Walker

XVIII-20-1B

HISTORY

OF

CORPS OF ENGINEERS

BALLISTIC MISSILE CONSTRUCTION OFFICE

CONSTRUCTION AND CONTRACT

ACTIVITIES

AT

WALKER AIR FORCE BASE
ROSWELL, NEW MEXICO

JUNE 1960 - JUNE 1962

~~"FOR OFFICIAL USE ONLY"~~

Stanford I Polonsky
STANFORD I. POLONSKY
Lt. Col., CE
Area Engineer

ATCOEO

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

WS-107A-1 MISSILE LAUNCH COMPLEXES
WALKER AIR FORCE BASE
ROSWELL, NEW MEXICO

TABLE OF CONTENTS

INTRODUCTION

PART I	ADMINISTRATION
PART II	CONSTRUCTION
PART III	CONTRACT ADMINISTRATION
PART IV	MISCELLANEOUS

PART I - ADMINISTRATION

	Page No.
Establishment and Function: Corps of Engineers Ballistic Missile Construction Office (CEBMCO)	1-1
Establishment and Function: Walker Area Office	1-2
Area Engineer	1-4
Deputy Area Engineer	1-4
Executive Officer	1-4
Administration Branch	1-5
Engineering and Technical Branch	1-5
Contract Administration Branch	1-6
Construction Branch	1-6
Safety Office	1-7
Office of Counsel	1-7
Administrative Problems	1-8

PART II - CONSTRUCTION

	Page No.
Origin and Mission	2-1
Description of Project	2-2
Topography	2-3
Geology and Ground Water Conditions	2-3
Source of Utilities	2-6
Means of Access	2-6
Construction Period	2-6
Construction Features and Operations	2-8
Mass Excavation	2-8
Shafting	2-8
Water Control	2-9
Concrete Operations	2-15
Crib Steel	2-18
Launch Control Center	2-21
Mechanical Work	2-25
Electrical Work	2-27
Propellant Loading System	2-30
Layouts and Surveys	2-35
Photos	2-37
Design Changes	2-37
Engineering and Technical Branch	2-38
Labor Relations	2-40

PART III - CONTRACT ADMINISTRATION

	Page No.
General	3-1
Construction Prime Contracts	3-2
Launch Complexes	3-2
Liquid Oxygen Plant	3-3
Re-Entry Vehicle Facilities	3-4
Shops, Missile Assembly and Maintenance and Technical Supply Building	3-4
Water Supply for 12 Sites	3-5
Principal Subcontracts	3-5
Mass Excavation	3-5
Reinforcing Steel	3-6
Crib Steel Erection	3-6
Mechanical	3-6
Electrical	3-6
Personnel Elevators	3-6
Propellant Loading System	3-6
Painting	3-6
Roads and Parking Areas	3-6
Major Modifications and Claims	3-7

PART IV - MISCELLANEOUS

Accidents	4-1
Visits	4-2
Ceremonies	4-2

	Page No.
Relations with SATAF	4-3
Conclusions	4-3
Recommendations	4-3

LIST OF FIGURES

		Follows Page No:
Figure 1	Organization Chart - CEBMCO	1-1
Figure 2	Organization Chart - Walker AFB - July 1961	1-3
Figure 3	Organization Chart - Walker AFB - January 1962	1-3
Figure 4	Silo on X-X Axis	2-3
Figure 5	Silo on Y-Y Axis	2-3
Figure 6	Launch Control Center	2-3
Figure 7	Vicinity Plan	2-3
Figure 8	Boring Logs - Sites 1, 2 and 10	2-5
Figure 9	Boring Logs - Sites 3, 4 and 5	2-5
Figure 10	Boring Logs - Sites 6 and 7	2-5
Figure 11	Boring Logs - Sites 8 and 9	2-5
Figure 12	Boring Logs - Sites 11 and 12	2-5
Figure 13	Organization Chart - SATAF	4-3

APPENDICES

Construction Photos	Appendix A
Claims	Appendix B
Visits and Ceremonies	Appendix C

I N T R O D U C T I O N

Presented herewith is a complete and factual summary report of construction and contract activities associated with the construction of the Walker Air Force Base Atlas F Ballistic Missile Launching Facilities.

The scope of the report includes activities in connection with construction of twelve launching complexes and support facilities. It does not include installation of missiles and controls which is being accomplished by separate contract directly under the administration of the Site Activation Task Force of the Air Force.

The report is prepared and submitted in accordance with instructions contained in Corps of Engineers Ballistic Missile Construction Office Circular Number 61-74, issued 27 October 1961, subject: "Historical Summary Report of Major ICBM Construction".

PART I

ADMINISTRATION

ESTABLISHMENT AND FUNCTION: CORPS OF ENGINEERS BALLISTIC MISSILE CONSTRUCTION OFFICE (CEBMCO)

The U. S. Army Engineers established the 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 Vandenburg AFB, California and Cape Canavaral, Florida.

The Corps of Engineers Ballistic Missile Construction Office (CEBMCO) is commanded by Colonel E. E. Wilhoyt, Jr.

CEBMCO, through various Construction Directorates, controls the overall missile site construction program and supplies to the Area Offices any guidance required of them, ie: Construction, Electrical, Mechanical, Engineering, Propellant Loading System (PLS), Administration, etc.

Inasmuch as the Atlas F Areas were quite a distance from CEBMCO, numerous visits were made by CEBMCO Representatives to the different Area Offices, thereby assuring CEBMCO of the currency of events occurring in the field.

The Organization Chart (Fig. 1) shows the five ICBM Directorates under CEBMCO, with a further breakdown of the Atlas "F" Directorate, together with its six area offices.

ORGANIZATION CHART

CORPS OF ENGINEERS BALLISTIC MISSILE CONST. OFFICE
U S ARMY
LOS ANGELES, CAL.

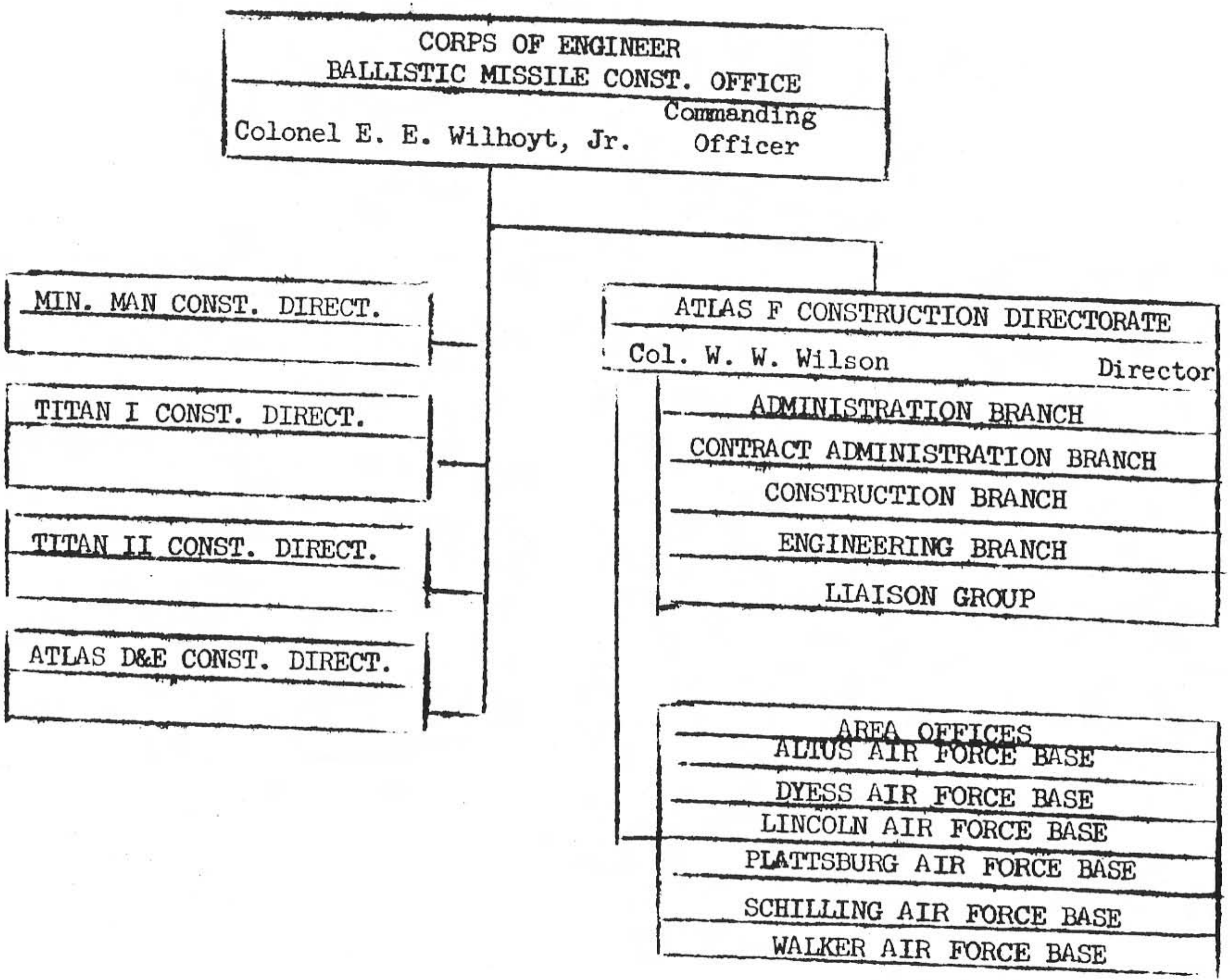


Figure 1

ESTABLISHMENT AND FUNCTION: WALKER AREA OFFICE

The decision to construct Atlas Missile Launching Facilities in this area was reached in early January 1960, at which time the Albuquerque District Office was requested to perform certain soils investigations, et cetera, to determine whether or not the geological conditions in this area would support the proposed installation. This investigation was accomplished by the Spencer J. Buchanan Co., and by Gordon Herkenhoff and Associates with favorable results.

Design was initiated in early March 1960 after completion of the investigation.

The Walker (Roswell) Area Office was established 15 May 1960 by District Order #231 under the Albuquerque District, to handle supervision, inspection and contract administration for construction of 12 Atlas Missile Sites in the vicinity of Roswell, New Mexico.

The facility was advertised for bids on 16 May 1960 and a total of six bids were received. Bids were opened on 15 June 1960.

Successful bidder was the Macco Corporation, Raymond International, Inc., The Kaiser Co., Puget Sound Bridge and Dry Dock Co., a Joint Venture. The contract was awarded 16 June 1960 and the Notice to Proceed issued 20 June. Work started on 23 June 1960.

Although, as indicated previously, a Ballistic Missile Construction Office was established with Headquarters in Los Angeles on 1 August 1960, it was not until 22 November 1960, by means of General Order 37, that the transfer of construction responsibility from the Albuquerque District Office to CEBMCO was accomplished. By this means the Walker Area Office came under the jurisdiction of CEBMCO and was removed from the control of the Albuquerque District. Effective that date, a Civilian Personnel Administration agreement was entered into by CEBMCO and the Support District. Extensive recruiting efforts were continued.

The mission of the Walker Area Office was to perform those portions of Contract Administration which were delegated from the Atlas F Directorate of CEBMCO to the 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 CEBMCO and the Albuquerque District to the extent indicated in the document entitled "Division of Responsibilities, Administrative and Logistical Support, Walker Area Office".

The Walker Area Engineer's Office was organized with four primary branches and two offices (Safety and Counsel), each reporting directly to the Area Engineer. Organization Chart Fig. 2 shows the organization at approximately peak strength in July 1961. Organization Chart Fig. 3 shows the organization on 1 January 1962, at which time construction progress permitted the assignment of one project engineer to two or sometimes three missile sites, depending on the status of completion of each site. As the construction phase neared completion, personnel phase-cuts were increasingly evident. Displacement of personnel was accomplished almost entirely by attrition, and spirited efforts were made by the Area Engineer's staff to assist these individuals in securing positions in other agencies, particularly within CEBMCO. A great deal of cooperative spirit prevailed also in the rotation of individuals to accomplish needed tasks, which often became necessary due to the selection and loss of individuals for new assignments within the Corps and to other agencies.

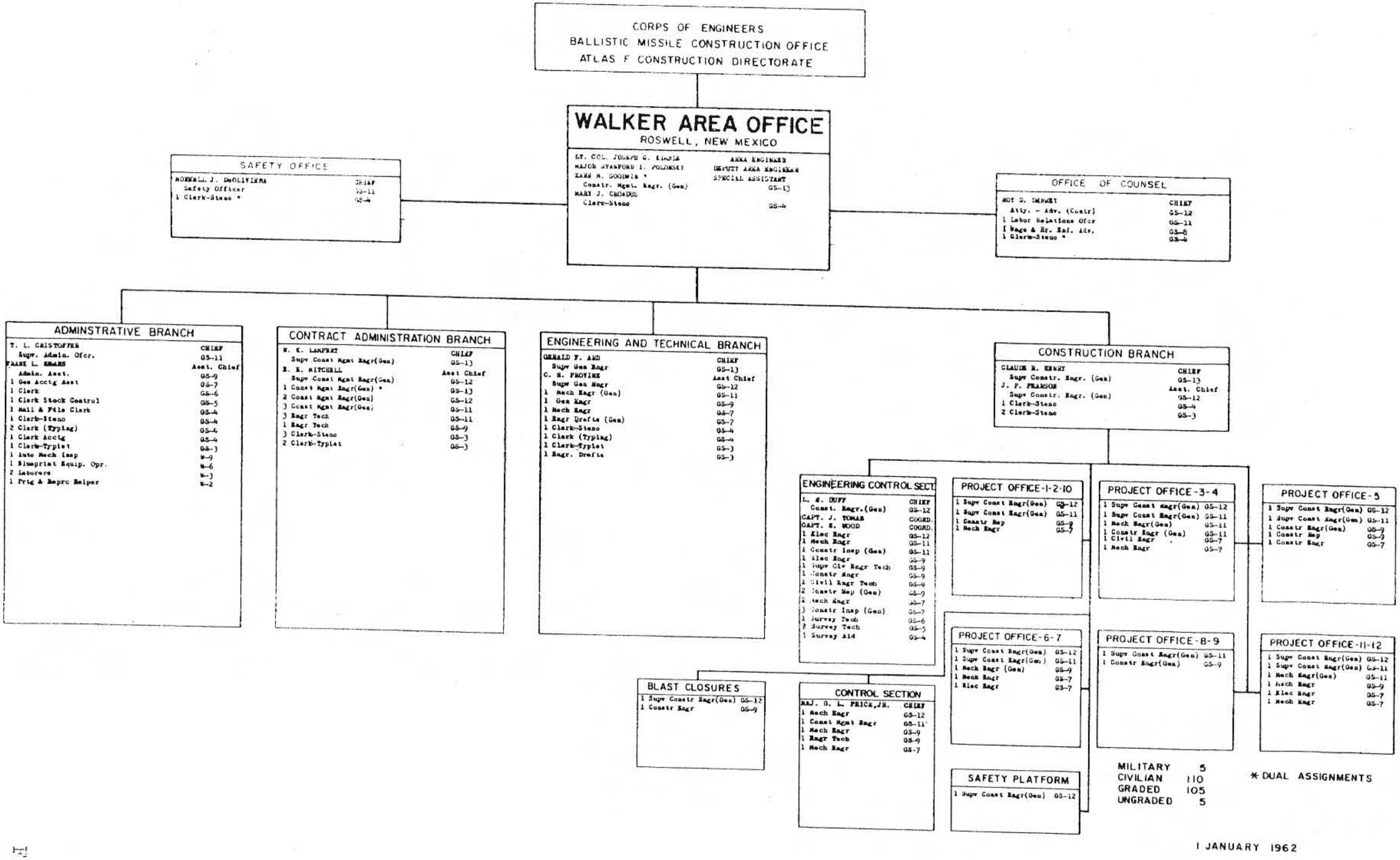

CORPS OF ENGINEERS
BALLISTIC MISSILE CONSTRUCTION OFFICE
ATLAS F CONSTRUCTION DIRECTORATE
WALKER AREA OFFICE
ROSWELL, NEW MEXICO
LT. COL. JOSEPH G. K. ALSIE AREA ENGINEER
MAJOR STANFORD I. POLONSKY DEPUTY AREA ENGINEER
ZANE H. GOODWIN * SPECIAL ASSISTANT
Constr. Mgmt. Engr. (Gen) GS-13
MARY J. CRONDUS
Clerk-Steno GS-4
SAFETY OFFICE
ROSWELL J. DeOLIVIERA CHIEF
Safety Officer GS-11
1 Clerk-Steno * GS-4
OFFICE OF COUNSEL
ROY D. DENNEY CHIEF
Atty. - Adv. (Contr) GS-12
1 Labor Relations Ofcr GS-11
1 Wage & Hr. Enf. Adv. GS-8
1 Clerk-Steno * GS-4
ADMINSTRATIVE BRANCH
T. L. CRISTOFFER CHIEF
Supv. Admin. Ofcr. GS-11
FRANK L. SEARS Asst. Chief
Admin. Asst. GS-9
1 Gen Acctg Asst GS-7
1 Clerk GS-6
1 Clerk Stock Control GS-5
1 Mail & File Clerk GS-4
1 Clerk-Steno GS-4
2 Clerk (Typing) GS-4
1 Clerk Acctg GS-4
1 Clerk-Typist GS-3
1 Auto Mech Insp W-9
1 Blueprint Equip. Opr. W-6
2 Laborers W-3
1 Prtg & Repro Helper W-2
CONTRACT ADMINISTRATION BRANCH
W. K. LAMPERT CHIEF
Supv Const Mgmt Engr(Gen) GS-13
R. K. MITCHELL Asst Chief
Supv Const Mgmt Engr(Gen) GS-12
1 Const Mgmt Engr(Gen) * GS-13
2 Const Mgmt Engr(Gen) GS-12
3 Const Mgmt Engr(Gen) GS-11
3 Engr Tech GS-11
1 Engr Tech GS-9
3 Clerk-Steno GS-3
2 Clerk-Typist GS-3
ENGINEERING AND TECHNICAL BRANCH
GERALD F. AND CHIEF
Supv Gen Engr GS-13
C. H. PROVINE Asst Chief
Supv Gen Engr GS-12
1 Mech Engr (Gen) GS-11
1 Gen Engr GS-9
1 Mech Engr GS-7
1 Engr Drafts (Gen) GS-7
1 Clerk-Steno GS-4
1 Clerk (Typing) GS-4
1 Clerk-Typist GS-3
1 Engr. Drafts GS-3
CONSTRUCTION BRANCH
CLAUDE R. HENRY CHIEF
Supv Constr. Engr. (Gen) GS-13
J. P. PEARSON Asst. Chief
Supv Constr. Engr. (Gen) GS-12
1 Clerk-Steno GS-4
2 Clerk-Steno GS-3
ENGINEERING CONTROL SECT
L. G. DUFF CHIEF
Const. Engr. (Gen) GS-12
CAPT. J. TOMAS COORD.
CAPT. E. WOOD COORD.
1 Elec Engr GS-12
1 Mech Engr GS-11
1 Constr Insp (Gen) GS-11
1 Elec Engr GS-9
1 Supv Civ Engr Tech GS-9
1 Constr Engr GS-9
1 Civil Engr Tech GS-9
2 Constr Rep (Gen) GS-9
2 Mech Engr GS-7
3 Constr Insp (Gen) GS-7
1 Survey Tech GS-6
2 Survey Tech GS-5
1 Survey Aid GS-4
PROJECT OFFICE-1-2-10
1 Supv Const Engr(Gen) GS-12
1 Supv Const Engr(Gen) GS-11
1 Constr Rep GS-9
1 Mech Engr GS-7
PROJECT OFFICE-3-4
1 Supv Const Engr(Gen) GS-12
1 Supv Const Engr(Gen) GS-11
1 Mech Engr(Gen) GS-11
1 Constr Engr (Gen) GS-11
1 Civil Engr GS-7
1 Mech Engr GS-7
PROJECT OFFICE-5
1 Supv Const Engr(Gen) GS-12
1 Supv Const Engr(Gen) GS-11
1 Constr Engr(Gen) GS-9
1 Constr Rep GS-9
1 Constr Engr GS-7
PROJECT OFFICE-6-7
1 Supv Const Engr(Gen) GS-12
1 Supv Const Engr(Gen) GS-11
1 Mech Engr (Gen) GS-9
1 Mech Engr GS-7
1 Elec Engr GS-7
PROJECT OFFICE-8-9
1 Supv Const Engr(Gen) GS-11
1 Constr Engr(Gen) GS-9
PROJECT OFFICE-11-12
1 Supv Const Engr(Gen) GS-12
1 Supv Const Engr(Gen) GS-11
1 Mech Engr(Gen) GS-11
1 Mech Engr GS-9
1 Elec Engr GS-7
1 Mech Engr GS-7
BLAST CLOSURES
1 Supv Constr Engr(Gen) GS-12
1 Constr Engr GS-9
CONTROL SECTION
MAJ. G. L. PRICK, JR. CHIEF
1 Mech Engr GS-12
1 Const Mgmt Engr GS-11
1 Mech Engr GS-9
1 Engr Tech GS-9
1 Mech Engr GS-7
SAFETY PLATFORM
1 Supv Const Engr(Gen) GS-12
MILITARY 5
CIVILIAN 110
GRADED 105
UNGRADED 5
* DUAL ASSIGNMENTS
1 JANUARY 1962

FIGURE 3

The relatively high percentage of professional engineers comprising the Area Office was a major factor in the accomplishment of construction efforts. It is considered noteworthy that at one time (when the organization was approximately at peak strength) 92% of all Area Office personnel were qualified professional engineers.

Project Engineers, responsible to the Construction Branch, were selected for each of the 12 sites to inspect and supervise contract construction. The Propellant Loading System (PLS) functions were also accomplished under the immediate responsibility of the Construction Branch.

The functions of the branches and offices of the Walker Area Office were as follows:

AREA ENGINEER: The Area Engineer supervised assigned construction contracts, represented the Contracting Officer and enforced contract provisions as well as providing direction and coordination of the area's organization activities.

DEPUTY AREA ENGINEER: The Deputy assisted the Area Engineer and acted as Area Engineer during his absence. He provided direction to the technical, advisory, and administrative in all matters of a technical nature.

EXECUTIVE OFFICER: He assisted the Area Engineer and the Deputy in a staff capacity in delegated matters not requiring the immediate or personal attention of those officials. His duties included the coordination, review or approval of matters delegated by the Area Engineer or his Deputy, serving as focal point in all matters relating to the Administrative and Advisory staff. He supervised Military Personnel Administration as directed, and performed numerous additional duties as specifically assigned.

ADMINISTRATION BRANCH: Furnished administrative services to all elements of the Area Office, including each of the twelve missile construction sites. Furnished instruction to clerical personnel and provided stenographic and typist assistance. Provided office services including: supply, communication, custodial services, reproduction, transportation, mail distribution, records, purchasing and procurement. Directed civilian personnel actions and maintained records to include: time and attendance, leave, cost and pay. Received and approved for funds all obligating documents other than Construction Contracts and Modifications.

ENGINEERING AND TECHNICAL BRANCH: Provided engineering and technical assistance to area personnel. Reviewed plans and specifications and furnished comments to CEBMCO. 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, CEBMCO, KCDO, and other Corps of Engineer Districts on engineering and technical matters.

CONTRACT ADMINISTRATION BRANCH: Advised area personnel on contractual matters. Received progress schedules from contractors, reviewed same, and initiated action for revision or approval. Furnished Engineering Branch with comments for addendum changes on plans and specifications. Prepared Government Construction Cost Estimates for Change Orders. Branch Chief represented Area Engineer on SATAF Change Order Board. Monitored proposed change orders within Area Office and initiated change order action with contractors. Conducted modification negotiations and prepared and distributed modification documents. Investigated and determined validity of claims. Initiated action and follow-up on government furnished equipment until arrival at job site or railhead. Expedited construction materials. Maintained and reported status of modifications and claims. Reported work stoppages to CEBMCO. Processed documents on transfer of completed work to Air Force.

CONSTRUCTION BRANCH: Supervised and conducted continuous inspections of construction activities. Directed the job-level Engineer Trainee Program. Reported to the Engineering Branch conflicts and design inadequacies occuring in the plans and specifications. Reviewed proposed changes for construction feasibility and time impact. Provided Contract Administration with information for progress reports. Insured maintenance of a set of contract prints showing as-built conditions. Provided Contract 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. Directly supervised the Project Engineers.

<u>SAFETY OFFICE</u>: Assisted the Area Engineer in administering the Corps of Engineers' Safety Program within the Area.

Provided for frequent safety inspections at all work sites.

Advised the Area Engineer of potential safety hazards on all sites which he was unable to have corrected.

Prescribed and coordinated a balanced program of Safety activities.

Assured prompt reporting of accidents.

Prepared formal reports of findings with recommended corrective action on all accidents and serious hazards which hampered efficient uninterrupted construction progress.

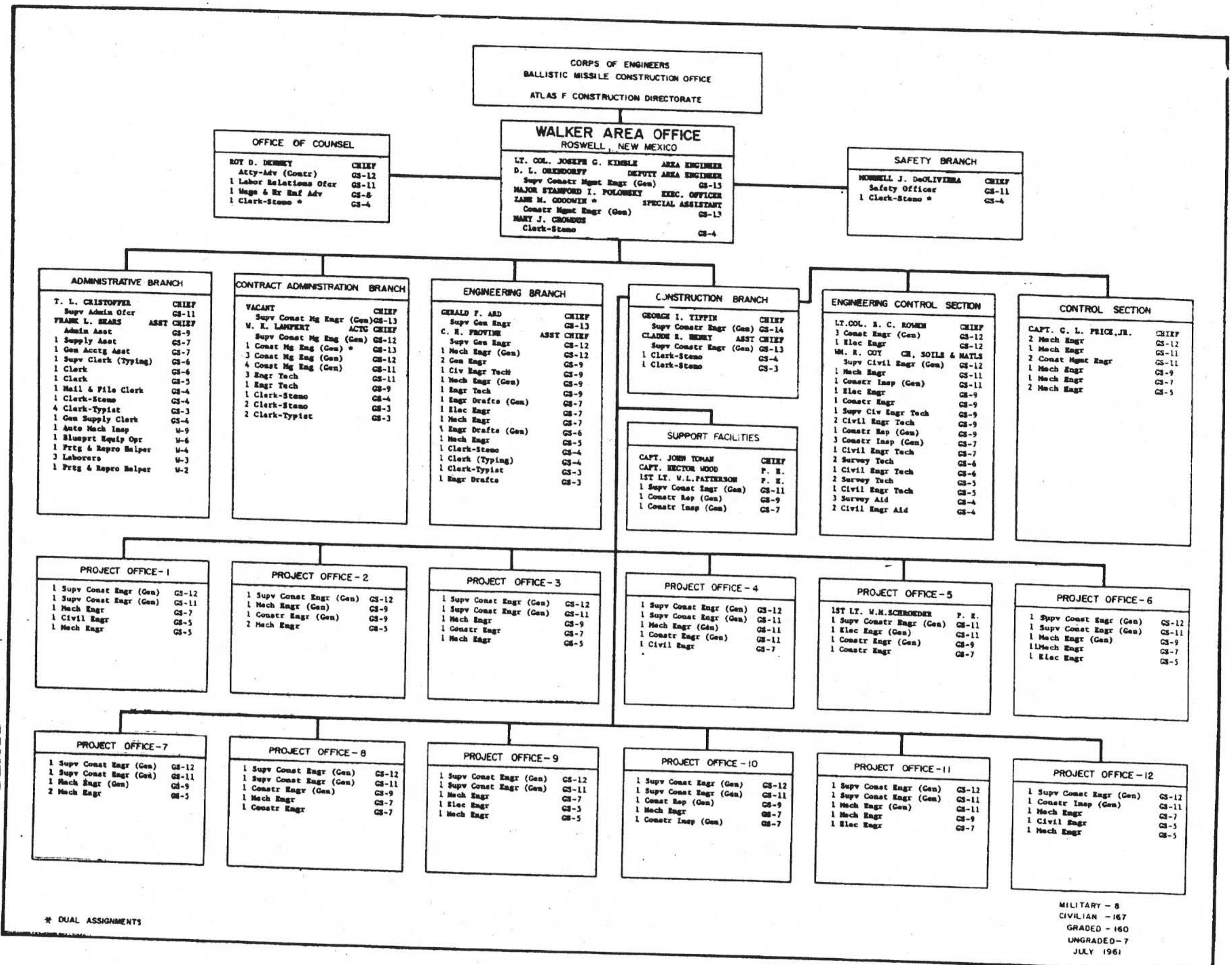
<u>OFFICE OF COUNSEL</u>: Assisted and advised the Area Engineer and his supporting elements on legal matters except Real Estate.

Rendered staff advise in the negotiation and preparation of contractual documents and reviewed all contract actions for legal sufficiency.

Reviewed actions concerning all contractual and non-contractual claims initiated by Contract Administration Branch.

Processed settlement of contractual documents as delegated by the Office of Counsel, CEBMCO.

Reviewed actions initiated by Contract Administration Branch on appeals made by contractors to decisions made by the Contracting Officer or Contracting Officer's Representative.


CORPS OF ENGINEERS
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D. L. ORENDORFF DEPUTY AREA ENGINEER
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ZANE M. GOODWIN * SPECIAL ASSISTANT
Constr Mgmt Engr (Gen) GS-13
MARY J. CROMDUS
Clerk-Steno GS-4
OFFICE OF COUNSEL
ROY D. DENNEY CHIEF
Atty-Adv (Contr) GS-12
1 Labor Relations Ofcr GS-11
1 Wage & Hr Enf Adv GS-8
1 Clerk-Steno * GS-4
SAFETY BRANCH
MORRELL J. DeOLIVIERA CHIEF
Safety Officer GS-11
1 Clerk-Steno * GS-4
ADMINISTRATIVE BRANCH
T. L. CRISTOFFER CHIEF
Supv Admin Ofcr GS-11
FRANK L. SEARS ASST CHIEF
Admin Asst GS-9
1 Supply Asst GS-7
1 Gen Acctg Asst GS-7
1 Supv Clerk (Typing) GS-6
1 Clerk GS-6
1 Clerk GS-5
1 Mail & File Clerk GS-4
1 Clerk-Steno GS-4
4 Clerk-Typist GS-3
1 Gen Supply Clerk GS-4
1 Auto Mech Insp W-9
1 Blueprt Equip Opr W-6
1 Prtg & Repro Helper W-4
3 Laborers W-3
1 Prtg & Repro Helper W-2
CONTRACT ADMINISTRATION BRANCH
VACANT CHIEF
Supv Const Mg Engr (Gen) GS-13
W. K. LAMPERT ACTG CHIEF
Supv Const Mg Eng (Gen) GS-12
1 Const Mg Eng (Gen) * GS-13
3 Const Mg Eng (Gen) GS-12
4 Const Mg Eng (Gen) GS-11
3 Engr Tech GS-11
1 Engr Tech GS-9
1 Clerk-Steno GS-4
2 Clerk-Steno GS-3
2 Clerk-Typist GS-3
ENGINEERING BRANCH
GERALD F. ARD CHIEF
Supv Gen Engr GS-13
C. R. PROVINE ASST CHIEF
Supv Gen Engr GS-12
1 Mech Engr (Gen) GS-12
2 Gen Engr GS-9
1 Civ Engr Tech GS-9
1 Mech Engr (Gen) GS-9
1 Engr Tech GS-9
1 Engr Drafts (Gen) GS-7
1 Elec Engr GS-7
1 Mech Engr GS-7
1 Engr Drafts (Gen) GS-6
1 Mech Engr GS-5
1 Clerk-Steno GS-4
1 Clerk (Typing) GS-4
1 Clerk-Typist GS-3
1 Engr Drafts GS-3
CONSTRUCTION BRANCH
GEORGE I. TIFFIN CHIEF
Supv Constr Engr (Gen) GS-14
CLAUDE R. HENRY ASST CHIEF
Supv Constr Engr (Gen) GS-13
1 Clerk-Steno GS-4
1 Clerk-Steno GS-3
SUPPORT FACILITIES
CAPT. JOHN TOMAN CHIEF
CAPT. HECTOR WOOD P. E.
1ST LT. W.L.PATTERSON P. E.
1 Supv Const Engr (Gen) GS-11
1 Constr Rep (Gen) GS-9
1 Constr Insp (Gen) GS-7
ENGINEERING CONTROL SECTION
LT.COL. R. C. ROWEN CHIEF
3 Const Engr (Gen) GS-12
1 Elec Engr GS-12
WM. R. COY CH, SOILS & MATLS
Supv Civil Engr (Gen) GS-12
1 Mech Engr GS-11
1 Constr Insp (Gen) GS-11
1 Elec Engr GS-9
1 Constr Engr GS-9
1 Supv Civ Engr Tech GS-9
2 Civil Engr Tech GS-9
1 Constr Rep (Gen) GS-9
3 Constr Insp (Gen) GS-7
1 Civil Engr Tech GS-7
2 Survey Tech GS-6
1 Civil Engr Tech GS-6
2 Survey Tech GS-5
1 Civil Engr Tech GS-5
3 Survey Aid GS-4
2 Civil Engr Aid GS-4
CONTROL SECTION
CAPT. G. L. PRICE, JR. CHIEF
2 Mech Engr GS-12
1 Mech Engr GS-11
2 Const Mgmt Engr GS-11
1 Mech Engr GS-9
1 Mech Engr GS-7
2 Mech Engr GS-5
PROJECT OFFICE-1
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1 Mech Engr GS-7
1 Civil Engr GS-5
1 Mech Engr GS-5
PROJECT OFFICE-2
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1 Mech Engr (Gen) GS-9
1 Constr Engr (Gen) GS-9
2 Mech Engr GS-5
PROJECT OFFICE-3
1 Supv Const Engr (Gen) GS-12
1 Supv Const Engr (Gen) GS-11
1 Mech Engr GS-9
1 Constr Engr GS-7
1 Mech Engr GS-5
PROJECT OFFICE-4
1 Supv Const Engr (Gen) GS-12
1 Supv Const Engr (Gen) GS-11
1 Mech Engr (Gen) GS-11
1 Constr Engr (Gen) GS-11
1 Civil Engr GS-7
PROJECT OFFICE-5
1ST LT. W.M.SCHROEDER P. E.
1 Supv Constr Engr (Gen) GS-11
1 Elec Engr (Gen) GS-11
1 Constr Engr (Gen) GS-9
1 Constr Engr GS-7
PROJECT OFFICE-6
1 Supv Const Engr (Gen) GS-12
1 Supv Const Engr (Gen) GS-11
1 Mech Engr (Gen) GS-9
1 Mech Engr GS-7
1 Elec Engr GS-5
PROJECT OFFICE-7
1 Supv Const Engr (Gen) GS-12
1 Supv Const Engr (Gen) GS-11
1 Mech Engr (Gen) GS-9
2 Mech Engr GS-5
PROJECT OFFICE-8
1 Supv Const Engr (Gen) GS-12
1 Supv Const Engr (Gen) GS-11
1 Constr Engr (Gen) GS-9
1 Mech Engr GS-7
1 Constr Engr GS-7
PROJECT OFFICE-9
1 Supv Const Engr (Gen) GS-12
1 Supv Const Engr (Gen) GS-11
1 Mech Engr GS-7
1 Elec Engr GS-5
1 Mech Engr GS-5
PROJECT OFFICE-10
1 Supv Const Engr (Gen) GS-12
1 Supv Const Engr (Gen) GS-11
1 Const Rep (Gen) GS-9
1 Mech Engr GS-7
1 Constr Insp (Gen) GS-7
PROJECT OFFICE-11
1 Supv Const Engr (Gen) GS-12
1 Supv Const Engr (Gen) GS-11
1 Mech Engr (Gen) GS-11
1 Mech Engr GS-9
1 Elec Engr GS-7
PROJECT OFFICE-12
1 Supv Const Engr (Gen) GS-12
1 Constr Insp (Gen) GS-11
1 Mech Engr GS-7
1 Civil Engr GS-5
1 Mech Engr GS-5
* DUAL ASSIGNMENTS
MILITARY - 8
CIVILIAN - 167
GRADED - 160
UNGRADED - 7
JULY 1961

FIGURE 2

were not entitled to re-employment rights. In a number of cases, too, individuals were assigned to the Area Office from a Corps of Engineer District at a much later date than other individuals not formerly connected with the Corps. This inequality was particularly applicable to young engineer trainees who were recruited from college and who, during phase-out, did not have re-employment rights with the Corps even though they were, in many cases, among our most desirable employees from the standpoint of insuring their retention in CEBMCO. Over twenty (20) engineer trainees were thus affected. Although a number of these individuals subsequently received assignment to other newly activated Area Offices, many of them accepted assignment in other federal agencies or with private industry and their services were thus lost to CEBMCO.

