HISTORIC PROPERTIES REPORT

CORNHUSKER ARMY AMMUNITION PLANT

GRAND ISLAND, NEBRASKA

FINAL REPORT

AUGUST 1984

This document was prepared by the MacDonald and Mack Partnership, Minneapolis, Minnesota, under Contract CX-0001-2-0033 between Building Technology Incorporated, Silver Spring, Maryland, and the Historic American Buildings Survey/Historic American Engineering Record, National Park Service, U.S. Department of the Interior.

EXECUTIVE SUMMARY

The Cornhusker Army Ammunition Plant (Cornhusker AAP) was constructed in 1942 to load, assemble, and pack bombs of various sizes. A part of the Army's Armament, Munitions and Chemical Command (AMCCOM), Cornhusker AAP was one of 60 ordnance plants constructed at the onset of World War II. It was renovated and reactivated during the Korean War to produce rockets and artillery shells, and during the Vietnam War to produce shells and bombs. Located on an 11,936-acre site near Grand Island, Nebraska, the facility presently comprises 643 buildings, 545 of which date from World War II.

The architecture of the buildings is utilitarian in style. Much of the original production equipment was replaced after World War II. There are no Category I, II, or III historic properties at Cornhusker AAP.

CONTENTS

PREFACE

This report presents the results of an historic properties survey of the Cornhusker Army Ammunition Plant (Cornhusker AAP). Prepared for the United States Army Materiel Development and Readiness Command (DARCOM), the report is intended to assist the Army in bringing this installation into compliance with the National Historic Preservation Act of 1966 and its amendments, and related federal laws and regulations. To this end, the report focuses on the identification, evaluation, documentation, nomination, and preservation of historic properties at the Cornhusker AAP. Chapter 1 sets forth the survey's scope and methodology; Chapter 2 presents an architectural, historical, and technological overview of the installation and its properties; and Chapter 3 identifies significant properties by Army category and sets forth preservation recommendations. Illustrations and an annotated bibliography supplement the text.

This report is part of a program initiated through a memorandum of agreement between the National Park Service, Department of the Interior, and the U.S. Department of the Army. The program covers 74 DARCOM installations and has two components: 1) a survey of historic properties (districts, buildings, structures, and objects), and 2) the development of archaeological overviews. Stanley H. Fried, Chief, Real Estate Branch of Headquarters DARCOM, directed the program for the Army, and Dr. Robert J. Kapsch, Chief of the Historic American Buildings Survey/Historic American Engineering Record (HABS/HAER) directed the program for the National Park Service. Sally Kress Tompkins was program manager, and Robie S. Lange was

project manager for the historic properties survey. Technical assistance was provided by Donald C. Jackson.

Building Technology Incorporated acted as primary contractor to HABS/HAER for the historic properties survey. William A. Brenner was BTI's principal-in-charge and Dr. Larry D. Lankton was the chief technical consultant. Major subcontractors were the MacDonald and Mack Partnership and Jeffrey A. Hess. The author of this report was Robert Ferguson. The author gratefully acknowledges the help of Mr. S. C. Fisher, Commander's Representative at Cornhusker AAP; and of Joseph M. Higgins, Plant Manager, Jack Rodysill, Departmental Assistant, and William T. Hannan, Departmental Engineer, of the Mason & Hanger-Silas Mason Co., Inc.

The complete HABS/HAER documentation for this installation will be included in the HABS/HAER collections at the Library of Congress, Prints and Photographs Division, under the designation HAER No. NE-3.

Chapter 1

INTRODUCTION

SCOPE

This report is based on an historic properties survey conducted in September 1983 of all Army-owned properties located within the official boundaries of the Cornhusker Army Ammunition Plant (Cornhusker AAP). The survey included the following tasks:

- Completion of documentary research on the history of the installation and its properties.

- Completion of a field inventory of all properties at the installation.

- Preparation of a combined architectural, historical, and technological overview for the installation.

- Evaluation of historic properties and development of recommendations for preservation of these properties.

Also completed as a part of the historic properties survey of the installation, but not included in this report, are HABS/HAER Inventory cards for 34 individual properties. These cards, which constitute HABS/HAER Documentation Level IV, will be provided to the Department of the Army. Archival copies of the cards, with their accompanying photographic

negatives, will be transmitted to the HABS/HAER collections at the Library of Congress.

The methodology used to complete these tasks is described in the following section of this report.

