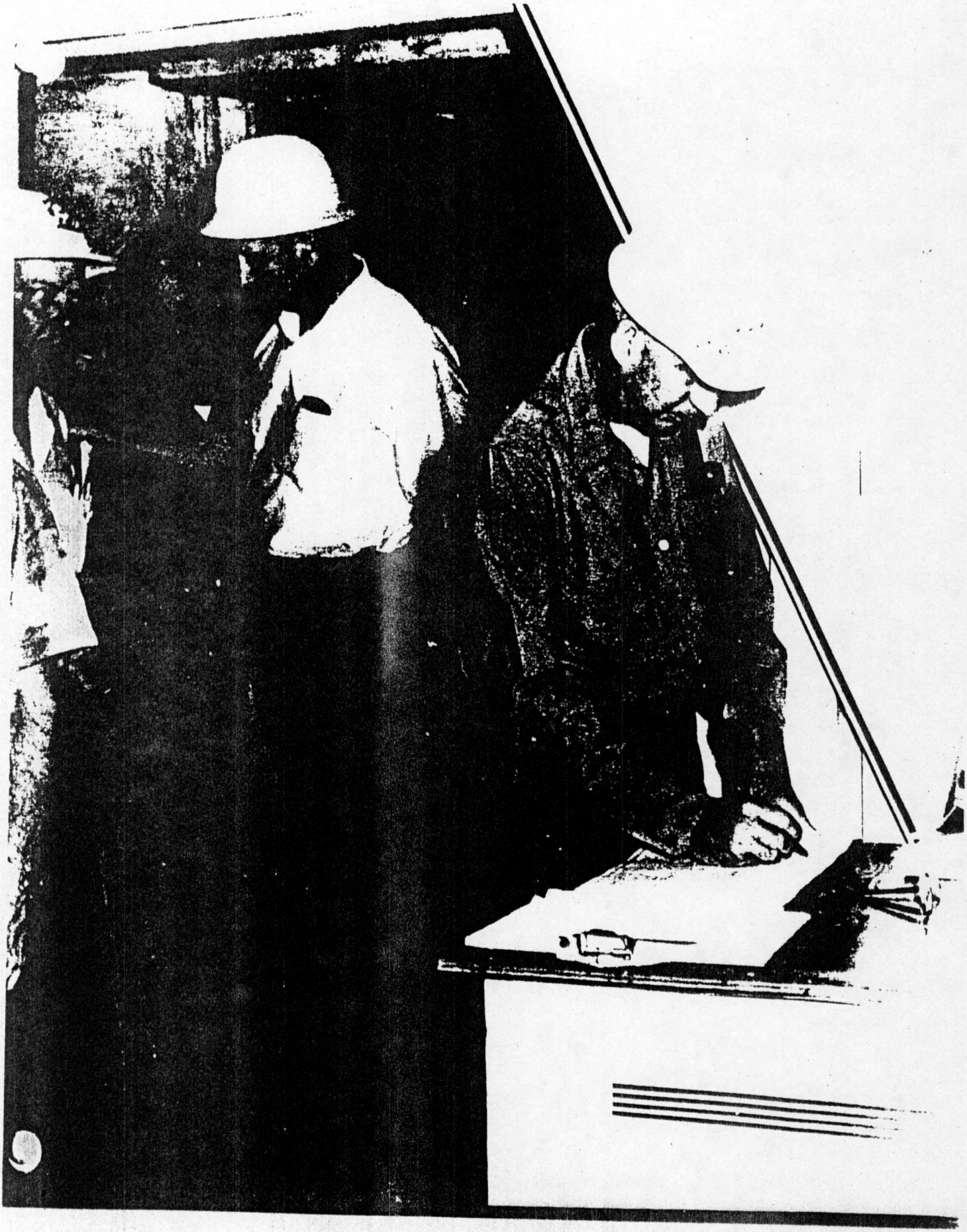


Figure 54. Col Jennings briefing Lt Gen Wilson (Chief of Engineers) at Site 2, 6 June 1961. Picture shows PLS piping which is above ground at the fill and vent shaft.

COL T.J.
GCI WILSON

Figure 55. Col Jennings briefing Lt Gen Wilson (Chief of Engineers) at Site 2 on 6 June 1961. Scene is Level 7 of silo.

COL JEFF

Figure 56. Schilling AFB, 16 June 1961, Salina, Kansas.
Officer's Club. Reception Table.

Figure 57. Schilling AFB, 16 June 1961, Salina, Kansas. Officer's Club. Press Luncheon. Seated at head table, left to right: Col W. W. Wilson, Atlas "F" Director; Col A. W. Cruikshank, Jr., SATAF Commander; Representative J. Floyd Breeding, 5th District Kansas; Col E. B. Jennings, Area Engineer; Brig Gen A. C. Welling, Deputy Commander for Site Activation, BSD; Mr. E. W. Littlefield, Executive Vice President, Utah Constr & Mining Co.

Figure 58. Schilling AFB, 16 June 1961, Salina, Kansas, Turn Over Ceremonies, Chapman Complex (near Chapman, Kansas). Press Personnel Touring Silo. C. I. C. - Capt F. Ames, USAF.

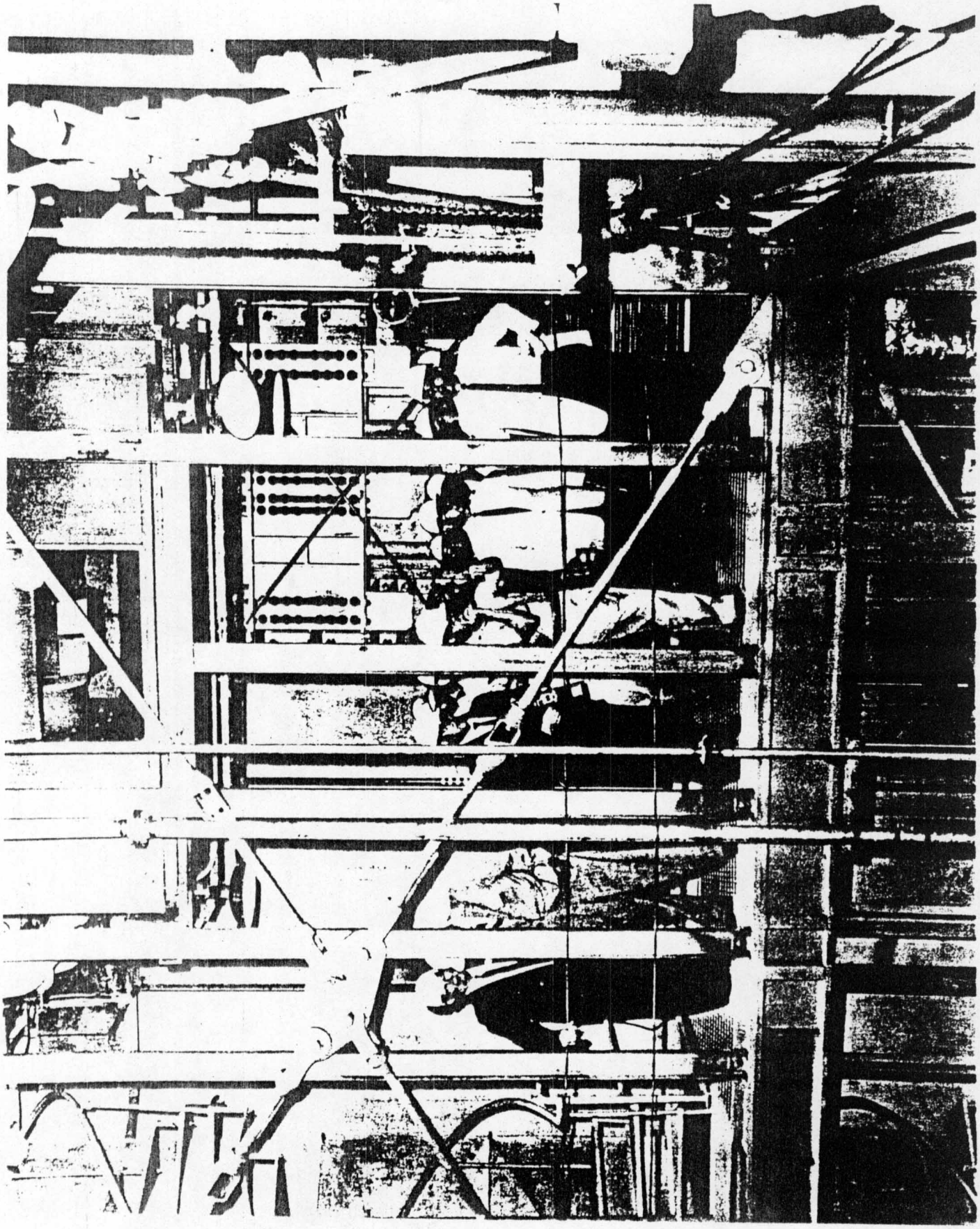


Figure 59. Schilling AFB, 16 June 1961, Salina, Kansas, Turn Over Ceremonies, Chapman Complex (near Chapman, Kansas). General view of public who attended ceremony.

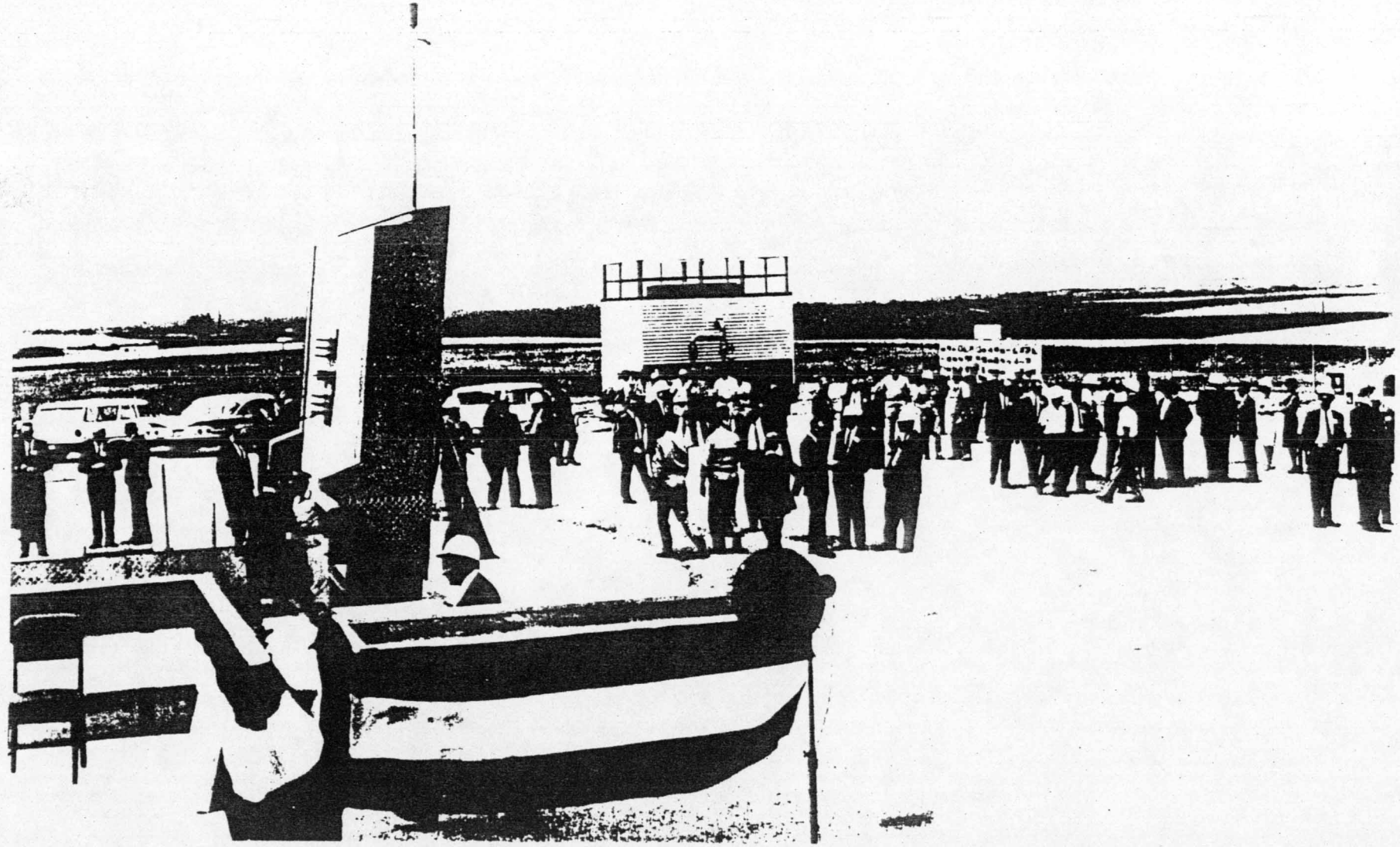


Figure 60. Schilling AFB, 16 June 1961, Salina, Kansas, Turn Over Ceremonies, Chapman Comples (near Chapman, Kansas). Music for the ceremony was provided by the 1ST INFANTRY BAND from Ft. Riley, Kansas under the command of CWO Rodriguz.

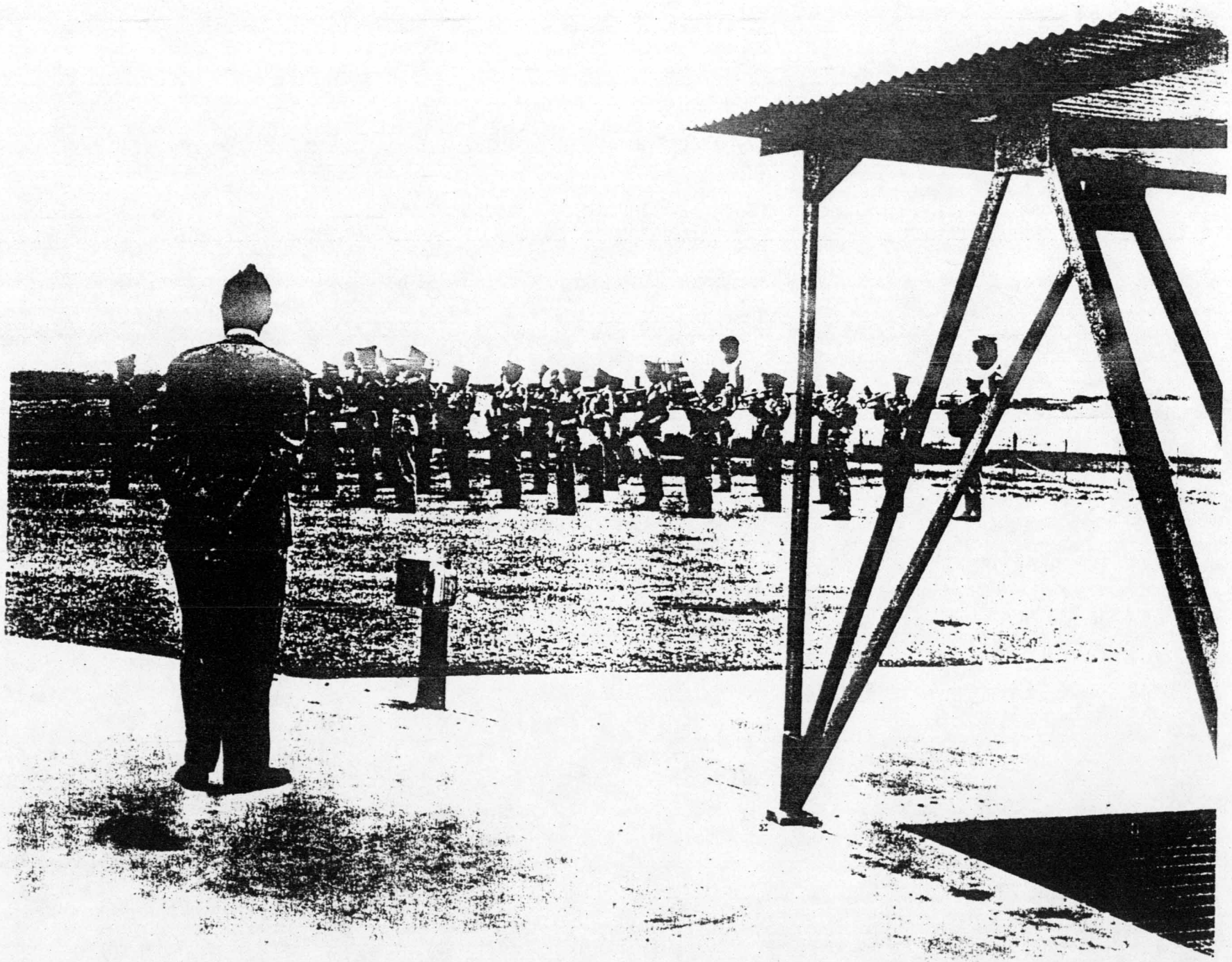


Figure 62. Schilling AFB, 16 June 1961, Salina, Kansas, Turn Over Ceremonies, Chapman Complex (near Chapman, Kansas). Dignitaries on low buoy, left to right: Col J. B. Summers, Schilling AFB Commander; Mr. E. W. Littlefield, Executive Vice President, Utah Constr & Mining Co.; Representative J. Floyd Breeding, 5th District Kansas; Mr. James Stewart, Project Manager, Utah-Manhattan-Sundt; Speaker - Col E. B. Jennings, Area Engineer; Mr. J. W. Petre, Base Activation Manager "F" Series GD/A; Maj C. V. Smith, Base Chaplain, Col W. W. Wilson, Atlas "F" Director; Brig Gen A. C. Welling, Deputy Commander for Site Activation, BSD.