Further complicating this problem was the fact that re-employment rights were based on the grade held by the individual at the time he departed a District Office. Upon exercising these re-employment rights, the affected individual competed with other District Office employees at their current grade while his rights were based on the grade held at the time of his departure from the District.

It is recommended that further study be made of the civilian personnel re-employment policy to afford more uniform treatment of individuals in like circumstances.

Prepared litigation reports as required.

Performed labor relations functions, assuring enforcement of contract labor standards and promoted good working relationships between the Corps of Engineers, organized labor and contractors.

Received, reviewed, and initiated necessary action on all contractor's payrolls.

ADMINISTRATIVE PROBLEMS:

The question of re-employment rights for CEBMCO employees created a great deal of confusion in the minds of most of the people assigned to the Area Office. Higher headquarters must have anticipated the problems which would result upon completion of the work at the different ICBM bases when individuals became available for a new assignment and/or wished to exercise re-employment rights. A letter published by the Office of the Chief of Engineers dated 13 December 1960, Symbol ENGEP-CE, established Civilian Personnel policies to provide re-employment rights for certain categories of CEBMCO employees. One basis for confusion or misunderstanding was the fact that so-called "absolute" re-employment rights were apparently granted to individuals assigned to Headquarters, CEBMCO, whereas so-called "administrative" re-employment rights, only, were granted to persons assigned to the different field offices. In addition, these administrative re-employment rights granted to field employees applied only to individuals who had reported for assignment to a field (Area) office directly from another Corps of Engineers Office. As a result, many individuals, assigned to the Area Office as recent graduate engineers or from government offices other than the Corps of Engineers,

PART II

CONSTRUCTION

ORIGIN AND MISSION:

Prime responsibility for Atlas "F" Weapon System Development rests with the United States Air Force. Six geographical locations in the United States were selected to house the construction of Atlas "F" Operational Base Missile Launch Complexes, each consisting of twelve unitary Silo Launch Complexes and Support Facilities. This is the history of the construction at Walker Air Force Base, Roswell, New Mexico. The United States Air Force, through its Ballistic Missile Division, established a Site Activation Task Force to accomplish this mission at Roswell, New Mexico. The United States Army Corps of Engineers was selected as the construction agency to perform construction for the Site Activation Task Force. This is solely a report of the work encountered by the United States Army Corps of Engineers element of the SATAF organization.

The decision to build the Atlas "F" Launch Facilities in the Roswell, New Mexico, area was reached in early January 1960, at which time the Albuquerque District of the United States Army Corps of Engineers was requested to perform soil investigation to determine if the geological conditions in this area would support the proposed installation.

This investigation was accomplished by Spencer J. Buchanan and Associates and Gordon Herkenhoff and Associates with favorable results. Design was assigned in early March 1960 to the Bechtel Corporation.

The proposed construction was advertised for bids on 16 May 1960, bids were opened on 15 June 1960, and the basic construction contract in the amount of $22,115,828 was awarded to a joint venture consisting of the Macco Corporation, Raymond International, Inc., The Kaiser Company, and Puget Sound Bridge and Drydock Company on 16 June 1960. Notice to proceed was issued on 20 June 1960 and the work was initiated on 23 June 1960. The Roswell Area Office of the United States Army Corps of Engineers was activated on 15 May 1960 with a nucleus of people that was expanded to eight officers and 168 civilians at the peak of activity. (See organizational chart, Part I)

Lt. Colonel Joseph G. Kimble was selected as the Area Engineer and was the Officer-in-Charge throughout the construction.

DESCRIPTION OF THE PROJECT:

Basically the project consists of a silo, having a twenty-six feet minimum inside radius by an inside height of 165 feet, and a launch control center, forty feet inside diameter by twenty-seven feet clear height. The launch silo consists of two feet six inch thick concrete walls up to a point approximately fifty feet below the top of the silo at which point the wall flares to a total thickness of nine feet. It has a concrete cap nine feet thick. Concrete floors normally are six inches thick, but are five feet thick where ground water causes excessive hydrostatic pressure. The launch control center has two feet six inch thick walls with a three feet six inch floor and a three foot roof. In the interior of the silo is a steel crib which is suspended by four shock absorbing hangers, contains eight levels, and supports all the facilities inside the silo. The launch control center has two suspended floors on which all the equipment is mounted. Descriptive sketches of silo and LCC appear on Figures 4, 5 and 6. The LCC and silo are connected by an underground tunnel. The silo and LCC represent the basic construction unit. Twelve such units are distributed within a forty mile radius in concentric arrangement around Walker Air Force Base. Distances vary from 21.4 and 42.4 road miles from Walker Air Force Base (See Vicinity Plan, Figure 7). In addition, maintenance and support facilities, consisting of a Re-Entry Vehicle Facility, a Missile Assembly Building, a Liquid Oxygen Generator Plant, and Water Supply Systems for the Missile Launch Complexes, were constructed.

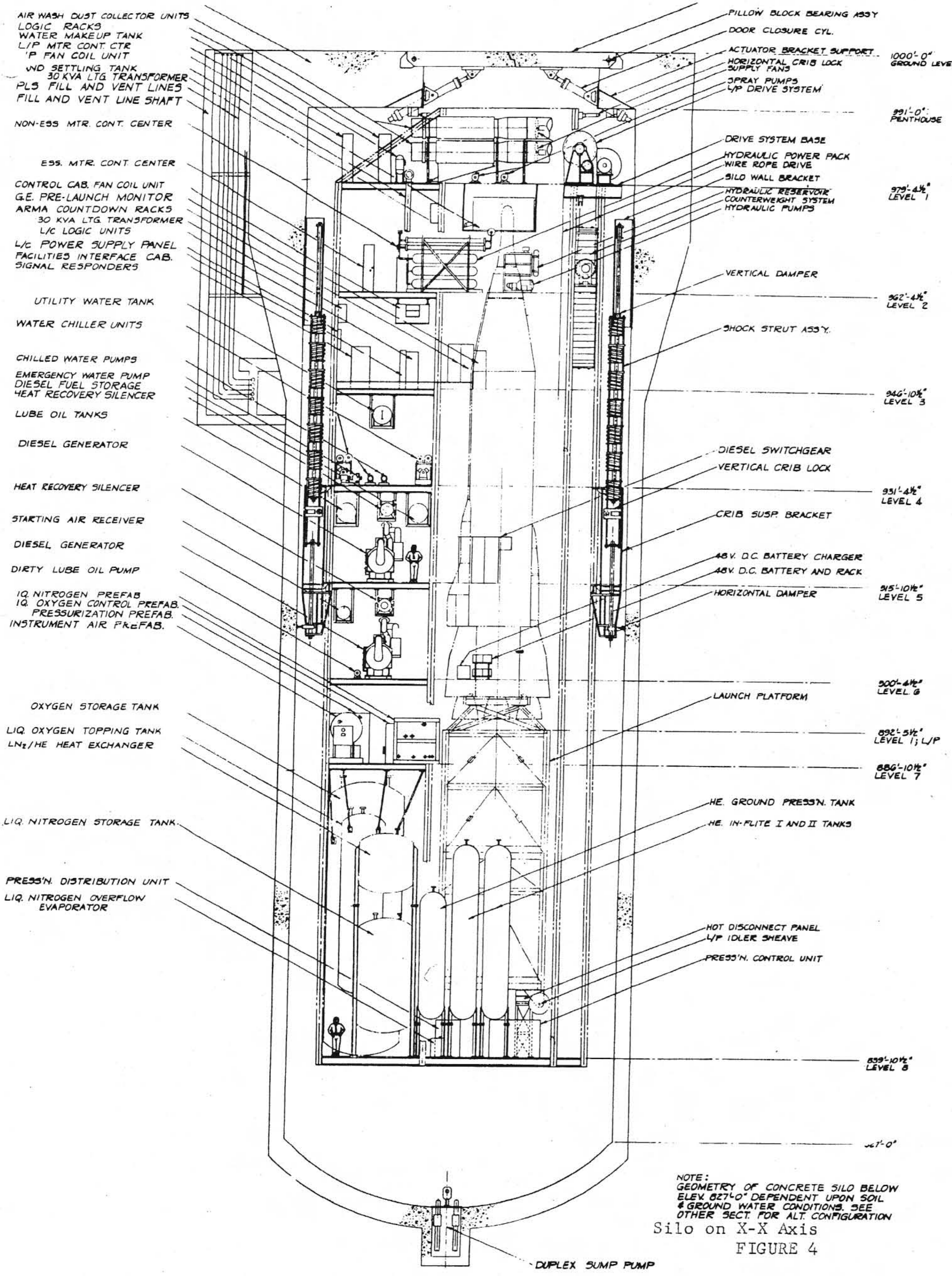
TOPOGRAPHY:

The sites are located in the majority of cases on gently rolling terrain adjacent to the Pecos River Valley. Site 5 lies actually in the valley fill area. Sites 6 and 7, near the foot of the Sacramento Mountains, lie on somewhat rougher ground. Elevations average about 3500 feet above sea level. Vegetation is scant, consisting of semi-desert type grasses and shrubs.

GEOLOGY AND GROUND WATER CONDITIONS:

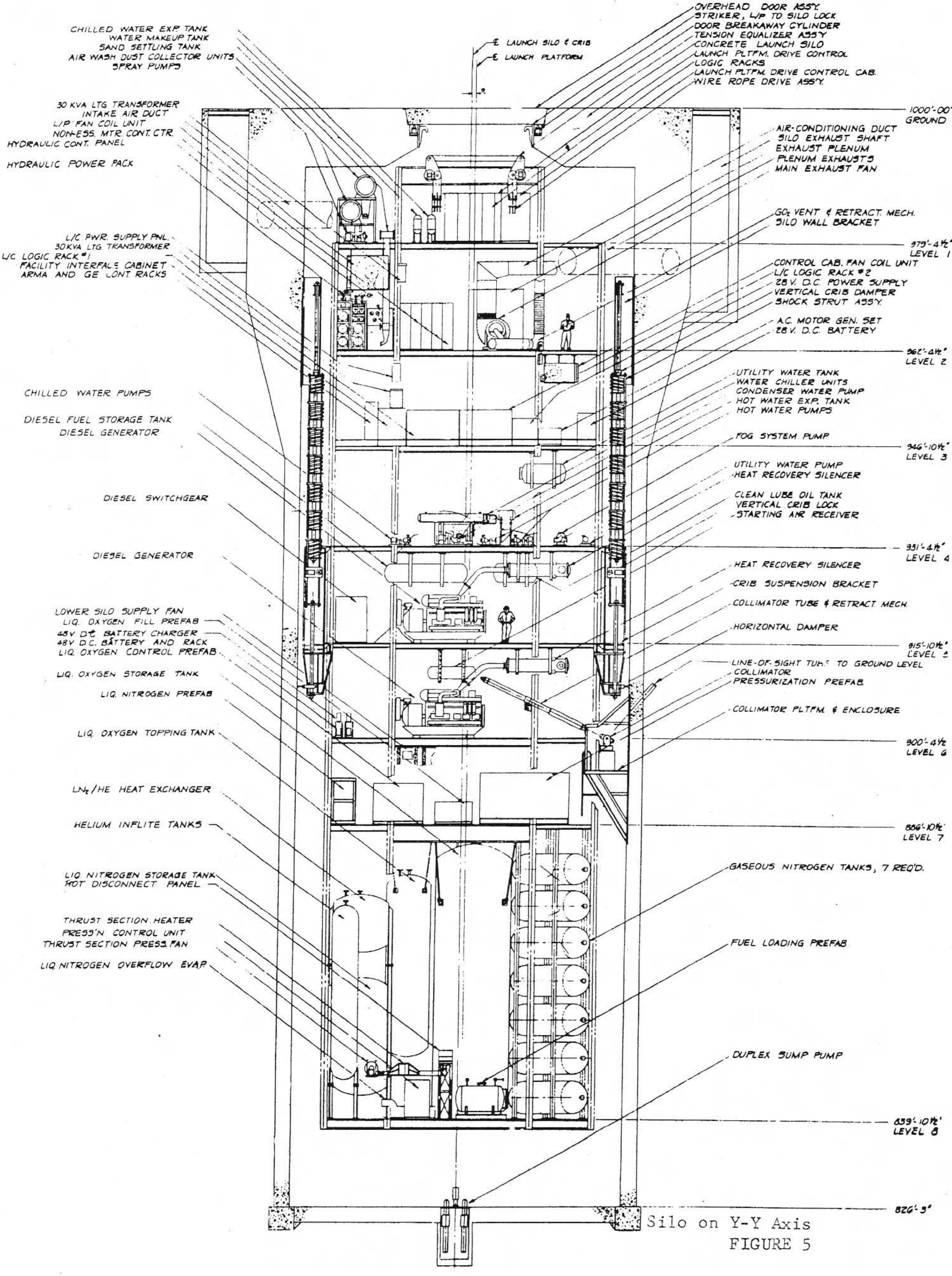
All sites are located in what is known as the Roswell Artesian Basin. This title is misleading. Artesian water production does occur in the vicinity of the City of Roswell. Some years ago there were large flowing wells in that area but the flows have ceased as a result of over-pumping of the artesian aquifer.

Geological formations are of Permian, Triassic and Quaternary ages. They consist of the Chupadera, Chalk Bluff and Dockum formations

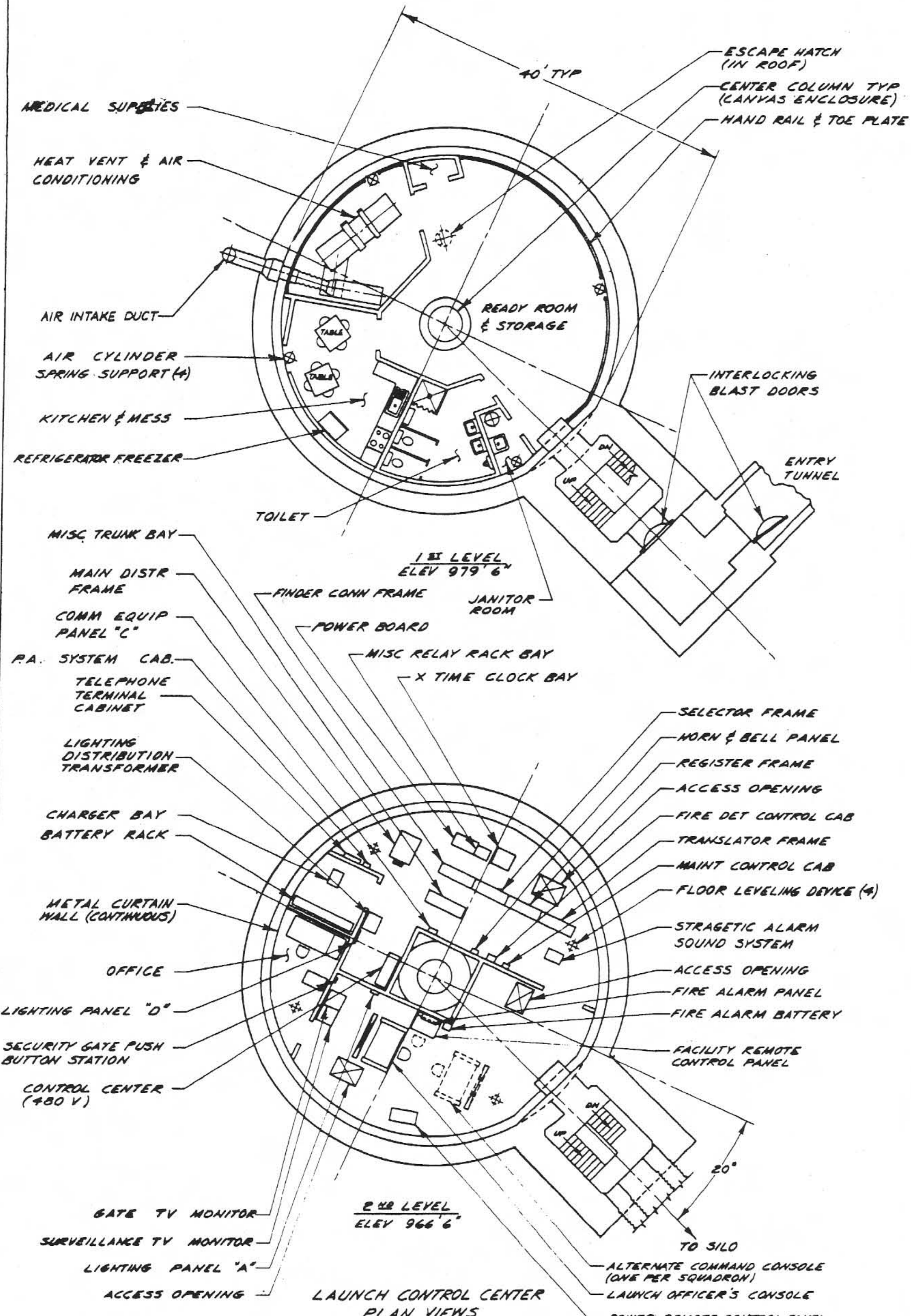


Silo on X-X Axis

FIGURE 4

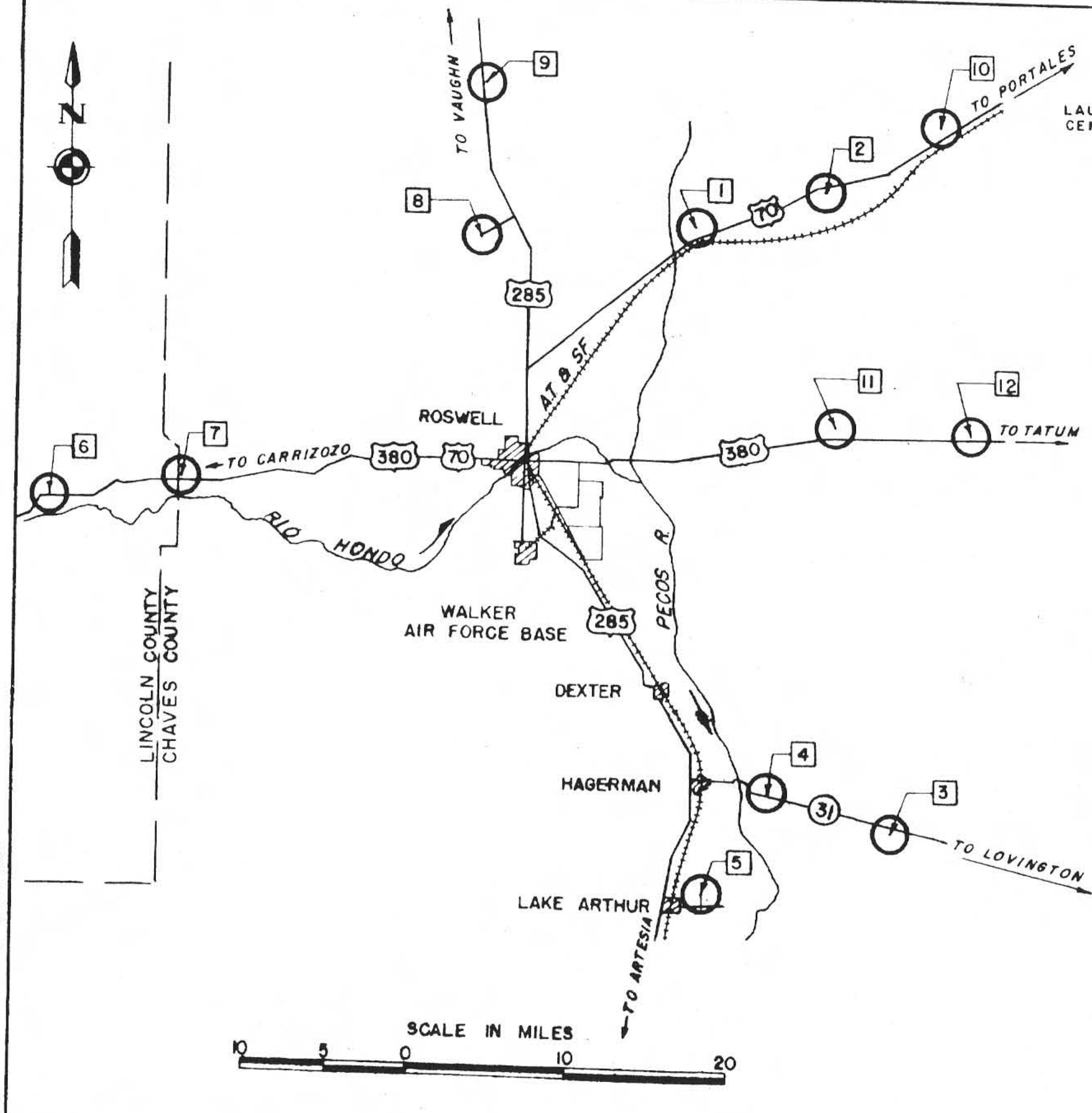


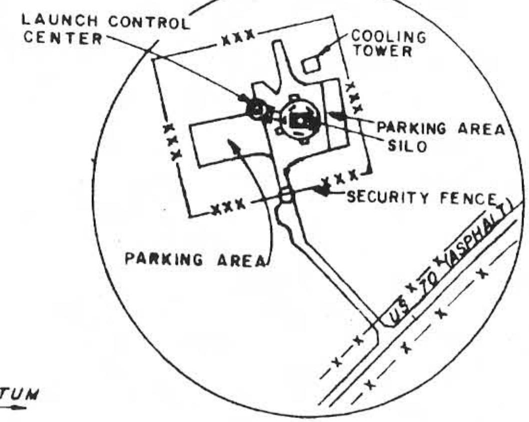
Silo on Y-Y Axis
FIGURE 5



LAUNCH CONTROL CENTER
PLAN VIEWS
SCALE 1/60

FIGURE 6





GENERAL CONFIGURATION-SITE I

MILES TO SITES

LOCATION OF CROSSROADS, INTERSECTION OF HIGHWAY'S 380 AND 285

SITE	FROM WALKER	FROM CROSSROADS
1	25.3	19.2
2	33.9	27.8
3	36.6	43.2
4	27.5	34.1
5	31.7	38.3
6	36.2	30.1
7	27.2	21.1
8	21.4	15.3
9	30.1	24.0
10	42.2	36.1
11	25.1	19.0
12	32.9	26.8

WALKER AIR FORCE BASE
ROSWELL, NEW MEXICO

VICINITY PLAN

FIGURE 7

overlain by a mantle of Quaternary overburden. The Chupadera formation is made up of the Yeso member at its base and the San Andres limestone member at its top. The San Andres has very recently been further subdivided, with the lower portion being known as the Glorieta formation and the upper part as the San Andres limestone. The Chalk Bluff formation overlies the San Andres and the Dockum formation overlies the Chalk Bluff. The formations generally dip eastward approximately one degree. The San Andres formation is exposed in the westward portion of the sites area near the foot of the Sacramento Mountains, the Chalk Bluff through the central portion, and the Dockum at the eastern limits.

The Artesian condition is brought about by the presence of the permeable San Andres limestone on the surface in the Sacramento Mountains, an area of fairly good annual rainfall, and by the slope of the San Andres to the east at fifty to sixty feet per mile, a slope greater than the surface. The relatively impermeable red beds of the Chalk Bluff formation tend to hold water in the permeable San Andres under pressure, although this is highly variable with local conditions since the formations are interconnected and leakage from fractures and improperly constructed wells locally modifies conditions.

Subsurface exploratory investigations were made prior to issuing plans and specifications for bid. Core hole and seismic investigations were made by Spencer Buchanan and Associates of Bryan, Texas. Ground water explorations were performed by Gordon Herkenhoff and Associates of Albuquerque, New Mexico. Findings of the investigations and the reports received thereof are the basis of most of this geological report. Results of the investigation were presented in log form on contract drawings. Descriptive logs and notes on water encountered are extracted from the drawings and exhibited as Figures 8 through 12.

Consistently, the material encountered in excavation was as shown on the logs, although there were some variations in thickness of strata across the width of silo excavations. Some unexpected difficulties in the way of more water than expected was encountered. Sites 3, 6, 7, 8, 9, 11 and 12 were dry holes. Site 10 had water in the shaft in negligible amounts. Considerable water was encountered at Sites 1, 2, 4, and 5, leading to claims by the contractor.

Generally, the valley area west of the Pecos River contains ground water in almost unlimited quantities and of fair quality. The thickness of the San Andres diminishes to the west and production tends to be less than in the valley fill area. Massive salt beds to the east, and particularly east of the Pecos river where wells were drilled in the Chalk Bluff formation, contained water with so many salts as to be unusable without special treatment. All water from the San Andres is hard and requires treatment if Public Health Standards are to be met.

Water for use at the sites was developed by wells at Sites 2, 5, 6, 7, 8, and 9. Water for Sites 1 and 10 is transmitted by pipe line from Site 2. Water for sites 3 and 4 is obtained from the nearby village of Hagerman via pump station and pipe line and for Sites 11 and 12 from the City of Roswell. All waters were too highly mineralized for intended usage. Special demineralization and softening processes were provided.

ite No. 2

LCC

	DOCKUM FORMATION (TRIASSIC)
Ca	CALICHE, brown & white, very soft
CL	CLAY, brown, sandy, silty
Ss	SANDSTONE, brown, fine-grained
CL	CLAY, dark red, sandy, soft, with streaks of green sandy clay
Ss	gray-green, silty; soft, red; streaks of red silty shale; SANDSTONE, dark red, hard, fine-grained with spots and bands of dark red silty clay with green streaks

BORING COMPLETED 2-6-60
AT A DEPTH OF 77.3 FEET
CONTINUOUS 6-INCH CORE

NOTE 1: A static water level was measured 128 feet below the ground surface in the deep boring upon recovery from total dewatering by bailing. The bailing rate was less than 15 g.p.m.

Site No. 10

Silo

OVERBURDEN (QUATERNARY)	
SAND, red, silty, soft	SM
CLAY, red, silty	CL
CALICHE, white	Ca
DOCKUM FORMATION (TRIASSIC)	
SANDSTONE, red, silty, massive, fine-grained, weathered, soft; sandstone becomes firm, unweathered	Ss
MUDSTONE, red, firm but crushed, weakened; slickensided	Ms
SANDSTONE & SILTSTONE red and greyish, firm to very firm; becoming brown sandstone; gray sandstone; dark gray sandstone with calcareous stringers at 140'; changing to light green sandstone with interbedded green shale, interbedded coal at 163'; light gray sandstone with 3-in. layer of limestone at 170'; gray sandstone with interbedded light green shale; sandstone, dark gray	Ss & Si
SHALE; red shale (mudstone), slickensided; red and green shale, slickensided	Sh

BORING COMPLETED 2-20-60
AT A DEPTH OF 225.0 FEET
CONTINUOUS 6-INCH DIA. CORE

LCC

	OVERBURDEN (QUATERNARY)
CL	CLAY, light reddish brown, soft, sandy, with caliche nodules to ½-in. size. Grades to lt. br. with weathered red siltstone seams
	DOCKUM FORMATION (TRIASSIC)
Sh	SHALE, red and gray, clayey
Ss	SANDSTONE, red, mod. hard, very fine-grained, argillaceous at top, micaceous below 34.3'. Occasional hairline seam of red shale; Seams of shale and silty clay 62.5'-64.0'; Sandstone becomes conglomeratic with shale & limestone @ 66'

BORING COMPLETED 2-19-60
AT A DEPTH OF 75.0 FEET
CONTINUOUS 6-INCH CORE

NOTE 1: The drilling water in the deep boring was bailed out upon completion of drilling at a bailing rate of less than 20 g.p.m. No recovery water level was reported after bailing the test hole.

DEPTH IN FEET: 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200

Contract No. DA-29-005-ENG-2598
Walker AFB-Roswell, New Mexico
BORING LOGS-NORTHEAST GROUP
SITES 1, 2 AND 10
(Extracted from Contract Drawings)
FIGURE 8.

Site No. 1

Silo

[...]RDEN (QUATERNARY)	
[...]d, silty, trace of sand, [...]gravel	CL
[...]UFF FORMATION (PERMIAN)	
[...] gray & pink, some gravel	Gy
[...]k red, very soft, contains [...] pebble gravel, some gypsum	CL
[...] gray and pink	Gy
[...] silty, trace of gravel	CL
[...] with traces of red clay	Gy
[...], sandy, trace of gravel	CL
[...], gray and pink [...]f red clay 65' to 66'	Gy
[...]d, silty	CL
[...], gray, with streaks of [...]lty clay and gravel	Gy
[...]d, very broken, slick-[...]ed at many angles	CL
[...], alternating in layers [...] CLAY, red, slickensided	Gy CL
[...]M, gray [...]h layer of clay [...]ded red mottled gray clay [...]h layer of red, silty, firm	Gy
[...]RITE, gray, with thin [...] partings	An
[...]M, gray, with scattered [...]s of gray anhydrite and [...]n bed of clay at 148 ft.	Gy
[...]ed and gray mottled, with [...] layers of gypsum, firm.	CL
[...]M, gray-brown, dense well [...]d fractures in all directions	Gy
[...]ed, soft to firm, with gyp-[...] partings and nodules; Gypsum bed; Gypsum bed	CL

[...]G COMPLETED 2-4-60
[...] DEPTH OF 225.0 FEET
[...]INUOUS 6-INCH CORE

LCC

	OVERBURDEN (QUATERNARY)
CL	CLAY, red, silty. Bed fine sand 10.0'-10.4'
	CHALK BLUFF FORMATION (PERMIAN)
Gy	GYPSUM, gray
CL	CLAY, dark red, shaly
Gy	GYPSUM, gray
CL	CLAY, red, shaly, gypsum particles
Gy	GYPSUM, gray. Lost water circulation at 45.5'
CL Gy	CLAY & GYPSUM. Alternating layers of gray gypsum and red clay. Gypsum fragments in clay. Gray gypsum at bottom.

BORING COMPLETED 2-7-60
AT A DEPTH OF 75.0 FEET
CONTINUOUS 6-INCH CORE

NOTE 1: A static water level was measured 27 feet below the ground surface upon completion of drilling. The deep boring could not be bailed dry by bailing at approximately 15 g.p.m. for four hours. However, the water supply test well, 250 feet from the deep boring was totally dry.

Site No. 2

Silo

DOCKUM FORMATION (TRIASSIC)	
SANDSTONE, red, friable, very fine grained	Ss
CLAY, red, sandy, loose, with gray granular gypsum. Soft bed 41'-42'	CL
SILTSTONE, red, firm	Si
SANDSTONE, red, fine-grained, friable, minor clay. sandstone is dark red, fine-grained, with dk. red, silty clay, jointed & air slakes. sandstone is gray and green, fine-grained, gypsiferous 86'-90'. Highly crushed. sandstone is dark red, fine-grained	Ss
CLAY, green, silty, with seams of dark red, silty clay & air slakes	CL
SHALE, dark gray, silty, and air slakes	Sh
SANDSTONE: gray, fine-grained; dark brown, fine-grained, scattered large lumps of very soft, green, silty clay; dark red, fine-grained; gray-green, fine-grained, with red soft, silty clay.	Ss
CHALK BLUFF FORMATION (PERMIAN)	
CLAY, red, silty, soft, with gypsum and streaks of hard gypsum. red, soft, silty, with gypsum streaks and horizontal, gypsum-filled cracks	CL

BORING COMPLETED 2-5-60
AT A DEPTH OF 226.1 FEET
CONTINUOUS 6-INCH CORE

LCC

	DOCKUM FORMATION (TRIASSIC)
Ca	CALICHE, brown & white, very soft
CL	CLAY, brown, sandy, silty
Ss	SANDSTONE, brown, fine-grained
CL	CLAY, dark red, sandy, soft, with streaks of green sandy clay
Ss	gray-green, silty; soft, red; streaks of red, silty shale. SANDSTONE, dark red, hard, fine-grained with spots and bands of dark red silty clay with green streaks

BORING COMPLETED 2-6-60
AT A DEPTH OF 77.3 FEET
CONTINUOUS 6-INCH CORE

NOTE 1: A static water level was measured 128 feet below the ground surface in the deep boring upon recovery from total dewatering by bailing. The bailing rate was less than 15 g.p.m.