METHODOLOGY

1. Documentary Research

The Cornhusker AAP was one of several government-owned, contractor-operated facilities constructed during 1940-1942 for the manufacture and storage of conventional ammunition. Since the plant was part of a larger manufacturing network, an evaluation of its historical and technological significance requires a general understanding of the wartime munitions industry. To identify published documentary sources on American ammunition manufacturing during World War II, research was conducted in standard bibliographies of military history, engineering, and the applied sciences. Unpublished sources were identified by researching the historical and technical archives of the U.S. Army Armament, Munitions and Chemical Command (AMCCOM) at Rock Island Arsenal.[1] In addition to such industry-wide research, a concerted effort was made to locate published sources dealing specifically with the history and technology of the Cornhusker AAP. This site-specific research was conducted primarily at the AMCCOM Historical Office at Rock Island Arsenal, the Grand Island Public Library, and the Cornhusker AAP government and

contractor files. Jack Rodysill, Bill Hannan, and Joe Higgins provided research assistance at Cornhusker AAP.

On the basis of this literature search, a number of valuable sources were identified. These included a Completion Report and Facilities Inventory prepared by the Army Corps of Engineers during World War II; a detailed, continuous history of the plant from 1950 through the present, prepared by the current operating contractor; and a history of the contracting firm, Mason & Hanger-Silas Mason Co., Inc., containing much information relevant to Cornhusker AAP.

Army records used for the field inventory included current Real Property Inventory (RPI) printouts that listed all officially recorded buildings and structures by facility classification and date of construction; the installation's property record cards; base maps and photographs supplied by installation personnel; and installation master planning, archaeological, environmental assessment, and related reports and documents. A complete listing of this documentary material may be found in the bibliography.

2. Field Inventory

Architectural and technological field surveys were conducted in September 1983 by Robert Ferguson. Following a general discussion and tour of the facility with S. C. Fisher, Commander's Representative at the installation, the surveyor was permitted access to most exterior areas without escort. Exterior and interior surveys of the major

manufacturing buildings were conducted, with William T. Hannan serving as guide.

Field inventory procedures were based on the HABS/HAER Guidelines for Inventories of Historic Buildings and Engineering and Industrial Structures.[1] All areas and properties were visually surveyed. Building locations and approximate dates of construction were noted from the installation's property records and field-verified. Interior surveys were made of major facilities to permit adequate evaluation of architectural features, building technology, and production equipment.

Field inventory forms were prepared for, and black and white 35 mm photographs taken of all buildings and structures through 1945 except basic utilitarian structures of no architectural, historical, or technological interest. When groups of similar ("prototypical") buildings were found, one field form was normally prepared to represent all buildings of that type. Field inventory forms were also completed for representative post-1945 buildings and structures.[2] Information collected on the field forms was later evaluated, condensed, and transferred to HABS/HAER Inventory cards.

3. Historical Overview

A combined architectural, historical, and technological overview was prepared from information developed from the documentary research and the field inventory. It was written in two parts: 1) an introductory description of the installation, and 2) a history of the installation

by periods of development, beginning with pre-military land uses. Maps and photographs were selected to supplement the text as appropriate.

The objectives of the overview were to 1) establish the periods of major construction at the installation, 2) identify important events and individuals associated with specific historic properties, 3) describe patterns and locations of historic property types, and 4) analyze specific building and industrial technologies employed at the installation.

4. Property Evaluation and Preservation Measures

Based on information developed in the historical overviews, properties were first evaluated for historical significance in accordance with the eligibility criteria for nomination to the National Register of Historic Places. These criteria require that eligible properties possess integrity of location, design, setting, materials, workmanship, feeling, and association, and that they meet one or more of the following:[3]

A. Are associated with events that have made a significant contribution to the broad patterns of our history.

B. Are associated with the lives of persons significant in the nation's past.

C. Embody the distinctive characteristics of a type, period, or method of construction, represent the work of a master, possess high artistic values, or represent a significant and distinguishable entity whose components may lack individual distinction.

D. Have yielded, or may be likely to yield, information important in pre-history or history.

Properties thus evaluated were further assessed for placement in one of five Army historic property categories as described in Army Regulation 420-40:[4]

Category I	Properties of major importance
Category II	Properties of importance
Category III	Properties of minor importance
Category IV	Properties of little or no importance
Category V	Properties detrimental to the significance of adjacent historic properties

Based on an extensive review of the architectural, historical, and technological resources identified on DARCOM installations nationwide, four criteria were developed to help determine the appropriate categorization level for each Army property. These criteria were used to assess the importance not only of properties of traditional historical interest, but of the vast number of standardized or prototypical buildings, structures and production processes that were

built and put into service during World War II, as well as of properties associated with many post-war technological achievements. The five criteria were often used in combination and are as follows:

1) Degree of importance as a work of architectural, engineering, or industrial design. This criterion took into account the qualitative factors by which design is normally judged: artistic merit, workmanship, appropriate use of materials, and functionality.

2) Degree of rarity as a remaining example of a once widely used architectural, engineering, or industrial design or process. This criterion was applied primarily to the many standardized or prototypical DARCOM buildings, structures, or industrial processes. The more widespread or influential the design or process, the greater the importance of the remaining examples of the design or process was considered to be. This criterion was also used for non-military structures such as farmhouses and other once prevalent building types.