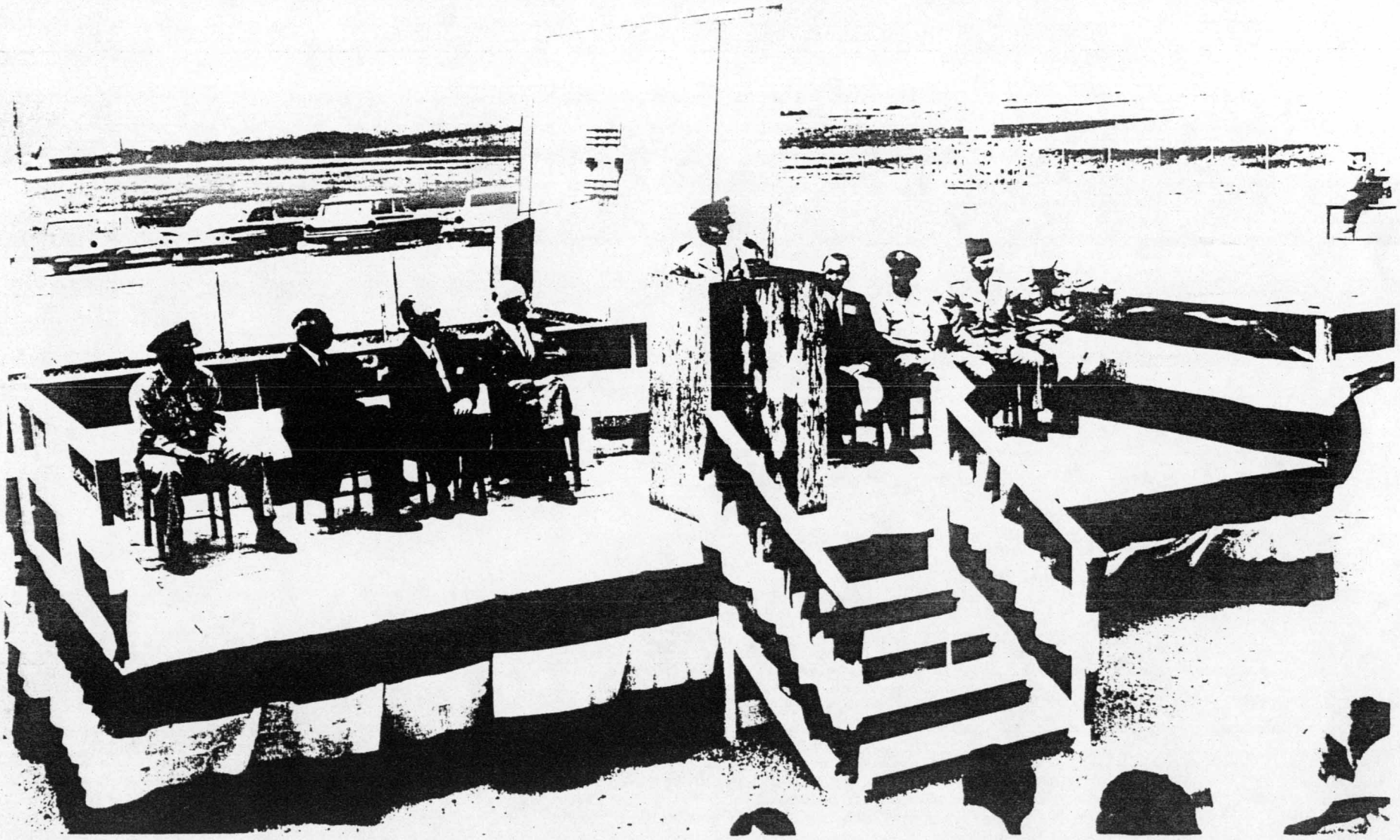


Figure 62. Schilling AFB, 16 June 1961, Salina, Kansas, Turn Over Ceremonies, Chapman Complex (near Chapman, Kansas). Col E. B. Jennings, Area Engineer and Mr. James Stewart, Project Manager, Utah-Manhattan-Sundt, posing with 30 lb key given to Area Engineer by Utah-Manhattan-Sundt.

Figure 63. Schilling AFB, 16 June 1961, Salina, Kansas, Turn Over Ceremonies, Chapman Complex (near Chapman, Kansas). Key personnel, left to right: Col E. P. Jennings, Area Engineer; Mr. James Stewart, Project Manager, Utah-Manhattan-Sundt; Col A. W. Cruikshank, Jr., SATAF Commander; Brig Gen A. C. Welling, Deputy Commander for Site Activation, BSD; Col W. W. Wilson, Atlas "F" Director.

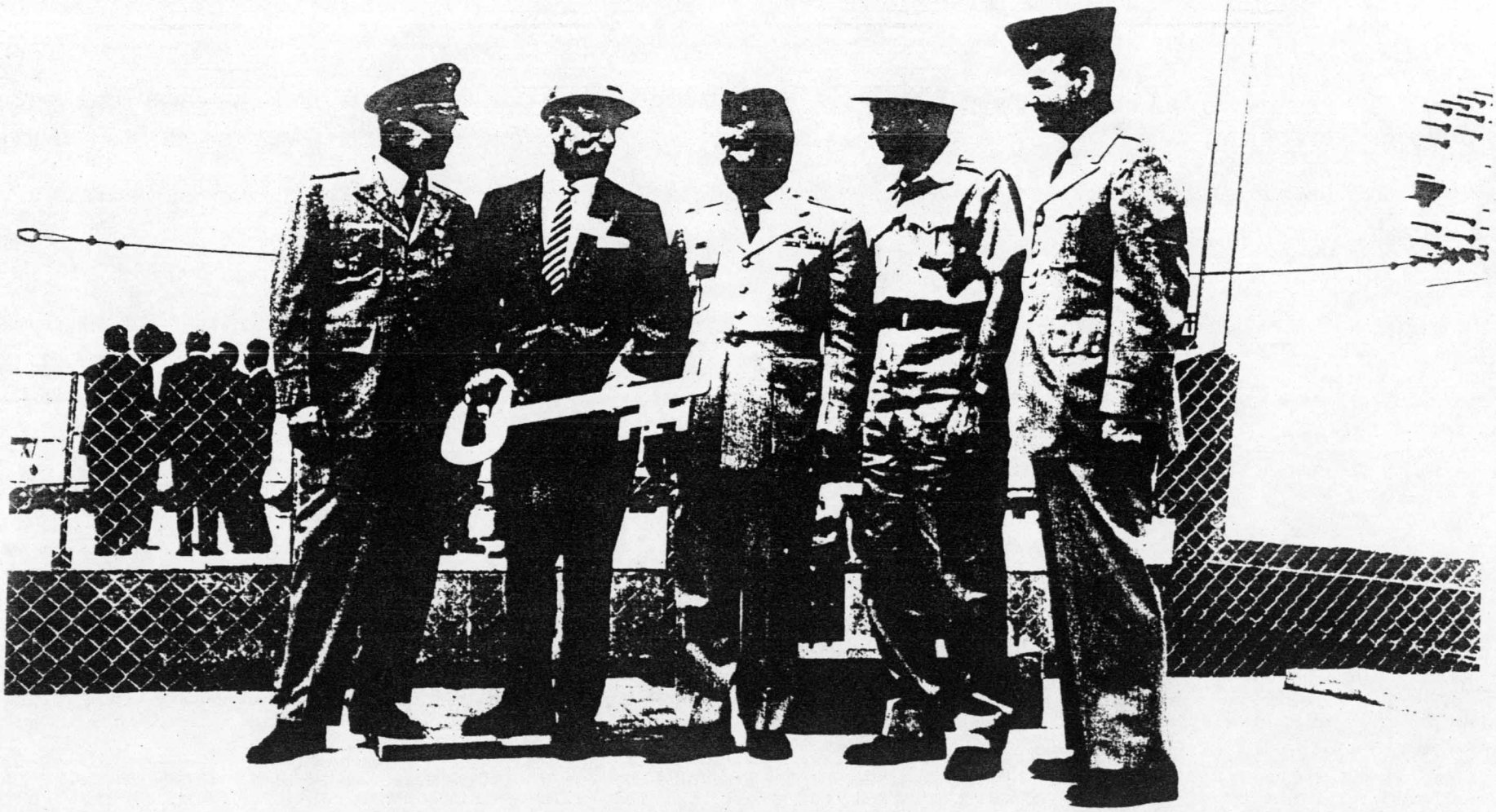


Figure 64. Schilling AFB, 16 June 1961, Salina, Kansas. Turnover Ceremonies. Chapman Complex. (Chapman, Kansas). View of personnel seated in bleachers.


U.S. ARMY

Figure 66. Schilling AFB, 16 June 1961, Salina, Kansas. Officer's Club. During Press Conference held at 1500 hours in the Officer's Club, said people answered press questions, left to right: Col A. W. Cruikshank, Jr., SATAF Commander; Maj Gen T. P. Gerrity, Commander, Ballistics Systems Division; Col E. R. Jennings, Area Engineer; Mr. James Stewart, Project Manager, Utah-Manhattan-Sundt.

Figure 67. Schilling AFB, 16 June 1961, Salina, Kansas. Officer's Club. General view of guests attending the evening dinner.

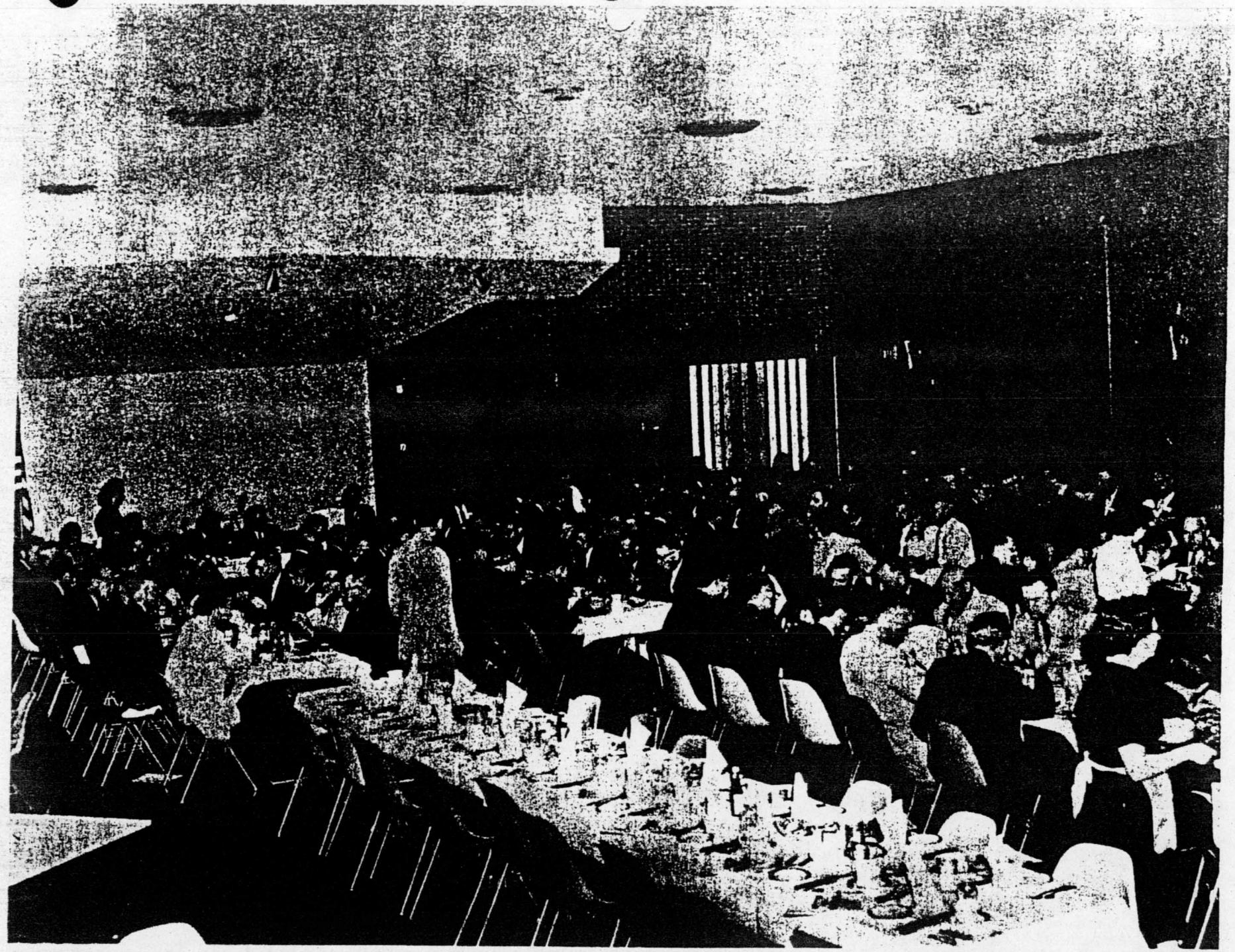


Figure 6[illegible]. Schilling AFB, 16 June 1961, Salina, Kansas. Officer's Club. Dignitaries seated at Head Table, left to right: Col A. W. Cruikshank, Jr., SATAF Commander; Mr. M. J. Miller, President Associated General Contractors of America; Brig Gen A. C. Welling, Deputy Commander for Site Activation, BCD; Representative J. Floyd Breeding, 5th District Kansas; Col W. W. Wilson, Atlas F. Director.

COL CRUIKSHANK

Figure 69. Schilling AFB, 16 June 1961, Salina, Kansas. Officer's Club. Dignitaries seated at head table, left to right: Col W. W. Wilson, Atlas "F" Director; Maj Gen T. P. Gerrity, Commander, Ballistics Systems Division; Mr. C. J. Haggerty, President, National Bldg. Trades Department, AFL-CIO; Col E. R. Jennings, Area Engineer.