Site No. 1

DEPTH IN FEET

10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230

Silo

OVERBURDEN (QUATERNARY)	
CLAY, red, silty, trace of sand, some gravel	CL
CHALK BLUFF FORMATION (PERMIAN)	
GYPSUM, gray & pink, some gravel	Gy
CLAY, dark red, very soft, contains small pebble gravel, some gypsum	CL
GYPSUM, gray and pink	Gy
CLAY, red, silty, trace of gravel	CL
GYPSUM, with traces of red clay	Gy
CLAY, red, sandy, trace of gravel	CL
GYPSUM, gray and pink bed of red clay 65' to 66'	Gy
CLAY, red, silty	CL
GYPSUM, gray, with streaks of red, silty clay and gravel.	Gy
CLAY, red, very broken, slickensided at many angles.	CL
GYPSUM, alternating in layers with CLAY, red, slickensided	Gy CL
GYPSUM, gray 6-inch layer of clay 1-in. bed red mottled gray clay 6-inch layer of red, silty, firm clay.	Gy
ANHYDRITE, gray, with thin clay partings.	An
GYPSUM, gray, with scattered zones of gray anhydrite and a 4-in. bed of clay at 148 ft.	Gy
CLAY, red and gray mottled, with thin layers of gypsum, firm.	CL
GYPSUM, gray-brown, dense well healed fractures in all directions	Gy
CLAY, red, soft to firm, with gypsum partings and nodules. Gypsum bed Gypsum bed	CL

BORING COMPLETED 2-4-60
AT A DEPTH OF 225.0 FEET
CONTINUOUS 6-INCH CORE

LCC

	OVERBURDEN (QUATERNARY)
CL	CLAY, red, silty. Bed fine sand 10.0'-10.4'
	CHALK BLUFF FORMATION (PERMIAN)
Gy	GYPSUM, gray
CL	CLAY, dark red, shaly
Gy	GYPSUM, gray
CL	CLAY, red, shaly, gypsum particles
Gy	GYPSUM, gray Lost water circulation at 45.5'
CL Gy	CLAY & GYPSUM Alternating layers of gray gypsum and red clay. Gypsum fragments in clay. Gray gypsum at bottom.

BORING COMPLETED 2-7-60
AT A DEPTH OF 75.0 FEET
CONTINUOUS 6-INCH CORE

NOTE 1: A static water level was measured 27 feet below the ground surface upon completion of drilling. The deep boring could not be bailed dry by bailing at approximately 15 g.p.m. for four hours. However, the water supply test well, 250 feet from the deep boring was totally dry.

Silo

DOCKUM FORMATION (TRIASSIC

SANDSTONE, red, friable, ver fine grained

CLAY, red, sandy, loose, with gra granular gypsum

Soft bed 41'-42'

SILTSTONE, red, firm

SANDSTONE, red, fine-grained friable, minor clay.

sandstone is dark red, fine-grained, with dk.red, silty clay. jointed & air slakes

sandstone is gray and green, fine-grained, gypsiferous 86'-9

Highly crushed

sandstone is dark red, fine-grained

CLAY, green, silty, with seams of dark red, silty clay & air slakes

SHALE, dark gray, silty, and air slakes

SANDSTONE

gray, fine-grained

dark brown, fine-grained, scattered large lumps of ver soft, green, silty clay.

dark red, fine-grained

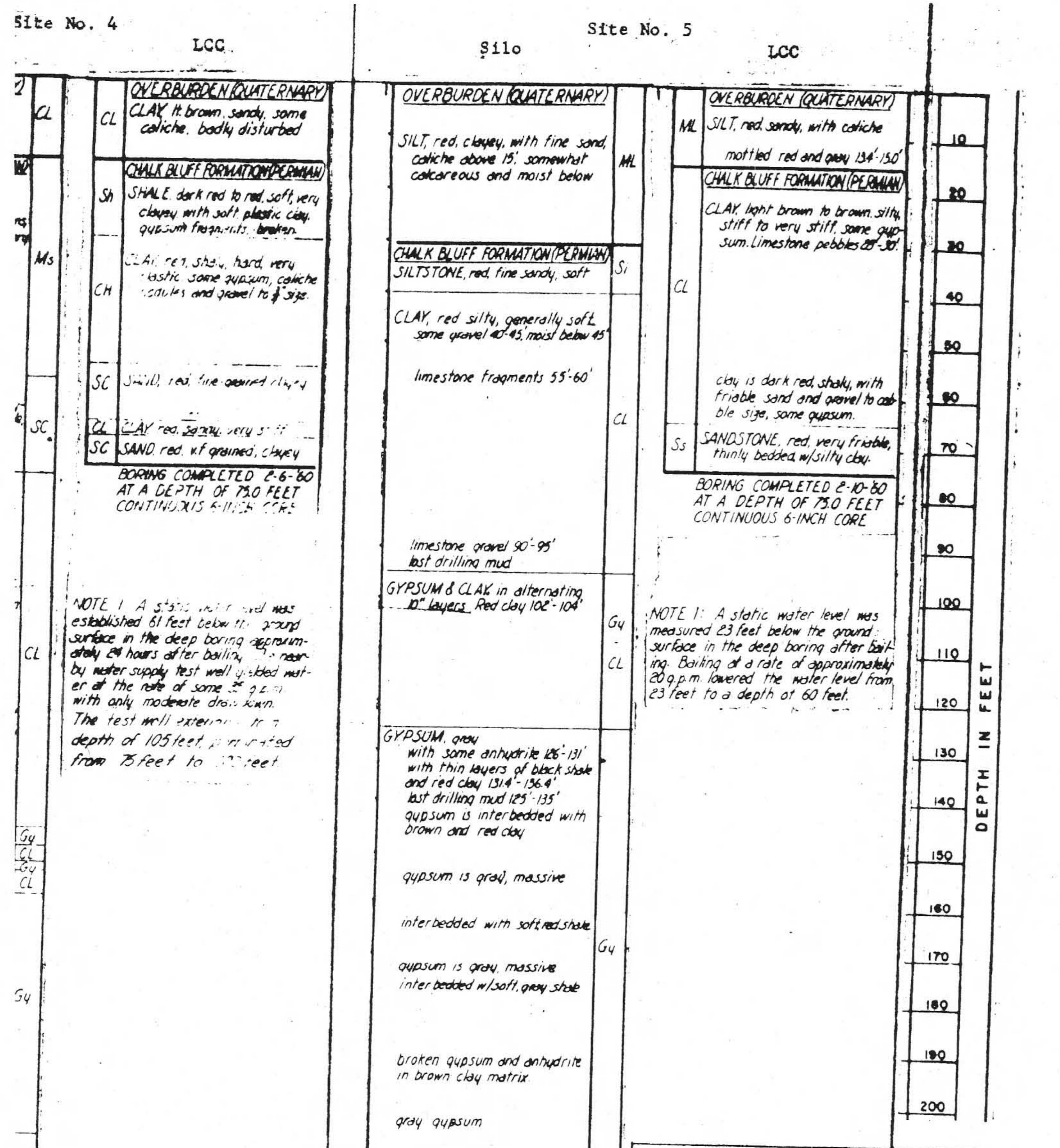
gray-green, fine-grained, with red, soft, silty clay.

CHALK BLUFF FORMATION (PERMIA

CLAY, red, silty, soft, with gyp sum and streaks of hard gypsum

red, soft, silty, with gypsum streaks and horizontal gypsu filled cracks

BORING COMPLETED 2-5-60
AT A DEPTH OF 226.1 FEET
CONTINUOUS 6-INCH CORE



Contract No. DA-29-005-ENG-2598
Walker AFB-Roswell, New Mexico
BORING LOGS-SOUTH GROUP
SITES 3, 4, AND 5
(Extracted from Contract Drawings)
FIGURE 9

Site No. 3

Silo

...URDEN (QUATERNARY) ...red, silty, with caliche	SM
...M FORMATION (TRIASSIC)	
...TONE & SILTSTONE. ..., fine-grained, very weakly ...ented, friable, some calcar-...s. ...raveling during drilling	Ss & Si
...BLUFF FORMATION (PERMIAN) ...ed, silty	CL
...ONE, red, mottled with ...gray, granular gypsum, ...rately firm	Si
...ed, silty, firm, mottled ...lenses of gypsum and ...clay ...ciated and weakly recemented	CL
...M, massive, broken and ...ed with clay along fractures. Collapse breccia ...M breccia in matrix of red, silty clay	Gy
...E, massive, with little ...clay	Ha

...COMPLETED 2-4-60
...EPTH OF 225.0 FEET

LCC

SM	OVERBURDEN (QUATERNARY) SAND, red, silty, with caliche
	DOCKUM FORMATION (TRIASSIC)
Ss & Si	SANDSTONE & SILTSTONE Red, fine to very fine-grained, calcareous, friable. Few beds of dark red, hard, sandy clay.
Ss	SANDSTONE, red, fine grained Bed of dark red sandy clay 71.0' - 71.7'

BORING COMPLETED 2-6-60
AT A DEPTH OF 75.0 FEET
CONTINUOUS 6-INCH CORE

NOTE 1. No water was encountered in the deep boring and the nearby water supply test well.

CONTINUOUS 6-INCH CORE
★ HOLE DEEPENED 2-11-60 TO A DEPTH OF 276.5 FT - ALL MASSIVE ROCK SALT BED WITH MINOR RED CLAY IMPURITY

Site No. 4

Silo

OVERBURDEN (QUATERNARY) CLAY, red, loose, silty, with broken pieces of caliche	CL
CHALK BLUFF FORMATION (PERMIAN)	
MUDSTONE, reddish, crushed, slickensided planes all directions, strength of stiff clay, secondary gypsum veins.	Ms
SAND, red, medium-grained, clayey, calcareous and very friable, gravelly at base.	SC
CLAY, red, silty, soft, with limestone gravel. Clay is red, silty to sandy, firm to soft, small (¼") green clay balls, carbonaceous. Clay contains angular pebbles of yellow mudstone and rounded pebbles of quartzite, with sandy lime and green clay fragments.	CL
GYPSUM, massive	Gy
CLAY, red, silty	CL
GYPSUM	Gy
CLAY, red and green, silty	CL
GYPSUM, broken, with red and green clay in fractures 161.5' - 172.2'; gray-green fractured siltstone 172.2' - 173.6'; massive gypsum 183' - 193'; soft, silty clay 193' - 199'; 10" of soft clay at 205'	Gy
ANHYDRITE & GYPSUM massive with small solution cavities	An & Gy

BORING COMPLETED 2-6-60
AT A DEPTH OF 225.5 FEET
CONTINUOUS 6-INCH CORE

LCC

CL	OVERBURDEN (QUATERNARY) CLAY, lt. brown, sandy, some caliche, badly disturbed
	CHALK BLUFF FORMATION (PERMIAN)
Sh	SHALE, dark red to red, soft, very clayey with soft plastic clay, gypsum fragments, broken.
CH	CLAY, red, shaly, hard, very plastic, some gypsum, caliche nodules and gravel to ¾" size.
SC	SAND, red, fine-grained, clayey
CL	CLAY, red, sandy, very stiff
SC	SAND, red, v.f. grained, clayey

BORING COMPLETED 2-6-60
AT A DEPTH OF 75.0 FEET
CONTINUOUS 6-INCH CORE

NOTE 1. A static water level was established 61 feet below the ground surface in the deep boring approximately 24 hours after bailing. The nearby water supply test well yielded water at the rate of some 25 g.p.m. with only moderate drawdown. The test well extended to a depth of 105 feet, perforated from 75 feet to [illegible] feet.

Site No. 3

DEPTH IN FEET: 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220

Silo

OVERBURDEN (QUATERNARY)

SAND, red, silty, with caliche — SM

DOCKUM FORMATION (TRIASSIC)

SANDSTONE & SILTSTONE, red, fine-grained, very weakly cemented, friable, some calcareous. — Ss & Si

Hole raveling during drilling

CHALK BLUFF FORMATION (PERMIAN)

CLAY, red, silty — CL

SILTSTONE, red, mottled with light gray, granular gypsum, moderately firm — Si

CLAY, red, silty, firm, mottled with lenses of gypsum and gray clay. Brecciated and weakly recemented — CL

GYPSUM, massive, broken and jointed with clay along fractures.

Collapse breccia

GYPSUM, breccia in matrix of firm, red, silty clay. — Gy

HALITE, massive, with little red clay — Ha

BORING COMPLETED 2-4-60 AT A DEPTH OF 225.0 FEET

LCC

OVERBURDEN (QUATERNARY)

SM — SAND, red, silty, with caliche

DOCKUM FORMATION (TRIASSIC)

SANDSTONE & SILTSTONE. Red, fine to very fine-grained, calcareous, friable. Few beds of dark red, hard, sandy clay. — Ss & Si

SANDSTONE, red, fine-grained. Bed of dark red sandy clay 71.0' - 71.7' — Ss

BORING COMPLETED 2-6-60 AT A DEPTH OF 75.0 FEET CONTINUOUS 6-INCH CORE

NOTE 1. No water was encountered in the deep boring and the nearby water supply test well.

CONTINUOUS 6-INCH CORE

★ HOLE DEEPENED 2-11-60 TO A DEPTH OF 276.5 FT. - ALL MASSIVE ROCK SALT BED WITH MINOR RED CLAY IMPURITY.

Silo

OVERBURDEN (QUATERNA[RY])

CLAY, red, loose, silty, with broken pieces of caliche

CHALK BLUFF FORMATION (PERM[IAN])

MUDSTONE, reddish, crushed, slickensided planes all direct[ions], strength of stiff clay, secon[dary] gypsum veins.

SAND, red, medium-grained, c[lay]ey, calcareous and very fri[able], gravelly at base.

CLAY, red, silty, soft, with lim[e]stone gravel.

Clay is red, silty to sandy, f[irm] to soft, small (¼") green clay balls, carbonaceous.

Clay contains angular pebbl[es] of yellow mudstone and roun[ded] pebbles of quartzite, with s[mall] lime and green clay fragmen[ts]

GYPSUM, massive

CLAY, red, silty

GYPSUM

CLAY, red and green, silty

GYPSUM,

broken, with red and green clay in fractures 161.5' - 172.2'

gray-green fractured siltsto[ne] 172.2' - 173.6'

massive gypsum 183' - 193'

soft, silty clay 197' - 199'

10" of soft clay at 205'

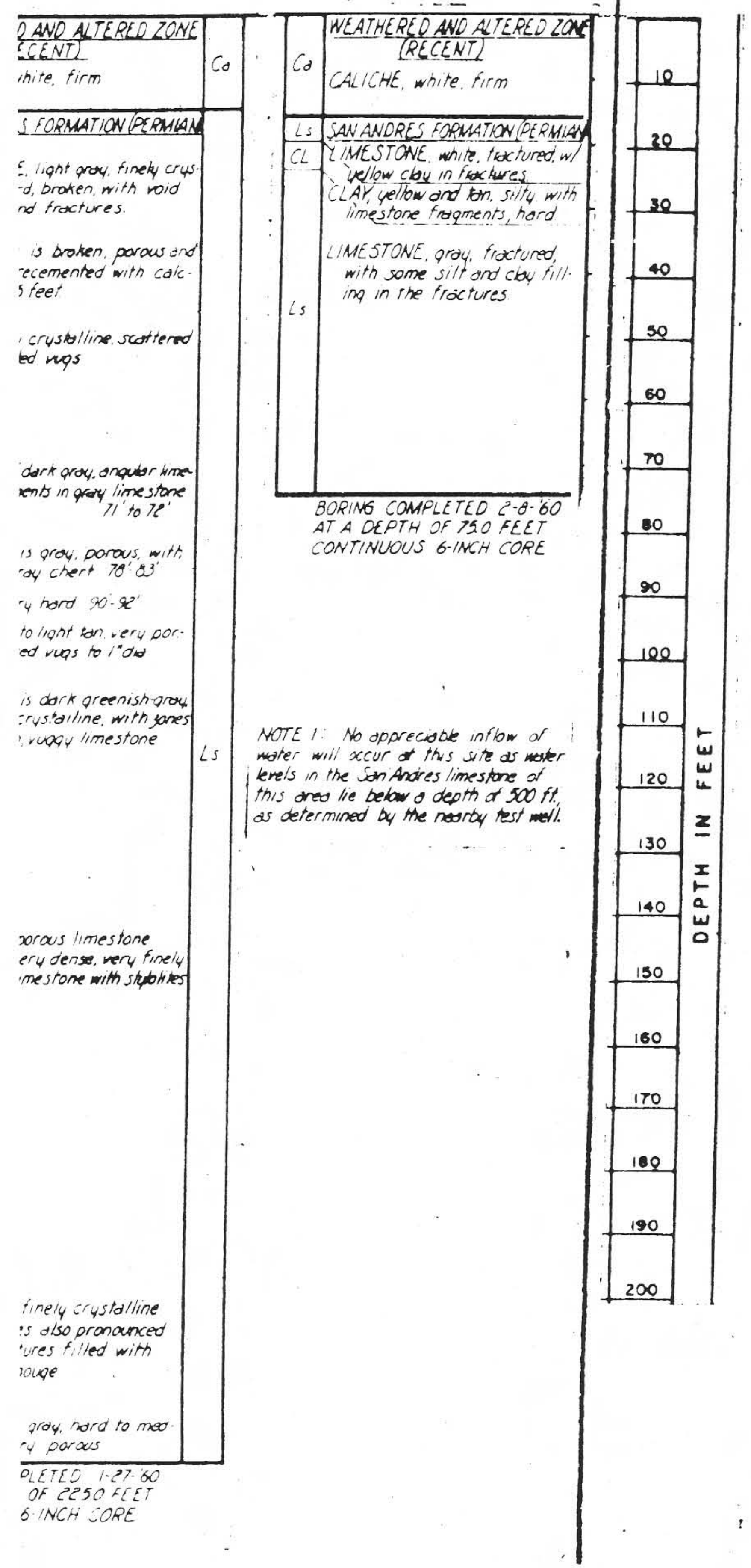
ANHYDRITE & GYPSUM, massive, with small solution cavities.

BORING COMPLETED 2-6-[60] AT A DEPTH OF 225.5 FEET

CONTINUOUS 6-INCH CORE

Site No. 7

Silo LCC



Contract No. DA-29-005-ENG-2598
Walker AFB-Roswell, New Mexico
BORING LOGS-WEST GROUP
SITES 6 AND 7
(Extracted from Contract Drawings)

FIGURE 10

Site No. 7

LCC

SAN ANDRES FORMATION (PERMIAN)

LIMESTONE, gray, hard with horizontal fracture seams containing silt and clay. Caliche above 10'.

Damp clay at 43'

BORING COMPLETED 2-9-60
AT A DEPTH OF 75.0 FEET
CONTINUOUS 6-INCH CORE

E 1: The 225-foot boring was uring drilling. The water levels in imestone of the area are believed below 500 feet.

Silo

WEATHERED AND ALTERED ZONE (RECENT)

Ca — CALICHE, white, firm

SAN ANDRES FORMATION (PERMIAN)

Ls — LIMESTONE, light gray, finely crystalline, hard, broken, with void pockets and fractures.

Limestone is broken, porous and partially recemented with calcite to 145 feet.

Gray, finely crystalline, scattered calcite filled vugs

Breccia of dark gray, angular limestone fragments in gray limestone 71' to 72'

Limestone is gray, porous, with dark gray chert 78'-83'

Hard to very hard 90'-92'

Light gray to light tan, very porous, scattered vugs to 1" dia.

Limestone is dark greenish-gray, very hard crystalline, with zones of light tan, vuggy limestone

Hard, gray, porous limestone grading to very dense, very finely crystalline limestone with stylolites

Gray, dense, finely crystalline, with stylolites, also pronounced vertical fractures filled with calcite and gouge

Limestone is gray, hard to medium hard, very porous

BORING COMPLETED 1-27-60
AT A DEPTH OF 225.0 FEET
CONTINUOUS 6-INCH CORE

LCC

WEATHERED AND ALTERED ZONE (RECENT)

Ca — CALICHE, white, firm

Ls — SAN ANDRES FORMATION (PERMIAN)

LIMESTONE, white, fractured, w/ yellow clay in fractures.

CL — CLAY, yellow and tan, silty with limestone fragments, hard

Ls — LIMESTONE, gray, fractured, with some silt and clay filling in the fractures

BORING COMPLETED 2-8-60
AT A DEPTH OF 75.0 FEET
CONTINUOUS 6-INCH CORE

NOTE 1: No appreciable inflow of water will occur at this site as water levels in the San Andres limestone of this area lie below a depth of 500 ft, as determined by the nearby test well.

DEPTH IN FEET: 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200

Contra
Walke
BC

(Extrac

DEPTH IN FEET: 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220

Site No. 6

Silo

SAN ANDRES FORMATION (PERMIAN)

LIMESTONE (Ls)

Gray, hard, with 5-10% solution vugs lined with calcite crystals, occasional clay seams 45°-60° and vertical joints

Gray, dense, hard, with hard red clay seams, calcite lenses.

Dark gray, with pink calcite and red clay seams.

Medium to light gray, dense, hard, fine to very fine crystalline with calcite seams.

Massive between 70' and 75'

Brownish-gray, hard, fine grained, 1" vugs lined with calcite, horizontal fractures with red calcareous clay.

Greenish gray, dense, irregular fractures, small, red clay seams between 119.5' and 123.5'

Dark gray, massive, highly fractured, fractures filled with calcite and clay. Slickensides at 143' within 1' clay, which may be gouge. Water seep 152.3'-152.8' in breccia.

Tan, silty, badly fractured, also crystalline, fractured, wet at 162'.

Mottled gray and tan, sandy, also gray, platy limestone.

Some raveling.

Gray, hard, dense, with interbeddings (¼") of red, tan, buff, clayey limestone. Fossilliferous.

Locally sandy and clayey limestone 175' to 185'.

Dark gray, hard, dense, horizontal fractures lined w/red clay & calcite.

BORING COMPLETED 1-31-60
AT A DEPTH OF 225.1 FEET
CONTINUOUS 6-INCH CORE

LCC

SAN ANDRES FORMATION (PERMIAN)

LIMESTONE, gray, hard with horizontal fracture seams containing silt and clay. Caliche above 10'. (Ls)

Damp clay at 43'

BORING COMPLETED 2-9-60
AT A DEPTH OF 75.0 FEET
CONTINUOUS 6-INCH CORE

NOTE 1: The 225-foot boring was dry during drilling. The water levels in the limestone of the area are believed to lie below 500 feet.

Site No. 7

Silo

WEATHERED AND ALTERED ZONE (RECENT)

CALICHE, white, firm. (Ca)

SAN ANDRES FORMATION (PERMIAN)

LIMESTONE, light gray, finely crystalline, hard, broken, with void pockets and fractures. (Ls)

Limestone is broken, porous and partially recemented with calcite to 145 feet.

Gray, finely crystalline, scattered calcite filled vugs

Breccia of dark gray, angular limestone fragments in gray limestone 71' to 72'

Limestone is gray, porous, with dark gray chert 78'-83'

Hard to very hard 90'-92'

Light gray to light tan, very porous, scattered vugs to 1" dia.

Limestone is dark greenish-gray, very hard crystalline, with zones of light tan, vuggy limestone

Hard, gray, porous limestone grading to very dense, very finely crystalline limestone with stylolites

Gray, dense, finely crystalline, with stylolites, also pronounced vertical fractures filled with calcite and gouge

Limestone is gray, hard to medium hard, very porous

BORING COMPLETED 1-27-60
AT A DEPTH OF 225.0 FEET
CONTINUOUS 6-INCH CORE

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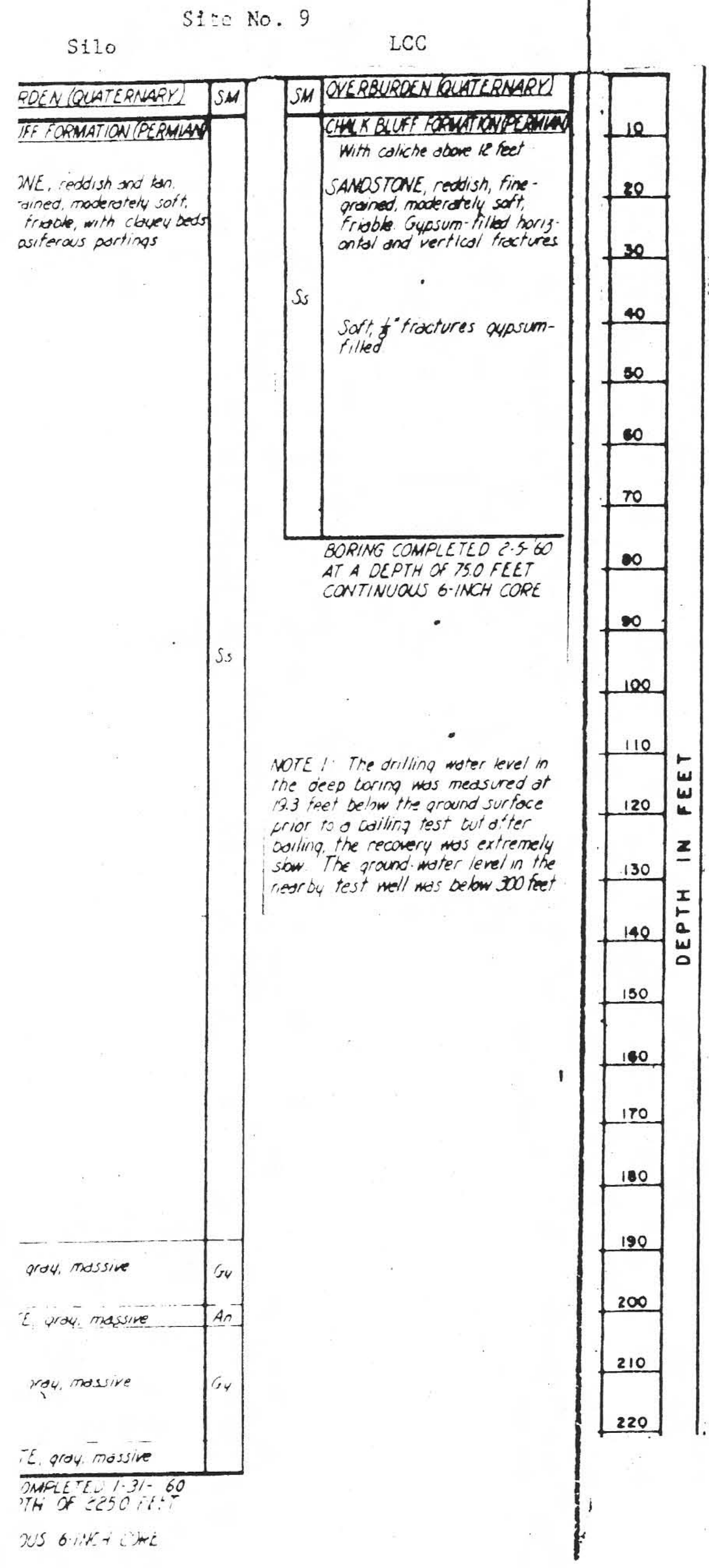

Contract No. DA-29-005-ENG-2598
Walker AFB-Roswell, New Mexico
BORING LOGS-NORTH GROUP
SITES 8 AND 9
(Extracted from Contract Drawings)

FIGURE 11

DEPTH IN FEET

10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220

Site No. 8

Silo

OVERBURDEN (QUATERNARY)	
SILT with caliche	
CHALK BLUFF FORMATION (PERMIAN)	
LIMESTONE, gray, hard, fine-grained.	Ls
GYPSUM, gray, massive, with few thin beddings and streaks of hard, gray limestone. Gypsum is reddish gray to dk. gray. Gray gypsum. Earthy, porous limestone, 6" at 64.5'. Very calcareous, tan clay, 74'-75'	Gy
SAN ANDRES FORMATION (PERMIAN)	
1' greenish, clayey, limestone; 2' brittle, calcareous claystone; 2' gray-green, soft, calcareous clay	Ls Cl
LIMESTONE, gray, porous, fractured, light gray, calcareous fillings. Greenish-gray, calcareous clay, 126'-129'. Limestone is gray, hard	Ls
CLAYSTONE, brown, calcareous, hard, fractured.	Cl
SHALE, gray, hard, calcareous, fractured.	Sh
LIMESTONE, gray, porous, partially decomposed, fractured and poorly recemented.	Ls
SHALE & LIMESTONE, shale is light to dark gray, clayey to silty, fractured.	Sh - Ls
CLAY, silty, moist	CL
SHALE, dark gray, with silty clay	Sh
LIMESTONE & ANHYDRITE	Ls-An
SHALE, turning to light gray, porous limestone w/shale at base	Sh

BORING COMPLETED 2-9-60
AT A DEPTH OF 225.0 FEET
CONTINUOUS 6-INCH CORE

ICC

	OVERBURDEN (QUATERNARY)
CL	CLAY, red, silty, with calcareous nodules. Brown, sandy 10'-13'
	CHALK BLUFF FORMATION (PERMIAN)
Gy Sh	GYPSUM, gray and SHALE, gray, in alternating layers.
Gy	GYPSUM, gray. Few gray clay shale layers

BORING COMPLETED 2-12-60
AT A DEPTH OF 74.9 FEET
CONTINUOUS 6-INCH CORE

NOTE 1: The water level was measured after bailing at a depth of 186 feet below the ground surface in the deep boring. This water level represents a slight artesian head, as no water was encountered in the deep boring above the depth of about 200 feet.

Site No. 9

Silo

OVERBURDEN (QUATERNARY)	SM
CHALK BLUFF FORMATION (PERMIAN)	
SANDSTONE, reddish and tan, fine-grained, moderately soft, mostly friable, with clayey beds and gypsiferous partings	Ss
GYPSUM, gray, massive	Gy
ANHYDRITE, gray, massive	An
GYPSUM, gray, massive	Gy
ANHYDRITE, gray, massive	

BORING COMPLETED 1-31-60
AT A DEPTH OF 225.0 FEET
CONTINUOUS 6-INCH CORE

[ICC]

SM	OVERB
	CHALK
	With
Ss	SANDS grain friab ontal
	Soft, filled

BORING
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bailing, the re
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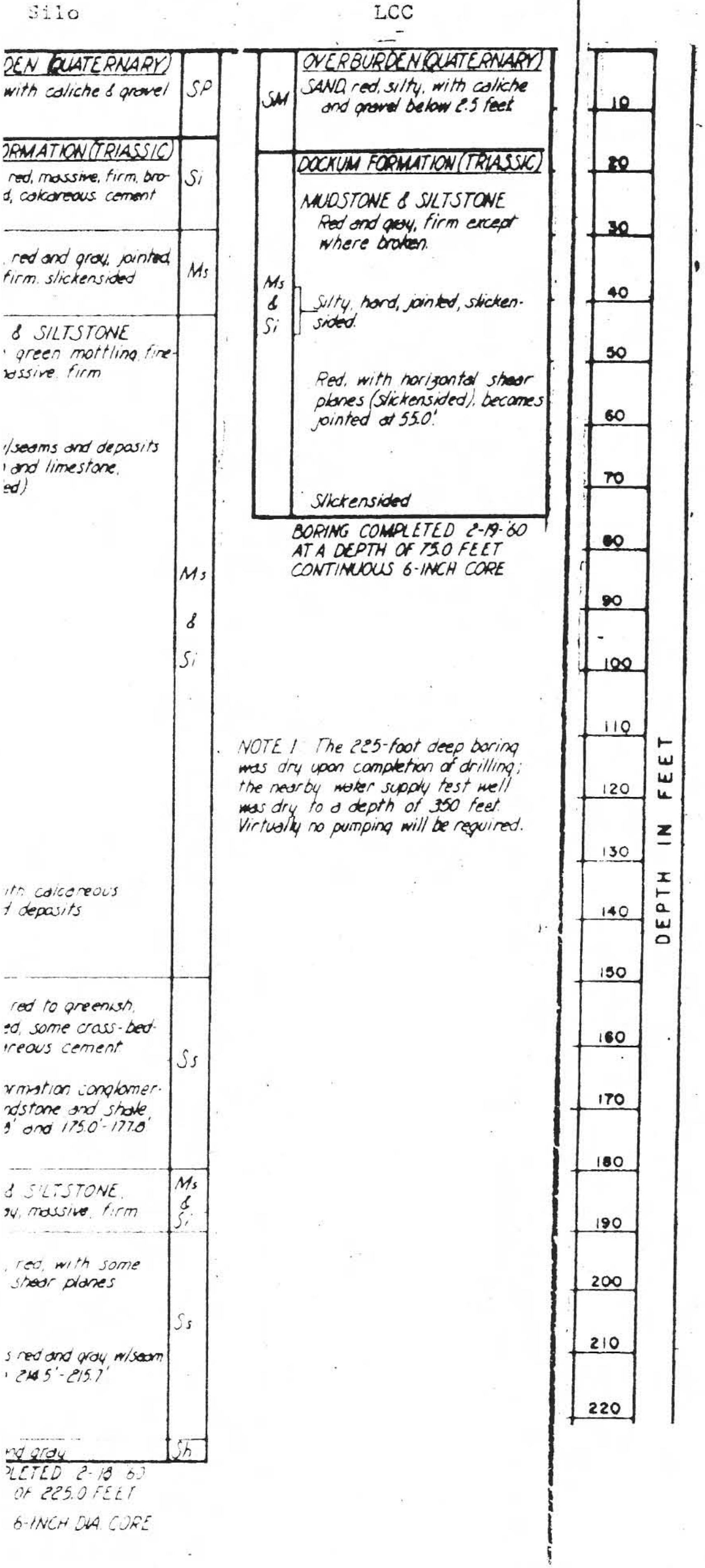
Site No. 12



Contract No. DA-29-005-ENG-2598
Walker AFB-Roswell, New Mexico
BORING LOGS-EAST GROUP
SITES 11 AND 12
(Extracted from Contract Drawings)
FIGURE 12

Site No. 11

Depth (feet): 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220

Silo

OVERBURDEN (QUATERNARY) — SM
SAND, red, fine, silty with caliche

DOCKUM FORMATION (TRIASSIC)

SHALE & SANDSTONE — Sh & Ss
red, badly broken, jointed and weathered above 17' becoming firmer below.

SANDSTONE, red, firm, fine to medium-grained, 45° joint from 33.5' to 34.0' — Ss

SILTSTONE, MUDSTONE, AND SANDSTONE, interbedded, moderately firm to firm, 60°-90° joints throughout — Si Ms Ss
crushed, with irregular slickensides: 47.5'-48.5', 52.0'-54.0', 56.0'-58.0', 75.5'-76.0'.

SANDSTONE, red, fine-grained, locally conglomeritic with claystone pebbles, generally firm but becoming soft where extremely broken, some cross-bedding. — Ss

SILTSTONE, SANDSTONE, AND MUDSTONE, about 4:4:2, red to locally gray, highly jointed throughout, firm to moderately firm except for crushed zones 161'-161.5'; 167.0'-167.1'; and 181'-194' (gypsiferous) which are soft. — Si Ss Ms

CHALK BLUFF FORMATION (PERMIAN)

GYPSUM AND SHALE, — Gy Sh
gypsum in massive beds to 3' thick, shale shot through with secondary gypsum plus some primary gypsum nodules. Below 220' gypsum beds show clay-filled solution joints. Shale is moderately soft to moderately firm.