3) Degree of integrity or completeness. This criterion compared the current condition, appearance and function of a building, structure, architectural assemblage, or industrial process to its original or most historically important condition, appearance, and function. Those properties that were highly intact were generally considered of greater importance than those that were not.

4) Degree of association with an important person, program, or event. This criterion was used to examine the relationship of a property to a famous personage, wartime project, or similar factor that lent the property special importance.

The majority of DARCOM properties were built just prior to or during World War II, and special attention was given to their evaluation. Those that still remain do not often possess individual importance, but collectively they represent the remnants of a vast construction undertaking whose architectural, historical, and technological importance needed to be assessed before their numbers diminished further. This assessment centered on an extensive review of the military construction of the 1940-1945 period, and its contribution to the history of World War II and the post-war Army landscape.

Because technology has advanced so rapidly since the war, post-World War II properties were also given attention. These properties were evaluated in terms of the nation's more recent accomplishments in weaponry, rocketry, electronics, and related technological and scientific endeavors. Thus the traditional definition of "historic" as a property 50 or more years old was not germane in the assessment of either World War II or post-war DARCOM buildings and structures; rather, the historic importance of all properties was evaluated as completely as possible regardless of age.

Property designations by category are expected to be useful for approximately ten years, after which all categorizations should be reviewed and updated.

Following this categorization procedure, Category I, II, and III historic properties were analyzed in terms of:

- Current structural condition and state of repair. This information was taken from the field inventory forms and photographs, and was often supplemented by rechecking with facilities engineering personnel.

- The nature of possible future adverse impacts to the property. This information was gathered from the installation's master planning documents and rechecked with facilities engineering personnel.

Based on the above considerations, the general preservation recommendations presented in Chapter 3 for Category I, II, and III historic properties were developed. Special preservation recommendations were created for individual properties as circumstances required.

5. Report Review

Prior to being completed in final form, this report was subjected to an in-house review by Building Technology Incorporated. It was then sent in draft to the subject installation for comment and clearance and, with its associated historical materials, to HABS/HAER staff for technical review. When the installation cleared the report, additional draft copies were sent to DARCOM, the appropriate State

Historic Preservation Officer, and, when requested, to the archaeological contractor perfonming parallel work at the installation. The report was revised based on all comments collected, then published in final form.

NOTES

1. The following bibliographies of published sources were consulted: Industrial Arts Index, 1938-1957; Applied Science and Technology Index, 1958-1980; Engineering Index, 1938-1983; Robin Higham, ed., A Guide to the Sources of United States Military History (Hamden, Conn.: Archon Books, 1975); John E. Jessup and Robert W. Coakley, A Guide to the Study and Use of Military History (Washington, D.C.: U.S. Government Printing Office, 1979); "Military Installations," Public Works History in the United States, eds. Suellen M. Hoy and Michael C. Robinson (Nashville: American Association for State and Local History), pp. 380-400. AMCCOM (formerly ARRCOM, or U.S. Army Armament Materiel Readiness Command) is the military agency responsible for supervising the operation of government-owned, contractor-operated munitions plants; its headquarters are located at Rock Island Arsenal, Rock Island, Illinois. Although there is no comprehensive index to AMCCOM archival holdings, the agency's microfiche collection of unpublished reports is itemized in ARRCOM, Catalog of Common Sources, Fiscal Year 1983, 2 vols. (no pl.; Historical Office, AMCCOM, Rock Island Arsenal, n.d.).

2. Historic American Buildings Survey/Historic American Engineering Record, National Park Service, Guidelines for Inventories of Historic Buildings and Engineering and Industrial Structures (unpublished draft, 1982).

3. Representative post-World War II buildings and structures were defined as properties that were: (a) "representative" by virtue of construction type, architectural type, function, or a combination of these, (b) of obvious Category I, II, or III historic importance, or (c) prominent on the installation by virtue of size, location, or other distinctive feature.

4. National Park Service, How to Complete National Register Forms (Washington, D.C.: U.S. Government Printing Office, January 1977).

5. Army Regulation 420-40, Historic Preservation (Headquarters, U.S. Army: Washington D.C., 15 Apr. 1984).

Chapter 2

HISTORICAL OVERVIEW

BACKGROUND

The Cornhusker Army Ammunition Plant (Cornhusker AAP)* is a government-owned, contractor-operated installation situated on 11,936 acres in Hall County, Nebraska, about six miles west of Grand Island. The plant was constructed in 1942 to load, assemble, and pack bombs of various sizes (Figure 1); it also produced auxiliary boosters, as well as ammonium nitrate for the various admixtures of TNT loaded into bombs. One of the three load lines was subsequently converted for loading 105-mm shells, and a fourth line, larger than the original three, was added in 1945 (Figure 2). The original operating contractor was the Q. O. Ordnance Corporation, a subsidiary of the Quaker Oats Company.