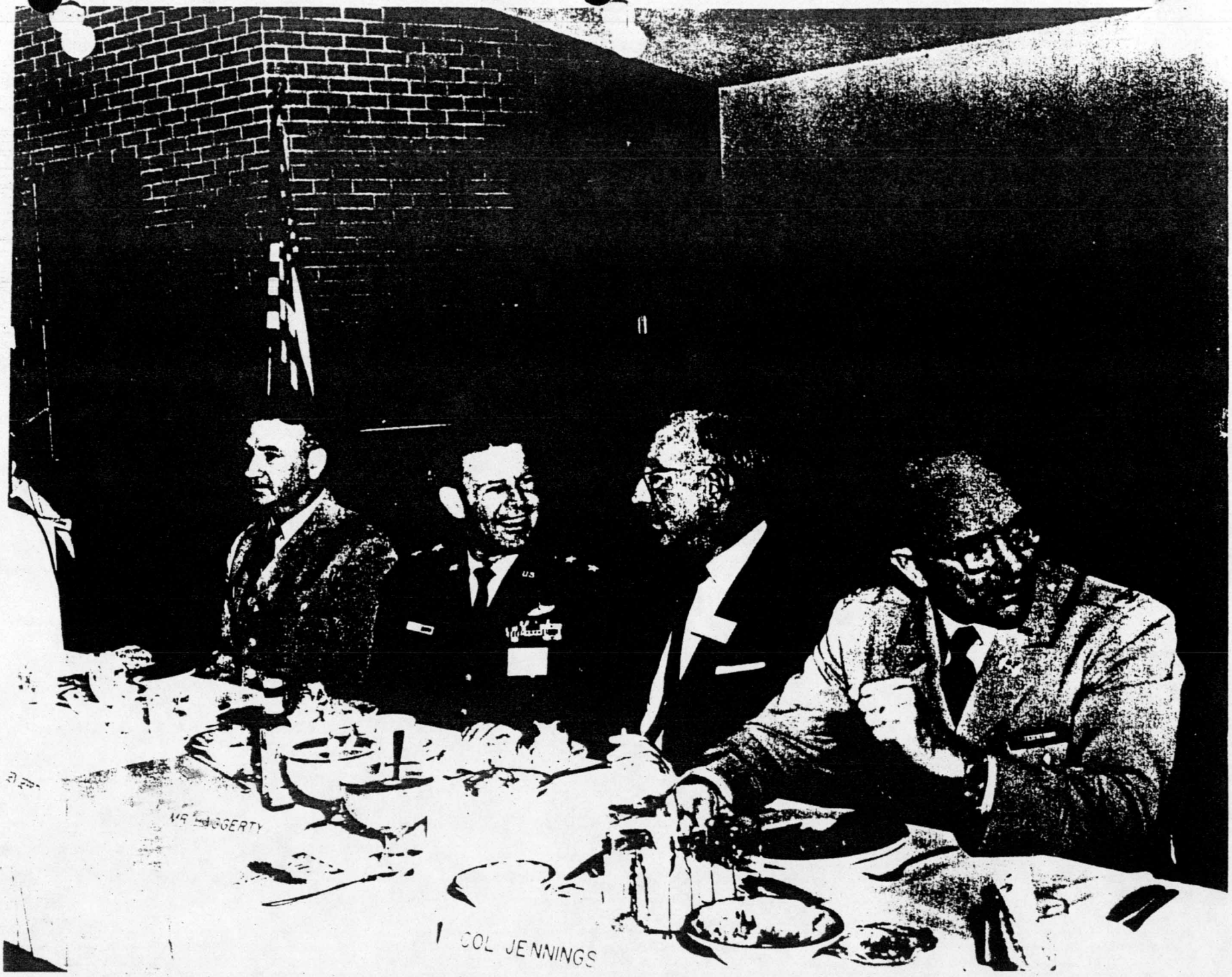
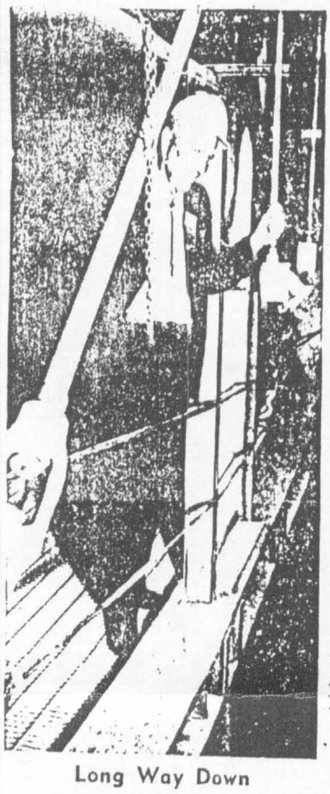

MR HAGGERTY
COL JENNINGS

Figure 70. Schilling AFB, 16 June 1961, Salina, Kansas. Officer's Club. Col E. B. Jennings, Area Engineer, receiving Air Force Commendation Award for outstanding work while assigned as Area Engineer. Lt Col J. W. Graybill, SATAF Deputy Commander reading the award order. Left to right: Representative J. Floyd Breeding, 5th District Kansas; Lt Col J. W. Graybill, SATAF Deputy Commander; Col E. B. Jennings, Area Engineer; Col W. W. Wilson, Atlas "F" Director; Maj Gen T. P. Gerrity, Commander, Ballistics Systems Division.

Figure 71. Schilling AFB, 16 June 1961, Salina, Kansas. Officer's Club. Certificate of Appreciation being given to Utah-Manhattan-Sundt, Joint Venture by the Corps of Engineers. Right to left: Brig Gen A. C. Welling, Deputy Commander for Site Activation, BSD, presenting the certificate, Mr. E. W. Littlefield, Executive Vice President Utah Constr & Mining Co. accepting on behalf of the Joint Venture; Congressman J. Floyd Breeding, 5th District, Kansas.

Figure 72. Schilling AFB, 16 June 1961, Salina, Kansas. Officer's Club. Maj Gen T. P. Gerrity, Commander, Ballistic Systems Division, closing the ceremonies as guest speaker; on his right is Representative J. Floyd Breeding, 5th District Kansas.



Long Way Down

John Sundt, Tucson, Ariz., president of Sundt Construction Co., member of Atlas construction venture, looks into 174-ft-deep chasm of missile site. Construction was a long, tough job.

U-M-S, Army Engineers Praised

Atlas Missile Silos In Air Force Hands

By Larry Boston

CHAPMAN — Standing at the edge of the deep missile silo at ceremonies Friday afternoon, the project manager for Utah Manhattan-Sundt Construction Co. summed up this area's Atlas missile program:

"I've been in construction work a long time," said James C. Stewart, "and this is the hairiest job I ever tackled."

He was remembering a year of muddy digging, sweating concrete work and high-lifting steel rigging in the awesome silos.

So it was a smiling [illegible] handed over 12 partially completed Atlas silos to the Air Force Friday. U-M-S and the Army Corps of Engineers shared praise for completing their part of the job ahead of schedule.

About 200 dignitaries and construction officials watched as Stewart handed a big, gold key to Col. Edward B. Jennings, Army area engineer and deputy commander for site activation of missile construction.

The Army's First Division band played.

A Milestone

Friday night at a dinner at the SAFB Officers Club the project was hailed as a "milestone in missile construction by Maj. Gen. T. P. Gerrity, commander of the Ballist Systems Division, Air Force Systems Command.

"If (the Salina area Atlas project) is not just on schedule, but ahead of schedule," General Gerrity said.

However, he cautioned that much work remains to be done.

The Air Force, General Dynamics-Astronautics and several subcontractors now will install machinery and Atlas missiles in the silos. The job is expected to be completed sometime in 1962.

Ironically, the turnover ceremonies took place at the Chapman missile site, the hole which gave the most trouble.

Originally scheduled as No. 4 in the series of 12 sites, the site would be last in basic construction.

There were good reasons. At both the Bennington and Chapman sites, workers dug into heavy streams of underground water and a long-buried petrified forest of logs.

Like A Pipe

Acting as hollow stone pipes, the logs poured water into the silos at up to 600 gallons per minute during digging operations. Massive pumps were installed to lift water out of the silos until concrete walls sealed out the moisture.

There were all sorts of problems, construction men remembered.

But what visitors saw Friday was a slicked-up silo, filled with steel framework and ready to receive the complicated gear needed to fuel and fire an Atlas.

Covered with concrete was the dark gray soil uncovered deep underground by bulldozers during digging operations. Just about every kind of soil and rock strata was encountered in the 12 sites. The strange, gray clay deep in the ground had to be covered with sprayed concrete, for it decomposed and crumbled when hit by air.

[illegible] fabricated by U-S machinists of [illegible]

[illegible] steel [illegible] in the [illegible] the silos, [illegible] work. [illegible] packaged [illegible] complexes and valves had to be [illegible] for the close quarters underground. Surgical clean[illegible] had to be observed in [illegible]

[illegible] of [illegible] and heavy in case of [illegible] Atlas. Workers [illegible] of [illegible] or [illegible] parts.

[illegible] diesel generators [illegible] enough power [illegible] supply a small city. Heat [illegible] Force generators exhaust [illegible] to silo in winter.

[illegible] are covered [illegible] steel doors.

[illegible] was all the [illegible] Friday. [illegible] expressions of [illegible]

"I didn't think we could ever do it," said Chris Ives, Detroit, Mich., vice-president of Struthers-Wells Corp., a firm which supplied [illegible] piping and tubing.

Electronics and fuel-loading [illegible] equipment will be [illegible] of the silos in the next phase of [illegible]

[illegible] required many [illegible] "Utah steel" men and [illegible]

Col. Arthur W. [illegible] Air Force site [illegible] Force [illegible] commander, presided at the afternoon ceremonies. He cautioned work on Atlas silos isn't finished yet.

Boss Is Pleased

"But I'm delighted to point to Utah-Manhattan and Schilling AFB people who are leading the way in the missile program," [illegible] of Gerrity and Lackey [illegible]

"We took in the [illegible] planned a construction [illegible] missiles in the [illegible] at Salina," he said.

"I don't know how long they'll be needed, but I hope Atlas missiles in the fields outside Salina will serve their purpose of [illegible] that we'll not ever have to be fired in anger."

Incidentally, the ceremonies were a time of good news for officers who participated.

Col. Jennings, an Army man, was awarded an Air Force Commendation Medal for his part in supervising construction work.

It was announced that Brig. Gen. A. C. Welling, also an Army man and deputy commander of the Ballistic Missile Systems Division under General Gerrity, has been confirmed as a major general.

Key For Success

Thirty-pound key, symbol of area Atlas bases' first-stage completion, is presented to Col. Edward B. Jennings, Army area engineer for missile construction, by James S. Stewart, U-M-S project manager.

Portrait Of A Happy Man

Maj. Gen. T. P. Gerrity, commander of Ballistic Missile Systems Divisions, Air Force Systems Command, enjoys a contented smoke after Schilling Atlas missile sites were turned over to Air Force by Corps of Engineers. There's a long job ahead but first phase is completed. Story and pictures of the turnover on Page 23. (Journal Photo)

Thanks For Fast Job

Col. Edward B. Jennings speaks to audience of area representatives and construction officials at ceremony at Chapman missile site. (Journal Photos)

Ceremony Will Mark End Of First-Stage Atlas Work

Completion of first-stage construction of 12 area missile bases—the nation's first underground, silo-type Atlas complexes — will be observed at ceremonies June 16.

The ceremonies will mark turnover of the bases to the Air Force by the Army Corps of Engineers. The corps was in charge of basic construction of the bases.

However, the ceremonies don't mark completion of the bases—only completion of basic construction. Considerable work remains to be done on installing machinery and the Atlas missiles in the silos.

Officials Invited

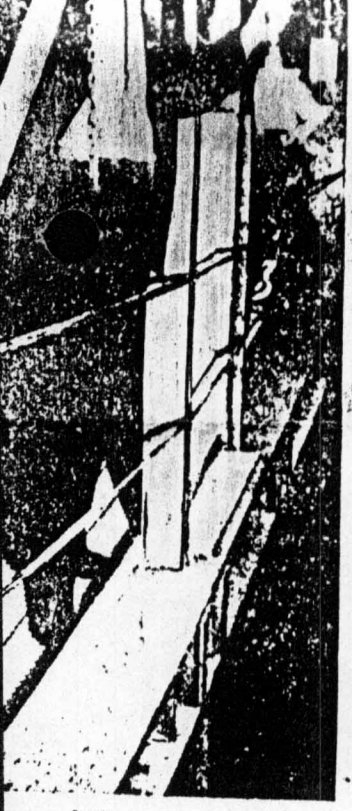
Several Salina and Kansas officials have been invited to the ceremonies and an inspection tour the afternoon and evening of June 16.

National press, radio and television representatives may be at the meeting, too.

Officials will inspect area missile complexes, beginning at 2, that attend a reception and dinner beginning at 5 at the SAFB Officers' Club.

Col. Edward B. Jennings, area engineer for missile construction will represent the corps in the formal turnover of the bases. Col. Arthur W. Cruikshank Jr., site activation task force commander, will represent the Air Force.

Officers from headquarters of the Army and Air Force missile construction offices also are expected to attend.



ong Way Down

lt, Tucson, Ariz., president of Sundt Co.,...member of Atlas construction into 171-ft-deep chasm of missile on was a long, tough job.

f A Happy Man

Gerrity, commander of Ballistic sions, Air Force Systems Com- ntented smoke after Schilling vere turned over to Air Force ers. T s a long job ahead mplet tory and pictures of e 23. (Journal Photo)

In Air Force Hands

By Larry Boston

CHAPMAN — Standing at the edge of the deep missile silo here Friday afternoon the project manager for Utah Manhattan Sundt Construction Co. summed up this area's Atlas missile program:

"I've been in construction work a long time," said James C. Stewart, "and this is the hardest job I ever tackled."

He was remembering a year of muddy digging, sweating concrete work and high flying steel rigging in the awesome silos.

So it was a [illegible] when he handed over 12 partially completed Atlas silos to the Air Force Friday. U-M-S and the Army Corps of Engineers shared praise for completing their part of the job ahead of schedule.

About 200 dignitaries and construction officials watched as Stewart handed a big, gold key to Col. Edward B. Jennings, Army area engineer and deputy commander for site activation of missile construction.

The Army's First Division band played.

A Milestone

Friday night at a dinner at the SAFB Officers Club, the project was hailed as a "major milestone" in missile construction by Maj. Gen. T. P. Gerrity, commander of the Ballist Systems Division, Air Force Systems Command.

"It (the Salina area Atlas project) is not just on schedule, but ahead of schedule," General Gerrity said.

However, he cautioned that much work remains to be done.

The Air Force, General Dynamics-Astronautics and several subcontractors now will install machinery and Atlas missiles in the silos. The job is expected to be completed sometime in 1962.

Ironically, the turnover ceremonies took place at the Chapman missile site, the hole which gave the most trouble.

Originally scheduled as No. 4 in the series of 12 sites, the site would up last in basic construction.

There were good reasons. At both the Bennington and Chapman sites, workers dug into heavy streams of underground water and a long-buried petrified forest of logs.

Like A Pipe

Acting as hollow stone pipes, the logs poured water into the silos at up to 600 gallons per minute during digging operations. Massive pumps were installed to lift water out of the silos until concrete walls sealed out the moisture.

There were all sorts of problems, construction men remembered.

But what visitors saw Friday was a slicked-up silo, filled with steel framework and ready to receive the complicated gear needed to fuel and fire an Atlas.

Covered with concrete was the dark gray soil uncovered deep underground by bulldozers during digging operations. Just about every kind of soil and rock strata was encountered in the 12 sites. The strange, gray clay deep in the ground had to be covered with sprayed concrete, for it decomposed and crumbled when hit by air.

[illegible] fabricated by U.S. [illegible] steel [illegible] in the [illegible] the silos.

[illegible] of pipes and valves had to be [illegible] for the close quarters [illegible] and surgical cleanliness [illegible] to be observed in installing them.

[illegible] of sandbags can seal off a [illegible] in case of [illegible] attack. Scrubbers can [illegible] of [illegible] pressure than [illegible] and air jets.

[illegible] diesel generators supply [illegible] enough power to supply a small city. Heat [illegible] exhaust [illegible] silo in winter.

[illegible] are covered [illegible] steel doors.

[illegible] all the things Friday [illegible] contractors watched [illegible] expressions of [illegible]

"I didn't think we could ever do it," said Glen Lees, Detroit, Mich., vice president of Struthers-Wells Corp., a firm which supplied [illegible] piping and tubing.

Electronics and fuel-loading specialists probably will be the stars of the show in the next phase of construction.

The first phase required mining specialists, "rich steel" men and [illegible]

Col. Arthur W. Cruikshank, Air Force site activation task force commander, presided at the afternoon ceremonies. He cautioned work on Atlas sites isn't finished yet.

Boss Is Pleased

"But I'm delighted to come to Utah Manhattan and Schilling AFB people who are helping show the way in the missile program," General Gerrity said Friday evening.

"We've been in the [illegible] phase [illegible] a round-clean-up period [illegible] missiles in the fields here at Salina," he said.

"I don't know how long they'll be needed, but I hope Atlas missiles in the fields outside Salina will serve their purpose of deterring war without ever having to be fired in anger."

Incidentally, the ceremonies were a time of good news for officers who participated.

Col. Jennings, an Army man, was awarded an Air Force Commendation Medal for his part in supervising construction work.