BORING COMPLETED 2-3-60
AT A DEPTH OF 227.3 FEET
CONTINUOUS 6-INCH CORE

LCC

OVERBURDEN (QUATERNARY)
CL — CLAY, dark red, sandy, silty

DOCKUM FORMATION (TRIASSIC)

Sh & Ss — SHALE & SANDSTONE, red, badly broken, jointed and weathered.

Ss — SANDSTONE, red, fine-grained, mod hard, calcareous. Becomes greenish-gray near base.

Si Ms Ss — SILTSTONE, MUDSTONE, & SANDSTONE, interbedded, moderately firm to firm.

Ss — SANDSTONE, red, fine-grained, firm to soft where broken

BORING COMPLETED 2-8-60
AT A DEPTH OF 76.9 FEET
CONTINUOUS 6-INCH CORE

NOTE 1: The deep boring was dry to the maximum depth of exploration. The nearby water supply test hole was dry to a depth of 435 feet.

Site No. 12

Silo

OVERBURDEN (QUATERNARY)
SAND, red, with caliche & gravel — SP

DOCKUM FORMATION (TRIASSIC)

SILTSTONE, red, massive, firm, broken, jointed, calcareous cement — Si

MUDSTONE, red and gray, jointed, weak to firm, slickensided. — Ms

MUDSTONE & SILTSTONE — Ms & Si
red with green mottling, fine-grained, massive, firm

Jointed w/seams and deposits of gypsum and limestone, (slickensided)

Jointed with calcareous seams and deposits

SANDSTONE, red to greenish, fine-grained, some cross-bedding, calcareous cement. — Ss

w/inner formation conglomerate of sandstone and shale, 163.8'-165.8' and 175.0'-177.8'.

MUDSTONE & SILTSTONE, red and gray, massive, firm — Ms & Si

SANDSTONE, red, with some horizontal shear planes — Ss

Sandstone is red and gray, w/seam of red shale 214.5'-215.7'

SHALE, red and gray — Sh

BORING COMPLETED 2-18-60
AT A DEPTH OF 225.0 FEET
CONTINUOUS 6-INCH DIA. CORE

[LCC]

OVERB...
SM — SAND, r... and g...

DOCKUM...

Ms & Si — MUDSTO...
Red an... where...

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BORING C...
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NOTE 1: The 2... was dry upon c... the nearby wate... was dry to a de... Virtually no pum...

SOURCE OF UTILITIES:

All permanent utilities, other than water which is described above, were developed at the site as a part of the project. Commercial power was brought in by pole line for use during construction. Communications during construction were by two-way radio, the Corps and the Contractor each having its own system. Water was available at some sites in test or permanent water supply wells and was used for such work as moistening earth fills for compaction. It was too highly mineralized for concrete mixing or drinking water use. Water for this purpose was hauled from Roswell, or elsewhere.

MEANS OF ACCESS:

All sites are served permanently by asphaltic-paved highways and access roads where shown on the Vicinity Map, Figure 7. Excepting for the irrigated valley portion, a narrow strip along the west side of the Pecos River, there are no secondary roads. Sites are grouped along highways and there are no interconnecting roads between groups. As can be seen on the Vicinity Map, the AT & SF Railroad passes through the area. Sidings for delivery of construction materials were available and used near sites 1, 2, 10, 4 and 5 and at Roswell. During the period of major activity the Contractor, Air Force and Corps of Engineers all utilized helicopters to facilitate movement of personnel between sites and headquarters.

CONSTRUCTION PERIOD:

The basic prime contract for the Launch Complexes was awarded 20 June 1960 and notice to proceed issued the same date. Construction was physically started 23 June 1960 and the last site completed

6 January 1962, fifty-seven days later than originally scheduled. The contract contained a completion schedule listing 25 August 1961 as completion date for the first site with others following at one week intervals. A sequence of construction starting dates by sites, was scheduled in early stages. However, due to differences in conditions met, progress did not develop at the same rate for each site and sequences changed several times. In addition, time extensions were granted in varying amounts by sites but averaging sixty days. Following is a tabulation of original contract completion dates by site sequence and a second tabulation of actual completion dates by Site Numbers:

Contract Schedule		Actual Completion	
Site Sequence	Completion Date	Site Number	Completion Date
1	25 Aug 61	10	24 Oct 61
2	1 Sep 61	9	30 Oct 61
3	8 Sep 61	1	6 Nov 61
4	15 Sep 61	8	13 Nov 61
5	22 Sep 61	3	19 Nov 61
6	29 Sep 61	12	27 Nov 61
7	6 Oct 61	11	5 Dec 61
8	13 Oct 61	6	18 Dec 61
9	20 Oct 61	2	22 Dec 61
10	27 Oct 61	7	25 Dec 61
11	3 Nov 61	5	5 Jan 62
12	10 Nov 61	4	6 Jan 62

The above actual completion dates coincide with scheduled completion dates revised to include time extensions. Final inspections on or before those dates revealed each site substantially complete. No liquidated damages were assessed. Support facilities contracts were awarded and completed within the period of custody by the basic prime contractor.

CONSTRUCTION FEATURES AND OPERATIONS:

MASS EXCAVATION: Mass excavation from ground to reference elevation 960 feet first commenced at site number 1 on 2 July 1960, upon completion of the clearing and grubbing operations. This particular phase of work was subcontracted by the prime contractor to Anderson Brothers, an earth moving corporation located in Albuquerque, New Mexico. This portion of the work progressed rapidly after two ten hour shifts were established on 12 July 1960. Some sites were excavated to reference elevation 960 feet in the short time of five days using three twenty yard Tournapulls, two D-8 bulldozers with rippers, one D-6 angle ditcher, a motor grader for dressing slopes and a service truck for serving field equipment. The amount of mass excavation at the various sites was approximately forty-eight to fifty thousand cubic yards, excavated, hauled and stock piled on individual site easement areas. On complex numbers 1, 2, 6, 7 and 8, drilling and blasting was necessary during the mass excavation operations and progress was considerably less on these sites. Caliche rock from one foot to three feet in thickness was encountered at sites 11 and 12. The site contractor was able to break up the rock utilizing heavy rippers on the D-8 caterpillar tractors and complete the mass excavation at these sites without resorting to drilling and blasting. Mass excavation was completed at the final site, Site No. 6, 12 October 1960.

SHAFTING: Shafting for silos for site numbers 1 and 2 commenced on 25 July 1960 and on 30 July 1960 for site number 10. This operation was completed on 22 November 1960 at site complex number 4 which was the wettest site complex of the twelve. Water was encountered during excavation at four of the twelve silos. The average time for shafting of the dry holes from reference elevation 960 feet to 820 feet was fifty-five days. This averaged 2.5 feet per day. The wet hole, complex number 4, was shafted in fifty-five calendar days, being shafted as rapidly as possible under very adverse conditions. Most of the material encountered was saturated sand, silt, and clay, all of which produced various amounts of water. Silo number 4 encountered anhydrite strata requiring drilling and blasting for the last ten feet of excavation. Extra silo ring beams and vertical supports were required. The vertical supports consisted of angle irons welded between ring beams to obtain a cage effect for mutual support against slopping pressure behind the lagging.

The wet hole at silo complex number 5 was shafted in eighty-one days, the longest time utilized in any shafting operation. An attempt to intercept the 150 to 200 gallons per minute was unsuccessful and shafting below reference elevation 930 feet was conducted in a vertical rain of water. Slowness of shafting was directly attributal to the unstable nature of the material and to the necessity of reducing blasting to a minimum amount for any one blasting operation. Discomfort of the miners working constantly in the falling water also contributed to the slow rate of progress. As in the instance of site number 4, extra silo wall support ring beams and angle iron vertical stiffeners were provided. Although the contractor started operations behind schedule he was able to increase progress and actually completed silo shafting some ten days ahead of schedule.

WATER CONTROL: At site complex number 1, a seep of water was encountered at a depth of nineteen feet with increasing amounts as the mass excavation progressed. Pumping was necessary from the mass excavation area and started on 25 July 1960. Shafting of the silo commenced on 29 September 1960 and increasing increments of water were encountered with additional depth for about fifty to sixty feet. Weep pipes were installed at numerous places through ringbeam lagging, and a system of sheet metal troughs was devised to intercept infiltrating water and decrease the amount falling on operations below. Pumping was continued from bottom of excavation as it progressed and from the air shaft excavation adjacent to the silo throughout silo shaft excavation and shaft wall concrete placement and was not discontinued until backfill operations started on 27 February 1961. Grouting was necessary, particularly in the area around the fill and vent shaft. Portland cement and pozzolan were used.

At site complex number 2, water was encountered at silo shaft excavation depth of 126 feet reference elevation 834 on 27 August 1960. Pumping started and the inflow increased with additional depth reaching a maximum of 270 gpm. It was necessary to change the type of foundation to an alternate type because of the water inflow and unstable conditions encountered at the bottom of shaft excavation. The contractor elected to provide a second sump for dewatering purposes in addition to the sump required by the contract drawings. Consequently, the shaft was excavated below the originally required level to provide space for filter material and the 5'6" thick base. A 6" electric driven turbine pump was installed in the temporary sump and effectively removed the water during silo floor and wall concrete placement. After the silo walls were completed, grouting was performed in the lower area of the silo through grout pipes installed prior to concrete placement.

Core logs indicated that water would be found in excavation for site complex number 4 at about sixty feet below original ground surface. The contractor test-pumped a test well located about 200' from the silo and found that as much as 150 gpm could be pumped from the 105' deep 6" test well with a twelve foot drawdown. Stang Corporation (Engineering Dewatering Specialists) was called in 29 July 1960 to make a study of the underground water, soil conditions and to recommend dewatering treatment. A 16" dia. test well was drilled about 150 feet from the 6" test well to a depth of 195 feet, cased and perforated and a core hole was drilled 100 feet from the original 6" test well in line with 16" well and center of the silo. Stang Corporation representative and the contractor installed pumps, pumped for several days making numerous measurements on drawdown and volume of water pumped.

Stang Corporation's report stated that as much as 400 to 500 gpm inflow could be expected in the silo excavation and that a peripheral treatment was recommended.

Halliburton Company (an oil well grouting specialist firm) was called in on 22 August 1960, and drilled holes and installed 2" grout pipes at five foot centers just inside the concrete ring beam collar support to a depth of sixty-one feet. These 2" diameter grout pipes were grouted in place with standard Portland cement with two per cent calcium chloride. Over 900 sacks of cement were used for an average of about fifteen sacks for each of the sixty-one grout pipes installed.

Chemical grouting started on 1 September 1960, using formalin and urea to form a synthetic resin belonging to the group of amino-aldehyde resins. The chemical was pumped at a rate of 1 to 2 gpm under pressures of 80 to 100 psi through perforations in the 2" grout pipe. Approximately eighty gallons of solution were pumped through each two feet increment of perforated pipe. The perforations in the pipe were made utilizing a shaped charge made by Jet Research Center and lowered into the pipe by a small cable and then detonated. A few areas took the grout so fast that pressures could not be built up and consequently some Howcogel (grained bentonite) was mixed with the chemical grout. All water for chemical grouting operations was hauled in from Artesia due to the fact that water available on the site was so salty that it affected the chemical reactions.

After placing some 17,000 gallons of this type of chemical grout, a rotary drill rig was brought in and cores were taken in the grouted area. Very little of the grout was found and as a result, operations with the resin chemical were discontinued on 17 September 1960. On 24 September, a shipment of PWG was received and some 7,100 gallons of this plastic type chemical grout were pumped in the ground by 28 September 1960. The grout used was polymerized water gel with additives that allowed control of time of set to as quickly as five minutes. Additional core boring was performed and very little of the PWG was found in the cores. Halliburton Company moved out 30 September 1960.

The contractor then drilled ten wells, eighty foot deep around the perimeter of the silo in the mass excavation area. These were 20" diameter gravel packed wells with 3" pump inside perforated casing. The first well was completed and pump installed on 6 October 1960. Drilling of the dewatering wells and shaft excavation was performed concurrently until shaft excavation reached about fifty foot depth at which time the inflow into the shaft increased considerably, and pumping had to be accomplished from the silo shaft excavation bottom. The water inflow was sixty gpm at a fifty-five foot depth and increased proportionately with additional depth to a 350 gpm inflow on 16 November 1960 at a depth of 130 feet at which time the ten dewatering wells stopped producing water. Shaft excavation was completed on 26 November 1960 and a 5'6" slab was placed 17 December 1960. Pumping was continued until after the fourth wall lift of concrete was placed.

Any evaluation of the effectiveness of the chemical grouting is pure speculation as it is not known what the conditions would have been without the grouting. However, it is the general consensus of opinion among the engineers working with the water problem at site number 4 that the chemical grouting was ineffective due to the fact that the movement or flow of the underground water was fast enough to dilute and wash the grout away before it could set.

At complex number 5, mass excavation was started on 13 August 1960 and water was encountered before reaching the bottom on 18 August. A collection trench was dug around the perimeter of the mass excavation area from eight to fourteen feet deep, draining to a sump on the northwest side and was backfilled with gravel. An electric turbine pump was then installed in the sump. Silo shafting started on 26 August 1960 with dewatering being accomplished by means of electric and air sump pumps operating from the bottom of the shaft excavation. Water inflow increased with depth from about 20 gpm at twenty foot depth to a maximum of 200 gpm at 60 to 100 foot depth. Serious sloughing of material behind the ring beams and lagging occurred, making it necessary to suspend shaft excavation on several occasions. Lean concrete and grout was placed in the voids behind the lagging and additional ring beams and vertical stiffeners were installed. Rock (anhydrite) was encountered at the sixty foot level in the shaft and drilling and blasting were necessary for the balance of the shaft excavation. Layers of clay sandwiched between layers of rock made dewatering and excavation difficult. At the time the shaft was at the sixty-five foot depth, two dewatering wells were drilled from the bottom of the mass excavation area, one on the north side and one on the south. Pumps were installed but insufficient water entered the wells to make any appreciable change in the volume of water entering the silo excavation. The water did not travel in any particular strata, but seeped through the clay and made sloughing a real problem. Shafting was completed on 17 November 1960 and metal plates were welded to the ring beams from elevation 887 to 903 and grout pipes were installed at frequent intervals. Grouting started on 7 February 1961 after the silo concrete walls were placed and continued intermittently until 14 April 1960, effectively sealing off all but a few minor seeps.

CONCRETE OPERATIONS: Concrete placement started on 25 September 1960, about five days behind schedule and proceeded slowly at a rate considerably less than the scheduled rate. This was due in part to the rate of delivery and in part to the inability of the contractor to get forms ready for succeeding pours.

Conventional type forming was selected because of the Type V (Sulphate resistant) cement specified for use. Time of set for this type cement was known to be much longer than Type I standard Portland cement. Tests were made on the time of set of the Type V cement at the Corps of Engineers Southwest Division Laboratory, and initial set was found to be approximately seven hours at 50°F.

The contractor started silo wall concrete placement with three sets of forms thirty foot in heighth for the portion below reference elevation 962, and two sets of forms for use from reference elevation 962 to 991. Early in November 1960, the Area Engineer directed the contractor to construct a fourth set of lower wall forms. The contractor complied and also constructed a third set of upper wall forms.

Reinforcing steel forming and placement was subcontracted to Cobusco-Salyer, a joint venture consisting of Colorado Builders Supply Company and Ira Salyer of California. All bending and forming was performed on several sites and hauled to others. About 12,000 tons of reinforcing steel was placed in the twelve silos and launch control centers in sizes from number two through number eighteen bars. The reinforcing steel ironworkers worked two ten hour shifts per day throughout most of the construction period and were able, in most instances, to keep ahead of forming and placement by use of several ingenious jigs and slings that allowed placement of a score or more bars with a single crane operation. The number eighteen bars in the silo cap and doors were required to be butt-welded by either the exothermic or shielded arc methods. The contractor elected to make the welds manually, using a low hydrogen rod by the shielded arc welding process with certified welders. After the joints were butt-welded, radiographic films were made of ten per cent of the welds by Western Industrial X-Ray Corporation of Lubbock and Houston, Texas, using an iridium isotape. A few questionable welds were found, cut out, re-welded and additional radiographs taken.

All concrete was furnished by the F. M. Reeves Company of Roswell. The aggregates were produced from Reeves pit southwest of Roswell, except that about twenty-five per cent of sand from the Acme pit, twenty miles northeast of Roswell was blended with sand from the Reeves pit to improve gradation. Originally, the concrete was dry-batched into two batch truck-trailers, hauling two six yard batches to five transfer hoppers located near the midpoints of two and three site complex groupings. At the hoppers the dry-batched concrete and water hauled from Roswell was transferred to truck mixers for mixing and transporting to the various sites. During cool weather it was possible to supplement the twelve batch trucks with truck mixers hauling direct from the batch plant to the sites. In cold weather the mixing water was heated by steam at the batch plant supplemented by additional heating from liquid petroleum gas burners in the water tanks of the dry batch trucks. During the hot summer weather of 1961, all concrete was hauled by the dry batch trucks to the transfer hoppers, at which point ice was added in lieu of mixing water in amounts up to 300 pounds per six yard batch. In addition, the major portion of concrete placement was scheduled for night placement in order to take advantage of the lower night time temperatures.

Winter concrete protection met minimum requirements through the use of tarpaulins and various types of heating devices. No frozen concrete was experienced, and all placing temperatures were 50°F or higher.

Concrete quality control was very good. Adequate tests were made on aggregates and compression tests on the finished product. One set of compression test cylinders was made from each approximate eighty cubic yards of concrete placed. Engineer control personnel were continuously present on a twenty-four hour basis at the (1) batch plant, (2) the transfer hopper points, (3) the work site for receiving, running slumps and making cylinders and (4) for proper placement and vibration. Further, in consideration of the hour experience factor of Corps of Engineers field personnel, during two of the three daily shifts, the Construction Branch assigned two coordinators to the concrete operation, one to swing shift and one to the graveyard shift. In this manner, the Roswell area deviated from normal practice of assigning coordinators to groupings of complex sites and assigned coordinators to specific construction operations over the entire twelve sites to provide a high degree of continuity of control.

Compression cylinders made on the sites were hauled to the contractor's fog curing room located at his Roswell shop and yards area, and then transferred to the Corps of Engineers field testing laboratory, located on Walker Air Force Base as the break dates fell due. Average cylinder breaks on Class AA concrete were approximately 500 psi above the 3750 psi required and on Class AAA concrete were well above the 5000 psi requirement.

Most milestones for silo wall concrete placement were met except that the last four silos slipped four to seven days because of unusually severe storms in December. All milestones for silo cap and door concrete placement were reached ahead of schedule. Concrete placement rates for LCC and silo concrete (except caps) were less than forty cubic yards per hour on a twenty-four hour basis, although the forty yard per hour rate was exceeded for short periods of time. The slow rate was caused by the inability of the supplier to transport concrete from the central batch plant to the various sites. Truck breakdowns, tire trouble, slick highways, delayed deliveries of cement (also truck transported) all added up to a slow rate of placement. On the silo cap pours, it was determined that a minimum rate of fifty cubic yards per hour would be necessary because of a modified Type V cement with faster time of set proposed for use and because of higher summertime temperatures. The supplier was able to place his equipment in such condition that the fifty yard per hour rate was exceeded at all sites and no cold joints were experienced.

The finished concrete product at all sites is considered excellent and well above average in appearance, soundness and structural stability.

<u>CRIB STEEL</u>: An interesting phase of construction was the erec-

tion of the steel structure inside the concrete silo known as crib steel. After the completion of the concrete walls of the silo, the necessary progressive task was the erection of the crib steel. This operation consisted of erecting the equivalent of an eighteen story fifty foot by fifty foot building, built of high strength structural steel, inside of the silo. Approximately 500 tons of steel went into each silo, enough to build a first class railroad for a length of two and one half miles. The eighteen story steel frame structure is an eight sided structure with a 22.5-foot vertical opening near the east side of the silo which was to later become the Missile Inclosure. The steel structure thus built around the Missile Inclosure contains eight floor levels. Level eight, the lowest, is at elevation 840, fourteen feet above the silo floor. Level one, the highest, is at elevation 979'-6", approximately eleven feet below the silo cap. At each floor, steel grating and checkered plate was placed and utilized as a base to set the numerous Propellant Loading System, heating, air conditioning, ventilation and electrical equipment. The erection of crib steel commenced from the bottom of the silo on temporary column extensions resting on concrete pads. There are eight exterior columns and two interior. The crib structure is hung from four compression spring type shock hangers with suspensions points at Level 5. A peripheral truss between Levels 5 and 4 transfers loads to the suspension points. The two interior columns are supported by trusses between Levels 4 and 3. Columns are in tension below trusses and compression above. At the lower portion of the Missile Inclosure are two frames composed of box girders and box hangers which are located one each at the north and south sides of the inclosure. The box hangers serve to hold the Missile in true position while in the silo and are correlated with lock brackets placed at the silo cap to hold the top of the Missile in alignment with the bottom of the Missile. The box hangers have Korfund springs at the top and bottom pre-compressed to 70,000 pounds. The purpose of these springs is to give the Missile a vertical flexible movement. All structural members were designed with high strength bolted connections and conformed to the AISC specifications for structural steel joints utilizing ASTM A-325 bolts. Fabrication of the steel was performed by Mosher Steel Company of Dallas, Texas. After the crib steel had been erected from the silo floor through level three, suspension assembly systems consisting of high strength steel rods and pre-tension springs were installed. These assemblies were known as the shock hangers. Shock hangers consisted of hanger rods and a series of compression springs which were shipped in an un-compressed state. The springs were compressed at the site, utilizing a hydraulic jack, to approximately seventeen inches less length than in the shipping state. Stanchions were then placed at the assembly base to hold the springs in a compressed state until such time as they were supporting the entire silo crib load. The assemblies were then attached by their upper ends to steel plates previously embedded in the silo concrete wall and to the crib structure at their lower ends. At this point in time the crib steel had been erected through the third level.

At this time it was necessary to vertically jack the crib steel approximately two inches to allow eight inch threaded nuts to be fastened to the base of the shock hanger assembly rods. This was accomplished through the use of eight hydraulic jacks placed under the eight exterior columns. During this operation the contractor had to be exceptionally careful in order to meet critical design criteria of the final position of the crib structure. The crib steel structure at the fifth level, elevation 915 feet 10.5 inches, had to be placed within a quarter inch vertical of reference elevation and 1/16 inch of a true north, south, east and west position. The shock hanger assemblies were positioned to within a quarter inch plumbness, top to bottom. When this task was accomplished the hydraulic jacks and jack pads were removed from the base of the eight exterior columns and the crib structure was left suspended on the shock hanger assemblies fastened to the concrete silo walls. With the crib structure suspended from four sides to the silo walls, a gentle but measurable swaying motion was in effect at all time. This lateral and vertical sway which is comparable to the gentle rocking of the baby crib, led to the naming of the crib structure. This motion, combined with the position hanger Korfund spring motion, will enable the Missile to remain in a slightly flexible position through its tenure inside the silo. At the suspension of the crib structure the erection of the crib through level one was completed.

LAUNCH CONTROL CENTER: The Launch Control Center, better known as the LCC, is a two story cylindrical structure of reinforced concrete set six feet below ground level, wherein operating personnel for the Atlas Launch Complex will be housed. The first or top level has kitchen, first aid, toilet and living accommodations as modern and complete as the average new home. The second level houses the remote control and communications equipment, and is the nerve center of the Launch Complex. The bulk of the control and communications equipment will be installed by others (not under CE contract) during the second phase of construction.

A reinforced concrete stairway and entry tunnel leads from grade level down two flights of stairs, through a pair of electrically locked entrapment doors, past a surveillance TV camera and into a vestibule adjoining the LCC. Stairwell affords the sole means for personnel entrance to the LCC and Launching Silo. The LCC in turn is connected to the Launching Silo by an eight-foot diameter steel tunnel, thirty-five foot below grade, leading from the LCC stairwell to the silo vestibule. Two pairs of heavy steel blast doors located in the entry tunnel and silo vestibule seal off the LCC from ground level and the Launching Silo.

The LCC as stated before is a cylindrical structure, 44'-6" in diameter and 33'-6" high outside, having walls 2'-3" thick, a 3'-6" base slab and a 3'-0" roof slab, all of reinforced concrete amounting to 875 c.y. A center column 4'-0" in diameter with a 12'-0" diameter cone base and capital extending from the base slab to roof slab is the lone interior support member for the roof slab.

Concrete was placed in three lifts, base, walls, and roof slab, with the stairwell placed monolithically with the LCC. The entrance stairway and vestibule were treated as separate structures and concrete placed accordingly. Ninety-six tons of steel were placed in the concrete as reinforcing, varying in size from # 4 to # 10 bars and in certain locations constituted such a dense maze that it was all but impossible to place concrete.

Within this concrete shell, a structural steel frame or "crib" was erected as the framing structure for the two levels and the various rooms. The entire crib is suspended from the concrete roof slab by four air cylinder spring supports and is free to move independently of the concrete shell, providing protection for personnel and equipment from external shock waves. Four floor leveling devices sense the level of the crib in respect to the concrete base slab and supply or bleed off compressed air to their respective air cylinders as necessary to maintain the crib level and at the proper height regardless of the load distribution within the L.C.C. Crib members range in size from light angles and channels up to 21" wide flanged beams 30'-6" long.

It would appear that since the crib is suspended from the concrete roof slab that steel erection would precede roof concrete placement. Yet, because of the monolithic placement requirements resulting in restricted access for hoisting heavy and bulky materials into the L.C.C. (down the Launching Silo and through the connecting tunnel, for pieces longer than 10'-0" could not negotiate the corners or narrow doorways in the entry stairway and vestibule passage) it became necessary to erect the crib before placing the roof slab. However, the crib being designed for suspension at the upper level, it could not be used as the sole support of the roof forms. The lighter members designed for tension only would, in compression, be subject to over-stressing. The contractor did erect steel on one site after placing the roof slab, but found the experiment costly and time consuming. Thereafter crib erection preceded concrete placement. The crib was solidly blocked up from the base slab, shored between levels with 4" x 4" studs approximately 3'-4" on centers set on the main floor members, and the top level decked over with 3" - 12" planking. Steel forming scaffolds were then set on the planking to support the roof forms. The planking was field cut so as to distribute the load to the shored framing members. Prior to shoring, crib erection including steel decking was completed.

Construction through completion of concreting was accomplished in the open excavation area simultaneously with silo concreting and crib steel erection. Subsequent to concreting, work by the various crafts within the L.C.C. was completed during backfill operations of the open excavation.

The contractor did not prosecute work on the L.C.C. as a separate entity. Instead, he elected to work the L.C.C. simultaneously with each phase of construction in the Launching Silo. Thus, while completion of the L.C.C.'s was delayed in a sense, waiting for the larger silo structure to catch up before entering another phase of construction, it proved advantageous in that the L.C.C. provided the means to correct organizational inefficiencies and to shake out crews. Certainly then the L.C.C.'s absorbed much of the "learning curve" inherent to large construction, particularly where so much of the work is consolidated within a single narrow structure and yet so widely dispersed over a large geographical area.

MECHANICAL WORK:

1. Utility and Domestic Water: The utility water system is installed with a hydropneumatic pressure booster system which is located in the silo. The system consists of one turbine type utility water pump and one certrifugal fog spray pump, a hydro-pneumatic tank, with all necessary valves, fittings, and controls attached thereto. The domestic water is used for human consumption and is so piped to all facilities used by the occupants. Utility water is classified as water used for fire protection equipment and make up water for the other systems.

2. Hydro-Pneumatic Tank: This tank is the center of all water systems with the exclusion of hot and chilled water used for air conditioning systems. This tank supplies the pressure and the make up for the water systems.

3. Sump Water Disposal System: This system is so constructed as to dispose of all water used for human consumption. The water is disposed of by the use of two pumps and is so piped into a drainage field outside of the silo. Other waste water is disposed of by another set of pumps which pipe the water to grade and so to drainage ditches.

4. Condenser Water Supply and Return System: The purpose of this system is to remove heat from the diesel generator and the water chillers. This water is in turn piped to a cooling tower at grade for cooling and then returned to diesel generators and chillers for the removal of heat.

5. <u>Chilled and Hot Water Systems</u>: These are two separate systems which work in conjunction in the heating and air conditioning systems. Two refrigeration plants keep the chilled water at its proper temperature. The hot water system gets its source of heat from the exhaust of the diesel generator and is so controled to keep the water temperature at desired conditions.

6. <u>Heating, Ventilating and Air Conditioning Systems</u>: Both of these systems are complex in nature and gigantic in size. The purpose of both systems is to keep a constant temperature as required by the various locations within the complex itself. Outside air is taken in and purified by a dust collector before it is available for use in the silo. A combination of fans, supply and exhaust the air at the complex so as to maintain enough fresh air for consumption.

7. <u>Compressed Air System:</u> This system supplies air pressure to the air cylinder supports, blast closures and the hydro-pneumatic tank. The Air cylinder spring supports suspend the floor at the Launch Control Center in four columns of air within the cylinders so as to have a floating floor. The blast closures when closed will isolate the complex from the outside atmosphere.

8. <u>General</u>: All the systems are fully automatic. The many automatic controls that operate these systems are so wired as to reflect any malfunction in the systems on an indicating lights cabinet. The supply of water for the systems is obtained from four underground storage tanks. All piping is rigidly supported to the floating crib steel and is identified as to the type of liquid being carried by it.

ELECTRICAL WORK:

1. Site Work: The electrical features at grade include gate controls, communications, remote power receptacles for support equipment, personnel audio and visual warning alarms, lighting of work areas and a cooling tower which automatically cools condenser water from major units located in the silo.

Rough-in work has been accomplished to provide means for future commercial power, heat and shock sensing devices and communication manholes for intersite communications system.

2. Security Control: The entry tunnel is equipped with an entrapment area for security control. Entry to the entrapment area is remotely controlled from the L.C.C. A pushbutton, when operated, warns the operator in the L.C.C. that entry into the entrapment area is desired. The first entrapment area door latch is released by the L.C.C. operator for entry. When inside the entrapment area, a television camera, which is connected to a monitor set in the L.C.C. provides the means for proper recognition of the party desiring entry. Communication with the party and the L.C.C. operator is maintained through a speaker-mike set installed in the proximity of the entrapment area. The second entrapment area door latch is also remotely controlled from the L.C.C. by the operator. Once past the entrapment area, access to the L.C.C. and silo is gained through a series of blast doors. All doors encountered are equipped with limit switches to alarm the L.C.C. personnel of activity taking place and location. Each door limit switch is identified at the monitor station, Facility Remote Control Panel.

3. <u>Stairwell</u>: The stairwell is equipped with an electrically controlled pneumatically operated blast closure. The blast closure operates under blast conditions and seals off the flow of air to and from the stairwell. Emergency light units provide limited lighting during a power failure. Communication means, public address and telephone, are provided at various locations.

4. <u>Launch Control Center - First Level</u>: The first, upper, level of the L.C.C. includes two blast closures which are electrically controlled and pneumatically operated. The mechanical room and kitchen are equipped with surge panels to protect the direct burial cables from surges due to lightning and/or overload conditions. The panels are equipped with lightning arrestors. This level is also equipped with telephone outlets, public address system outlets, fire alarm detector, audible and visual alarms. The four air-spring cylinder supports for the L.C.C. crib are equipped with solenoid valves which cause the cylinders to raise and lower the crib. The solenoid valves are energized by the operation of the floor leveling devices installed in four respective locations at the second level of the L.C.C. The floor leveling devices are mechanically controlled which in turn operate limit switches. Electrical power is provided for the range, refrigerator, water cooler, garbage grinder, hot water heater and lighting.

5. <u>Launch Control Center, Second Level</u>: The L.C.C. second, lower, level includes the main power panel, lighting distribution transformer and various lighting and communications distribution panels. There is a diesel general remote control panel to start, stop, parallel

and transfer load at the diesel generators in the silo fifth and sixth levels respectively. The Facility Remote Control Panel located in the Launch Control room contains audible and visual alarms for critical circuits. The indicator panel visually indicates equipment normal operating conditions. In the event a failure occurs, the visual and audible alarms operate simultaneously. This is to provide immediate action to clear systems of faults or break down. The fire alarm system power supply and annunciators located by the Facility Remote Control Panel provides immediate audible and visual fire alarms from designated zones throughout the Launch Control Center and Silo.

6. Utility Tunnel: The utility tunnel, which provides access from the L.C.C. to the silo includes various cable trays which carry the control, power and signal cables. Provisions have been made for communications, public address system and emergency lighting at the utility tunnel.

7. Launching Silo: The Launching Silo is equipped with two 500 kilowatt diesel generators, one of which is normally in operation. Power is supplied to hundreds of relays, solenoid valves, limit switches and motors through miles of wiring and cables. Dry-type transformers were installed for all lighting and convenience receptacles. Interconnecting wiring and cabling was accomplished through numerous conduits, cable trays and wire-ways.

Various panels, cabinets and boxes have been provided to house relays, breakers, motor starters, terminal blocks, fuses, future telephone and public address system and motor disconnect switches.

In the missile enclosed area the receptacles, lighting, public address and telephone outlets and conduits are explosion-proof types. This is an explosion-proof area and rigid requirements are set forth to confine an electrical explosion within the explosion-proof fixtures.

An electrically operated personnel elevator was installed to provide immediate access to desired floor levels.

8. Grounding: Hundreds of bare stranded copper leads were installed throughout the Site, Launch Control Center and the Launching Silo. This was to reduce the noise, stray and static electrical current flow which otherwise would interfere with the missile critical operational electronic equipment.

9. Tests: All electrically operated equipment was subjected to tests to insure that desirable results were met.

PROPELLANT LOADING SYSTEM: The propellant loading system, or PLS, consists of facilities to store and transfer liquid propellant fuels with auxiliary fluids and gases from supply sources to the missile. Propellants used are liquid oxygen and RP-1 fuel. Auxiliary systems contain liquid nitrogen, gaseous nitrogen, gaseous oxygen, and gaseous helium.

Liquid oxygen is maintained at $-297^{\circ}F$ and liquid nitrogen at $-320^{\circ}F$. Piping systems for those liquids are heavily insulated and storage vessels are, in effect, giant thermos bottles, having inner and outer shells separated by a vacuumed annular space.

Gaseous oxygen, nitrogen and helium are confined in their systems under high pressure.