It was announced that Brig. Gen. A. C. Welling, also an Army man and deputy commander of the Ballistic Missile Systems Division under General Gerrity, has been confirmed as a major general.

Key For Success

Thirty-pound key, symbol of area Atlas bases' first-stage completion, is presented to Col. Edward B. Jennings, Army [illegible] sile constr[illegible] art, U-M-S

Thanks For Fast Job

Col. Edward B. Jennings speaks to audience of area representatives and construction officials at ceremony at Chapman missile site. (Journal Photos)

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National press, radio and television representatives may be at the meeting, too.

Officials will inspect area missile complexes, beginning at 2, [illegible] that attend a reception and [illegible] ner beginning at 5 at the SA[illegible] Officers' Club.

Col. Edward B. Jennings, [illegible] engineer for missile construc[illegible] will represent the corps in [illegible] formal turnover of the bases, [illegible] Arthur W. Cruikshank jr., [illegible] activation task force comman[illegible] will represent the Air Force.

Officers from headquarters [illegible] the Army and Air Force, mis[illegible] construction offices also are [illegible] pected to attend.

Long Way Down

[illegible] Sundt, Tucson, Ariz., president of Sundt Construction Co., member of Atlas construction venture, looks into 174-ft.-deep chasm of missile site. Construction was a long, tough job.

Portrait Of A Happy Man

Maj. Gen. T. P. Gerrity, commander of Ballistic Missile Systems Divisions, Air Force Systems Command, enjoys a contented smoke after Schilling Atlas missile sites were turned over to Air Force by Corps of Engineers. There's a long job ahead but first phase is completed. Story and pictures of the turnover on Page 23. (Journal Photo)

U-M-S, Army Engineers Praised

Atlas Missile Silos In Air Force Hands

By Larry Boston

CHAPMAN — Standing at the edge of the deep missile silo here Friday afternoon, the project manager for Utah-Manhattan-Sundt Construction Co. summed up this area's Atlas missile program:

"I've been in construction work a long time," said James C. Stewart, "and this is the hardest job I ever tackled."

He was remembering a year of muddy digging, sweating concrete work and high-flying steel rigging in the awesome silos.

So it was a [illegible] Stewart [illegible] handed over 12 partially completed Atlas silos to the Air Force Friday. U-M-S and the Army Corps of Engineers drew praise for completing their part of the job ahead of schedule.

About 200 dignitaries and construction officials watched as Stewart handed a big, gold key to Col. Edward B. Jennings, Army area engineer and deputy commander for site activation of missile construction.

The Army's First Division band played.

A Milestone

Friday night at a dinner at the SAFB Officers' Club the project was hailed as a "major milestone" in missile construction by Maj. Gen. T. P. Gerrity, commander of the Ballistic Systems Division, Air Force Systems Command.

"It (the Salina area Atlas project) is not just on schedule, but ahead of schedule," General Gerrity said.

However, he cautioned that much work remains to be done.

The Air Force, General Dynamics-Astronautics and several subcontractors now will install machinery and Atlas missiles in the silos. The job is expected to be completed sometime in 1962.

Ironically, the turnover ceremonies took place at the Chapman missile site, the hole which gave the most trouble.

Originally scheduled as No. 4 in the series of 12 sites, the site wound up last in basic construction.

There were good reasons. At both the Bennington and Chapman sites, workers dug into heavy streams of underground water and a long-buried petrified forest of logs.

Like A Pipe

Acting as hollow stone pipes, the logs poured water into the silos at up to 600 gallons per minute during digging operations. Massive pumps were installed to lift water out of the silos until concrete walls sealed out the moisture.

There were all sorts of problems, construction men remembered.

But what visitors saw Friday was a slicked-up silo, filled with steel framework and ready to receive the complicated gear needed to fuel and fire an Atlas.

Covered with concrete was the dark gray soil uncovered deep underground by bulldozers during digging operations. Just about every kind of soil and rock strata was encountered in the 12 sites. The strange, gray clay deep in the ground had to be covered with sprayed concrete, for it decomposed and crumbled when hit by air.

[illegible] ve, fabricated by U.S. [illegible]

[illegible] steel springs in the [illegible] the [illegible] the sides.

[illegible] would [illegible] packaged [illegible] and valves had to be [illegible] for the [illegible] Surgical cleanliness had to be observed in [illegible]

[illegible] of today's [illegible] out [illegible] bases in case of [illegible] attack. [illegible]

[illegible] diesel generators [illegible] enough power to supply a small city. Heat [illegible] generators' exhaust [illegible] in winter.

[illegible] steel doors.

[illegible]

"I didn't think we could ever do it," said Clem Lees, Detroit, Mich., vice president of Strothers Wells Corp., a firm which supplied [illegible] piping and tubing.

Electronics and fuel-loading [illegible] will [illegible] of the [illegible] in the next phase of [illegible]

[illegible] "[illegible] steel" [illegible] and [illegible] of Atlas [illegible]

Col. Arthur W. Cruikshank Jr., Air Force site activation task force commander, presided at the afternoon ceremonies. He cautioned [illegible] work on Atlas sites isn't finished yet.

Boss Is Pleased

"But I'm delighted to point to Utah-Manhattan and Schilling AFB people who are helping show the way in the missile program," General Gerrity said Friday evening.

"We [illegible] in the [illegible] a [illegible] at Sy[illegible]," he said.

"I don't know how long they'll be needed, but I hope Atlas missiles in the fields outside Salina will serve [illegible] have to be fired in a [illegible]."

Incidentally, the ceremonies were a time of good news for officers who participated.

Col. Jennings, an Army man, was awarded an Air Force Commendation Medal for his part in supervising construction work.

It was announced that Brig. Gen. A. C. Welling, also an Army man and deputy commander of the Ballistic Missile Systems Division under General Gerrity, has been confirmed as a major general.

Key For Success

Thirty-pound key, symbol of area Atlas bases' first-stage completion, is presented to Col. Edward B. Jennings, Army area engineer for missile construction, by James S. Stewart, U-M-S project manager.

Thanks For Fast Job

Col. Edward B. Jennings speaks to audience of area representatives and construction officials at ceremony at Chapman missile site. (Journal Photos)

Ceremony Will Mark End Of First-Stage Atlas Work

Completion of first-stage construction of 12 area missile bases—the nation's first underground silo-type Atlas complexes — will be observed at ceremonies June 16.

The ceremonies will mark turnover of the bases to the Air Force by the Army Corps of Engineers. The corps was in charge of basic construction of the bases.

However, the ceremonies don't mark completion of the bases—only completion of basic construction. Considerable work remains to be done on installing machinery and the Atlas missiles in the silos.

Officials Invited

Several Salina and Kansas officials have been invited to the ceremonies and an inspection tour the afternoon and evening of June 16.

National press, radio and television representatives may be at the meeting, too.

Officials will inspect area missile complexes, beginning at 2, then attend a reception and dinner beginning at 5 at the SAFB Officers' Club.

Col. Edward B. Jennings, area engineer for missile construction will represent the corps in the formal turnover of the bases. Col. Arthur W. Cruikshank Jr., site activation task force commander, will represent the Air Force.

Officers from headquarters of the Army and Air Force missile construction offices also are expected to attend.

(THE *Morning* KANSAS CITY STAR)

The Kansas City Times

★ KANSAS CITY, SATURDAY, JUNE 17, 1961—44 PAGES. K

Giant ICBM Sites Inspected.

By Ray Morgan.
(A Member of The Star's Staff.)

SALINA, June 16.—In a setting resembling something from "The War of the Worlds" by H. G. Wells, leaders of the construction industry today got a peek at the insides of the giant underground structures to be turned over to the Air Force for activation as intercontinental ballistic missiles sites.

At a spot near Abilene, Kas., the Air Force, the Corps of Engineers and industrial representatives gathered to commemorate the completion of the 12 so-called silo-type missile launching sites to be turned over to the Air Force.

Corridors 185 Feet Under.

The underground scene was a mass of television camera installations; 9-foot thick concrete reinforcing walls; right-angle corridors to provide a baffle against direct hits by nuclear bombs, giant steel doors sealing air-locks against damage from enemy attack, and a great excavation extending 185 feet into the Kansas soil.

These 12 sites were completed ahead of schedule and without labor difficulties to establish new records in the Air Force intercontinental ballistics missile program. The Atlas missiles, capable of traveling 6,000 miles toward the targets of an aggressor, will be launched from here in the event of war.

In the ceremonies commemorating the completion of the project construction, Maj. Gen. T. P. Gerrity, commander of the Air Force ballistics system division, pointed out that the United States intercontinental ballistics missile program was actually ahead of schedule despite criticisms.

Viewpoint in 1954.

"In 1954 when the decision was made for America to undertake such a program, there were those who said it could never be done because of problems of construction of launch pads, overcoming re-entry for the nuclear missiles and other problems," Gen. Gerrity said.

"Today we have seen here the completion of the initial construction phase of 12 of these intercontinental ballistic missiles launching sites and there are others which are already operational.

A Joint Enterprise.

"It is a tribute to American ingenuity and skill which has made this possible."

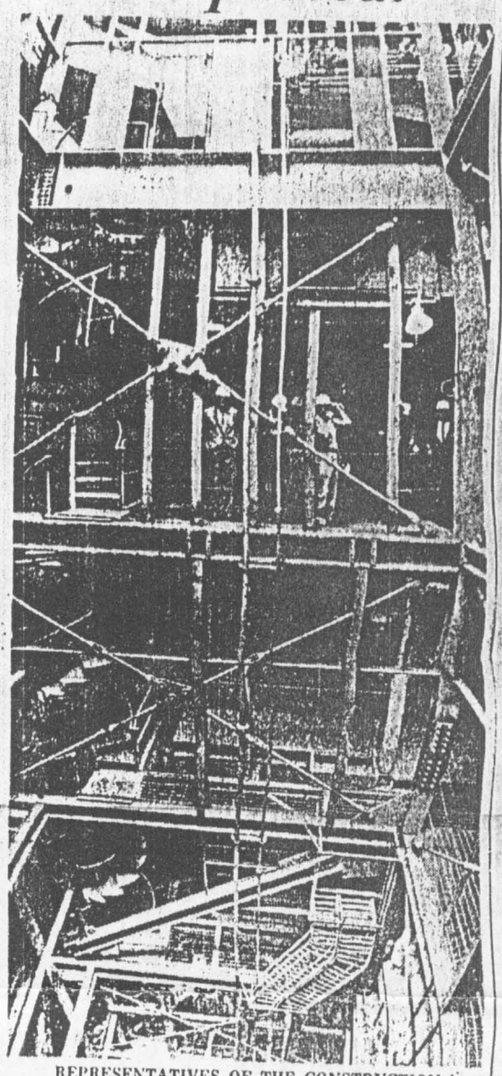
The projects here, the first such ICBM silo-bases to be ready in the United States, were completed by the Utah Construction and Mining company, San Francisco; the Manhattan Construction company, Muskogee, Okla., and the M. M. Sundt Construction company, Tucson, Ariz., acting jointly.

In a dinner at the Strategic Air command base here tonight, attended by 200 military, state and local dignitaries, Gen. Gerrity paid tribute to speed with which the ballistics missiles bases were made ready.

Teamwork Is Cited.

"Timely success in our top priority program depends on teamwork on a national scale," General Garrity said. "The Army, the Air Force, science, industry, and citi-

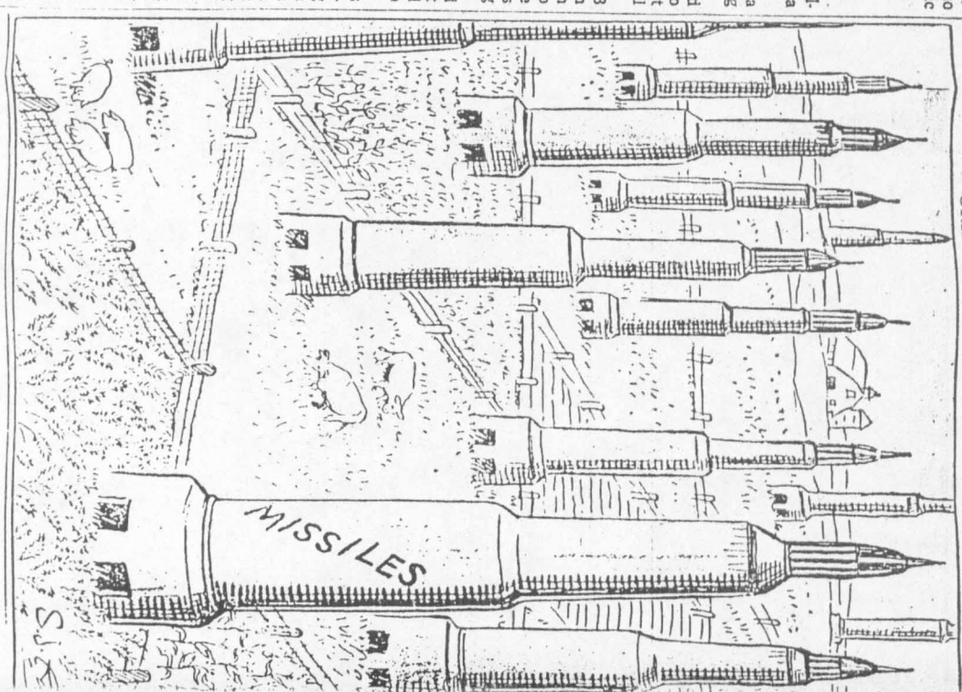
(Continued on Page 7.)



REPRESENTATIVES OF THE CONSTRUCTION industry and the military inspect one of the lower levels of the underground missile site base near Abilene, Kas. The base will be under the command of the Schilling Air Force Base, Salina. It is the last of 12 sites prepared for the launching of Atlas missiles, which have a range of 6,000 miles.

E KANSAS CITY STAR, MONDAY, JUNE 19, 1961.

GRIM CROP FOR THE MIDLANDS.



Speaking the Public Mind—

he Salina Journal Wednesday, June 14, 1961

Atlas Sites To Go To Air Force Friday

First Of Kind In Nation

Ceremonies marking partial completion of 12 Salina area Atlas missile complexes will attract lots of attention Friday.

The ceremonies, turnover the nation's first underground, silo-type Atlas complexes from Utah-Manhattan-Sundt Construction Co. to the Air Force.

The last of the 12 partially completed complexes — Silo 2 near Chapman — will be given to the Air Force during ceremonies Friday afternoon at the site.

Officials Here

Several Kansas and Salina area officials have been invited to inspect the Chapman site Friday afternoon, then attend a dinner and awards ceremony that evening at the SAFB Officers Club.

Officers from headquarters of Army missile construction and Air Force missile management offices are expected to attend.

Representatives of press, radio and television services are expected.

Friday's ceremonies mark completion of the first stage of Atlas missile installations, the end of basic construction of the missile silos. The Corps of Engineers was in charge of this phase of work.

Only a small percentage of "Cleanup" work remains to be done by the Corps on construction of the sites, officials said.

However, the bases aren't complete. Considerable work remains to be done on installing machinery and the Atlas missiles. The bases are a long way from combat readiness.

James C. Stewart, representing the Utah-Manhattan-Sundt joint construction venture, will present the Chapman complex to Col. Edward B. Jennings, Army deputy site activation task force commander.

The ceremonies will be at 3 pm at the Chapman site. The inspection party will leave the SAFB Officers Club at 2 pm for the site.

A reception will be from 5 to 6 pm at the Officers Club, followed by dinner and an awards ceremony.

Main speaker will be Maj. Gen. T. P. Gerrity, commander of the Ballistic Systems Division, Air Force System Command at Los Angeles.

Brig. Gen. A. C. Welling, deputy commander of BSD, will present an award to E. W. Little, field, executive vice-president and general manager of the Utah Construction and Mining Co., one of the partners in the joint construction venture.

Other members of U-M-S are Manhattan Construction Co., Howard P. Foley Co., and the M. M. Sundt Construction Co.

Stewart, Colonel Jennings and Colonel Cruikshank will introduce members of their staffs at the evening program.

Friday, June 16, 1961
Page 3—The Salina Journal

They Talk Of Missiles

Among officials at the area Atlas ceremonies Friday were (left to right) Col. Arthur W. Cruikshank jr., Air Force site activation task force commander; Congressman J. Floyd Breeding of Kansas and Col. Edward A. Jennings, Army area engineer for missile construction. (Journal Photo)

12 Area Missile Bases Presented To Air Force

CHAPMAN — Twelve partially completed area Atlas missile bases were presented to the Air Force during ceremonies at the base near here Friday afternoon.

The project drew praise for being ahead of schedule.

Utah - Manhattan - Sundt Construction Co., the construction contractor on the big missile silos, made the presentation. Col. Edward B. Jennings, Army area engineer for missile construction, accepted the sites on behalf of the Air Force.

Several area officials and officers from major Army and Air Force missile offices attended.

National press, radio and television services covered the event.

Basic Construction Finished

The bases still are far from being operational. Considerable work remains to be done on installing machinery and the Atlas missiles. Friday's ceremonies marked completion of the basic construction phase, supervised by the Army Corps of Engineers.

The Air Force Site Activation Task Force now will supervise installation of Atlas machinery. When completed, the bases will be turned over to the Strategic Air Command. The project is expected to be completed sometime in 1962.

A dinner Friday night at the SAFB Officers Club will be attended by military and construction officials. Main speaker will be Maj. Gen T. P. Gerrity, commander of the Ballistic Systems Division, Air Force System Command at Los Angeles, Calif.

General Gerrity said Friday he will offer praise, in his speech Friday night, of the teamwork of local Atlas workers under the direction of Col. Arthur C. Cruikshank, Air Force site activation task force commander at SAFB.

"Timely success in our top priority program depends on teamwork on a national scale," the general said.

This teamwork, General Gerrity added, includes "many skilled tradesmen of your local community."

Ahead of Schedule

An award will be presented by the Air Force to Utah-Manhattan-Sundt Co., for completing its part of the project ahead of schedule.

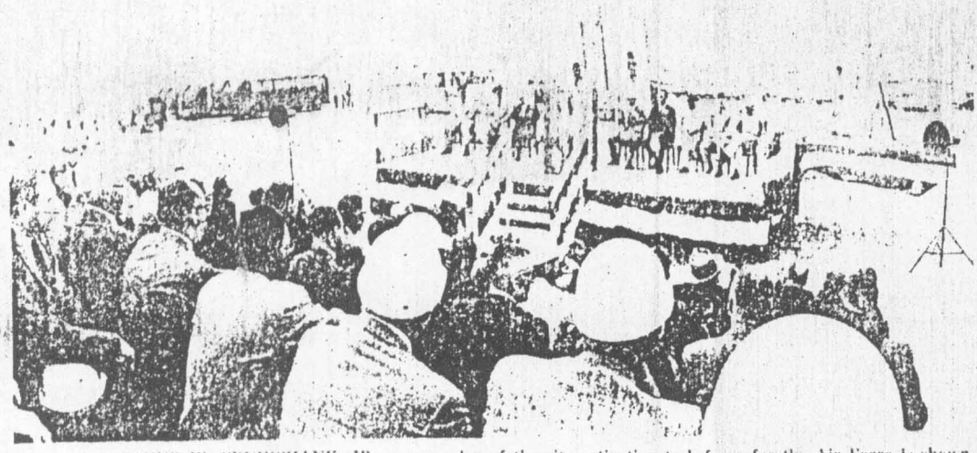
In addition to the Chapman missile complex, there are installations near Bennington, Carlton, McPherson, Goessel, Carneiro, Wilson, Beverly, Glasco, Tescott, Minneapolis and Abilene.

Construction industry officials attended a dinner given in Kansas City Thursday night by Utah Construction Co., and termed completion of the bases ahead of schedule as a refutation of what they termed "unfounded charges" of unnecessary delays in missile site construction because of labor disputes.

"So much criticism of the missile program was emanated from Washington that the successful completion of this first major project is receiving favorable attention from the Department of Defense," said Alfred L. Reeves Jr., former Missouri congressman and now senior vice president of Utah Construction.

"All 12 sites have been completed ahead of schedule, which answers one major criticism from Washington. There have been no work interruptions because of labor difficulties, which answers the second criticism. A third criticism has been answered when the difficult technical problems under a fluid design were promptly and successfully solved."

Giant ICBM Sites Inspected.



COL. ARTHUR W. CRUIKSHANK, JR., commander of the site activation task force for the Air Force is shown speaking at the ceremonies yesterday at which Kansas's new missile base was turned over to the Air Force. Also on the platform, from left, are Col. Julius E. Summers, jr., commander of the Schilling Air Force base; Col. Edward B. Jennings, area engineer for the Corps of Engineers; Rep. J. Floyd Breeding, member of Congress from Kansas's fifth district, and at far right, Maj. Gen. Alvin Charles Welling, deputy for site activation for the Corps of Engineers.

(Continued From Page 1)

zens of the many communities affected by this program must work together with a mutual understanding of the importance to our national security.

"Under the direction of Col. Arthur Cruikshank, our site activation task force commander, this team at Schilling and at the other sites around the country, involve elements of the Air Force, the Army, and a broad spectrum of contractors and subcontractors representing varied elements of the missile and construction industry. It also includes many skilled tradesmen of your local communities."

Some indication of the size of the completed structure underground at each of the sites is that it is equal to about an 18-story building. Between 40,000 and 50,000 cubic yards of earth were excavated at each site.

Totals Run High.

In addition to this, the Corps of Engineers said 15,000 cubic yards of excavation were involved in construction of the missile wells, and 7,000 cubic yards of concrete were required for the reinforcing walls, along with more than 2,000 tons of reinforcing and structural steel.

Maj. Gen. Alvin Charles Welling, deputy for site activation in the Ballistics System division of the new Air Force systems command, presented certificates of appreciation for the record in the construction phase to E. W. Littlefield, executive vice-president and general manager of the company and James Sweeney of Titusville, Pa., president of Struthers Wells corporation.

Rep. Floyd Breeding, Democratic member of Congress from this area, pointed out that he was reared on a farm visible from the missile base site.

"I never thought then there would be anything such as this," Breeding said. "It is a great pleasure for me to come to my own state and see one of these projects for which I have been voting the money in my seat in Congress."

Among officials present were C. J. Haggerty of Washington, president of the national Building Trades department, AFL-CIO; James D. Marshall, Washington, executive director of the Associated General Contractors of America, Inc.; A. L. Reeves, jr., senior vice-president of Utah Construction and a former member of Congress from a Kansas City area; L. F. Rooney, jr., of Muskogee, Okla., president of the Manhattan Construction company; W. E. Naumann, vice-president of M. M. Sundt Construction company; Bancroft T. Foley of Washington, president of the Howard T. Foley company, and James Sweeney of Titusville, Pa., president of Struthers Wells corporation.

Among military representatives present were Col. W. W. Wilson, jr., director of the Atlas F project of the Corps of Engineers ballistic missiles construction office; Lt. Col. Earle Zallenstein of the Kansas City district of the Corps of Engineers, and Col. Edward Jennings, area engineer for the missile base project.

Following the ceremonies tonight, the group flew back to Kansas City aboard a chartered Braniff International Airways flight.

INSPECTING PART OF THE INTRICATE SYSTEM of valves and pipes that has been installed to transport liquid oxygen and hydrogen are E. W. Littlefield, executive vice-president and general manager of Utah Construction & Mining Co., and Maj. Gen. Alvin Charles Welling, deputy for site activation for the Corps of Engineers. The liquid gasses will be used for rocket fuel.

A VAST 2-STATE ROLE IN ICBM DEFENSES.

DEVELOPMENTS this week have pointed up the highly important new role of the Missouri-Kansas area in the nation's defense program. Dozens of intercontinental ballistic missiles eventually will be emplaced in the two states. These weapons are part of a fast-building complex that is one of three major elements in the strategy to deter global war.

Missouri and Kansas already provide bases for the medium and long-range jet bombers of the Strategic Air command. Now the neighbor states are starting to furnish sites for ballistic missiles. Thus the area will be directly concerned with all war-deterring activities except the deployment of Polaris missile submarines.

Yesterday a ceremony was held at the Schilling Air Force base near Salina, Kas., to mark the completion of 12 Atlas F missile-launching sites. All 12 sites have been built ahead of schedule, some as much as three months ahead. There were no work interruptions because of labor difficulties.

This fact is worth noting because of the wide publicity given to strikes and delays at missile projects in Florida and California. Changes in design created extremely difficult technical problems. The finished job reflects credit on the Army corps of engineers, the participating labor unions and the four joint-venture contractors: The Utah Construction & Mining company of San Francisco; the Manhattan Construction company of Oklahoma City; the Sundt Construction company of Tucson, Ariz., and the Howard P. Foley company of Washington.

NINE Atlas bases also have been completed in Northeast Kansas. They are under the control of the Forbes Air Force at Topeka. Still under construction are 18 Titan ICBM sites in South Central Kansas.

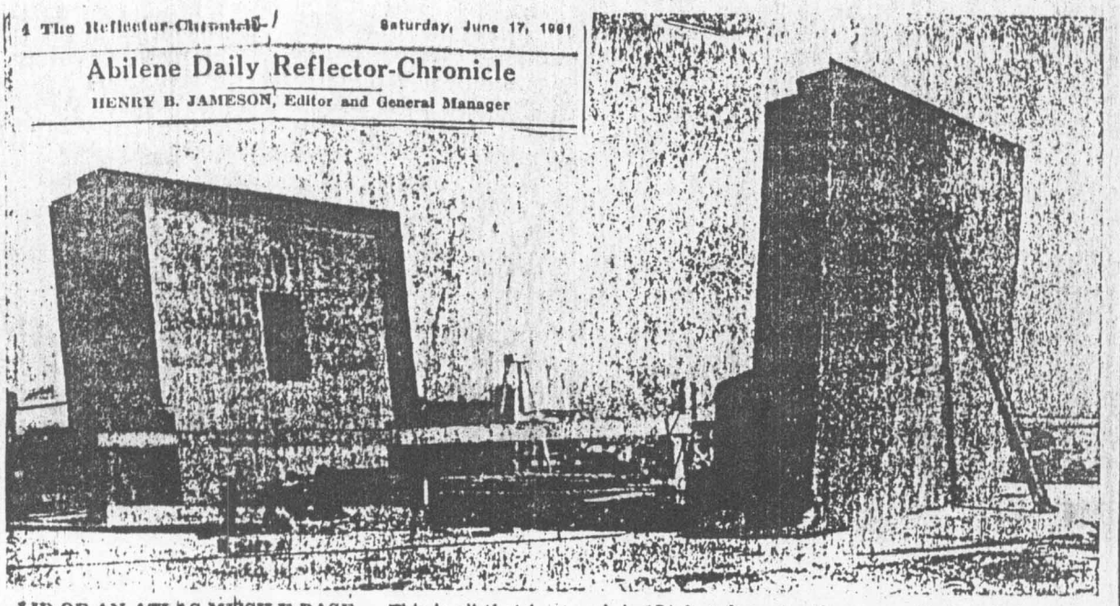
The big new development is an announcement that the Whiteman Air Force base at Knob Noster, Mo., will be the support base for the next hardened and dispersed Minuteman complex. The solid-fuel Minuteman ICBM is a second-generation weapon representing a step beyond the Atlases and Titans.

Thus residents of Kansas and Missouri will have in their midst a major share of the U. S. deterrent strength. The construction and operation of the ICBM sites will be important to the economy of this region.

Still unanswered is this question: If it is vital to disperse missile-launching sites to the least vulnerable midlands, why is it not equally important to disperse the more than 90 missile industry plants that are dangerously bunched up on the West and East coasts and in the South?

Logically the Mid-West should produce space weapons as well as furnish rocket-launching locations.

Abilene Daily Reflector-Chronicle
HENRY B. JAMESON, Editor and General Manager



LID OF AN ATLAS MISSILE BASE — This is all that is visible from above ground at any of the Atlas missile bases in the Abilene area, and this much cannot be seen when the huge concrete doors are closed. The concrete "silo" which will hold the missile and all of the equipment to make it work is 174 feet deep. Another connecting controls center building is buried the equivalent of three stories underground. An elevator system raises the 82-foot missile through these doors to the surface for firing.

Atlas Missile Bases Turned Over to Military, Putting Abilene in the 'Target Area'

By Henry B. Jameson
Editor Reflector-Chronicle

This is not intended as a "scare" story. But it would be foolhardy for us to pretend there is nothing to fear like the ostrich sticking its head in the sand, or the proverbial optimist who looked the other way hoping the problem would go away.

If this country ever becomes involved in a nuclear war Abilene and this entire central Kansas area will be smack in a prime enemy target area.

This was one of the conclusions one gained after spending most of a day and evening with some of the nation's top missile experts and others at various functions held Friday in connection with the formal completion of the first construction phases of the 12 Atlas F Intercontinental Ballistic Missile bases in the Schilling Air Force base complex. One of the highlights was an official "turning over" ceremony and tour of the last of the sites to be completed on a knoll that used to be part of a wheat field just a few miles northwest of Chapman.

One hundred years ago Indians were attacking wagon trains in the same general area that now houses one of America's most potent space-age weapons.

These are the country's first Atlas F (silo type launching facilities) bases on which construction has been completed to the point of the U.S. Corps of Engineers accepting the sites from the contractors. The next two phases will include installation of all the complicated electronics equipment and component parts and then placing and hooking up the actual missiles. This work will go on into 1962.

Confirmation that this could be considered a "target area" came from no less an authority than Major General T. P. Gerrity, commander of the Air Force ballastic systems division, who flew from California to take part in Friday's activities which he called "a major milestone in the Atlas program and the nation's defense."

It could not be otherwise, with all of the prime military installations that now exist in central Kansas. The list includes Topeka, Wichita, Salina, and many intermediate points—and the 12 missile sites themselves.

However, General Gerrity quickly pointed out that location of the missile sites should cause no special alarm. "As a matter of fact," he said, "the fact these are virtually hidden and blast proof as underground fortresses tells the enemy that it would be virtually impossible for him to destroy the missiles before they could be fired into his own homeland in retaliation. This greatly lessens the vulnerability of this area."

Questions concerning this aspect of the missile bases arose after the press, military officials, engineers, construction people and civic leaders from several cities (including Mayor C. W. Samuelson of Abilene) had an opportunity to take a tour of the Chapman base. It was noted throughout the tour, and explanations of the construction, that every possible precaution has been taken to protect the missile as well as the personnel in case of an enemy attack.

These include series after series of complicated electronic devices, blast doors and escape hatches. There is nothing special about this at these installations, the general pointed out. It is just part of the overall construction program applied at all similar sites.

It was re-emphasized that the Atlas bases in this area are designed for firing of the missiles only as an offensive weapon after the enemy has struck the first blow, and Gen. Gerrity said there is no reason at this time to believe this plan will be changed.

He compared the country's missile program to the B-36 bomber, which he credited with "having won a war that was never fought—the fact we had it kept us out of war." "We hope the Atlas missile will serve the same purpose by never having to be fired," he said.

Main reason for location in this area was deployment in areas near large air base control centers and to avoid large centers of population.

The missile base is an awesome sight. I visited the Chapman site a few months ago when it was a huge hole in the ground being ringed and filled with concrete. Today, it represents a huge concrete fortress all concealed underground and hardly visible from the air. This one and the others in the Schilling group were built in record time. The Chapman base was the last to be completed because construction people run into unexpected underground water veins which delayed the work in the early stages.

The "silo" portion which will hold the missile goes down 174 feet below the surface and is 52 feet in diameter. The concrete walls vary from two to nine feet in thickness. The lid consists of two huge reinforced concrete doors that open and close flush to the ground surface on the push of a button.

The missile is "stored" in the underground pit—but ready to go at any time—and is lifted to ground level for firing. It does not blast off from down in the hole.

Down about the equivalent of three stories underground is the concrete headquarters or controls nerve center, which also includes quarters for the base personnel. They will not live there except while on duty but this underground office includes all the necessary facilities, including a modern electric kitchen. This section is connected with the "silo" by a tunnel about

(Continued on Page Six)

Local Missile . . .

(Continued from Page One)

the size of the interior of a submarine.

One of the engineering achievements is that everything inside the concrete shells of the silo and the controls building is suspended on steel framework and held in adjustable positions by some of the largest steel springs ever built in this country. Nothing except electronic ground wires actually touches the concrete walls.