Storage vessels were fabricated and installed as a part of the prime contract. All piping and equipment were fabricated and installed by Paul Hardeman, Inc. under a separate contract administered by the Ft. Worth District. The installation portion of Hardeman's contract was assigned to the prime contractor with the status of a subcontractor. Piping was fabricated as spools and equipment assembled on six prefabricated skids as follows:

Skid	Silo Location
Liquid Oxygen Control Prefab	Level 7
Liquid Oxygen Fill Prefab	Level 7
Liquid Nitrogen Prefab	Level 7
Pressurization Prefab	Level 7
Instrument Air Prefab	Level 7
Fuel Loading Prefab	Level 8

During the first few months of silo construction, plans were being made to meet the new challenge of installing and testing a complex Propellant Loading System, in which the Walker Area Office had almost no one trained and very few with past experience. The magnitude of importance could be measured by the strict and almost unbelievable cleanliness criteria. Specifications stated that the Contractor must install and maintain a system with no particulate matter in excess of 150 microns in size. There were other criteria, of course, but the greatest problem remained with developing techniques to minimize airborne and man-made particulate contamination during system installation. This phase was considered by many as the determining factor, whether or not the using agency could satisfactorily launch or have to abort a missile. It was imperative that a program be instituted to familiarize all of Engineering personnel concerning the intricacies of PLS.

In the Fall of 1960, a Propellant Loading Service Systems Orientation Course was conducted in Denver, Colorado by United Testing Laboratories' personnel, under the auspices of CEBMCO. It was realized that this course would be instrumental in establishing a basic and common understanding of Propellant Loading Service Systems and to standardize installation and acceptance testing procedures. During the latter part of the year, more than fifty of the Walker Area Engineers, including the Chief of Military Construction Branch and his staff, attended this course.

The 15th day of March 1961, PLS installations commenced in the Walker Area. At the inception of the PLS installation stage, an indoctrination course was set up at the Area level for all Engineering personnel who had not attended the course in Denver. A serious attempt was made to duplicate the Denver material in order to give one and all a common background. In addition, intensified training was given in the techniques involved in connecting spools to maintain the highest degree of cleanliness possible. Cleanliness of the Area, personnel, tools, and using of the proper inspection aids, such as blacklight, white light, and Wipe Test, were stressed.

To attain the highest degree of confidence possible with the using agencies, Air Force and General Dynamics/Astronautics, a compact Propellant Loading Systems Indoctrination Course was offered to them. It was the belief that in this way the agencies involved would benefit from the same information and also would be useful as a sounding board for differences of opinion. During the months of May and June, approximately eighty GD/A and Air Force personnel attended lectures designed to acquaint the customer with the Area Office's dedicated interest of giving them a system that would be functionally sound.

During the installation of PLS at the up-stream sites, the PLS section, consisting of a staff of approximately six engineers, devoted themselves to constantly roving the sites in a attempt to standardize our procedures and techniques. Wherever possible, spools were connected together top-side within the confines of a more than adequate spool make-up enclosure. The wall interiors were covered with polyethylene, a vacuum intake was located in the enclosure, strict uniform requirements were maintained, all lines being connected were under constant, adequate, gaseous nitrogen purge, a window was placed in each enclosure for observation of spool hook-ups by staff members, to again insure our strict techniques were being followed.

From their arrival, all prefabs and vessels were daily monitored to insure adequate, positive pressure was maintained at all times. Periodic spot checks were taken to establish correct dewpoint maintenance.

To further assist its staff, Corps of Engineers transferred personnel from up-stream bases, giving the Area invaluable knowledge and experience to further develop its PLS capability. During this time, preparations were being made to establish a program of standardization for acceptance testing. Specifications were reviewed meticulously for these requirements, sample testing forms were developed, and again, a course in acceptance testing was begun. Night after night each system was reviewed to a select group of test engineers, so that one and all would understand not only the systems individually, but as they relate to one another. The slogan "Be one step ahead of the Contractor" was instituted and was the ultimate goal of all.

Approximately the first of August, PLS testing commenced with the lead site, Site 10. It was realized that all decisions made at this time would pattern effectiveness of down-stream sites. Continuous surveillance by the PLS section was maintained. It was at this site that Modification #94, which concerned the blowing down of the gaseous nitrogen and gaseous oxygen A. O. Smith vessels, commenced. Techniques developed at this lead site saved many man-hours in accomplishing this modification down-stream. The gaseous nitrogen bottle in particular was most troublesome. Approximately one hundred blowdowns were required before obtaining an acceptable blowdown pad. During PLS acceptance testing at this site, refinements of the test procedures were made, accounting for sizeable savings in time and money. During this period, a PLS bulletin was developed and distributed to all sites. Each problem as it arose was studied, and final resolution was dissiminated to all. A policy was established to insure that the down-stream sites would be in a position to take full advantage of the experience gained at the lead site.

Approximately one million gallons of liquid nitrogen was used in checkout and testing of the PLS system. The majority of this liquid was converted to high pressure gas for pressurization and blowdown of the systems. Liquid nitrogen was also used for cold flow tests on the liquid systems in place of the more hazardous liquid oxygen. In addition, 900,000 standard cubic feet of helium and 10,000 gallons of RP-1 were used.

LAYOUTS AND SURVEYS: The Atlas "F" Launching Silos and their contents were constructed under unusually close tolerance requirements. In fact, it is believed that many of the requirements were something new in the heavy construction industry. To accomplish the degree of accuracy required by the contract documents it was necessary to establish special survey controls and procedures.

The launching silo design and construction was measured and located from three axis lines. Two horizontal axes, 90° apart, were centered on a vertical axis which constituted the rotational center line of the truly cylindrical shape of the silo concrete structure. The X-X axis was oriented parallel to a true East-West direction, the Y-Y axis parallel to true North-South, and the Z-Z axis was plumb. Vertically, the structure was controlled by measurements above specified data surfaces. Each silo structure was referenced to an exact elevation above mean sea level datum. For uniformity of plans all silos were detailed, vertically, to a reference datum 1000.00 feet below the finished top surface of the concrete cap.

Because of the high degree of accuracy required to be established in locating the silos horizontally and vertically, the United States Coast and Geodetic Survey was called on to establish base line control markers. Prior to issuance of plans and specifications the Coast and Geodetic Survey established a base line at each site with brass cap monuments. It provided the exact length and true bearing of each base line which it terminated at each end with a brass cap monument showing grid locations and elevation above mean sea level. At a later date, and before start of construction it provided similar brass cap monuments on the X-X and Y-Y axes of each silo.

During excavation and concreting operations the Corps of Engineers survey crews, equipped with highly accurate instruments, set brass cap markers on the X-X and Y-Y axes adjacent to or on the structures as work progressed. They first set markers at ground surface near the lip of the open cut excavation, then on the concrete collar at beginning of shaft excavation, later in the silo concrete floor, and finally in the silo concrete walls.

For control of crib steel erection the survey crews installed four vertical wire cables on the X-X and Y-Y axes, one at each silo wall. The ironworkers were thus able to locate the axes by attaching horizontal string lines to the cables across the silo at any floor elevation. For vertical control during crib steel erection the survey crews provided a rigidly attached high-grade calibrated steel tape from top to bottom of the silo, located on the silo wall.

Many construction features required highly accurate setting to unusually close tolerances. The contractor's surveyors located the items first and were followed by the Corps of Engineers in a careful check. Principal of the items thus installed, together with tolerance setting requirements, were as follows:

1. Silo wall form panels - plus or minus 1 inch tolerance horizontally from the Z-Z axis.

2. Special steel wall form panel with collimator plate insert-maximum 3/8 inch from Y-Y axis and plus or minus 1 inch from the Z-Z axis.

3. Imbedded items in silo wall concrete-variable tolerances.

4. Site tube - 3/8 inch tolerance horizontally and ¼ inch vertically.

5. Shock hanger wall bracket concrete inserts, approximately 10 feet wide by 12 feet high and 9000 pounds each - 1 inch tolerance, all directions and elevations.

6. Crib steel - 1/8 inch tolerance at each floor level, horizontally and vertically.

7. Launch platform counterweights and drive base assemblies - 1/8 inch tolerance.

8. Silo cap door - 1/16 inch tolerances.

9. Propellant loading system flanged interface connections - 1/16 inch tolerances.

A part of the final setting accuracy checks was participation by General Dynamics/Astronautics surveillance teams. Their interest was in verifying accuracies required for their later installation of the missile and control systems.

PHOTOS: Photos of construction features and operations are contained in Appendix A.

DESIGN CHANGES: There were no major design changes after construction started, but there were a multitude of small ones. An outstanding example is in silo crib steel drawings. In the interest of interchangibility of parts and operating and maintenance personnel the Using Service established the policy that plans and specifications for all six Atlas "F" missile base projects must be identical. Contract documents contained normal engineering drawings of the silo crib steel structure, but the concept of uniformity was carried further to structural details. A provision in the specifications stated that supplemental structural steel detail drawings would be issued after award of contract. Normally, such detail drawings are prepared for the contractor by its structural steel fabricator, and their accuracy are thus a contractor responsibility. The supplemental detail drawings, as later provided, were subsequently found to contain many errors and deviations from the contract drawings. These led to loss of time and extra work on the part of the contractor; and, since he was not responsible for the accuracy of detail drawings, he was able to recover costs incurred.

The contract drawings were revised a number of times during construction. The revisions were not major in scope but so numerous in number that they caused unusual confusion, delays and loss of effort in tearing out and replacing work.

A list of modifications and allied claims resulting from design changes is contained in the MAJOR MODIFICATIONS AND CLAIMS section, Part III, of this report.

ENGINEERING AND TECHNICAL BRANCH:

With the establishment of the Roswell Area Office, the Engineering and Technical Branch came into being. It was staffed with three engineers and six engineer trainees.

The design architect-engineers contracted to the Air Force and were to perform design on all changes to the standard package. After the issuance of the first eleven modifications, subsequent modifications totaling one hundred and twenty-five were designed and contract documents revised by E and T Branch engineers and drafts-ment. The Walker Area Office was the only one under the Atlas "F" Directorate that revised the contract drawings to reflect all changes. The modifications varied from simple to very complex and in numerous cases required revisions to hundreds of reproducible drawings. Over one thousand three hundred contract drawings were revised by E and T Branch personnel.

The file room in the E and T Branch contained over nine-thousand seven hundred shop and contract drawings. Approximately five thousand shop drawings were reviewed and approved by personnel of the E and T Branch. A drawing log was maintained constantly to show all information about each drawing and its whereabouts. Drawings were processed at the rate of eighteen per day and were reviewed and approved at the rate of nine per day.

A large percentage of time of the higher level engineers in the E and T Branch was spent in liaison between the Area Office and Air Force (SATAF), higher authority (CEBMCO), General Dynamics/Astronautics (GD/A), Inspecting Districts, and Districts responsible for the seventeen Assigned Services Contracts. Much of their time was spent advising the Air Force of construction progress feasibility of proposed changes, estimating costs of changes and in determining that changes were mandatory.

LABOR RELATIONS: Relations between contractors and labor at the Walker Area were excellent. There were some disputes which resulted in six walkouts or strikes by certain trades for periods of two to six days as follows:

Strikes and/or Work Stoppages

Start	End	Union	Cause	Man Days Lost
23 Aug 60	26 Aug 60	Carpenters	Work Assignment	66
31 Aug 60	5 Sept 60	Laborers	Safety Factors	2231
4 Apr 61	5 Apr 61	Electricians	Discharge of Workers	32
8 June 61	9 June 61	Electricians	High Time Pay	68
9 June 61	12 June 61	Plumbers	Ice Water	75
20 June 61	21 June 61	Ironworkers	Work Assignment	40
			Total	2512

PART III

CONTRACT ADMINISTRATION

GENERAL: The construction of the Walker Air Force Base Atlas "F" Ballistic Missile launching facilities was accomplished under five prime contracts - a basic contract for the twelve missile launch complexes consisting of silo, LCC and immediate site work and four support facilities contracts.

Because of an atmosphere of urgency, plans and specifications were prepared hurriedly and issued for bids with full knowledge that revisions would be required to fit requirements of the missile which was still in the development stage. This understanding became known as a "concept of concurrency." Because of this condition many changes were made to plans and specifications during construction. In many instances, changes were made upon changes, quite often resulting in the necessity to tear out construction work already accomplished. A total of 177 modifications in the aggregate amount of $16,240,500.00 were negotiated and processed for the basic construction contract. Approximately half of the dollar volume of this amount resulted from directed changes and the remaining half from claims found valid.

In the early stages of construction the impetus of urgency continued. The Contractor was in constant reminder that there would be no alternative but to complete the job on schedule; to include changes and additions by modifications. A close watch was kept on progress as reported versus a progress schedule established at the beginning of the job. When it began to appear that progress was lagging behind that schedule the contractor was prodded by GC-5 letters to get back on schedule. In February 1961, the "big push" was relaxed by directive. All GC-5 letters were rescinded with the exception of those on cryogenic vessel fabrication which were known to be the most critical features of the job. Nevertheless, situations had been created which resulted in large claims.

Another aspect of the job which led to large claims was the number of people on the sites other than contractor and normal inspection forces. The Air Force, being vitally concerned that the finished product be compatible with the needs and requirements of its missile, placed a surveillance crew by its missile contract at each site. In addition, personnel from the various branches and departments of the Air Force's Site Activation Task Force and related Ballistic Missiles Division made frequent and periodic visits. This, coupled with the limited work space in silos, led to claims of unusual and astronomic proportions.

A total of 241 claims were received from the basic contractor. Of these, 197 were denied or withdrawn, thirty-eight were approved and successfully negotiated, and six remain outstanding. The contractor has signed a release from all claims as negotiated. A part of the release is a stipulation placing dollar value limitations on the six outstanding claims, thus limiting the dollar value of the contract.

<u>CONSTRUCTION PRIME CONTRACTS</u>:

<u>LAUNCH COMPLEXES</u>: The basic construction prime contract was Contract No. DA-29-005-ENG-2598, WS-107A-1 Operational Base Missile

Launch Complexes, awarded to a joint venture composed of the Macco Corporation, Raymond International, The Kaiser Company, and Puget Sound Bridge and Dry Dock Company. The Macco Corporation, as sponsors administered the project from its home office at Paramount, California The original contract, in the amount of $22,115,828.00 was awarded 20 June 1960. Work was accepted as substantially completed 6 January 1962 with all minor deficiencies corrected as of 8 February 1962. Because of the great number of changes, "concept of concurrency," limited working spaces and other unusual conditions there were a great many modifications and an abnormal number of claims. As a result of 177 modifications and 241 claims, thirty-eight of which were recognized, the contract was finally settled at $38,356,329.42, with time extensions granted averaging sixty days per site. There were no liquidated damages. The final settlement is subject to six claims exceptions which are stipulated in a release signed by the contractor not to exceed $274,000.00.

The contractor's performance has been rated above average in quality of work performed and satisfactory in all other respects.

LIQUID OXYGEN PLANT: Contract No. DA -29-005-ENG-2654, 25 Ton Liquid Oxygen Plant, was awarded to S.I.P., Inc., of Houston, Texas, 31 October 1960, in the amount of $383,893.00. It consisted of central storage and handling facilities for liquid oxygen and liquid nitrogen, located at Walker Air Force Base. The contract was completed on 18 August 1961, ahead of contract schedule and with no time extensions. There were ten modifications, all minor in nature. The contract was closed at a total cost of $385,088.00.

The contractor's performance is rated average on evidence of ingenuity and economy, excellent in effectiveness of safety program, and above average in all other factors.

RE-ENTRY VEHICLE FACILITIES: Contract No. DA-29-005-ENG-2656, Re-Entry Vehicle Facilities, was awarded to Earl F. Puckett, of Roswell, New Mexico, 4 November 1960, in the amount of $118,254.00. It consisted of a vehicle maintenance building addition, office and toilet additions to an existing storage building, and a mounded concrete igloo storage magazine. All are located at Walker Air Force Base. The basic contract was completed 3 months ahead of schedule on 9 June 1961, with no time extensions and with five modifications. All additional work was completed by 12 September 1961. The contract was closed at a total cost of $123,830.32.

The contractor's performance rating has been established as excellent in quality of work, effectiveness of safety program, and cooperative attitude and above average in all other respects.

SHOPS, MISSILE ASSEMBLY AND MAINTENANCE, AND TECHNICAL SUPPLY BUILDING: Contract No. DA-29-005-ENG-2697, Shops, Missile Assembly and Maintenance, and Technical Supply Building, wasawarded to Arvol D. Hays, Lubbock, Texas, 25 November 1960, in the amount of $536,883.00. It was a building job, as titled, at Walker Air Force Base. The contract was completed 30 September 1961, on schedule and with no time extensions. Eighteen minor modifications were issued, bringing the total cost of the job to $536,658.02 at closing.

The contractor's performance rating: Effectiveness of Safety Program - Excellent; Quality of work and Cooperative Attitude - Above

Average Meeting Schedules, Ingenuity and Economy, Organizational Ability and Efficiency, and Adherence to Security Regulation - Average; Effective Use of Materials, Equipment, Manpower and Facilities - Satisfactory; Effectiveness of Supervision - Unsatisfactory. The last rating resulted from the condition that supervision with authority to act for the contractor was available on an indeterminate, part-time basis only.

WATER SUPPLY FOR 12 SITES: Contract No. DA-29-005-ENG-2801, Water Supply for 12 Sites, was issued to Brown-Olds Plumbing and Heating Corporation, El Paso, Texas, 18 January 1961, in the amount of $814,253.70. It provided domestic and service water for the sites and consisted of wells, raw water storage, demineralization and softening treatment, treated water storage, pump stations and transmission pipelines. Sixteen modifications have been negotiated and processed in amounts ranging from a $35,911.05 decrease to a $19,218.25 increase, bringing the total cost of the contract to $854,893.44. Nine claims have been received, of which four have been recognized and processed as modifications, three have been withdrawn, and two are outstanding as of this date. The contract was physically completed 9 March 1962 on schedule as revised by time extension granted by reason of added work and excusable delays.

The contractor's performance rating: above average for adherence to security regulations and effectiveness of safety program; average in quality of work, ingenuity and economy, and cooperative attitude; and satisfactory in all other factors.

PRINCIPAL SUBCONTRACTS: The basic construction contractor awarded nine major subcontracts as follows:

MASS EXCAVATION: Anderson Brothers of Albuquerque, New Mexico. Open cut excavation to a level at the bottom of the LCC structure, about 35 feet of depth.

REINFORCING STEEL: Cobusco-Salyer Company of Denver, Colorado. Furnish and install concrete reinforcing steel in LCC's and silos.

CRIB STEEL ERECTION: Owl Trucking and Construction Company of Compton, California. Erection of crib steel at the last seven sites. The prime contractor performed crib steel erection with its own crew at the first five sites.

MECHANICAL: The Stanley-Carter Company of Detroit, Michigan. Furnish and install plumbing, heating, ventilating and air conditioning systems in LCC's and silos.

ELECTRICAL: Clarkson-Douglass Electric Company of El Paso, Texas. Furnish and install electrical work in LCC's and Silos.

PERSONNEL ELEVATORS: Otis Elevator Company of New York City, New York. Installation of personnel elevators in silos. Otis had a separate contract with the Government for fabrication and installation of the elevators. In accordance with terms of their contracts, the installation portion was assigned to the prime contractor, thus Otis effectively became a subcontractor.

PROPELLANT LOADING SYSTEM: Paul Hardeman, Inc., of Stanton, California. Installation of missile fuel propellant systems, including piping and equipment. Hardeman also had a separate contract with the Government for fabrication and installation. The installation portion was assigned to the prime contractor.

PAINTING: Eric Lundeen of Los Angeles, California. All painting work.

ROADS AND PARKING AREAS: Floyd Haake of Roswell, New Mexico. Paving and graveling of access roads and parking areas.

Data on cost to the prime contractor of the above subcontracts are not available. Efficiencies of the subcontractors have not been analyzed and thus cannot be included. There were no major subcontracts under the Support Facilities prime contracts.

MAJOR MODIFICATIONS AND CLAIMS: In connection with the basic prime Contract No. DA-29-005-ENG-2598, Launch Complexes, there were twenty-two major contract modifications negotiated for amounts in excess of $100,000.00. Of these, four formally assigned seventeen Assigned Service Contracts to the prime contractor in the aggregate amount of $4,142,193.90. Assignment was in accordance with contract provisions of both prime and Assigned Service contractors. The prime contract contained an estimate of the value of the ASC contracts as $4,774,000.00. However, this amount was not included in the prime contractor's original contract amount. The assigned amount, therefore, actually constitutes a reduction of about $630,000.00 in the anticipated dollar volume of the prime contract. Eight more of the twenty-two major modifications were for changes or additions and ten resulted from recognized claims. Six claims remain unsettled but are limited in maximum amounts by stipulations contained in a release signed by the Contractor. The above are listed as follows:

Modification Number	Description	Amount
	A - Assigned Service Contract Assignment Modifications	
40	PLS Subcontract	$1,702,000.48
41	Overhead Door Hinge Assembly Subcontract	239,199.75
42	Electric Switchgear, etc., Subcontract	166,669.61
46	Remaining ASC Subcontracts	2,034,173.45
	B - Major Modifications Due to Changes	
11	Major Mechanical and Structural Changes	$1,215,000.00
13	Provide for a Continuous Electromagnetic Screen	112,592.55
57	Struc., Mech. and Elec. Changes & Revisions	111,500.00
77	Mechanical & Electrical Changes & Additions	135,800.00
87	Add Hangars & Pipe Supports	137,000.00
100	Supplemental Design Drawings - Changes	308,000.00
106	Operate Diesel Generator for Power	388,000.00
108	Mech., Elec., & Painting Changes & Additions	157,800.00
	C - Major Modifications Due to Recognized Claims	
155	Struc. Steel - Field Correction Memoranda	$ 129,000.00
157	Silo Slip Forms vs., Conventional Forms	932,100.00
158	Additional Modif. Overhead for Time Extensions	525,000.00
159	Crib Steel Erection Tolerances	277,000.00
161	Joint Occupancy & Multiple Inspection	1,250,000.00
162	Validation Procedures	244,000.00
163	Acceleration	3,499,950.00
171	Jt. Occup. & Mult. Insp., Elec. Sub.	296,122.00

Modification Number	Description	Amount
172	Valid. Procedures - Elec. Sub.	114,838.00
176	Acceleration - Elec. Subcontractor	643,539.00

Copies of memoranda describing claims resulting in the above modifications are contained in Appendix B.

D - Unsettled Claims with Stipulated Maximum Amounts

Claim Number	Description	Amount
C-20	Crane Accident at Site 2	$ 25,000.00
C-24	Delayed Delivery, PLS Vessels, Yuba Industries	53,000.00
C-26	Concrete Supplier - Davis-Bacon Wages	17,000.00
C-40	Delayed Delivery, PLS Vessels, Taylor-Forge	30,000.00
C-32 & 131	Delayed Delivery, PLS Vessels, GAT Co.	149,000.00
	Total Stipulation	$ 274,000.00

There were no major modifications or claims in connection with the Support Facilities contracts.

PART IV

MISCELLANEOUS

ACCIDENTS:

The Walker Area suffered three major accidents involving eight fatalities as follows:

1. Laborer electrocuted while guiding a corrugated culvert section suspended from a crane boom when the crane boom contacted a power line. The accident occured 29 August 1960. It resulted in one fatality and two temporary total disabilities. Corrective action: Contractor was issued strict instruction that no equipment with the capability of contacting high voltage lines would be operated, maneuvered, or in any manner positioned in close proximity to high voltage lines until compliance with the provisions of Section 18-10 of General Safety Requirements had been satisfied.

2. Oiler-driver of truck crane started truck engine as ironworkers removed outriggers and wheel chocks. Truck was in reverse gear and backed into silo. This accident occured 16 February 1961. It resulted in six fatalities, one permanent disability, eighteen temporary disabling injuries and $149,000.00 damage. Action taken: Backfill to be kept eighteen inches below top of silo parapet walls. Braking systems to be checked periodically. Shaped wheel chock blocks to be provided. Recommendation that truck cranes used near silos be equipped with "fail safe" braking systems.

3. Ironworker, while attempting to tighten bolts between Levels 4 and 5, leaned over and grasped a tie rod which was loose at one end.

The spring action of the tie rod threw him against the silo wall and he fell to the bottom. The accident occurred 1 May 1961 and resulted in one fatality. Action taken: Contractor directed to properly secure all structural members immediately at time of installation in silo. Nets to be installed to afford protection in rattle spaces as well as in shafts.

The Walker Area accident experience data was as follows:

Man-hours Worked	3,971,189
Disabling Injuries	74
Fatalities	8
Days Lost	51,086
Frequency Rate	18.63
Severity Rate	12.89

VISITS:

Because of the nature of the project there were many visitors to the Area Office and the job sites. A list of visits, as extracted from the Area Daily Log and Register, is contained in Appendix C.

CEREMONIES:

There were two formal ceremonies during the construction work.

The Liquid Oxygen Plant was turned over to Walker Air Force Base 28 April 1962.

Site 10 was turned over to the Air Force 31 October 1961 in a ceremony wherein the keynote speech was made by New Mexicos' Governor Mechem.

Photos and newspaper articles appear in Appendix C.

RELATIONS WITH SATAF:

Key personnel heading the Site Activation Task Force are shown on Figure 13.

Relations with SATAF were generally excellent. However, the quality of personnel initially employed by General Dynamics Astronautics, which is a part of the SATAF organization, was extremely marginal. This Area was staffed with 92% graduate or professional engineers. GD/A surveillance personnel were composed of airplane factory quality control types of personnel, similar in quality with inspection type personnel in the GS-5 to GS-7 grade range. They lacked basic comprehension of their tasks and were not familiar with construction practices. As the job progressed and GD/A personnel became available from "up-stream" bases, the situation improved in direct relationship to influx of qualified engineers employed by GD/A on the sites.

CONCLUSIONS:

a. The program as constituted was generally properly organized and controlled by CEBMCO in Los Angeles, California.

b. The plans and specifications for the work, while requiring many changes due to the "concept of concurrency", were generally satisfactory.

RECOMMENDATION:

It is recommended that:

a. Information from "up-stream" bases should have been more promptly relayed to down-stream bases.

b. The lump-sum fixed price control not be utilized for

S I T E   A C T I V A T I O N   T A S K   F O R C E

Walker AFB, New Mexico

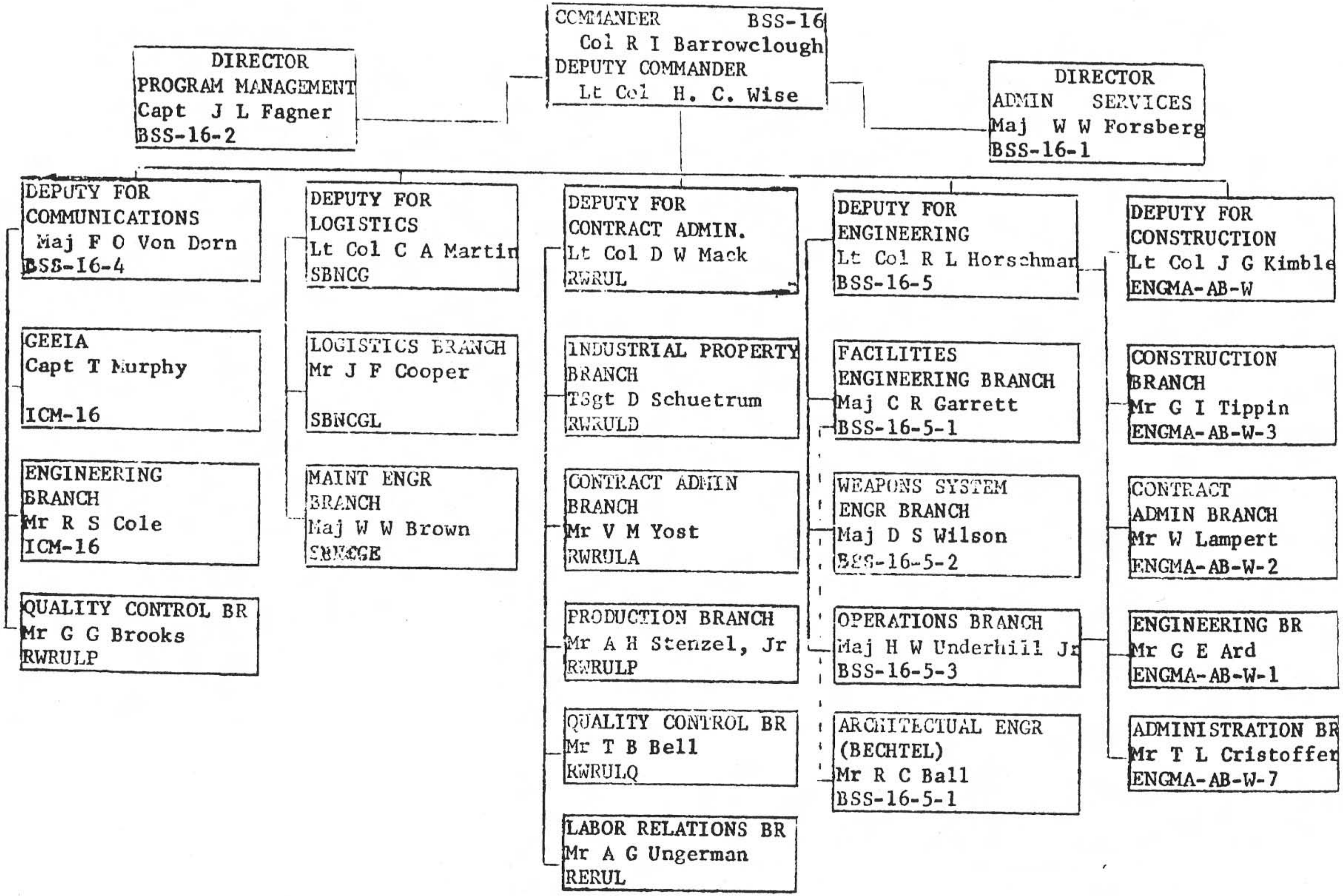
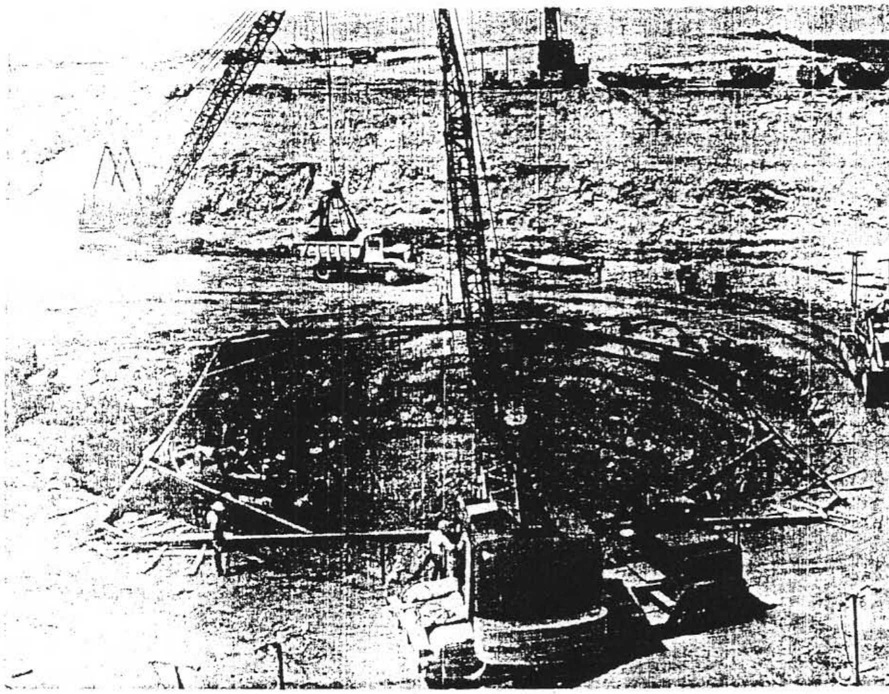


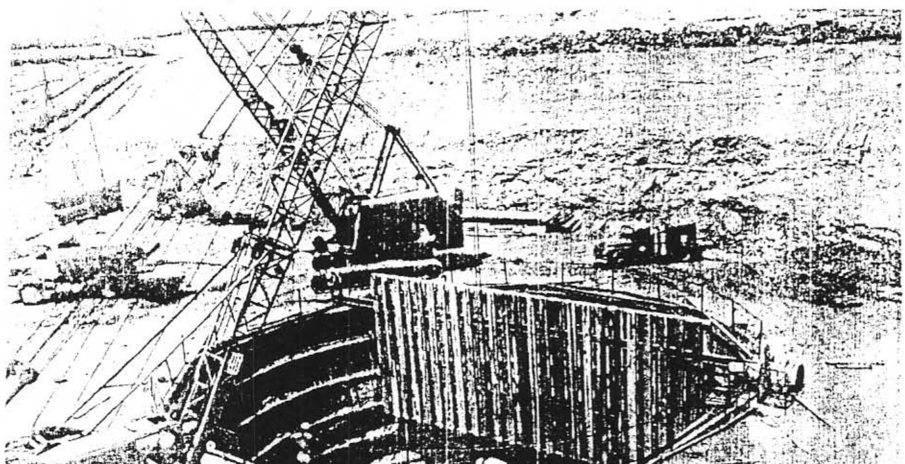
FIGURE 13

construction involving concurrency. A fixed price incentive type contract would appear to be more appropriate.

c. The installation and checkout phase of the work should have been under the direction of the construction contracting officer in order to facilitate better control of the quality and cost of the work.