The silo portion is divided into eight levels and under these is still enough room to place a three story building. Each level, all around the center circle which will hold the missile, is crammed with complicated equipment or prepared to receive it in the next phase of work. Huge diesels generate power for lights, air conditioning and scores of other uses.

Winding steel steps lead from one level to the other—but there is also a large elevator which is busy most of the time.

Under the present program, and with completion of these 12 sites, the United States will be capable of firing 72 Atlas missiles simultaneously, or in series, to most any point on the globe with amazing accuracy. Any one of them can be fueled and fired within 15 minutes. They have a range of over 6,300 miles and zoom to their target at 17,000 miles an hour.

On the target accuracy of less than two miles is claimed.

The Atlas missile itself is 82½ feet long, 16 feet wide at the flared points.

All the Atlas missile sites, if used for storage of wheat, could hold five million more bushels than the total grain elevator capacity of the city of Indianapolis and the concrete in them would build a highway 20 feet wide and six inches thick from St. Louis past Chicago.

Gen. Gerrity and other officials declined to estimate the "life span" of the Atlas bases in this area. "This depends on too many factors", said Gerrity. He could not venture a guess as to what might happen to them if and when the Atlas might become outmoded as an intercontinental weapon. The number of permanent personnel at the base is a secret but about 600 will be divided among the Schilling control center and the 12 bases.

"But I would not be counting on storing wheat in them," he laughed.

More than 100 guests attended a dinner at Schilling Friday night to complete the day's activities. Various speakers were highly complimentary of the workmen on these jobs and the communities for their cooperation.

PART IV

MISCELLANEOUS

23. SPECIAL EVENTS

Of major interest to the Schilling Area Office, as per special events, were two key visits and two ceremonies. Said visits were by the respective Chiefs of Engineers, Lt. Gen. E. C. Itschner, the past Chief of Engineers; and, Lt. Gen. W. K. Wilson, the present Chief of Engineers. Visits by the other numerous key personnel, to this office, are listed at the end of this section.

The ceremonies of interest occurred when: The Schilling Area Office was transferred from the operational control of the Kansas City District Office to CEMSCO (refered to as "The Change Over Ceremony") and the turning over to the USAF by the Corps of Engineers, ahead of schedule, of the 12 Missile Launch Facilities here at SAFB (refered to as "The Turn Over Ceremony").

VISIT OF LT. GEN. E. C. ITSCHNER

Lt. Gen. Itschner, Chief of Engineers, accompanied by Major Gen. Minton, Brig. Gen. Welling, Brig. Gen. Gill, Brig. Gen. Drenger, Brig. Gen. Leonhard and party arrived by plane at Schilling Air Force Base from Lincoln AFB on 19 August 1960.

Gen. Itschner was met by Major General Barney, MRD Engineer, Colonel Jumper, Commander 310th Bomb Wing; Colonel Summers, Commander 310th Combat Support Group; Colonel Cruikshank, SATAF Commander and Lt. Col. Leonard, Area Engineer.

General Itschner and party proceeded by cars to the Area Office where they were briefed on construction progress by Lt. Col. Leonard.

General Itschner and party were then taken by helicopter to Missile Construction Site 8 (Beverly) and Site 12 (Tescott) for a familiarization tour and an inspection. Upon returning to the Area Office a short conference was held. The group then boarded their plane and departed for Washington, D. C. General Itschner's visit was mainly for familarization, and he requested minimum publicity. The group's visit lasted approximately 6 hours.

VISIT OF LT. GEN. WALTER K. WILSON

On Tuesday, 6 June 1961, Lt. Gen. Walter K. Wilson, Chief of Engineers, arrived by plane at Schilling Air Force Base from McConnell Air Force Base, Wichita, Kansas, on a familarization and inspection tour of various Missile Construction Sites.

General Wilson was welcomed to Schilling by Colonel Summers, Base Commander; Colonel Hayes, 310th Wing Commander; Colonel Cruikshank, SATAF Commander and Colonel Jennings, Area Engineer.

General Wilson was accompanied by Colonel T. J. Hayes, Colonel J. Lemm, Colonel C. H. Whitesell, Colonel W. W. Wilson, Major Hargraves and Captain Needham. General Wilson and party boarded two Army Helicopters and were flown to Chapman (Site 2) and Carlton (Site 3) Missile Sites where a familarization and inspection tour was conducted by Colonel Jennings.

Tuesday evening General Wilson and other key guests from the base and the community (Salina, Kansas) attended a dinner reception at the home of Colonel Jennings.

Wednesday morning, 7 June 1961, General Wilson met the Area Engineers' staff and was briefed by Colonel Jennings on the Schilling

Area Missile Construction Program. Colonel Jennings used numerous color slides to show the various stages of progress from the start of construction up to the then present point of construction.

General Wilson held a short conference with officials of the prime contractor, then boarded his plane for Lowry Air Force Base, Colorado, the next stop on his tour. See figures 52 to 55.

CHANGE OVER CEREMONY

Pursuant to General Order No. 34, WCL, dated 11 October 1960, the Schilling Area Office was transferred from the operational control of the Kansas City District to the operational control of the then, newly formed, Corps of Engineers Ballistic Missile Construction Office with Headquarters in Los Angeles, California.

Change over ceremonies were held at Site #4, McPherson, Kansas on 25 October 1961.

Representing the Kansas City District Office was the District Engineer, Col L. F. Laurion; representing CEBMCO was the Director of the Atlas F Program, Col. W. W. Wilson.

The ceremony was an informal one. Col Laurion made a short speech, stressing the national defense need and importance of the missile program, the fine work done up to this point by everyone concerned and the role played by the Kansas City District Office. Col Wilson, in a short speech, formally accepted on behalf of CEBMCO, the Schilling Area Office.

After the ceremony, everyone descended to the McPherson Country Club for dinner. Coordinator for the ceremony was Capt James Z. Metallios, Schilling Air Force Base.

The following is a list of some of the guests who attended:

Col T. J. Hayes, (then) Vice Commander CEBMCO, Los Angeles, Calif.

Col W. W. Wilson, Director of Atlas "F", CEBMCO, Los Angeles, Calif.

Col L. E. Laurion, Kansas City District Engineer, Kansas City, Mo.

Col Arthur W. Cruikshank, Jr., SATAF Commander, Schilling AFB, Kans.

Lt Col Edward L. Little, Chief AFBMD, Schilling AFB, Kansas

Lt Col J. M. Leonard, Area Engineer, Schilling AFB, Kansas

Lt Col Earle L. Valenstein, Project Officer, Missiles, Kansas City District Office, Kansas City, Missouri

Capt Robert D. Vincent, Special Assistant, PLS, Schilling AFB, Kansas

Capt James L. Metalios, Assistant Resident Engr (Coordinator of Ceremony) Site 3, Carlton, Kansas

Mr. Richard E. Fayzant, Assistant Area Engineer, Schilling AFB, Kansas

Mr. James C. Stewart, Project Manager, Utah-Manhattan-Sundt

Mr. Carl Ramsey, Mayor of Salina, Kansas

Mr. G. G. Dixon, Mayor of McPherson, Kansas

Mr. Wayne Dailey, Chairman of Military Affairs Committee, Salina Chamber of Commerce

Mr. Glen Blangers, President Trade Council, Salina, Kansas

Mr. Kenneth Maury, President, McPherson Chamber of Commerce

Also present were other key personnel from the Schilling Area Office, SATAF, Salina and the surrounding community.

TURN OVER CEREMONY

Commensurate with the 186th Birthday of the Corps of Engineers on this date, 16 June 1961, the Schilling Area Office turned over to the United States Air Force, ahead of schedule, the twelve missile launching sites in this area. The turn-over ceremonies for this date consisted

of the following: All the invited guests (see attached list) were asked to assemble and sign in at the Officer's Club, Schilling AFB, Kansas prior to 11:30 A. M. Everyone then proceeded to have a light buffet lunch at the club. Among the distinguished guests present were Congressman J. Floyd Breeding, (D-Kansas), Maj Gen A. C. Welling, USA, Deputy Commander for Site Activation, Col W. W. Wilson, USA, Director Atlas F, CEBMCO, Colonel A. W. Cruikshank, USAF, Site Activation Task Force Commander and Col E. B. Jennings, USA, Schilling Area Engineer, plus other dignitaries from Utah-Manhattan-Sundt, the town of Salina, Kansas and various state and local reporters. After lunch all personnel were driven to Site 2, Chapman, Kansas, via four Army buses supplied by Ft. Riley, Kansas, where the second part of the ceremony took place. At Site 2 the reporters were escorted through the Launch Control Center and Launching Silo on a familiarization tour. The remainder of the group visited the site in general. On display at the site was a series of photographs (60) depicting, in chronological order, the various construction phases (in general) of this project. On a second bulletin board was a display of the Atlas F. Missile in various positions of pre-launching and in flight. Thirdly, a soft drink and coffee stand was available for those who desired to utilize it and lastly the Ft. Riley Army Band provided interludes of music commensurate with the occasion. A bleacher section utilized by the guests was created and a low buoy was utilized for the key dignitaries and guest speaker. Col E. B. Jennings, Schilling Area Engineer, accepted on behalf of CEBMCO and the Government the twelve completed sites from Mr. James C. Stewart, Project Manager, Utah-Manhattan-Sundt. Colonel Jennings then transferred the twelve sites

over to Colonel A. W. Cruikshank, Jr., Site Activation Task Force Commander, who accepted them on behalf of the United States Air Force. After the ceremonies at Site 2, which lasted approximately 45 minutes with short speeches by each of the above mentioned (3) personnel, all the guests were transported back to the Officer's Club at Schilling AFB and a press conference was held with the following people answering the various questions asked by the press: Maj Gen T. P. Gerrity, USAF, Commander Ballistics Systems Division, Colonel A. W. Cruikshank, USAF, Site Activation Task Force Commander, Colonel L. B. Jennings, USA, Schilling Area Engineer and Mr. James C. Stewart, Project Manager, Utah-Manhattan-Sundt. Upon the completion of the press conference, a cocktail hour and dinner followed. The events of the evening included a presentation of a Certificate of Appreciation to Utah-Manhattan-Sundt, Joint Venture, for outstanding work on the twelve missile sites in the Schilling Area. Said award was given to Utah-Manhattan-Sundt by the Corps of Engineers. Making the presentation was Maj Gen A. C. Welling, Deputy Commander for Site Activation and accepting on behalf of the Joint Venture was Mr. E. W. Littlefield, Executive Vice President, Utah Construction and Mining Company. Also, Col L. B. Jennings received the Air Force Commendation Award for outstanding work while assigned as Area Engineer here at Schilling. The key speaker for the evening was Maj Gen T. P. Gerrity, Commander Ballistics Systems Division (who was only present for the evening portion). The ceremony concluded at approximately 2200 hours. (See photographs Fig 56 to Fig 72 and newspaper clippings Fig 73 to Fig 77).

The coordination committee for the ceremony consisted of Maj Frank W. Robson, representing CEBMCO, Capt James Z. Metalios, representing Schilling Area Office and Mr. Clyde Barrington, representing Utah-Manhattan-Sundt.

The following is a list of some of the guests who attended:

Congressman J. Floyd Breeding, 5th District, Kansas

Maj Gen T. P. Gerrity, USAF, Commander, Ballistic Systems Division

Maj Gen A. C. Welling, USA, Deputy Commander, Site Activation Task Force

Col W. D. Alexander, III, USAF, Chief of Facilities Design Branch, Ballistic System Division

Col A. W. Cruikshank, Jr., USAF, SATAF Commander

Col E. B. Jennings, USA, Area Engineer, Schilling Area, Schilling AFB, Kansas

Col J. B. Summers, USAF, Schilling Air Force Base Commander

Col W. W. Wilson, USA, Atlas "F" Director, CEBMCO

Lt Col Earl L. Valenstein, USA, Deputy District Engineer, Kansas City District Office

Mr. E. W. Littlefield, Executive Vice President, Utah Construction and Mining Co.

Mr. J. W. Petre, Base Activation Manager, "F" Series, GD/A

Mr. James C. Stewart, Project Manager, Utah-Manhattan-Sundt

Mr. J. S. Sundt, President of Sundt Construction Company

Mr. C. J. Haggerty, President National Building and Trades Department AFL/CIO

Mr. Jim Marshall, Executive Director Associated General Contractors

Mr. Wayne E. Dailey, Chairman, Salina Military Affairs Committee

Mr. L. F. Rooney, President, Manhattan Construction Company

Mr. D. T. Foley, Sr., Howard P. Foley Company

Mr. C. R. Jackman, Base Project Manager, GD/A

Mr. Charles McGraw, Vice President, Utah Construction & Mining Company

Mr. Charles Berrell, Vice President, H. P. Foley, Company

Mr. Finley Basore, Vice President, Manhattan Construction Co.

Mr. Paul Hardeman, President, Paul Hardeman, Inc.

Also present were other key personnel from CEBMCO, BSD, Schilling Area Office, Kansas City District Office, SATAF, the Contractors, and the Salina community.

COMMAND, STAFF VISITS, AND INSPECTIONS

Corps of Engineers, Schilling Area

May 1960 to November 1961

Period	Agency	Inspector	Facility Inspected
19 May 1960	KCDO	Col Laurion	Command Visit Schilling AFB, Kansas
26 May 1960	Altus Air Force	CWO Bushwell	Orientation Visit Schilling Area
7 Jun 1960	KCDO	Col Laurion	Command Visit Schilling Area
8 Jun 1960	NYDO	Major Rhodes	Orientation Visit Schilling Area
8 Jun 1960	Hq USAF	Major Gen Minton	Command Orientation Visit
13 Jun 1960	KCDO	Lt Col Carlson	Orientation Visit
17 Jun 1960	KCDO	Col White	Orientation Visit
29 Jun 1960	ADIA	Sec OFC E. Smith	Security Staff Visit
7 Jul 1960	OCE	E. H. Nesbitt	Schilling Area, KCDO
7 Jul 1960	OCE	Geo. E. Olson	Schilling Area, KCDO
7 Jul 1960	MRD	L. B. Underwood	Schilling Area, KCDO

Period	Agency	Inspector	Facility Inspected
18 Jul 1960	MRD	T. J. Reading	Schilling Area, KCDO
21 Jul 1960	MRD	K. S. Love	Schilling Area, KCDO
26 Jul 1960	LAFC/OCE	L. H. Miller	Schilling Area, KCDO
3 Aug 1960	MRD	A. J. Willhart	Schilling Area, KCDO
3 Aug 1960	MRD	M. L. Irvine	Schilling Area, KCDO
17 Aug 1960	MRD	T. J. Reading	Schilling Area, KCDO
23 Aug 1960	MRD	Sec Ofc J Driskell	Staff Visit
29 Aug 1960	CEBMCO	Lt Col W Sanders	Staff Visit
9 Sep 1960	MRD	J W MacDonald	Schilling Area, KCDO
13 Sep 1960	ADC	B Gen Yancez	Command Orientation Visit
13 Sep 1960	Base Com	Col Jumper	Command Orientation Visit
19 Sep 1960	OCE	LtGen E. C. Itschner (Chief of Engineers)	Command Orientation Visit and Briefing - Visited Missile Sites 8 & 12
19 Sep 1960	MRD	Maj Gen K Barney	" " "
19 Sep 1960	CEBMCO	Col Conni	" " "
19 Sep 1960	OCE	Col Arthur Frye, Jr.	" " "
19 Sep 1960	MRD	Mr. Wendell Johnson	" " "
19 Sep 1960	KCDO	Mr. Meredith Broyles	" " "
19 Sep 1960	CEBMCO	B Gen Welling	" " "
19 Sep 1960	Hq, USAF	Maj Gen A Minton	" " "
19 Sep 1960	Hq, USAF	B Gen C. F. Drenger	" " "
19 Sep 1960	BMC-AMC	B Gen J. E. Gill	" " "
19 Sep 1960	Hq, AFBMD	B Gen W. E. Leonhard	" " "
19 Sep 1960	OCE	Col W. Fowler	" " "
19 Sep 1960	AF	Col Cipolla	" " "

Period	Agency	Inspector	Facility Inspected
19 Sep 1960	SAC, Omaha	Col Kenneth Payne	Command Orientation Visit and Briefing - Visited Missile Sites 8 & 12
19 Sep 1960	CEBMCO	Lt Col W Sanders	" " "
19 Sep 1960	CEBMCO	Col T. J. Hayes	" " "
19 Sep 1960	Ft Worth Dist	Col N. R. West	" " "
19 Sep 1960	CEBMCO	LtCol T. Spencer	" " "
19 Sep 1960	COE, Plattsburgh	J. Melot	" " "
25 Sep 1960	MRD	K. L. Love	Schilling Area, KCDO
27 Sep 1960	KCDO	Maj E L Valenstein	Schilling Area, KCDO
29 Sep 1960	MRD	Meredith Broyles	Schilling Area, KCDO
12 Oct 1960	MRD	C C Gunn	Schilling Area, KCDO
12 Oct 1960	MRD	C Houlehan	Schilling Area, KCDO
12 Oct 1960	CEBMCO	Donald Greek	Co-ordinating change over of Area from KCD to CEBMCO
12 Oct 1960	CEBMCO	R W Miller	" " "
12 Oct 1960	CEBMCO	R R Reynolds	" " "
13 Oct 1960	MRD	C C Gunn	Safety Inspection
13 Oct 1960	MRD	B Gen W R Shuler	Command Orientation Visit
13 Oct 1960	MRD	Wendell Johnson	" " "
13 Oct 1960	MRD	Kenneth Middleton	" " "
13 Oct 1960	CEBMCO	N J Mounts	" " "
13 Oct 1960	CEBMCO	Phil Garberg	" " "
16 Oct 1960	CEBMCO	W W Wilson, Col	" " "
16 Oct 1960	KCDO	Maj Valenstein	" " "
16 Oct 1960	KCDO	Col A R Rollins, Jr.	" " "

Period	Agency	Inspector	Facility Inspected
25 Oct 1960	CEBMCO	Col Hayes	Command Orientation Visit
25 Oct 1960	CEBMCO	Col W W Wilson	" " "
15 Nov 1960	MRD	E E Maurer	CEBMCO, Schilling Area
17 Apr 1961	USAAA	C Scott	Army Audit Inspection *
17 Apr 1961	USAA	C. O. Cochran	Army Audit Inspection *
27 Apr 1961	OCE	T E Silvers	CEBMCO, Schilling Area
17 May 1961	USAAA	J P Cody	Army Audit Inspection *
7 Jun 1961	OCE	LtGen W.K.Wilson, Jr. (Chief of Engineers)	Command Visit, Briefing and Familiarization Tour of Missile Constr Sites 2 & 3
7 June 1961	OCE	Capt W.R.Needham	Command Visit, Briefing and Familiarization Tour of Missile Constr Sites
8 Jun 1961	USAA	R.W. Hartman	Army Audit Inspection *
14 Jun 1961	OCE	J P Cale	CEBMCO, Schilling Area
14 Jun 1961	MRD Labs	F M Mellinger	CEBMCO, Schilling Area
16 Jun 1961	CEBMCO	Col W. W. Wilson	Turn-over Ceremonies
16 Jun 1961	BSD-USAF	Lt Col Priest	" " "
16 June 1961	SATAF	Lt Col Vivian	" " "
16 Jun 1961	House of Representatives	Congressman J. Floyd Breeding (D-Kansas)	" " "
16 Jun 1961	Washington D. C.	C. J. Haggerty	" " "
16 Jun 1961	BSD	B Gen A Welling	" " "
22 Jun 1961	CEBMCO	Maj F. Robson	I G Inspection
14 July 1961	CEBMCO	WO Ray D Lucas	Security Staff Visit
17 Jul 1961	EIG Fld Of Chicago	Lt Col R W Cowart	Annual General IG Inspection

Period	Agency	Inspector	Facility Inspected
18 Jul 1961	KCD	W N Moore	Blast Closure Conference w/Schilling Area Personnel
18 Jul 1961	Henry Pratt	C M Stearns	" " "
18 Jul 1961	CEBMCO	D W Smith	" " "
18 Jul 1961	Henry Pratt	R Saar	" " "
18 Jul 1961	Henry Pratt	G Helm	" " "
18 Jul 1961	Armour Res. Foundation	John MacDonald	" " "
18 Jul 1961	Flick Rudy Corp	H. S. Rasmussen	" " "
18 Jul 1961	CEBMCO	Chas J. Teeple	" " "
18 Jul 1961	CEBMCO	WO Ray D Lucas	Security Inspection
20 Jul 1961	PtWorth Dist	J C Sheffield	PLS-Gov't Furnished Equip.
20 Jul 1961	CEBMCO	J L Fishback	Area Visit with CAB
26 Jul 1961	CEBMCO	F W Robson, Maj	I G Inspection
26 Jul 1961	CEBMCO	Solomon kibakoff	Conference
26 Jul 1961	Hq, USAF	Daniel Guyton	Conference
31 Jul 1961	CEBMCO	John J. Martin	Review of Property Records
4 Aug 1961	CEBMCO	LtCol F J Dirkes	Staff Visit
11 Aug 1961	Ft Worth	D E Walker	PLS Inspection
11 Aug 1961	Ft Worth	Charles Hazelwood	PLS Inspection
29 Aug 1961	CEBMCO	T J Hayes, Col	Command Visit
29 Aug 1961	Plattsburgh	L B Bromkamp, LtCol	Staff Visit of Plattsburgh Area Engineer
7 Sep 1961	CEBMCO	F W Robson, Maj	I G Inspection
14 Sep 1961	CEBMCO	L T Rose	PLS Acctg
14 Sep 1961	CEBMCO	F W Munneke	PLS Equip
29 Sep 1961	KCD	Meredith Broyles	Area Visit

Period	Agency	Inspector	Facility Inspected
29 Sep 1961	KCD	C H Erickson	Area Visit
29 Sep 1961	KCD	Ray Watson	Area Visit
10 Oct 1961	CERMCO	Lyle Johnson	Conference with Area Engineer: Ref Struthers Wells, Inc.
10 Oct 1961	CERMCO	J Devine	" " "
12 Oct 1961	CERMCO	L J Sullivan	Inspection of Admin Records
8 Nov 1961	CERMCO	T F Spencer, Col	Staff Visit
13 Nov 1961	CERMCO	Anna Davis	Record Inspection
13 Nov 1961	KCD	C M Strain	Clearance - Property
14 Nov 1961	CERMCO	Kendall Silva	Staff Review of Property
16 Nov 1961	San Francisco District	Earl Moss	BDS Installations
16 Nov 1961	ITT - Kellogg	E C Hechinger	BDS Installations
20 Nov 1961	CERMCO	W J Mountz	Modifications

* Auditing contractor's books for use in settling contract modifications and possible claims.

24. ACCIDENTS

The following narratives concern the five major (fatal) accidents that occurred during the construction of the 12 Atlas Missile Silos under the control of the Schilling Area Office:

ACCIDENT NO. 1 (FATAL)

a. Date: 23 July 1960

b. Time: 0755 Hours

c. Location: Site #4

d. Name of Deceased: Mr. Merle Jennings

e. Description of Accident: A thirty-five ton crane was moving deck forms for the Launch Control Center (LCC) from a storage space (on the ground) to the top of the LCC. The storage space was on the opposite side of the access road from the LCC. This required the load to be swung over the road. Carpenters attached the forms to the crane with a 3/4-inch endless rope sling. The crane operator picked up each load about two feet to see if it was in balance before swinging it. Mr. Jennings and two other carpenters were repairing a scaffold about 10 feet from the base of the LCC. They were working approximately under the swing of the crane's load. Seven forms were lifted without incident. When the 8th form was test lifted, it appeared to be in balance. As it neared the top of the LCC, it became loose and slipped out of the sling falling on Mr. Jennings' head. The form also hit one of the other carpenters with a glancing blow on the right hip. Said form apparently struck the second carpenter after first hitting the ground.

f. Recommendations for Prevention of this Accident:

1. Rigging

(a) Use two slings instead of one sling.

(b) Place the sling on the parallel sides when handling these trapezoidal shaped forms.

(c) Use nails to prevent rope from slipping.

(d) Use of "eye-bolt" through 2" x 6" member.

2. Indorsement and the inforcement of preventing men from working under swinging loads.

3. Use of a whistle when starting to lift loads.

4. Use of posters such as "Warning - Crane Working Overhead."

5. Publicizing details of the accident

6. More attention to contractor's job site layout by everyone to minimize the exposure of workmen to hazards incident to this heavy type of construction work.

ACCIDENT NO. 2 (FATAL)

a. Date: 3 August 1960

b. Time: 1530 Hours

c. Location: Near Site #8

d. Name of Deceased: Mr. Alvin Leikam

e. Description of Accident: Mr. Alvin Leikam was driving a transit mix truck between Sites #8 and #12, a distance of approximately 10 miles. He left for Site #12 with a load of concrete between 1515 and 1530 hours and headed for Site #8. He headed west on Kansas Highway #18 and then turned North on the gravel county road leading to Site #8. Approximately one half mile from Site #8 the truck traveled for approximately 137 feet on the edge of the shoulder before the right front wheels stuck in the soft earth of the ditch. The truck rolled over on the right side and the

butane fuel system caught fire. Mr. Leikam either climbed or fell out of the cab during the accident. His body was burned quite badly. He apparently died before the fire was ever extinguished. The front of the vehicle received extensive fire damage.

f. Recommendations for Prevention of this Accident:

1. That vehicle operators conform more closely to Paragraph 18-115 of the Corps of Engineers Manual "General Safety Requirements", which limits the length of time that an operator may operate a motor vehicle, to 10 consecutive hours. The evidence indicated that Mr. Leikam's working hours were quite long on this date.

2. That an investigation be made regarding the position of the butane tanks and the feasibility of additional fire protection for it and for the fuel lines.

ACCIDENT NO. 3 (FATAL)

a. Date: 10 October 1960

b. Time: 0915 Hours

c. Location: Site #10

d. Name of Deceased: Mr. J. C. Nelson

e. Description of Accident: Immediately prior to the accident the following construction operations were in progress inside the silo. Dismantling of the slip form into four sections and removal of each section from the silo. One one-quarter section had been removed and the truck mounted crane was being re-spotted to remove a second section. The remaining three (3) sections of the slip form were tied off with wire rope to the reinforcing steel, (#14) bars, which projected approximately 5 ft. above the inside face of the concrete silo wall. The deceased,

together with two others who were on the slip form were preparing one-half of a 55 gallon barrel so that it could be taken and re-filled with sandblasting grit. A fourth person was preparing to rig this section of the slip form so that it could be lifted out. The aforementioned four men who were on this section of the slip form, heard it crack. Said form then broke loose from the tie off. Three of the men were able to catch hold of reinforcing bars mentioned above and pull themselves to safety. Mr. Nelson lost his balance and was not able to grasp the reinforcing bars and fell with the section of slip form that broke off. He fell to the bottom of the silo, a distance of approximately 165' where he was impaled on a piece of angle iron serving as a lifting stanchion on a float for the water pump in the silo. The impact caused the pump float to turn over in the water which was approximately 15 feet deep, causing Nelson to be held below the water. He was dead when reached by rescuers.

f. Recommendations for Prevention of this Accident:

1. When slip forms are tied off, the wire rope be run around the laminated wales rather than the 2 x 8 floor joists.

2. That all personnel except those essential for rigging be prohibited from getting on the slip form once lateral bracing has been removed and prior to actual removal of the form from the silo.

3. Publication of information on this accident and discussion of same at the weekly safety meetings, stressing the importance of knowing the soundness of any scaffolding before going on it or working from it.

ACCIDENT NO. 4 (FATAL)

a. Date: 19 November 1960

b. Time: 0915 Hours

c. Location: Site #11

d. Name of Deceased: Mr. James E. Mills

e. Description of Accident: Immediately prior to the accident the following construction operations were in progress within the launching silo. An eight-man crew of the American Bridge Division were connecting cross bracing to structural steel which formed the cribbing inside of the launching silo. Several rods had been connected successfully. Mr. J. E. Mills then positioned himself on a vertical "I" beam to make pin and clevis connections between the 1st and 2nd levels. Mr. Mills supported himself by wrapping his legs around the vertical member and reached out over the silo opening to insert the pin. He apparently shifted his position and over-reached, lost his leg grip on the "I" beam and fell. His foreman attempted to catch him as he fell, but was unable to hold him. Mr. Mills struck a swinging scaffold, hanging between the third and fourth levels, pitched forward and continued to fall another 150' to the floor of the silo, landing on his back. He was dead on arrival at the Abilene Hospital of multiple fractures which included a broken neck.

f. Recommendations for Prevention of this Accident:

1. That safety belts and life lines in accordance with mandatory provisions of Par. 7-1i of Section VII, EM 385-1-1 "General Safety Requirements" be utilized.

2. Publication of information on this accident to all concerned, stressing that life and death hinges on proper and constant use of one's safety belt.

ACCIDENT NO. 5 (FATAL)

a. Date: 6 January 1961

b. Time: 1305 Hours

c. Location: Site #9

d. Name of Deceased: Mr. Dave Moody

e. Description of Accident: Mr. Moody and his supervisor were checking the correct alignment of some large horizontal gaseous pressure vessels which had been placed in the silo. They had just returned from lunch and were climbing back up to continue checking the alignment. Mr. Moody and his supervisor had climbed up from level 5 to level 7B and were standing on a beam located on the perilery of the steel crib. An American Bridge crew was working on a float on the side of the tanks near the center of the silo. A crew of Paul Hardeman, Incorporated men were working on level 7 on the South side of the pressurization prefab. A welder from Southwest Ornamental Iron Company was working on level 7 on the Northwest side of the pressurization prefab cutting the steel grating. At approximately 1305 hours a piece of heavy steel pipe weighing about 60 lbs. fell from overhead approximately 35 feet between the pressure vessels and the silo wall and hit Mr. Moody on the back of his hard hat. Mr. Moody was knocked off the beam and fell 25 feet to the concrete floor of the silo. The section of steel pipe became wedged between the silo crib and the pressure vessel and to the bottom. The first person to reach Mr. Moody reported that he gasped several times and then became still. A check of his pulse and breath indicated that he was dead.

f. Recommendations for Prevention of this Accident:

1. That spools temporarily tied off in a horizontal position

be tightly secured at both ends and that the wire or rope be tightly wrapped around the spool several times.

2. The wire or rope should be tied to the grating only if no other support is available. If it is necessary to tie to the grating, a piece of plywood should cover the grating area.

3. That appropriate size wire or rope be used. Recommend that #9 gauge steel wire be the lightest wire to support pipes of this weight.

NON FATAL ACCIDENTS

Due to the crowded conditions which prevailed at the sites and in some cases use of improper or inadequate equipment and safety procedures, the following types of cases became prevalent here at Schilling:

a. Falls (non-fatal) - 15

b. Strains, sprains, cuts & bruises - 11

c. Hit by falling objects - 5

d. Burns (including chemical) - 4

In addition to the above mentioned incidents there were several cases (1 or 2) of: fires (truck & equipment), buckling boom, overturned crane, parts of body caught in, on, or between something, lead poisoning and an explosion.

The weather did not provide any major safety problems but did require added caution by everyone while in transit to and from the missile sites; (when it snows in Kansas --- "IT SNOWS").

The Contractor, throughout the duration of the project, received several letters from the Area Engineer when his safety program was faltering. He was cooperative in correcting these deficiencies

general his safety program was good. On numerous occasions he was noted taking safety precautions whenever necessary, without having to be notified of the safety hazard by the Area Engineer.

25. RELATIONSHIP WITH SATAF

RELATIONSHIP

In addition to the title and duties of Area Engineer, the Area Engineer obtained the title of Deputy for Construction for the SATAF on 1 July 1961. Since the inception of this joint organization our relationship with the SATAF has continued to be both amiable and workable, as its been all along. Although at the beginning of the program there were some problem areas with respect to coordination:

a. All design changes or resolution of conflicts or discrepancies which Schilling Area Office considered to be necessary were required to be approved by SATAF. Obtaining their concurrence or non-concurrence was time consuming and added to the time which the contractor claimed he was delayed. In many instances, several weeks passed awaiting reply to our correspondence to SATAF.

b. After experiencing the long delay in receiving replies from SATAF, it was necessary for the Engineering Branch of this Area to set up a suspense log of each letter written and continually push them by telephone calls and follow-up letters in order to obtain a reply.

c. In dealing with SATAF on interpretation of specifications, it was found they were inclined to read into the specification requirements which were not included. They failed in some cases to analyze the specifications completely but instead, based their case on only one portion of the specifications

d. In some instances, they questioned the manner in which work had been performed or specifications interpreted, but would not

state exactly what they desired or thought was required. They also interpreted test procedures. The Area Engineer's (Deputy for Construction) job description follows.