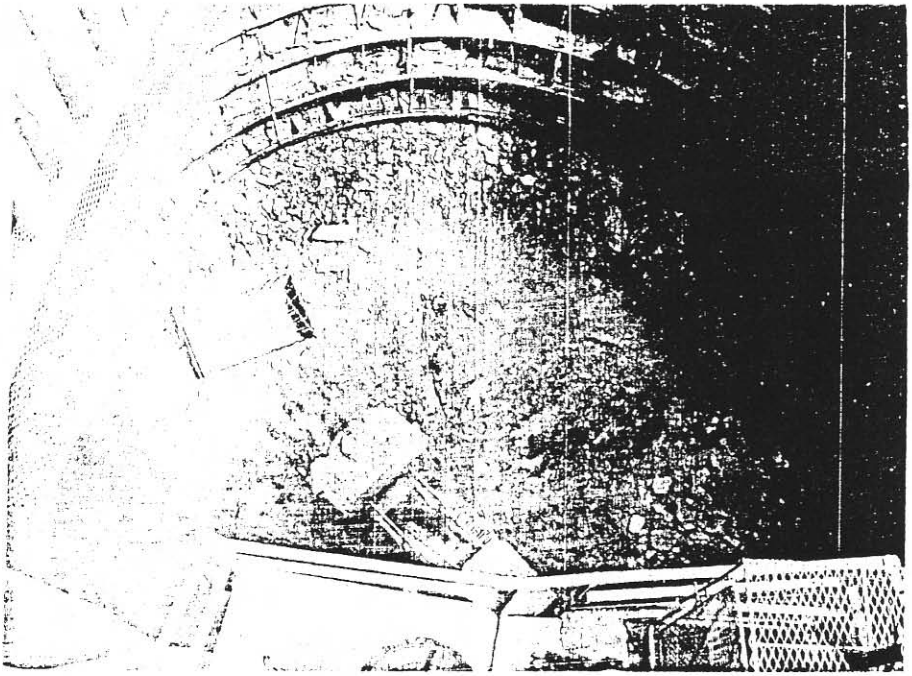


Open Excavation and Commencement of Shaft Collar

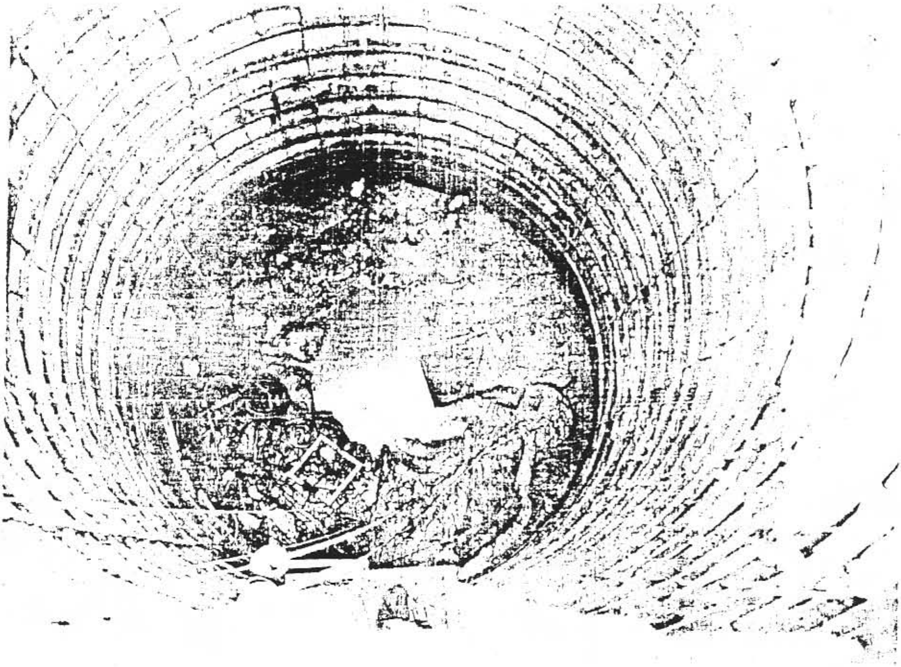


Collar Completed - Personnel Barrier - Lagging

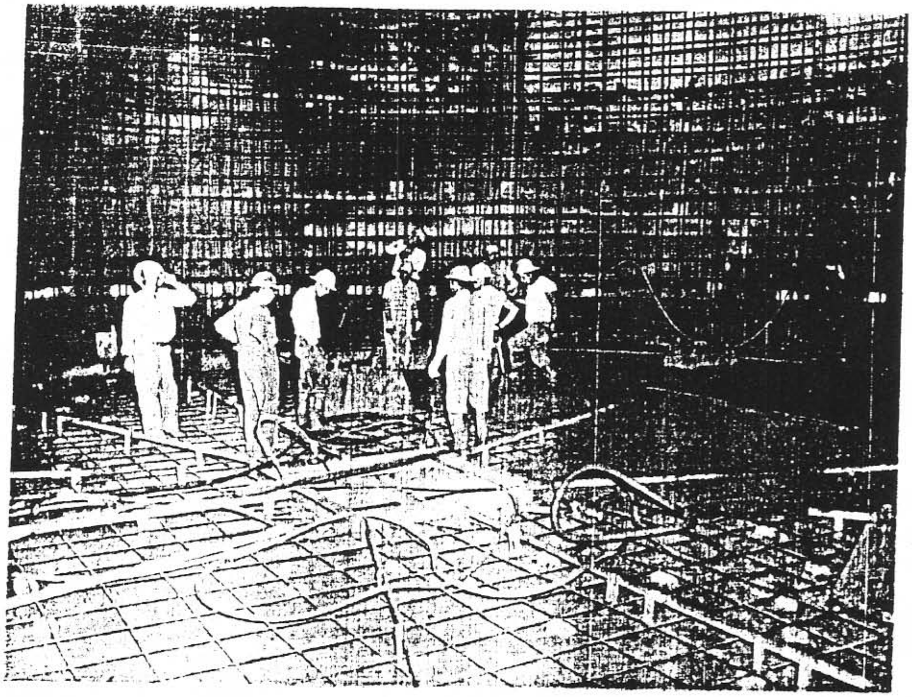
No original photos
only photocopies
thos photocopies of
photocopies.



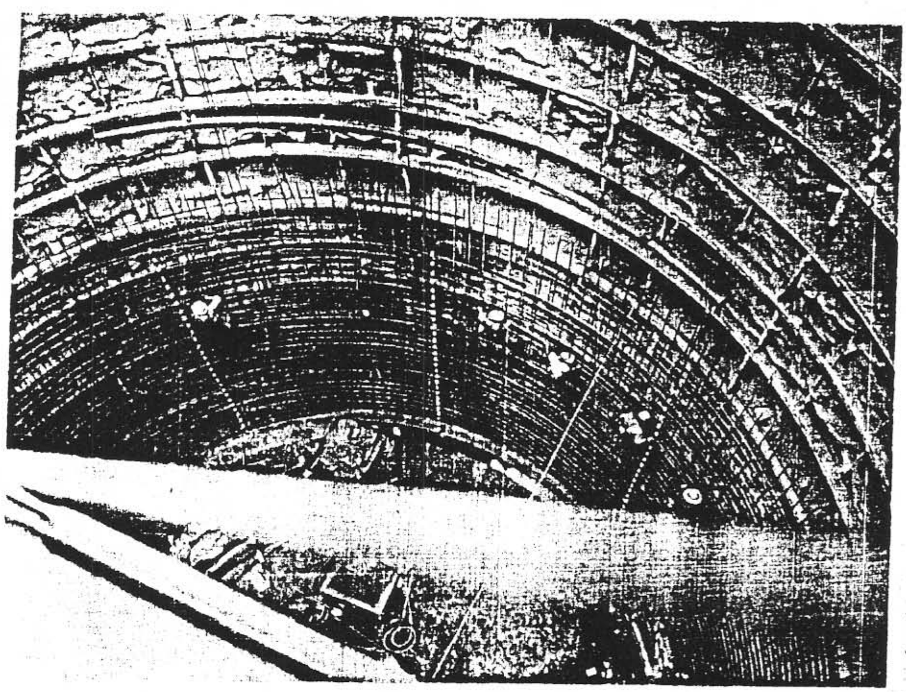
Shaft Excavation Approximately 80 feet deep



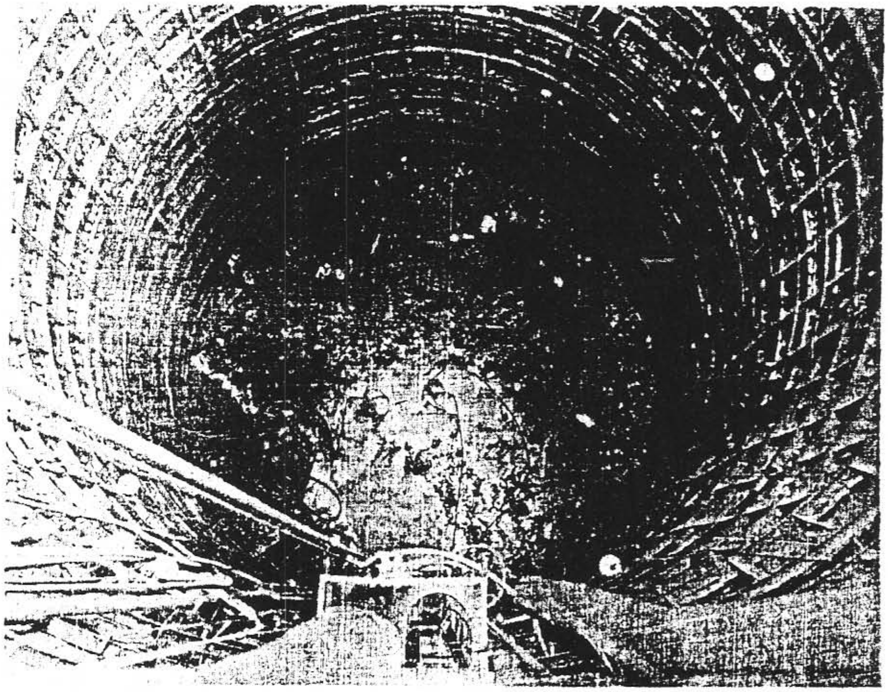
Shaft Completed - Water encountered at Site 2 only



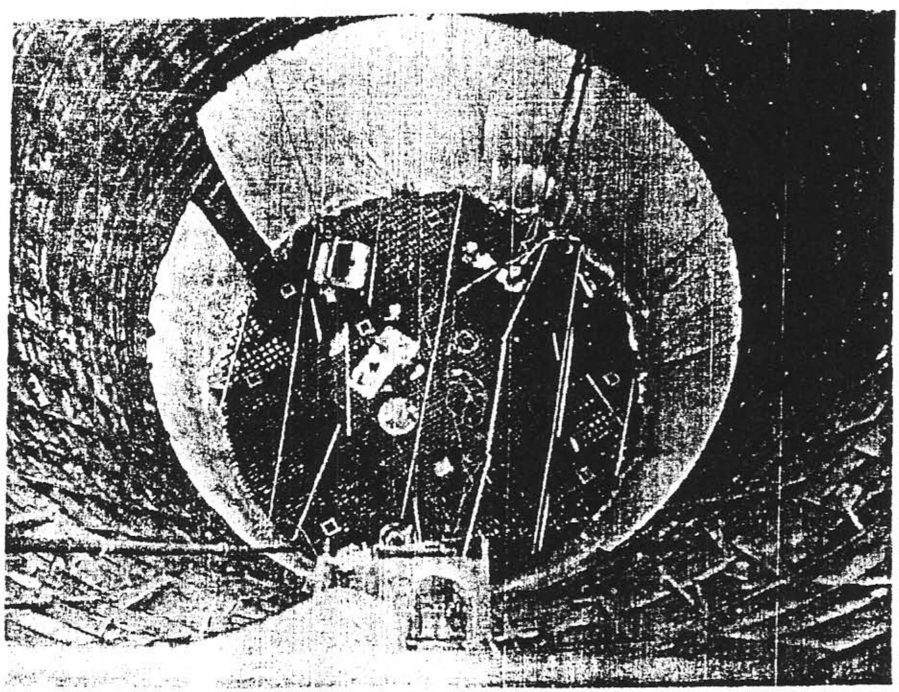
Typical Floor Concrete Placement



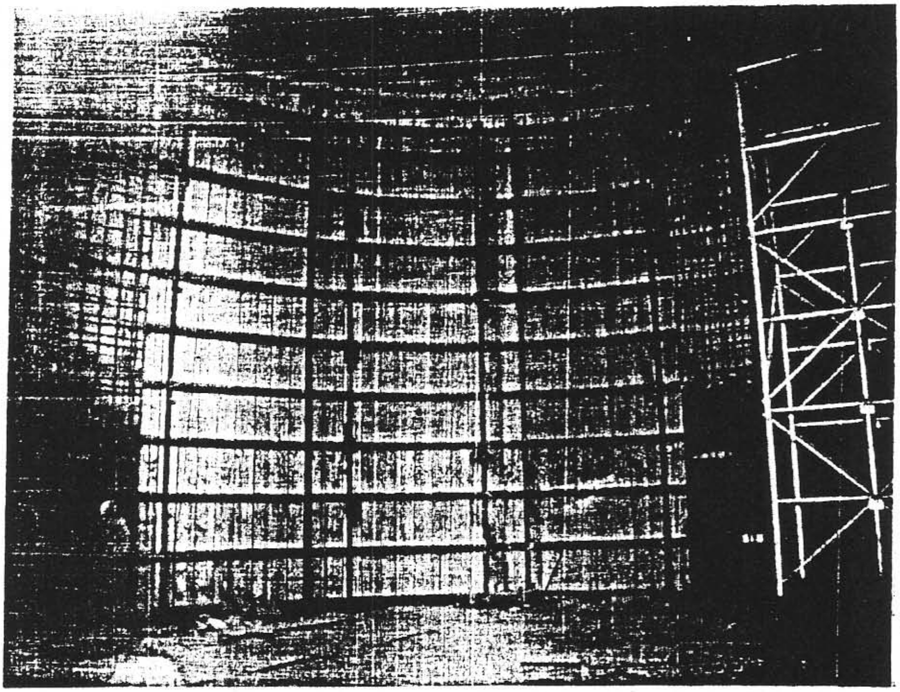
Installing vertical reinforcing bars for silo walls above foundation level



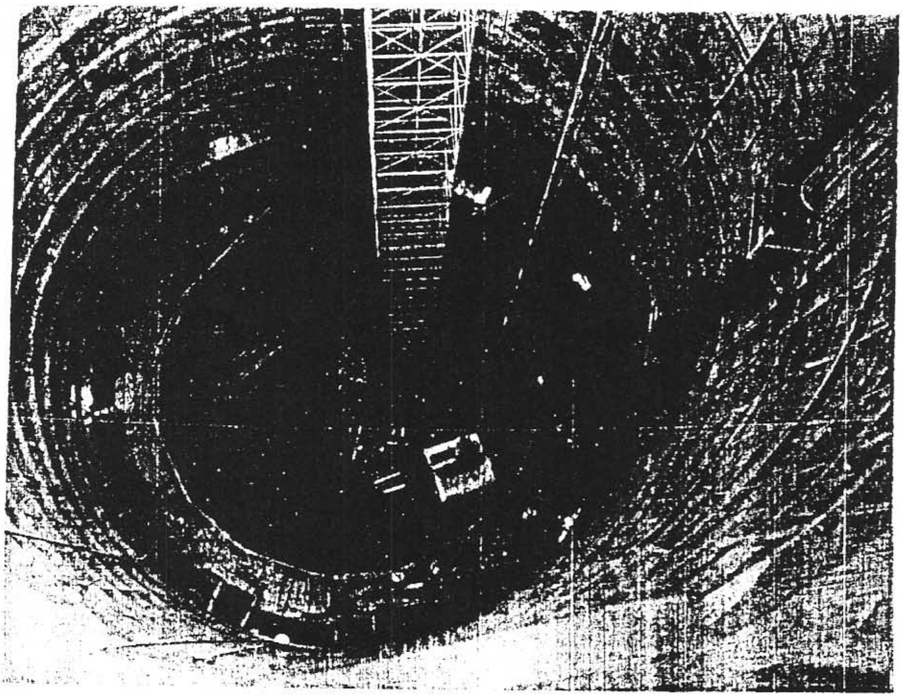
Site No. 4 - Loading blasting holes. Note water coming in from left.



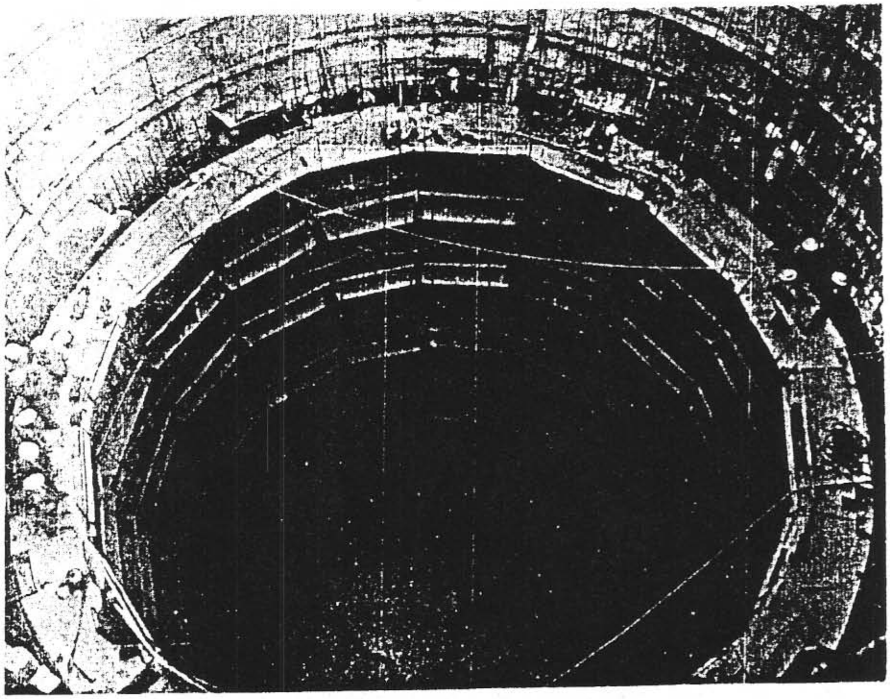
Site No. 4 - Preparing to place concrete in silo floor. Downshaft.



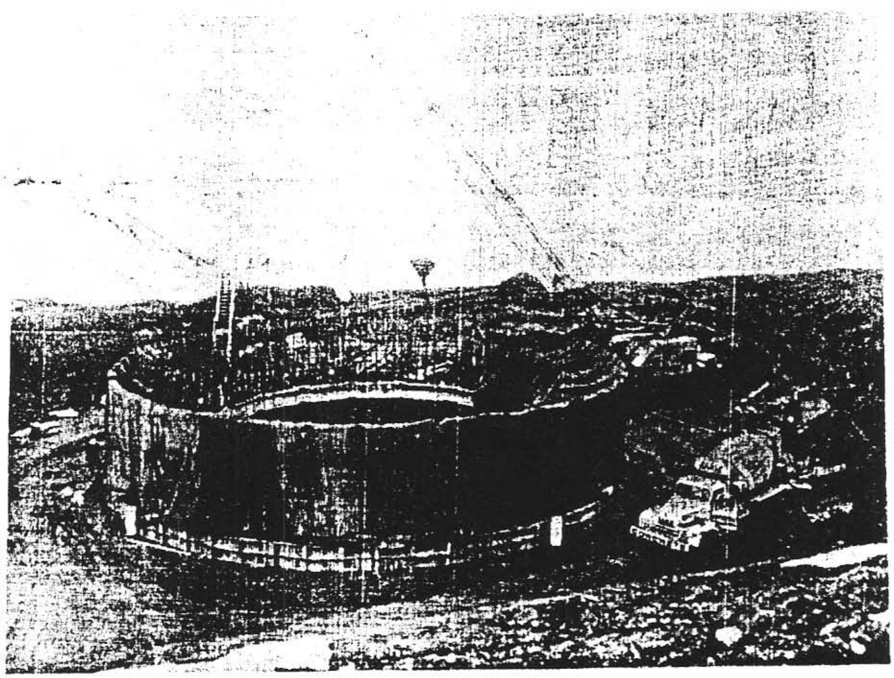
Erection of Concrete Wall Forms



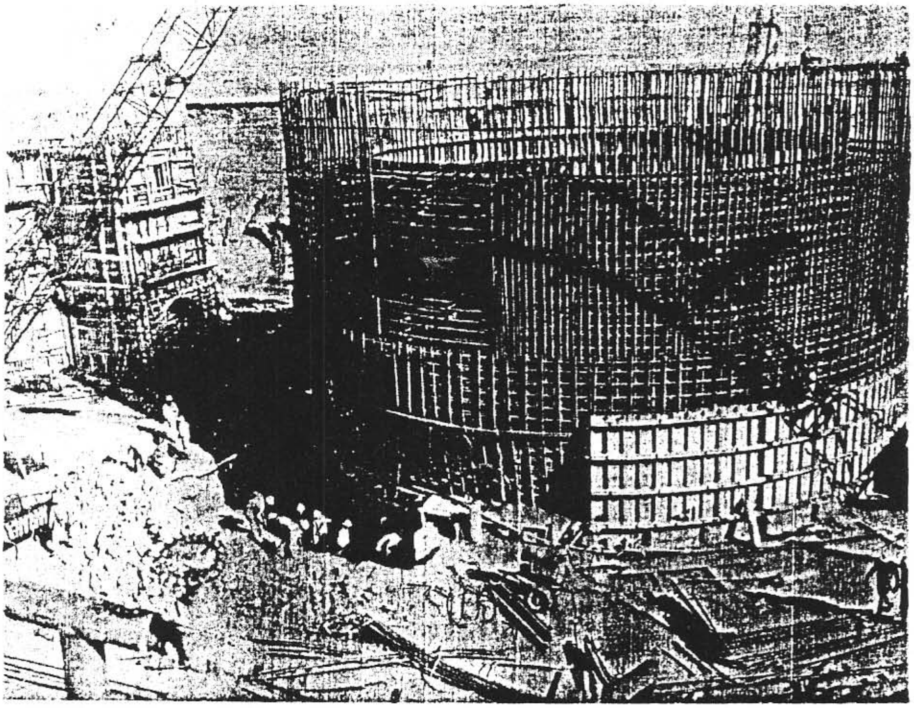
Placement of Wall Concrete



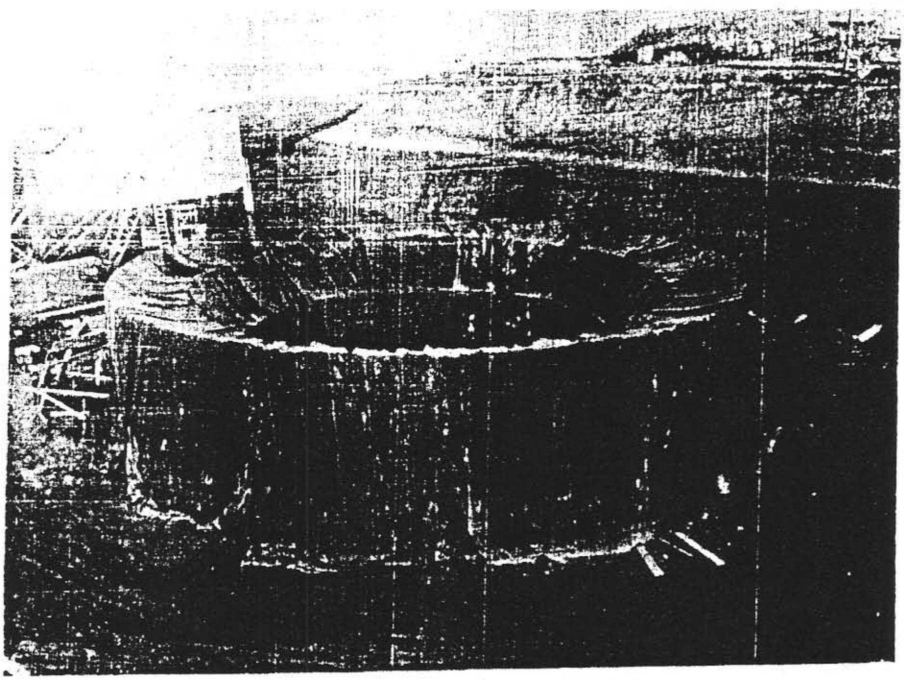
Site No. 11 - Starting 3rd lift concrete placement
Downshaft



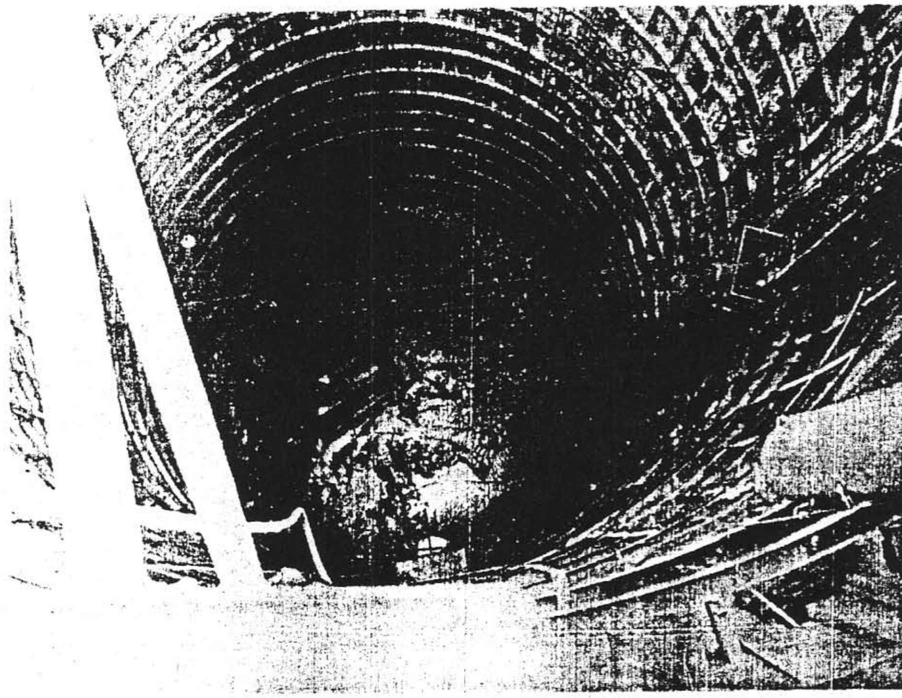
Site No. 12 - Placing 5th lift concrete in Silo
East to West along Y-Y axis.



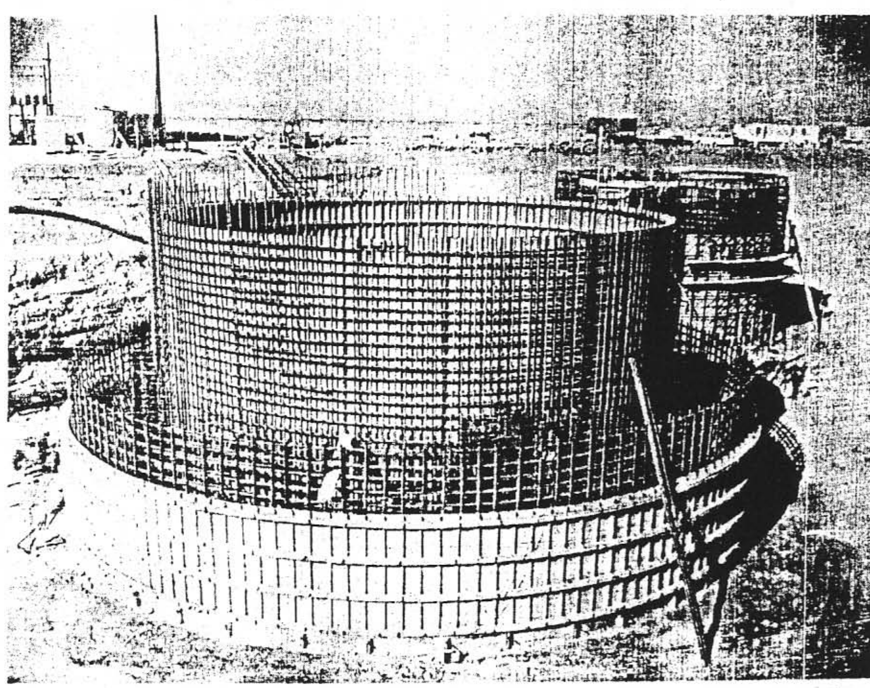
Site No. 2 - Reinforcing placement for 6th & 7th lift.



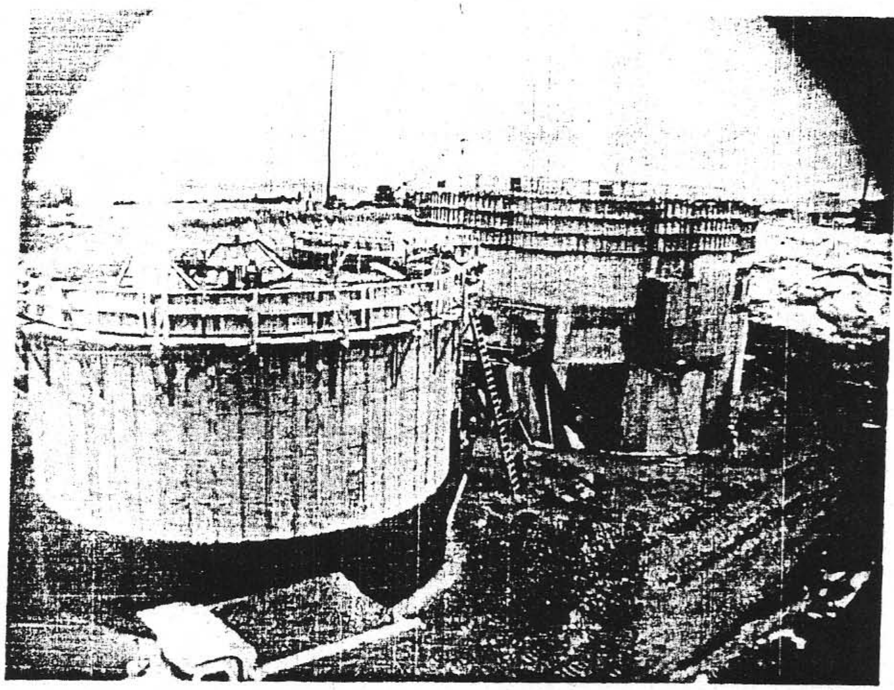
Site No. 3 - Complete 5th lift concrete placement. South to North along X-X axis.



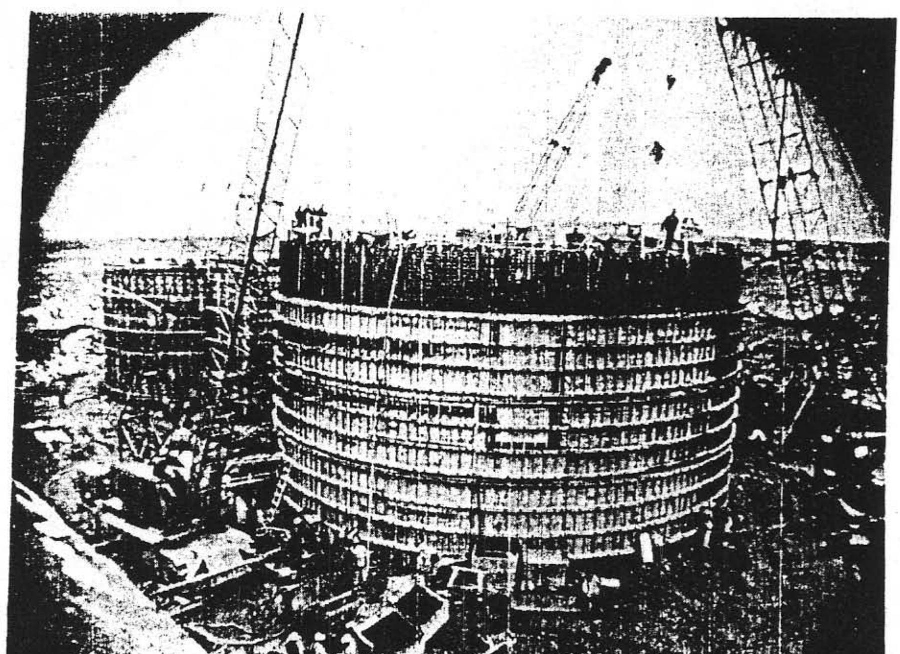
Site No. 5 - Mucking



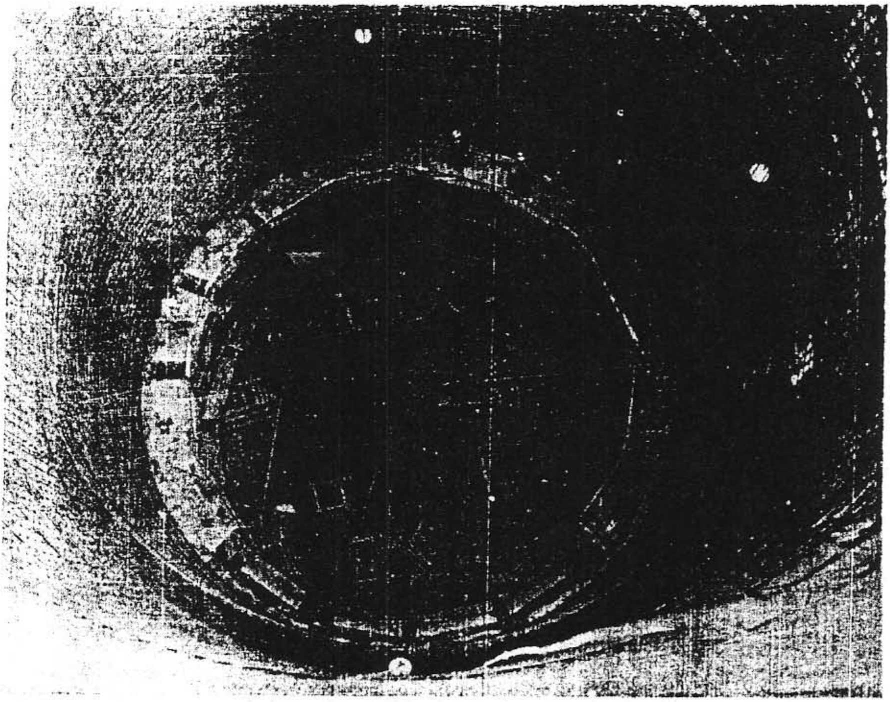
Site No. 2 - Placing 6th & 7th lift rebars and forms. Placing outer wall forms for LCC.



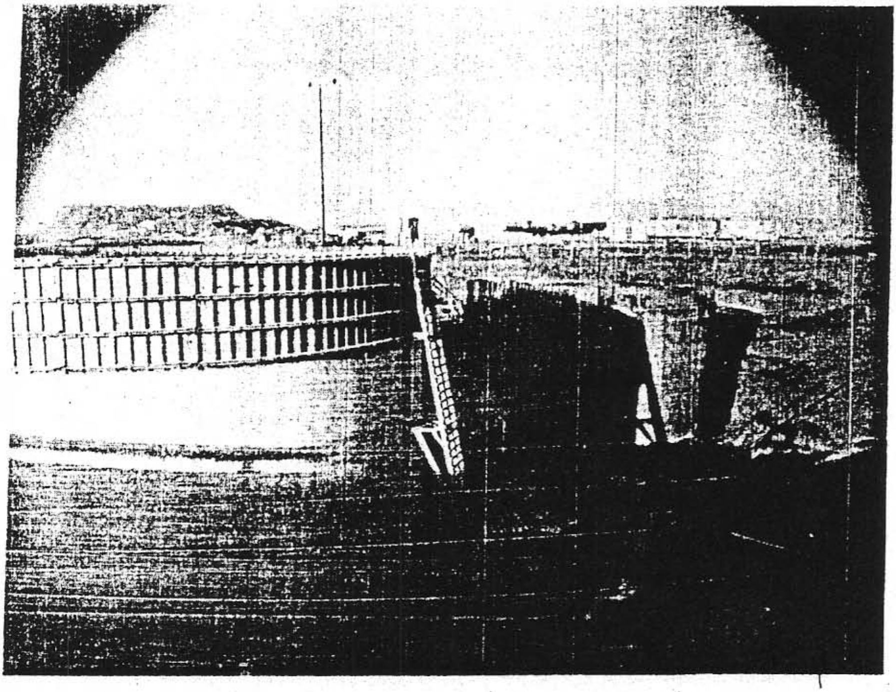
Site No. 2 - Backfilling open cut. Erecting LCC Roof forms. Looking West to East along Y-Y Axis



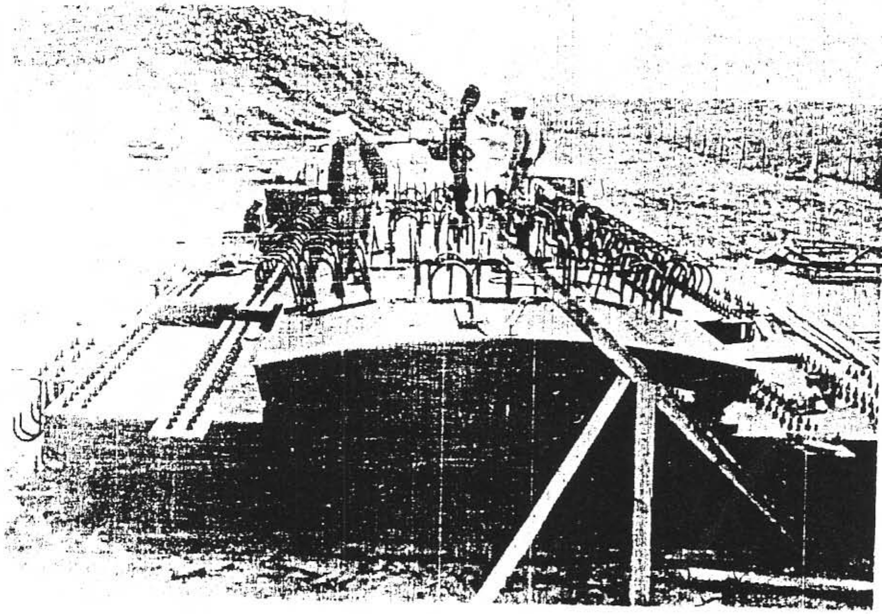
Site No. I - Placing concrete in 6-7 Lift in Silo. Looking South to North along X-X Axis



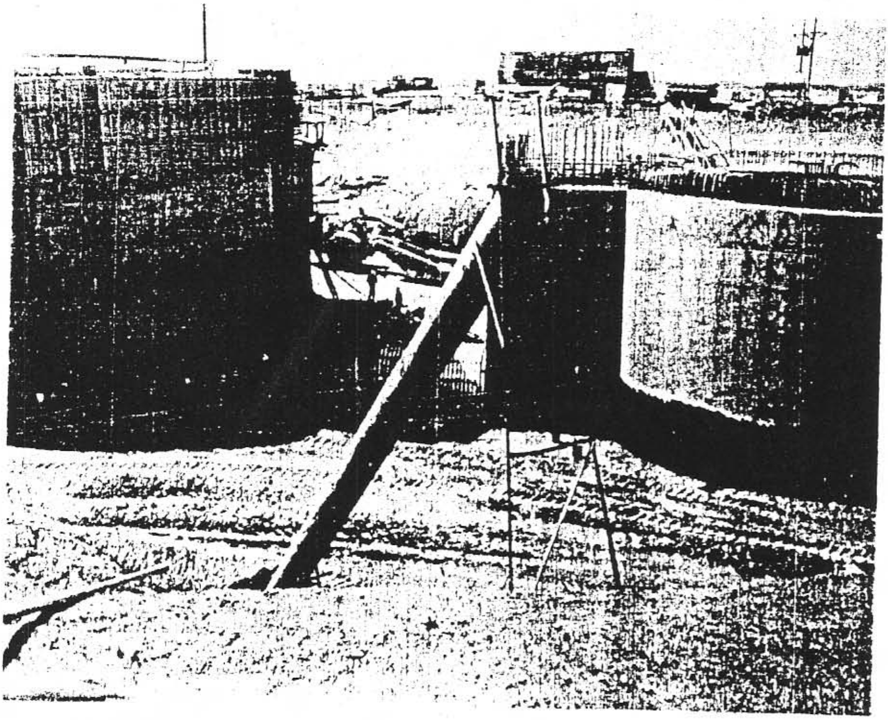
Site No. 7 - Erecting forms for Ist lift concrete. Downshaft.



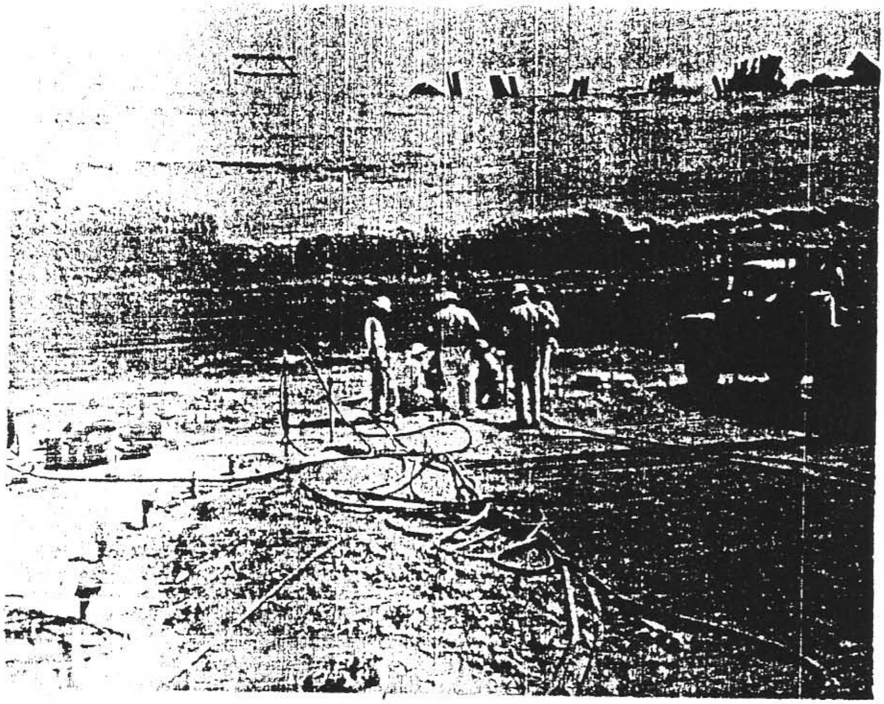
Site No. 9 - Placing top form for silo East to West along Y-Y axis.



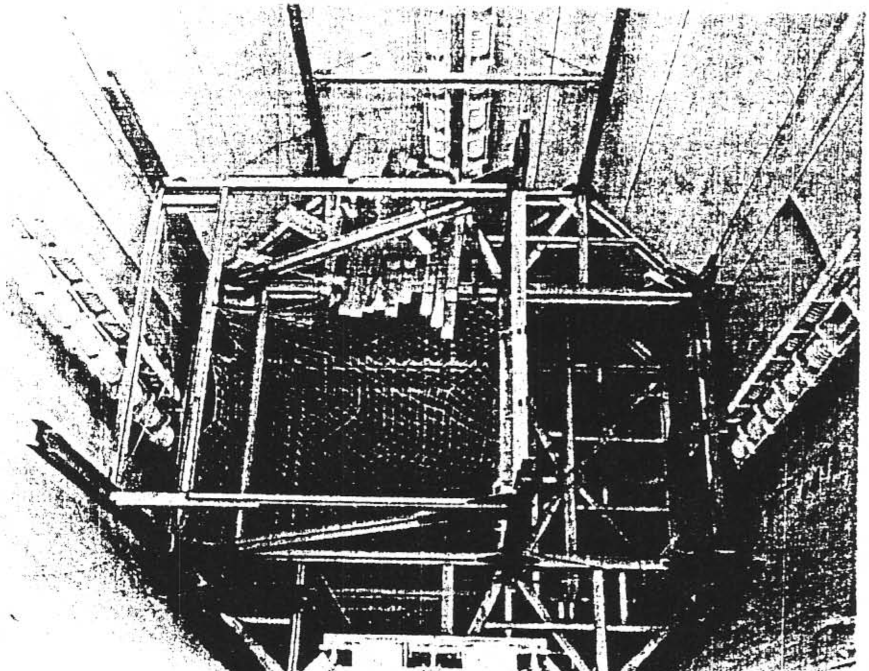
Collimator Plate Assembly
Site #2



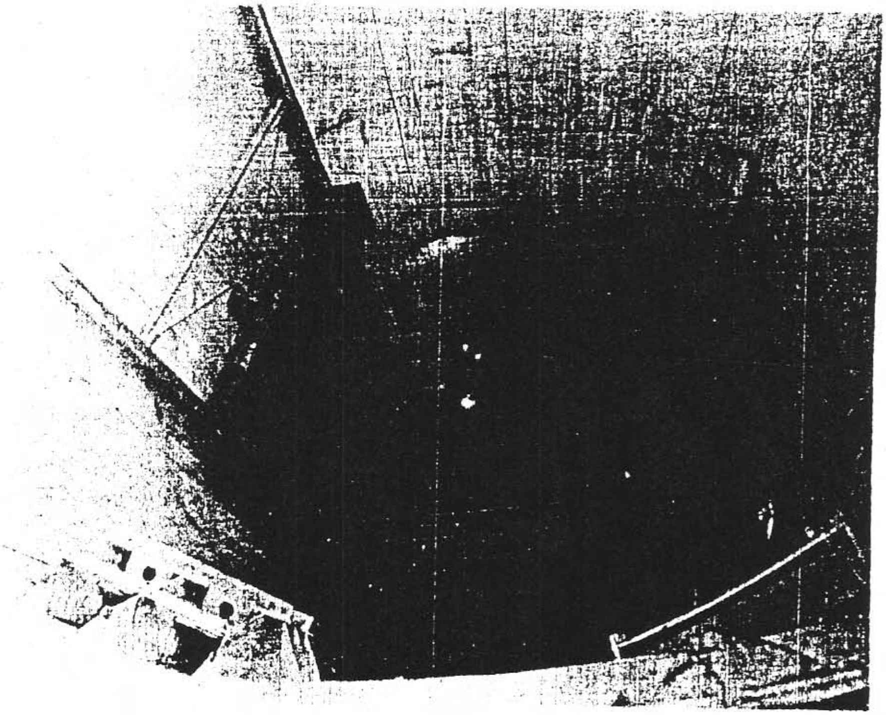
Backfilling around tunnel
Sight Tube
Site #4



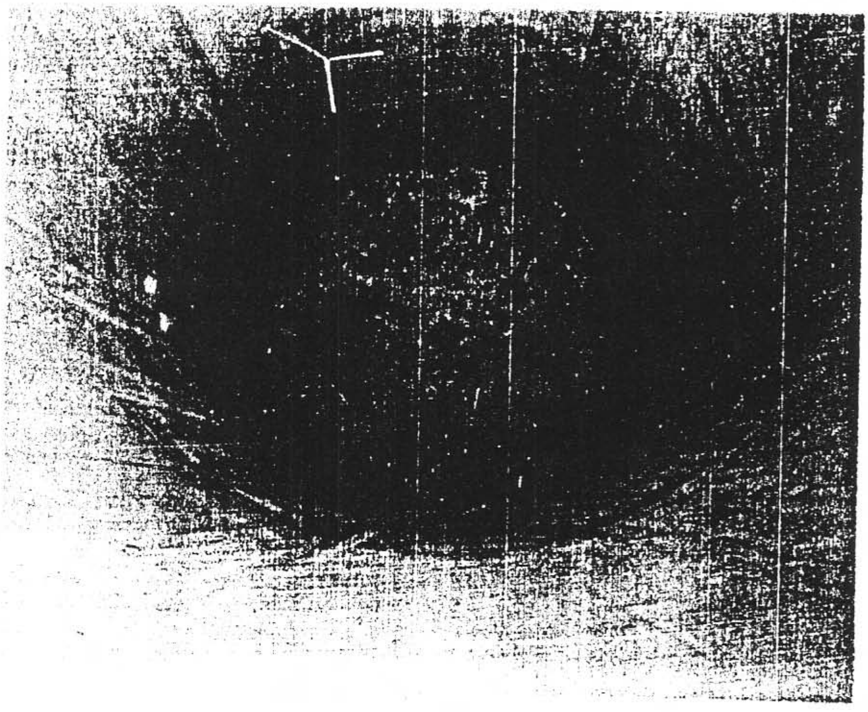
Dewatering Operations - Halliburton
Site #4



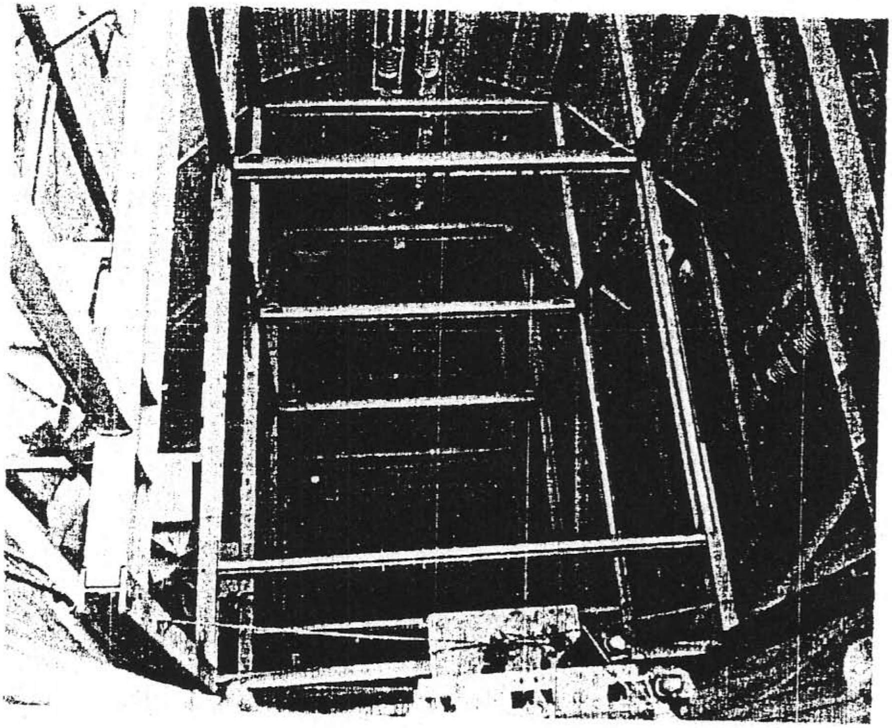
Crib assembley
Site #6



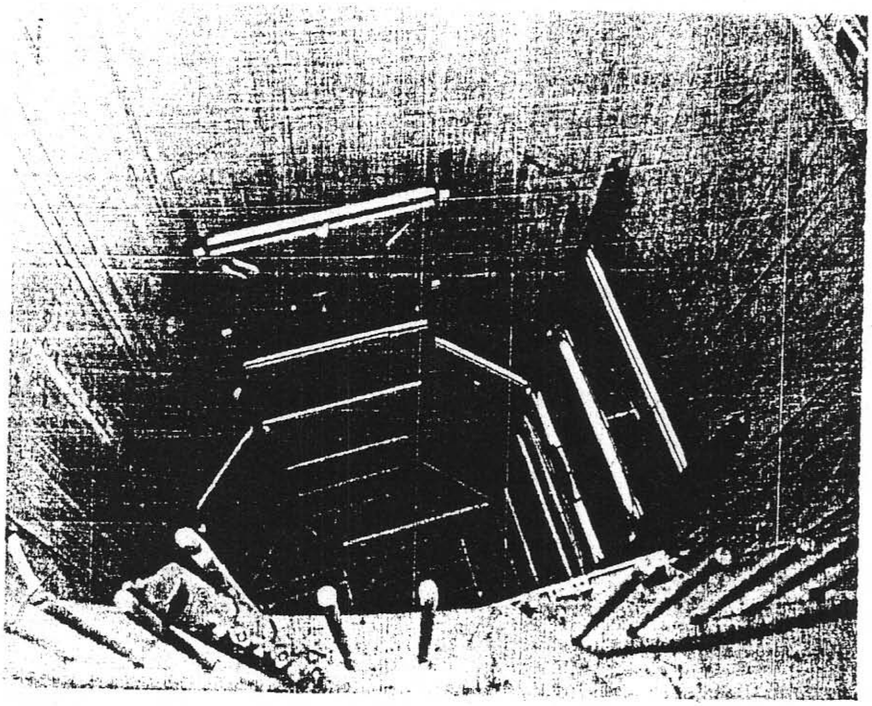
Errecting Crib Steel
Site #7



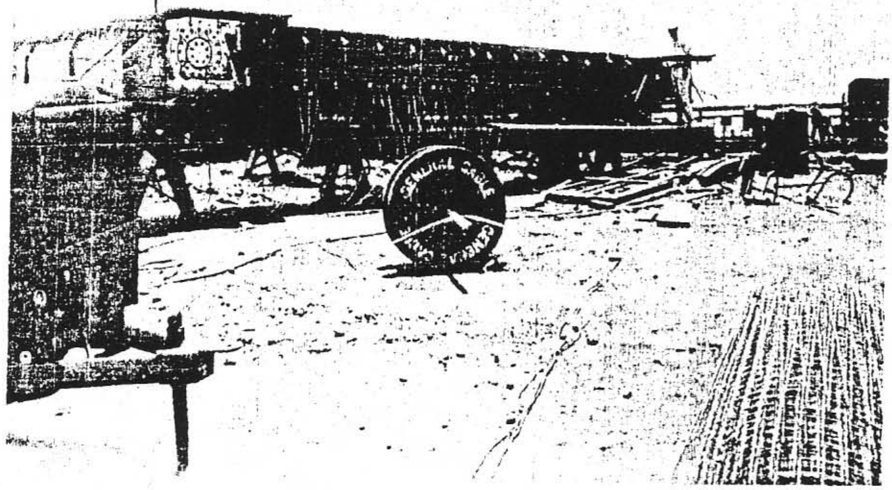
Installing crib steel
looking downshaft
Site #8



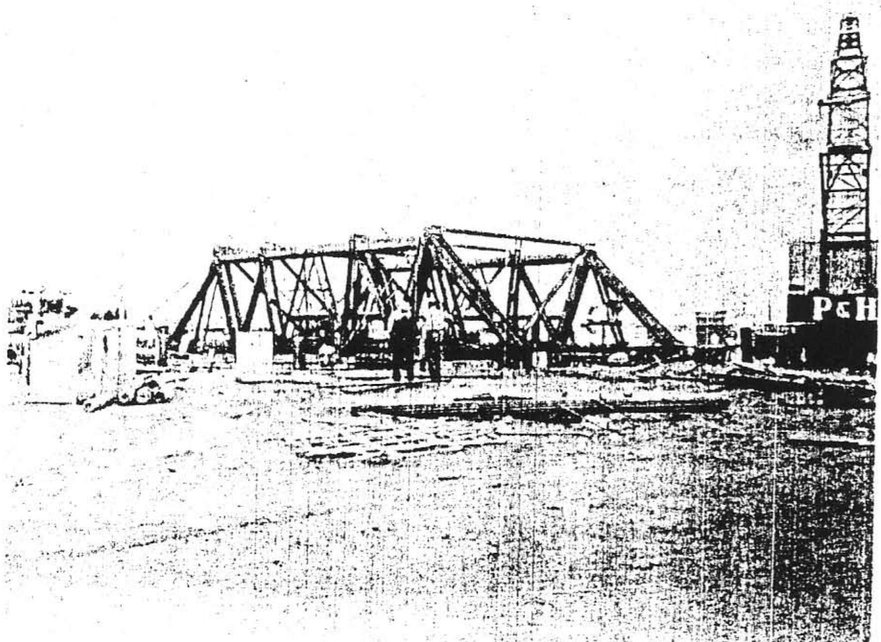
Structural crib steel
(lower sections)
Site #9



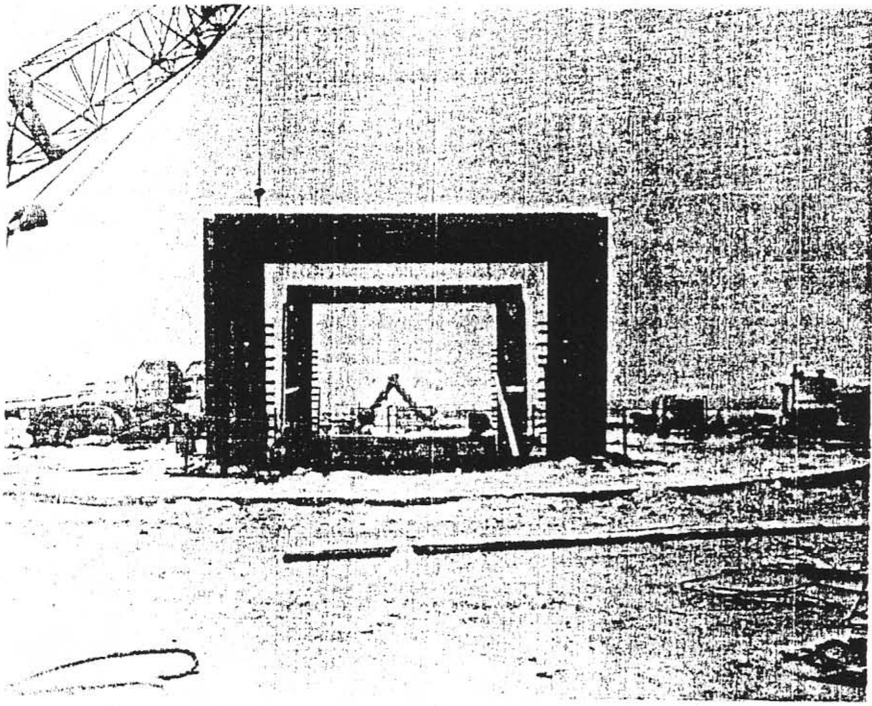
Installing crib steel
Site #10



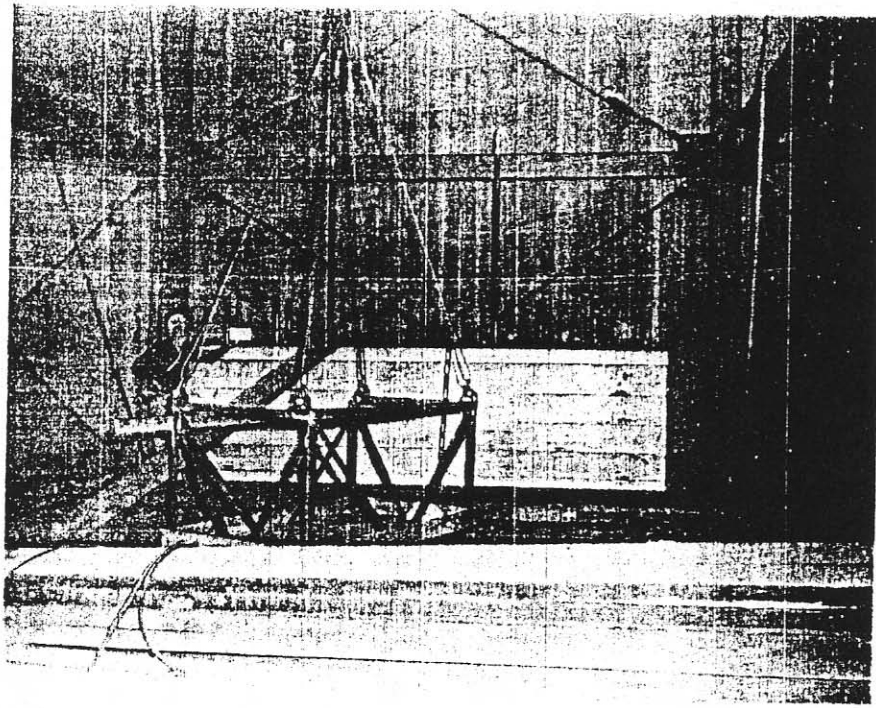
Erecting Silo Cap
door frame
Site #9



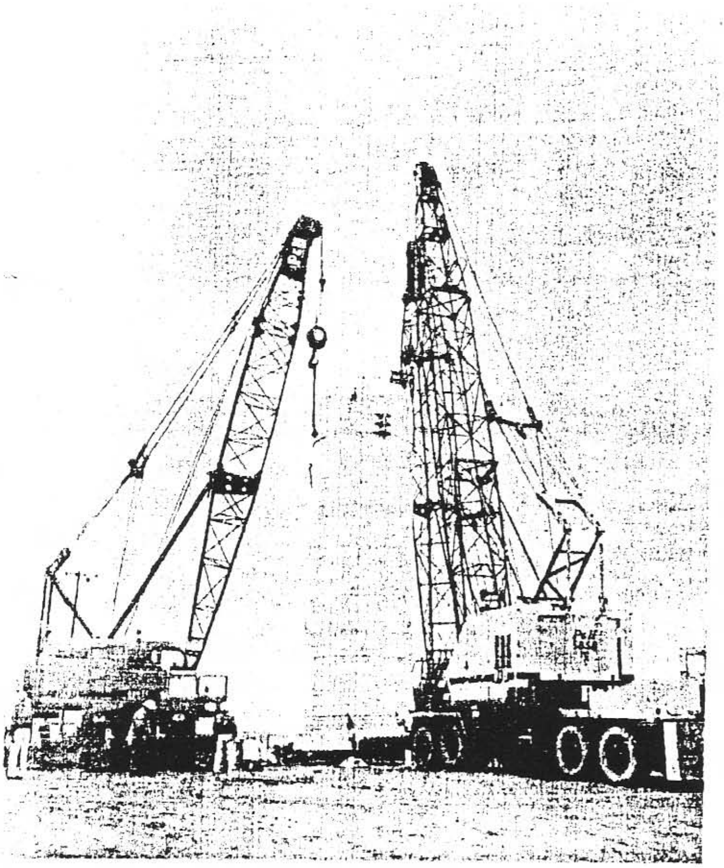
Silo Cap support
Site #10



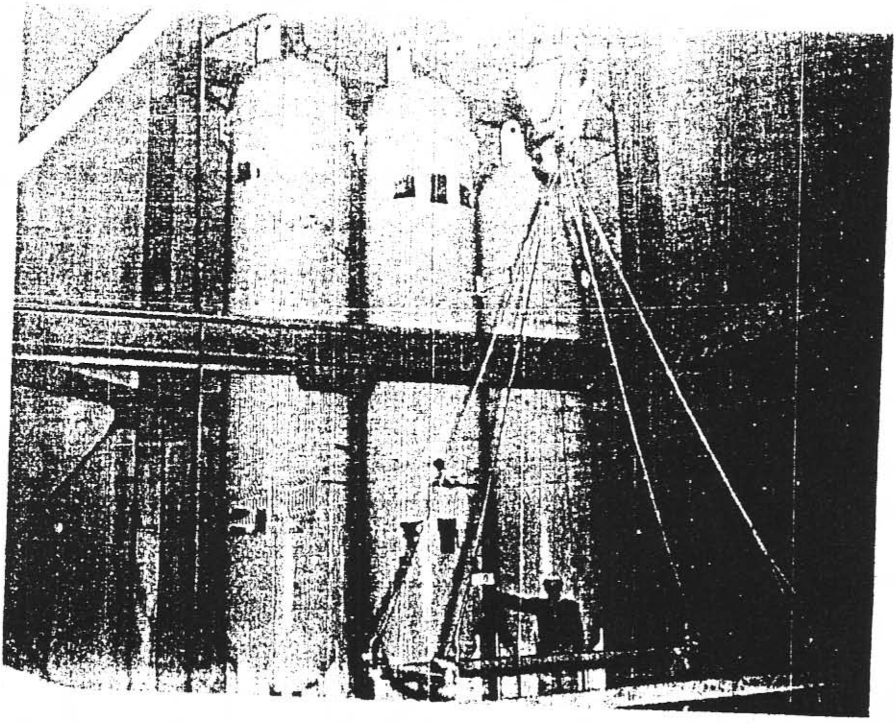
Activating Door Frames
Site #1



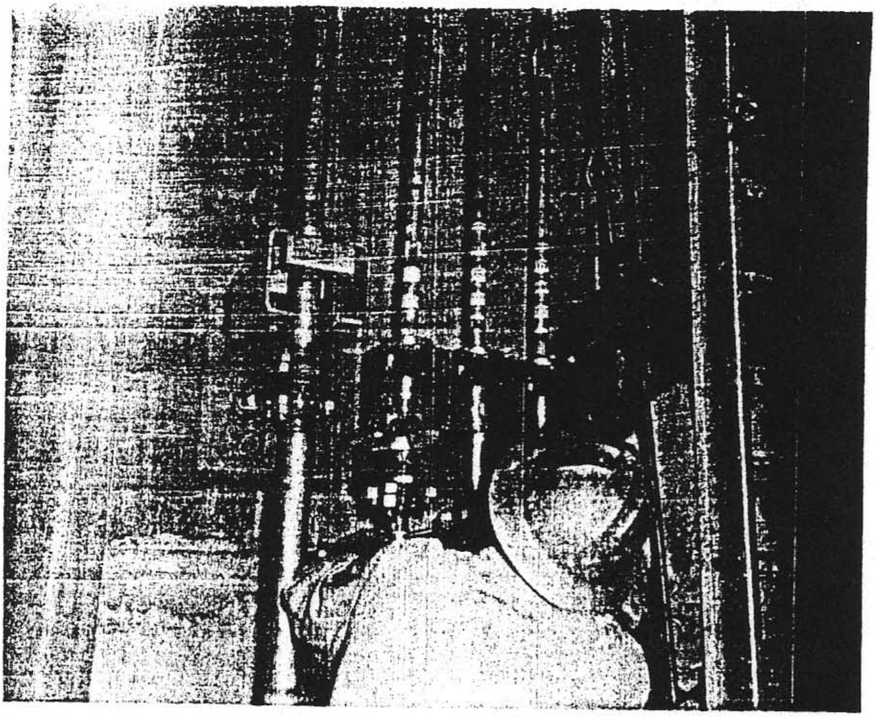
Installing Launch platform
counterweights
Site #10



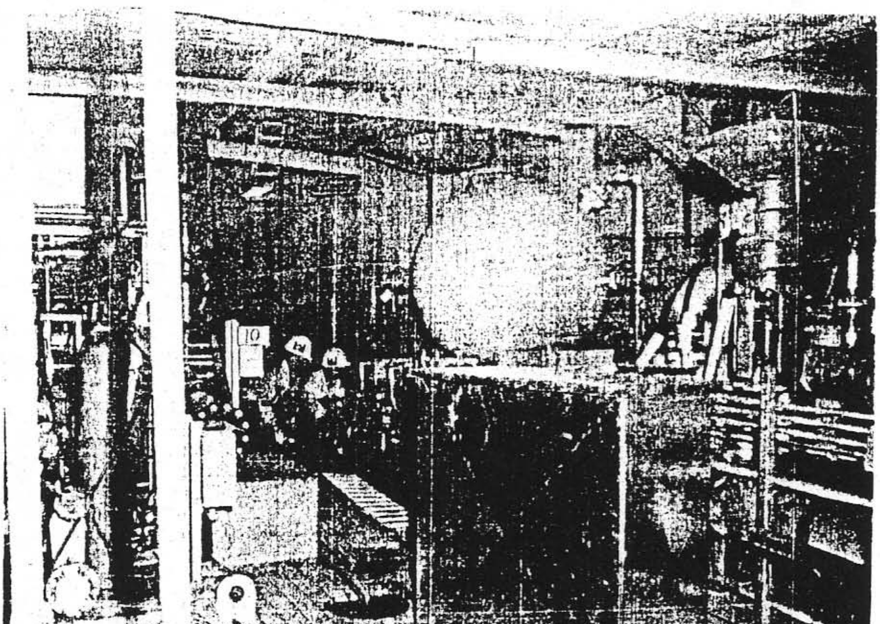
Lifting Lox Storage
Tank over parapet
Site #8



Helium Storage Tanks
Site 10



Tightening PLS Spool
connections
Site #9



PLS Prefabs
Site #10

APPENDIX B

CLAIMS

Copied only
one example
claim
mostly all labor related

SECURITY CLASSIFICATION (If any)

DISPOSITION FORM

FILE NO.	SUBJECT Claim- Structural Steel Field Correction Memoranda, Contract No. DA-29-005-ENG_2598		
TO Memo To File	FROM Hollis Norine	DATE 9 May 1962	COMMENT NO. 1

ltc/543

THRU: Area Engineer

1. CLAIM: Additional expense incurred during erection of Silo Crib Steel by reason of Supplemental Design drawing detail errors and inadequate coordination in the amount of $292,305.00. Submitted by letters of 8 and 15 December 1961 and 30 January , 2 February, 7 February and 27 February 1962.

2. FINDINGS: Each field correction memorandum was first reviewed against contract plans and specifications and supplemental design drawings by the Area Engineer staff for validity. In general, those found valid resulted from errors or divergence from contract requirements on the part of the supplemental design drawings. Supplemental design drawings were issued to the contractor after award of contract and were not available to bidders. After the above check, memoranda determined valid were taken to the field where actual accomplishment at each site was determined. By letters of 25 January and 27 February 1962 to the contractor, the Area Engineer listed as acceptable that portion of the claim, thus determined valid.

3. CONCLUSION: The additional expense incurred by reason of the changes recorded by field correction memoranda and determined valid claims by the Area Engineer are compensable under Clause 3, "Changes", of the contract and the contractor is entitled to an equitable adjustment thereof.

STANFORD I. POLONSKY
Major, CE
Acting Area Engineer

Mod - 155

B-1

APPENDIX C

VISITS AND CEREMONIES

APPENDIX C

VISITS

21 June 1960: Col. F. O. Reeves, Albuquerque District, for pre-construction conference.

22 June 1960: J. M. Sawyer, Macco Corporation for pre-construction conference.

July 1960: Col. A. L. Reed, Albuquerque District Engineer, for conference with the Area Engineer.

2 Aug. 1960: Col. A. L. Reed, Albuquerque District Engineer, for conference with Area Engineer and Contractor.

11 Aug. 1960: Col. A. Kroeber, AFRCE-SWR; Col. S. G. Reiff, SW Division Engineer; and Col. A. R. Reed, Albuquerque, District Engineer, met with the Area Engineer and the Contractor.