JOB DESCRIPTION

a. The Area Engineer (Deputy for Construction, under SATAF) is responsible to the SATAF Commander for assuring the timely accomplishment of the construction operation for the site activation program.

b. Operates as the field representative of the Construction Director.

c. Administers construction contracts. Inspects work under his jurisdiction; gathers and records contract data; prepares reports and contractor's payment estimates.

d. Assures compliance with contract requirements, including modifications. Accomplishes construction in accordance with approved progress schedules and contractual completion dates.

e. Recommends changes to drawings, mainly to conform with local conditions.

f. Enforces labor provisions of his construction contracts. Examines contractor's payroll data and takes action with contractors to correct discrepancies, if required.

g. Issues change orders on approved changes and prepares cost estimates for modifications. As contracting officer's representative, negotiates costs of modifications and processes contractor's claims.

h. Enforces safety provisions of the contract. Cooperates with contractors' top supervisors in establishment of safety program and follows through during life of the contract to insure compliance therewith.

i. Provides the Deputy for Engineering with continual data reflecting actual field conditions for incorporation into as-built drawings.

j. In conjunction with the SATAF Commander, works out joint occupancy agreements.

k. Schedules pre-final and final acceptance inspections.

ORGANIZATIONAL CHART

Fig 75 is the organization chart for the local SATAF with the key personnel listed.

26. GENERAL PROBLEM AREAS AND RECOMMENDATIONS

GENERAL:

It was recognized at an early date that many unusual problems would arise at the Schilling Missile Complex because it was constructed on the theory of concurrency (i.e., design, construction, and testing were undertaken simultaneously). Such a procedure naturally lead to major design changes and revisions in changes in a design which was already of great inherent technical complexity and difficulty. Specific major changes at Schilling included the complete redesign of the steel crib structures, and drastic revisions in the electrical and mechanical work. The delays in the work attributable to multiple and complex design changes were compounded (at Sites 1 and 2) by unanticipated site conditions (excessive water) at these sites. The government insisted that all delays be over come or offset so that the construction could be completed on or before the contract completion date.

The test requirements and performance criteria were vastly more rigid and exacting than was anticipated by the Prime Contractor at the time he prepared his bid. This was further complicated by the fact that the construction was inspected by three different agencies: the Corps of Engineers, the Air Force, and Convair Division of General Dynamics — each of whom used different criteria in making inspections.

The assignment of Government-awarded procurement and construction contracts and discrepancies between specifications (particularly cleanliness in the PLS) presented administrative problems above and beyond problems normally encountered in a construction contract.

The crisis nature of the construction schedule and the skyrocketing

SITE ACTIVATION TASK FORCE

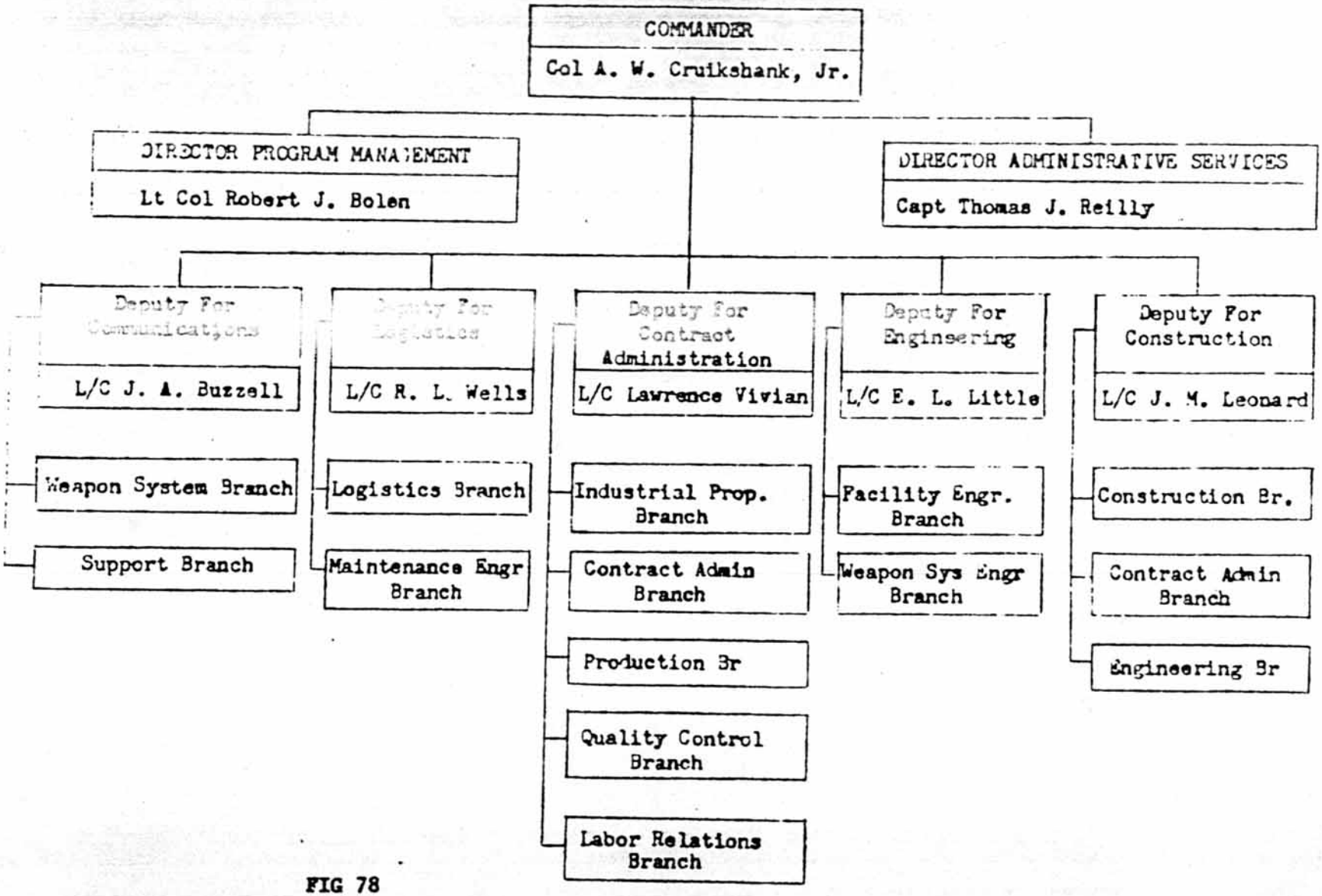


FIG 78

costs made it difficult, if not impossible, to properly segregate the direct and/or impact costs caused by a design change to specific modifications. Sound fixed-price contract administration with specific additional amounts allowed for each modification, as in normal contract work, was impossible. Neither the contractor nor the government personnel could estimate the cost of individual change orders or design changes. A design change normally found the silos in twelve different stages of construction; and in most cases, before the contractor could make the necessary changes, there were additional design changes superimposed on the original change.

This report therefore will be confined to problem areas where definite recommendations for improvement can be made, rather than re-hashing each and every problem that occurred (which were numerous).

LACK OF SUFFICIENT QUALIFIED AND EXPERIENCED PERSONNEL

It is believed that all problems which arose at the Schilling Area could have been minimized if the Area Engineer's Office had been more fully staffed with qualified and experienced personnel. Many of the problems which are stated later in this report would not have arisen if the key personnel had been assigned to this area at the inception of the project. In other words, the construction of a complicated missile base does not present insurmountable problems that cannot be overcome by a more fully staffed Corps of Engineers' Area Office.

Prior to October 1960 when the command responsibilities for the Schilling Missile Complex was transferred to SPRCOO, the Schilling Area office lacked sufficient qualified and experienced manpower to accomplish the assigned mission in an economical and orderly manner. In particular,

there was a serious need for graduate Engineers in the electrical and structural fields. Also, there was a shortage of qualified and experienced Estimators.

The shortage of experienced and qualified personnel made it imperative that Engineers be utilized in a manner that would render them, a maximum benefit to the government. Therefore, functions were performed by engineering personnel that could have possibly been performed more efficiently and at a less cost to the government by an intermediate level employee in the Career Development Program for Comptroller Personnel. These functions dealt primarily with:

a. The coordination between the Area Office and the CFBMCO Comptroller to verify that funds are available prior to issuing modifications.

b. Assisting in the preparation of numerous reports which touch on accounting.

RECOMMENDATIONS:

a. That the policy set forth in CFBMCO Circular 61-22 which provides, in substance, that qualified employees with JCP experience be retained in the missile program and utilized in the staffing of future projects be rigidly complied with. This should minimize the possibility of future projects being understaffed.

b. That one person from the CFBMCO Comptroller Branch be permanently assigned to each Area Office (in the Contract Administration Branch) to perform these duties and such other duties as may be assigned by the Area Engineer and/or the Chief, Contract Administration Branch.

c. That an Area Counsel should be assigned to an Area Office on or before the date the invitations to bid are issued; and that a

Labor Relations Officer and a Safety Officer be assigned to the Area at least fifteen days prior to the start of construction.

APPROVAL OF SHOP DRAWINGS:

There was an alleged delay in the approval of Shop Drawings for Struthers-Wells Corporation. This delay may have been due, in part, to the fact that the shop drawings were transmitted by Struthers-Wells (in Pennsylvania) to Utah-Manhattan-Sundt (in Kansas) - to the Area Engineer (in Kansas) - to Bechtel (in California) for approval; and then back to the sub-contractor through the same channels.

This problem was partially overcome by directing the Prime Contractor to have Struthers-Wells' personnel go to Bechtel's office and stay there until the Shop Drawings were approved.

RECOMMENDATION:

It is believed that some time would have been saved, had the shop drawings been air mailed or hand-carried directly from Struthers-Wells to Bechtel with copies of the letter of transmittal and the shop drawings furnished to the Prime Contractor and the Area Engineer.

INSPECTION PROCEDURES OF SUPPORTING DISTRICTS:

There was a lack of uniform action by supporting districts on inspection of the work performed by sub-contractors and suppliers. Specifically, it was believed that some suppliers were confused on the definition of the terms "inspection" and "acceptance". Struthers-Wells Corporation, for example, believed that their vessels were "accepted" at the time the vessels were "inspected" by the Pittsburgh District.

RECOMMENDATION:

That the Statement of Policy and Guidance contained in CFHCC Circular 61-23 dated 6 March 1961 be disseminated to all personnel in

inspecting districts, who are working on materials and supplies which are destined for incorporation in the ICBM program.

PHOTOGRAPHIC COVERAGE:

It would have been in the best interests of the Government to have had more and better photographic coverage of construction. This would be very valuable in litigation if the contractor should appeal decisions of the contracting officer.

RECOMMENDATIONS:

a. That all photographs taken by CEMCO Headquarters or Area personnel should be uniformly numbered and indexed.

b. That this problem area could be overcome by a CEMCO directive on this subject; said directive to include a uniform system for numbering and indexing photographs. It is also recommended that this suggested directive on photographs contain comments which read substantially as follows:

"All photographs should include a plaque showing the name of site, number and date of photograph. In many instances, it is suggested that the photographer place a slate (on which he has written the site number, time, date and place) in the area to be photographed.

A level rod or other suitable scale should be included in the background. The number of the photograph should be referenced on the sketch showing the location of the camera, and the direction of the photograph.

Photographs should be taken to show the following:

1. The original site conditions before construction.

2. The method and equipment used by the contractor.

3. The completion of each phase of construction.

4. Typical conditions encountered.

5. Any important or unusual conditions encountered.

6. Safety Hazards."

OBTAINING ADEQUATE INFORMATION FROM THE FIELD:

It is essential that adequate and sufficient information be obtained from Resident Engineers. This information must be in a form that will:

a. Be of assistance in evaluating contractor's demands for additional funds.

b. Furnish the Area Engineer data so he can maintain an adequate rate of construction progress.

c. Furnish a historical summary of construction progress.

d. It is also very important that the Area Office (which has the overall picture) alert the resident engineers, of possible claims or disagreements, thereby making it possible for the resident engineer to keep a more detailed cost and time data history, combined with a closer and sharper scrutinizing on all the actions of the contractor, on these particular areas.

PREPARATION OF FORMS IN THE FIELD:

It has been the practice in the Schilling Area to prepare certain forms at the resident engineer's office with the use of carbon paper. It is recommended that consideration be given to the use of NCR (no carbon required) forms, or their equivalent.

DAILY LOG OF CONSTRUCTION:

The basic form prepared by the resident engineer is ENG Form 2538,

entitled Daily Log of Construction. The information recorded thereon was used a great deal by the estimators in determining fair value for work performed. However, the form was apparently designed for Civil projects, thereby requiring it to be modified for ICBM construction usage.

RECOMMENDATIONS:

a. The blank for "River Stage" should be deleted and eliminated.

b. The blank which reads: "Has anything developed on the work which might lead to a change order or finding of fact?" has little or no value as presently written. Our experience has been that, in all cases, the resident engineer checked "NO" in this blank, even during the days when there were obvious changed conditions at the site of work. It is therefore recommended that the following questions be placed on the Daily Log of Construction instead: (All questions should be answered "YES" or "NO"). All questions answered "YES" should be explained in detail.

1. Did the contractor encounter any subsurface or latent physical conditions at the site differing materially from those indicated in the contract?

2. Did the contractor encounter any unknown physical conditions at the site, of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in the work of the character provided for in this contract?

3. Was the contractor delayed this date by unusually

severe weather.

4. Did you observe, or have knowledge of, any featherbedding or other uneconomical labor practices?

c. The blank showing the number of contractor's employees is insufficient for our purposes. It is essential that the Area Engineer know the number of employees by prime contractor and sub-contractor, and in some cases by craft. In view of the fact that the shifts of some sub-contractors may vary from the shifts worked by the Prime or other contractors, it is believed that the form should be modified to show the following information for the prime and individual sub-contractors:

1. Supervisory personnel
2. Manual workers
3. Beginning and ending time of shifts
4. It might be desirable to show the hours worked by each craft.

IMPROPER LABOR PRACTICES:

It is further recommended that the following information be furnished either on the Daily Log of Construction or on some other periodic report prepared by the resident engineer:

a. All instances of work stoppage.

b. Safety hazards or unsafe working conditions.

c. Featherbedding or other improper or uneconomical work practices.

d. Excessive and unwarranted overtime worked by certain crafts or contractor.

The problems of featherbedding and/or uneconomical work practices did not arise at the Schilling Area due to aggressive action by Corps of Engineers and contractor personnel. However, because of Congressional interest in the matter, it might be well to require the resident engineer to report improper labor practices or to make periodic affirmative statements that no such practices exist.

CONSTRUCTION PROGRESS MANUAL AND USE OF ADDITIONAL FORMS:

It is recommended that the Manual of Instruction for Reporting Construction Progress, Department of the Army, Corps of Engineers, 1 January 1956 (hereinafter called Manual) be carefully reviewed to see wherein it should be modified so that the reports contained therein will be designed to reflect progress in the construction of Missile Complexes. Our examination indicates that the Manual, and the forms contained therein, are in many cases designed for Civil construction projects; and are ill adapted to ICBM construction. Consideration could be given to the issuance of a comparable Manual by [illegible]. It is recommended that a few classes be held for resident engineers (and their personnel) on the compilation and recording of adequate data.

It is also believed that some of the following forms contained in the manual could be used to good advantage, although to the best of our knowledge, they are not presently being used by any Atlas [illegible] Area:

ENG Form 2477	Inspectors Shift Report - Miscellaneous Items
ENG Form 2479	Inspectors Shift Report - Earthwork
ENG Form 2481	Inspectors Shift Report - Pressure Grouting
ENG Form 2483	Inspectors Shift Report - Concrete Batching

ENG Form 2186	Inspectors Shift Report - Concrete Placing
ENG Form 2189	Concrete Mixer Plant - Shift Report
ENG Form 2190	Aggregate Inspector's Report
ENG Form 2191	Daily Report of Metal Placed

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