22 Aug. 1960: Col. E. D. Comm, of CEBMCO, and Col. J. F. Arfman, Albuquerque District Engineer, visited the Area office.

27 Aug. 1960: General E. C. Itehsner, Chief of Engineers; Col. S.G. Reiff, SW Division Engineer; Col. J. F. Arfman, Albuquerque District Engineer; and Mr. John Sawyer, Macco Corporation, met in conference.

7 Sep. 1960: Col. J. F. Arfman and Mr. J. Sawyer met in conference with the Area Engineer.

15 Sep. 1960: Col. J. F. Arfman met with the Area Engineer.

27 Sep. 1960: Gen. Joseph E. Gill, Director of Site Activation, met with SATAF and the Area Engineer.

5 Oct. 1960: Col. A. Kroeber met with SATAF and the Area Engineer.

12 Oct. 1960: General Harold K. Kelley, Deputy Director of Site Activation; Col. F. P. Koisch, Col. J. E. Carroll; Col. S. G. Reiff; Col. J. F. Arfman; Mr. H. Dow, Civilian Assistant to the Secretary of the Army; and Mr. J. Sawyer met at the Area Office.

28 Oct. 1960: Gen. A. C. Welling, Commanding CEBMCO, and Col. J.F. Arfman met with SATAF and the Area Engineer.

2 Nov 1960: Col. B. deMelker, of OCE, visited the construction sites.

17 Nov 1960: Col. A. Kroeber visited the sites.

22 Nov 1960: Col. W. W. Wilson, Director of Atlas F, and Col. J. F. Arfman held a meeting with the Area Engineer relative to transfer of the Area from the Albuquerque District to CEBMCO.

1 Dec 1960: Members of the House Appropriations Committee met with the Corps of Engineers and visited sites.

2 Jan 1961: Col. A. Kroeber visited the Area Office.

30 Jan 1961: Gen. A. C. Willing met with Mr. Cornwall and Mr. John Sawyer of Macco, and the Area Engineer.

2 Feb 1961: Col. J. F. Arfman and Col. A. Kroeber met at the Area Office.

31 Mar 1961: Gen. A. C. Welling visited the Area Office.

6 Apr 1961: Col. W. W. Wilson met with Messrs. Cornwall and Sawyer, of Macco Corporation.

1 May 1961: Gen. Donald Coupland, Deputy Commander of BSD visited sites.

3 May 1961: Col. A. Kroeber made a staff visit.

18 May 1961: Col. G. H. Sewell, I.G., for inspection

27 Jun 1961: Col. W. W. Wilson met with the Area Engineer and visited sites.

20 Jul 1961: Col. A. Kroeber made an inspection and staff visit.

26 Jul 1961: Col. T. J. Hayes visited the sites.

13 Sep 1961: Col. A. Kroeber made a staff visit.

22 Sep 1961: Col. W. W. Wilson met with the Area Engineer and made a site inspection.

27 Sep 1961: Col. J. F. Arfman met with Area employees to discuss reemployment rights.

29 Sep 1961: Col. A. W. Sanders, of CEBMCO made a staff visit

30 Oct 1961: Col. A. Kroeber made a staff visit.

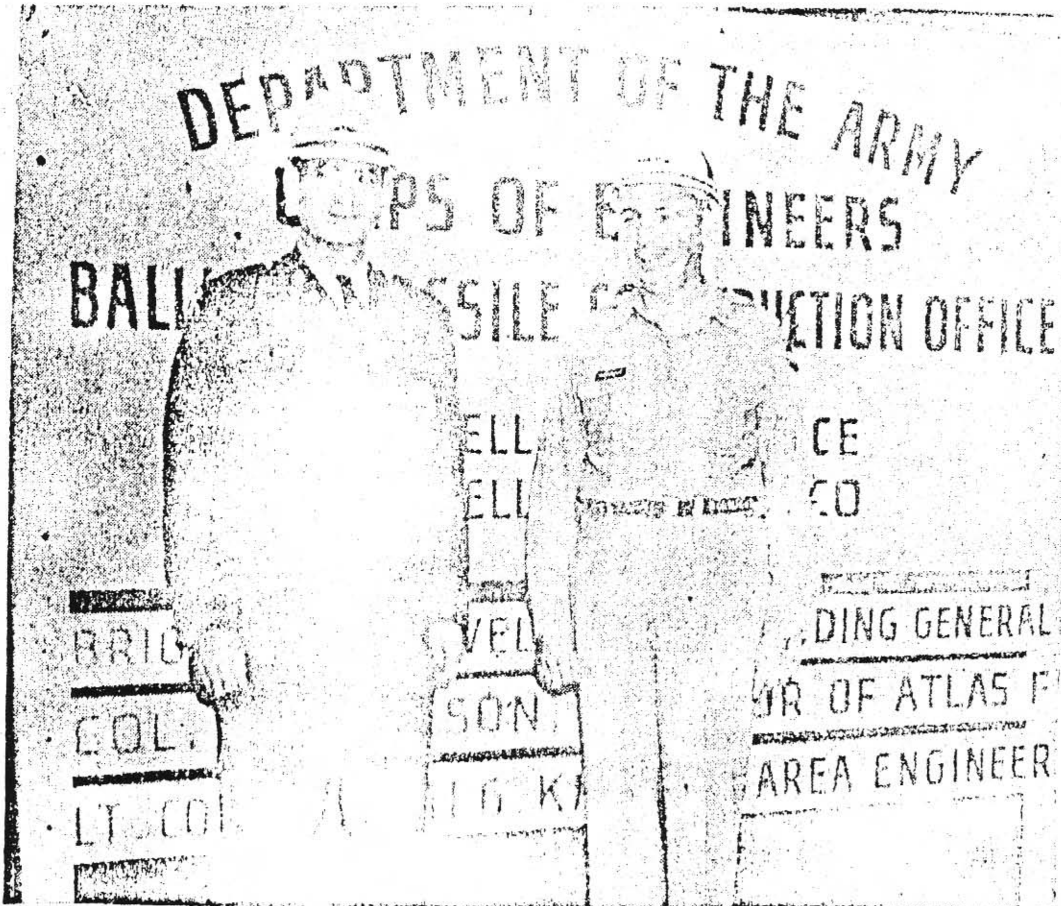
31 Oct 1961: Col. W. W. Wilson made an inspection visit.

29 Dec 1961: Col. W. W. Wilson made a staff visit.

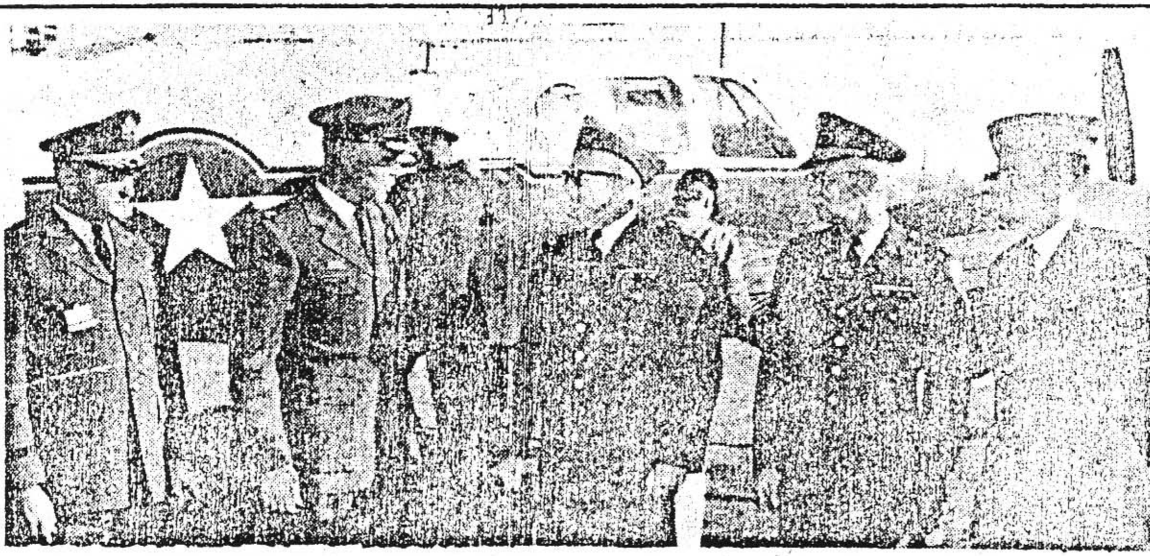
11 Jan 1962: Col. C. F. Townsend, I.G. Office made an annual genera inspection.

12 Feb 1962: Col. W. W. Wilson made an inspection visit.

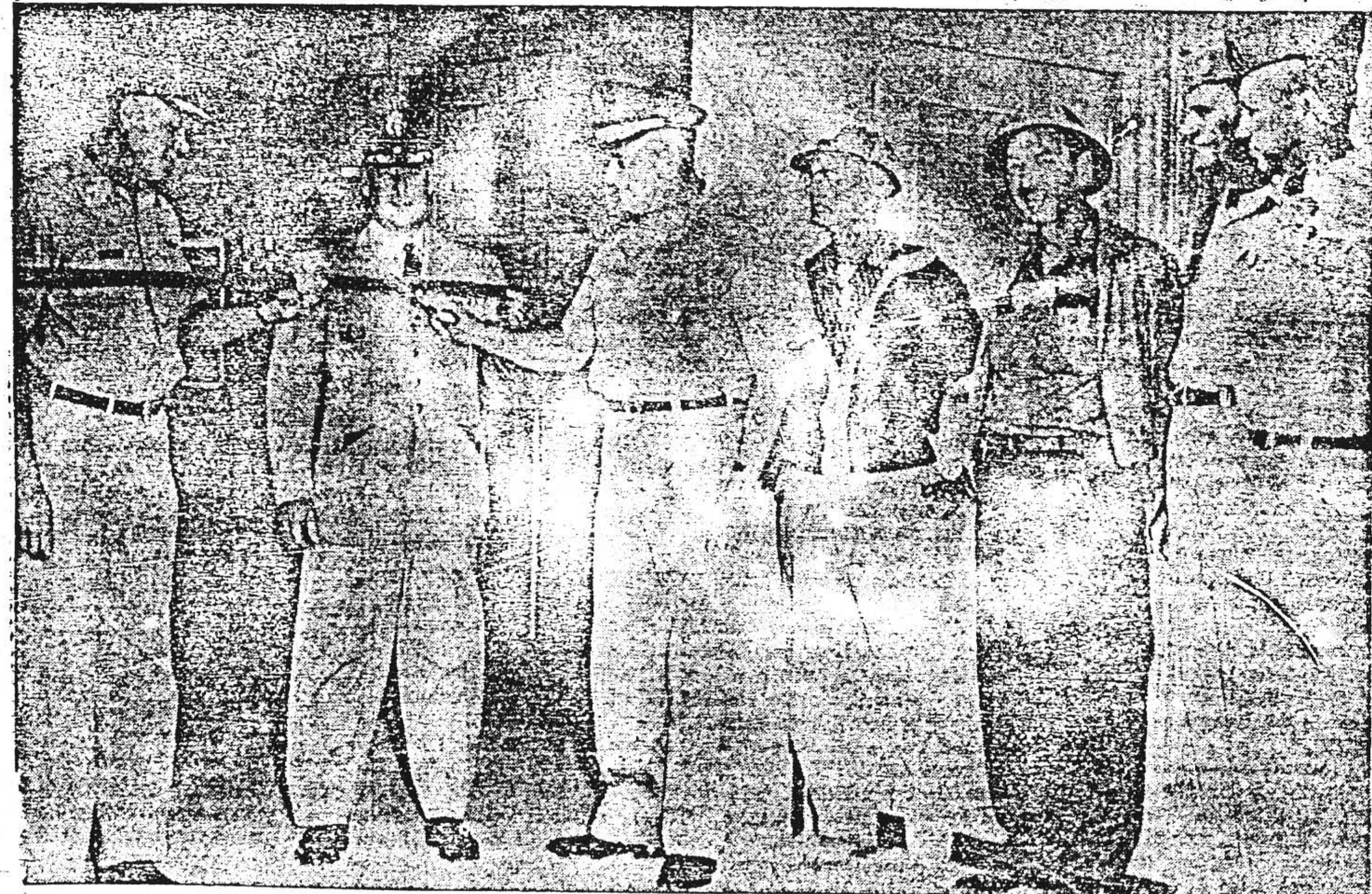
8 May 1962: Col. W. W. Wilson and Col. T. F. Spencer attended a final contract negotiation conference with the prime contractor and the Area Engineer.



CHIEF OF ATLAS PROGRAM—Col. W. W. Wilson, left, director of the Atlas F program in the United States for CEBMCO, (Corps of Engineers Ballistics Missile Construction Office) of Los Angeles, is shown during a visit to Roswell yesterday and prior to a tour of an Atlas launching site here. On the right is Maj. Standord I. Polonksy, U. S. Corps of Engineers, local office at Walker Air Force Base.
Record (Smith) Photo.



GENERAL INSPECTS -- Col. Roderic D. O'Connor, Base Commander, and Col. Donald E. Hillman, Wing Commander, greet Brig. General J. D. Stevens from Fort Bliss. Gen. Stevens along with Col. Joseph C. Moore and Lt. Col. Kimble were here to inspect the various missile sites located around the base. From left to right are Lt. Col. Kimble, Col. O'Connor, Gen. Stevens, Col. Moore, and Col. Hillman.



LOX PLANT TRANSFER—Lt. Col. Joseph Kimble, area engineer in charge of the Atlas complex construction, U. S. Corps of Engineers, handed over the Liquid Oxygen Plant to Walker Air Force Base, Friday, in formal ceremonies. In this picture Colonel Kimble is shown cutting a ribbon. From left to right are, Col. Roderic O'Connor, base commander, Col. Robert I. Barrowclough, Site Activation Task Force Commander; Colonel Kimble, Jerry Anderson, supervisor for the contractor, S.I.P., Inc., of Houston; Major H. W. Underhill SATAF civil engineer; John Butterworth, project engineer, Lox plant, Corps of Engineers; and Capt. John Toman, resident engineer, U. S. Corps of Engineers. Record (Smith) Photo.

U.S. Might Displayed At Roswell

El Paso Times, Nov 1, 1961

By BUCK LANIER
Times Regional Editor

Roswell, N.M.—The strength of America was demonstrated forcefully Tuesday afternoon, as Gov. Edwin Mechem made the key talk at the turnover of Atlas F Missile Site No. 10.

The governor said "We are here to protect the free world with this, one of six complexes in the United States, and it is our intention to see that this mission is accomplished."

Mechem's talk, 25 seconds worth, followed up an earlier comment by Maj. Stanford Polonsky of the Army Engineers, ceremony coordinator, who said:

"We want Russia to know where our striking power is. There is no secret about the location of any of our Atlas sites."

Constructors of the site were Macco Corp., Raymond International, Inc., the Kaiser Co., Puget Sound Bridge and Drydock Co., a joint venture under J. M. Sawyer, project general manager.

Area news media representatives were confronted with one of the most spectacular construction jobs they ever saw. The silo housing the gigantic missile is 180 feet deep, necessitating the removal of 1,200,000 cubic yards of dirt. Its concrete walls vary from two to nine feet in thickness; 90,000 cubic yards of concrete were used; 250 tons of pipe; and 470 miles of communications cables.

The Atlas F has a range of 9,000 miles, it stands 83 feet high and travels at 17,250 miles per hour.

Its payload is listed as a nuclear warhead.

Tuesday morning news media representatives convened at Walker Air Force Base for a briefing by Maj. Polonsky. Following

(Continued on Page 2, Col. 1)

briefing there was a question and answer period.

Walker Air Force Base, through Col. P. E. Hillman, commander, was host for lunch at the Officers Open Mess at which time comments were heard from Col. R. I. Barrowclough, site activation task force commander for Project Turnover; Col. W. W. Wilson, Atlas F director, and Maj. Gen. A. C. Welling, deputy for the site activation.

Air Force transportation was provided to the site 43 miles north of Roswell off of Highway 70.

Gov. Mechem cut the ribbon and Air Force officers steered newsmen into a completed tour of the entire installation.

The silo is constructed on eight levels:

1. Drive mechanism control and electric guidance equipment.
2. Hydraulic system and motor control.
3. Generator, battery, checkout equipment and launch motor.
4. Water.
5. Generator and control equipment.
6. Generator, battery and charger.
7. Monitors and controls for firing.
8. Storage, heat exchange and pressurization.

There is a connecting tunnel between levels four and three. A quite compact concrete house has the title of the launch operations building.

No photographs were permitted during the tour in this section.

Among those attending were Roswell Mayor Lake Frazier; Ross Malone, former president of the American Bar Association; Speaker of the House Jack Campbell; State Sen. Penrod Toles, Rep. Morgan Nelson; Rep. Larry Goodell; Capt. I. R. Funk, in charge of Roswell, New Mexico State Police and Lt. Gen. Hobart N. Gay, superintendent of New Mexico Military Institute;

Tony Barclay, representing the Carlsbad Fire Department; Al Stubbs, editor of Roswell Daily Record; Bob Beck, publisher of the Record, and Vic Jameson and Jim Rawls, Hobbs News-Sun.

Also Gordon Greaves, Portales News Tribune editor and George Dolan, Fort Worth Star-Telegram.

First Roswell Missile Site Ready for Final Checkout

By GORDON K. GREAVES
News-Tribune Editor

The first of 12 Atlas missile launching complexes surrounding Roswell — the one nearest Portales — is ready for its checkout preparatory to installing the 9,000-mile missile in its 180-foot deep silo.

Governor Edwin Mechem snipped a ribbon before the massive, 30-inch thick silo doors Tuesday afternoon, signifying the activation of the site, and a few minutes later, Major General A. C. Welling, Army Corps of Engineers, clipped another ribbon before the entrance to the launching control center. The Atlas missile, complete with its warhead, is due to be lowered into its cradle below the ground about January 1.

The brief ceremony, performed before about 125 civilians and military observers, marked what General Welling described as the "first battle of the first combat operation in the zone of the interior since the Civil War."

"Rifle is Ready"

He spoke of the site activation — the turning over of the missile complex with its fantastically intricate mechanisms —as a rifle now ready for the bullet. The Air Force now takes over the checkout of the fuel handling mechanisms, and General Dynamics Austronautics will have the responsibility for installing the 82½ foot-high Atlas F intercontinental ballistic missile.

In short order, the other 11 missile complexes will be completed, and turned over to the Air Force, adding to the growing system of nuclear tipped missiles upon which this n a t i o n will rely in case of a showdown with Russia.

General Welling's reference to the construction as a "battle" was rhetorical, but newsmen covering the event yesterday recalled vividly that past February seven men lost their lives in an accident at the Atlas site adjacent to the one dedicated yesterday.

General Welling said that from the d e s i g n and engineering through one construction phase the work was pushed with all the determination, and many of the frustrations, of a real battle.

He did not elaborate, but his listeners were aware of the real stakes in that battle, in which the United States' ability to deliver a nuclear warhead on targets over the north pole and into the heart of Russia, is this nation's main weapon in a game of blackmail by terror waged by an enemy with the capability of striking at the heart of America.

Six Similar Systems

There are six other Atlas F missile launching complexes in the United States, and only one is now operational.

Major Stanford I. Polonsky, executive officer for the Ballistic Missile Construction Office, described some of the features of the construction job now completed on Site No. 10, just a mile west of Elkins.

Ground was broken there on June 10, 1960, and the shaft was bored in 53 days, working three shifts, 7 days a week. The concrete work on the walls was started in September from a batching plant capable of turning out 40 cubic yards per hour. This was also a 24-hour operation.

Steelmen moved in last January, but worked only a 40-hour week because their work had to

(Continued on Page 8)

C-5a

Portales News--Tribune, Nov 1, 1961

AT THE BOTTOM — Major General A. C. Welling, of the Army Engineer Corps, tells newsmen how the fuel transfer system for Atlas missiles is handled. This interview took place 180 feet below the surface in the missile silo a mile west of Elkins as the missile complex was officially turned over to the Air Force after completion of the construction phase. The 12 missile sites surrounding Roswell will cost approximately $101,000,000 when they are ready for operation.

(News-Tribune Photo)

(Continued from Page 1)

dovetail with fabrication of vessels for the fuels and the complex control mechanisms. Major Polonsky credited the New Mexico Labor Council with ironing out many problems concerning the crafts represented in the work, to keep the work on schedule.

Tolerances Exacting

The complexity of the job, through all its phases was only imagined from the start, and was an entirely new experience for all concerned. "We grew to appreciate the learning curve" Major Polonski said, remarking that many of the problems surmounted seem relatively simple in retrospect.

The tolerances for all type of construction were far closer than any of the contractors had encountered in their previous jobs, and the work of many sub contractors had to dove-tail down to fractions of an inch.,

An example was the installation of the 52-ton liquid oxygen storage tank, and its related systems of pipes and pumps. The piping was all prefabricated, and had to fit in the concrete and steel silo with close tolerances. The workmen installing this equipment wore white gowns and masks such as surgeons wear in an operating room, for all foreign matter, down to the size of a dot made by a fine pencil point, must be kept out of the system.

The steel-reinforced concrete doors which close flush with the surface, had a tolerance of a sixteenth of an inch both vertically and horizontally.

No Trouble With Water

On Site No. 10 the work proceeded with a minimum of interruptions, Major Polonski said. The soil there was of a type suitable for handling with conventional equipment, and there was virtually no ground water to impede progress. But on other of the sites, it was necessary to bore through gypsum formations, and through water bearing stratas that required chemical grouting and special techniques that were learned on the job.

There is little to meet the eye on the surface to indicate what has gone on for the past 18 months at Site No. 10.

A graveled road leads off U.S. Highway 70 where two temporary quonset type buildings are the dominant features on a lonesome landscape. The ground in a 5-acre area is terraced leading up to the massive doors that yesterday were open above the 52-foot wide silo.

Off to one side was a cooling tower, and approximately 100 feet to the northwest was a concrete structure resembling an entrance to a fall-out shelter.

The visitors at the site were permitted to peer down the maw of the silo, but were reminded that in this case everything that goes down must come up.

Blast Doors Open

Through the narrow concrete lined door of the entrance a steel stairway led downward, making abrupt turns as it reached different levels, leading to the launching control center.

We were told that ten and a half feet of earth covered the top of this structure. Two huge steel doors, with interlocking closing surfaces stood open, and at each door we observed electrical interlocks and mechanisms for opening and closing.

Each of the doors served to block the narrow passageway, and we were told that only one will be open at a time when the site is in operation. They are designed both as a protection against blast, and as a guard for the control mechanisms below.

Around two more abrupt turns we stepped out into a circular room, and were told that this is to compose the living area for the select crew of men who will live underground for brief periods, monotoring the communications from the nation's vast network of controls.

The fascinating thing about this drum-like room is that it was in suspension. At four points the room hangs from immense chains to anchor points in the concrete above, but between each chain and the anchor point is a compressed air cylinder that automatically levels the floor, no matter what may disburb the room.

The living quarters includes a neat kitchen, bathroom facilities, and an area about the size of an ordinary living room in a home in which the men will presumably sleep if necessary. It was not explained at this time how many men will be on duty here, or how long they will be required to stay at a time. This, the Army Engineers explained, is in the realm of the Air Force, who will provide the men on duty.

Television Guard

Down another flight of stairs, is the control center, also a part of the hanging drum. Here was a maze of telephone dial circuits, and a television receiver for a closed circuit system that looks unblinkingly at every person who approaches the first steel door up the passageway.

This television guard, it was explained, will examine creditentals of every person who enteres the control center. Each person will find a steel door closing behind him, while he is identified, and then if he is to be admitted, the heavy blast doors open one at a time.

Somewhere in this second level of the drum-like room will be located the awesome "push button" which can launch the Atlas missile, but no one explained where the button was to be. We had been cautioned that in this room, no photographs should be made. It was the only "secret" part of the missile site, so far as Tuesday's visitors were concerned.

Connected By Tunnell

A tunnell, large enough for two men to walk side by side, and containing a maze of pipes and electrical cables, leads from the control center to the silo, all approximately 30 feet below the surface.

The visitors walked through this tunnel, and emerged on the third level of the silo where the generators were humming, and where the checkout equipment and launch motor are to be installed.

Looking down through the massive steel crib which will soon hold the missile, are five other levels, each with its special equipment. A spiral ladder connects all the levels except the bottom two which are reached by the straight steel rungs which require both hands and feet.

On the floor of the silo, Gen. Welling explained something of the mechanism of the silo. Tall tanks surround the central square of steel. These contain the liquid oxygen, liquid nitrogen, helium, and the container for the RPI fuel, which he explained is simply a "high grade of kerosene."

A maze of pipes, pumps and control panels all seemed to be in place, and General Welling explained that these serve the purpose of handling the components of the fuel, at temperatures down to 314 below zero. Thus a gigantic refrigeration system is necessary to keep the oxygen and nitrogen in the liquid state.

C-5c

Turn Over First Atlas Site To SATAF

Governor, High Officals At Ceremony

The first Atlas Missile silo was officially turned over by the Corps of Engineers Tuesday to SATAF when the Governor of New Mexico, Edwin Mechem, cut the ribbon at the official ceremony at Complex 10.

Under leaden skies, after a night of rain, a group of about 100 military and civilian officials watched the ceremony, heard the invocation read by Chaplain O. W. Voelzke and a brief speach by the governor and Col. R. L. Barrowclough, SATAF Commander.

Then the visitors, which included news media from Roswell, El Paso, Albuquerque, and other towns in the community, walked down into the strange world of an Atlas Missile Silo. For most it was almost like landing on the moon.

This is the first of 12 such complexes surrounding Walker which will be operated by the 579th Missile Squadron.

The visit to the complex was preceded by a luncheon at the Officer's Club at Walker where 100 distinguished guests heard Col. Barraclough announce that the first of the Atlas F missiles will arrive shortly after the first of the year.

At the luncheon Maj. Gen. Alvin Welling, deputy chief for site activation, Ballistic Systems Division, spoke. Prior to the luncheon, Maj. Stan Polonsky, of the Corps of Engineers, briefed newsmen on the progress of the Atlas program.

The caravan from Walker to the complex was escourted by Air Police, city and state police, arranged for by MSgt R. O. Nelson, of the Walker Air Police.

Among the distinguished guests at the ceremony, besides Walker officials, were: Governor of New Mexico, Edwin Mecham; State Senator J. P. Toles, Speaker of the House for New Mexico, Jack M. Campbell, State Representatives, W. G. Schrecengost, Lawrence Goodell, and Morgan Nelson; Maj. Gen. A. C. Welling, Brig. Gen. W. R. Yancey, Commander 47th Air Division; Mayor Lake J. Frazier, and Col. W. W. Wilson, US Army Commander CEBMCO.

U. S. AIR FORCE ☆ AEROSPACE POWER FOR PEACE

STRATEGIAN

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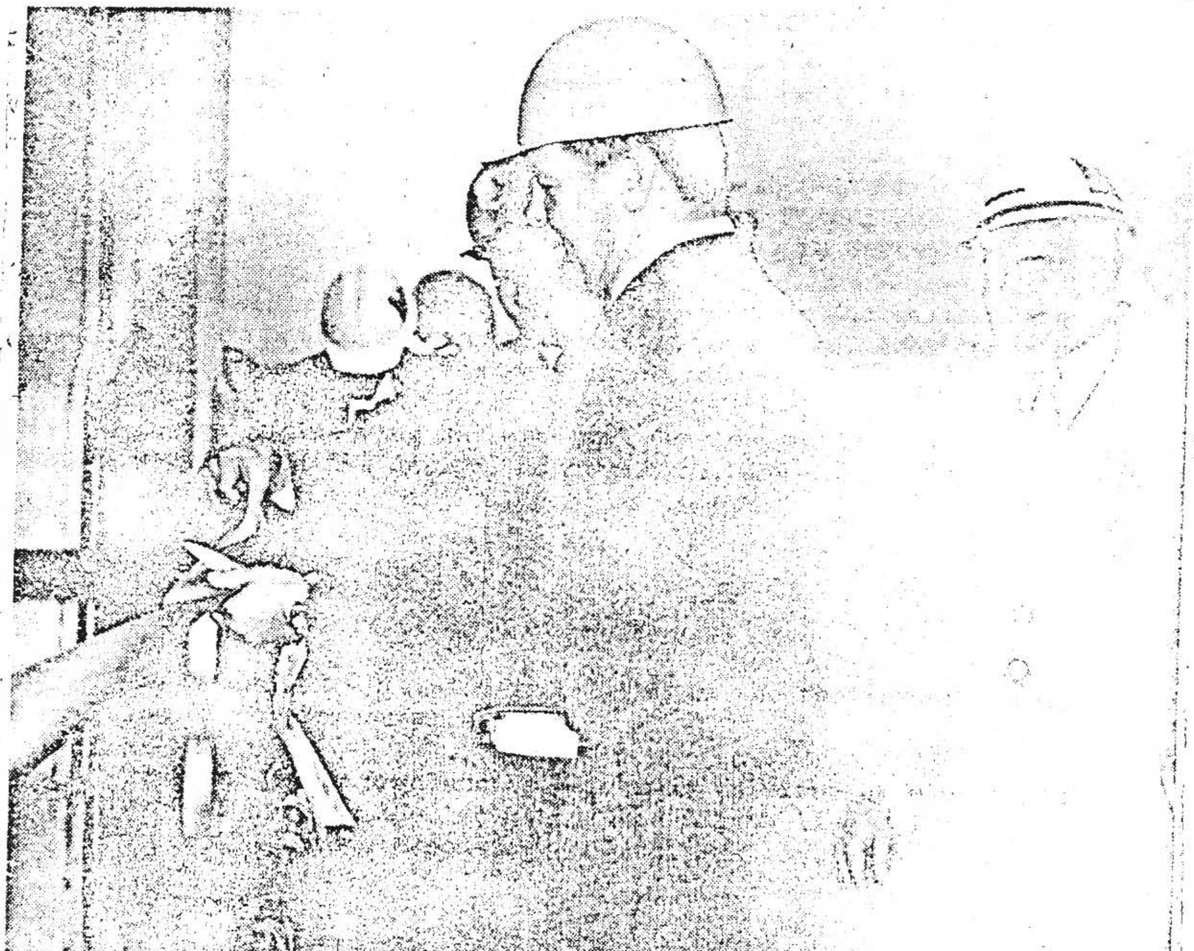
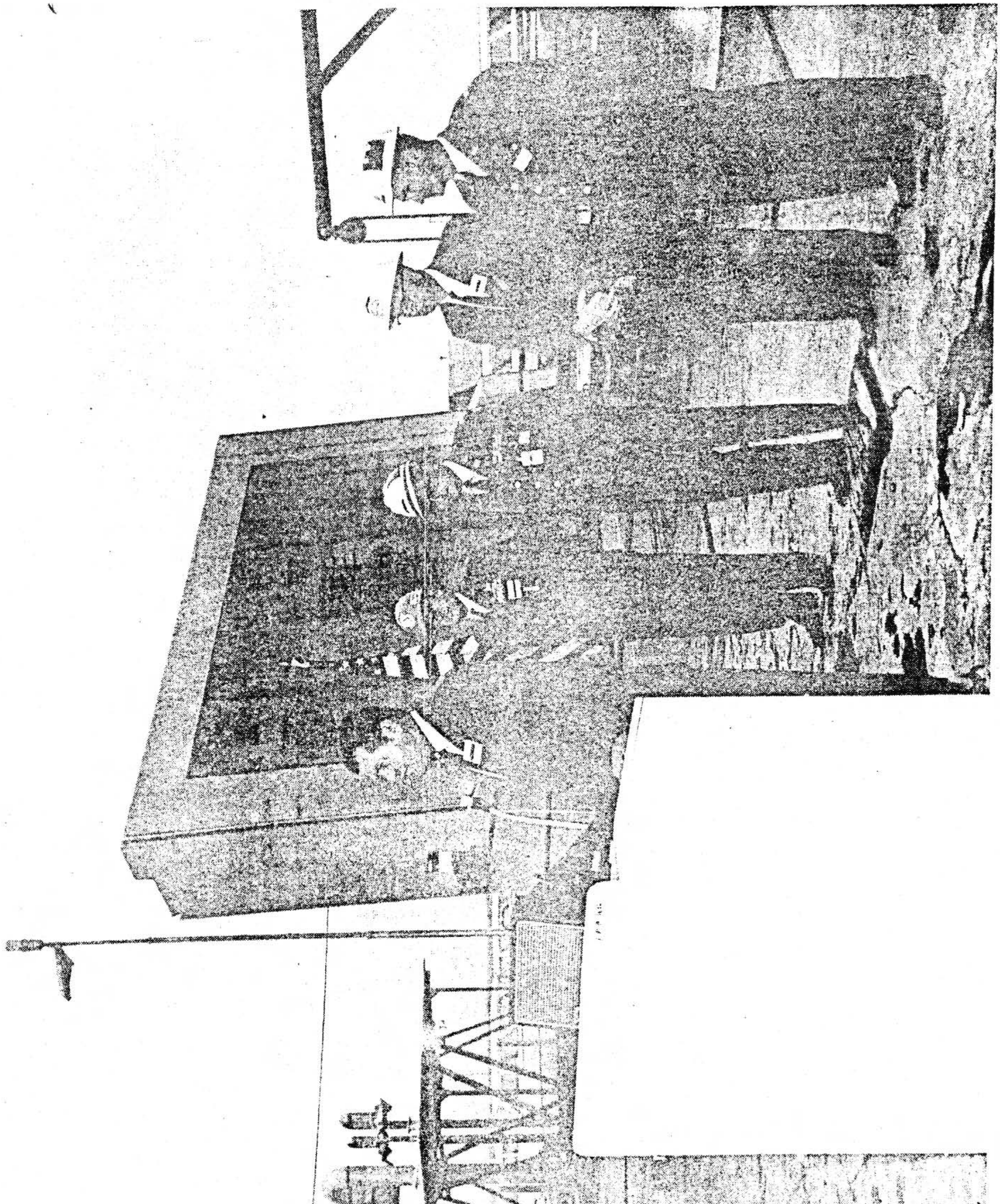
PEACE ☆ IS ☆ OUR ☆ PROFESSION

VOLUME XVIII, NO. 42 ROSWELL, NEW MEXICO FRIDAY, NOVEMBER 3, 1961



GOVERNOR CUTS RIBBON--Governor Edwin Mechem cuts the ribbon to formally open Complex 10 -- the first of the 12 missile complexes to be turned over by the Corps of Engineers to the Air Force upon completion of the basic construction. Now the black boxes and the communications system has to be completed before the first Atlas missiles are due in January. (PHOTO BY TODD).



C-7

TURNOVER CEREMONY

31 Oct 61

SITE 10

Governor Mechem Presenting Keynote Address