Immediately following V-J Day, Q. O. Ordnance suspended all load, assemble, and pack activities and turned the plant over to the government, which declared it surplus. Non-explosive storage type buildings were stripped of equipment and leased out for grain storage and fertilizer production. In 1950, however, due to the Korean War, the government reactivated

---

* From the time of construction through the Korean War, the official name of the installation was Cornhusker Ordnance Plant. For the sake of clarity and simplicity, this report will conform to the current usage.

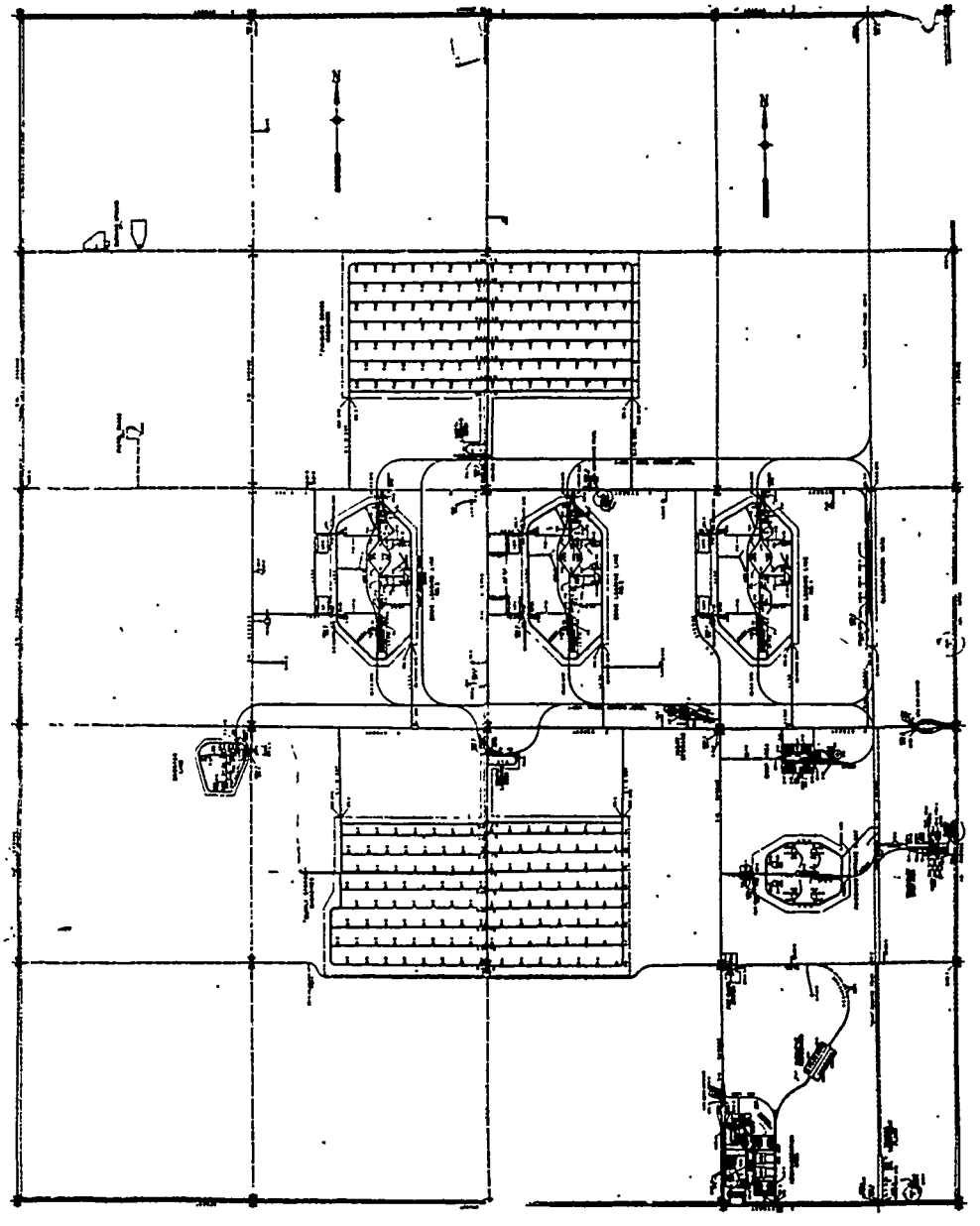

Figure 1: Cornhusker Ordnance Plant. Plot Plan, prepared by U.S. Engineer Office, Omaha, Nebraska, 1944. (Source: AMCCOM Historical Office, Rock Island Arsenal)

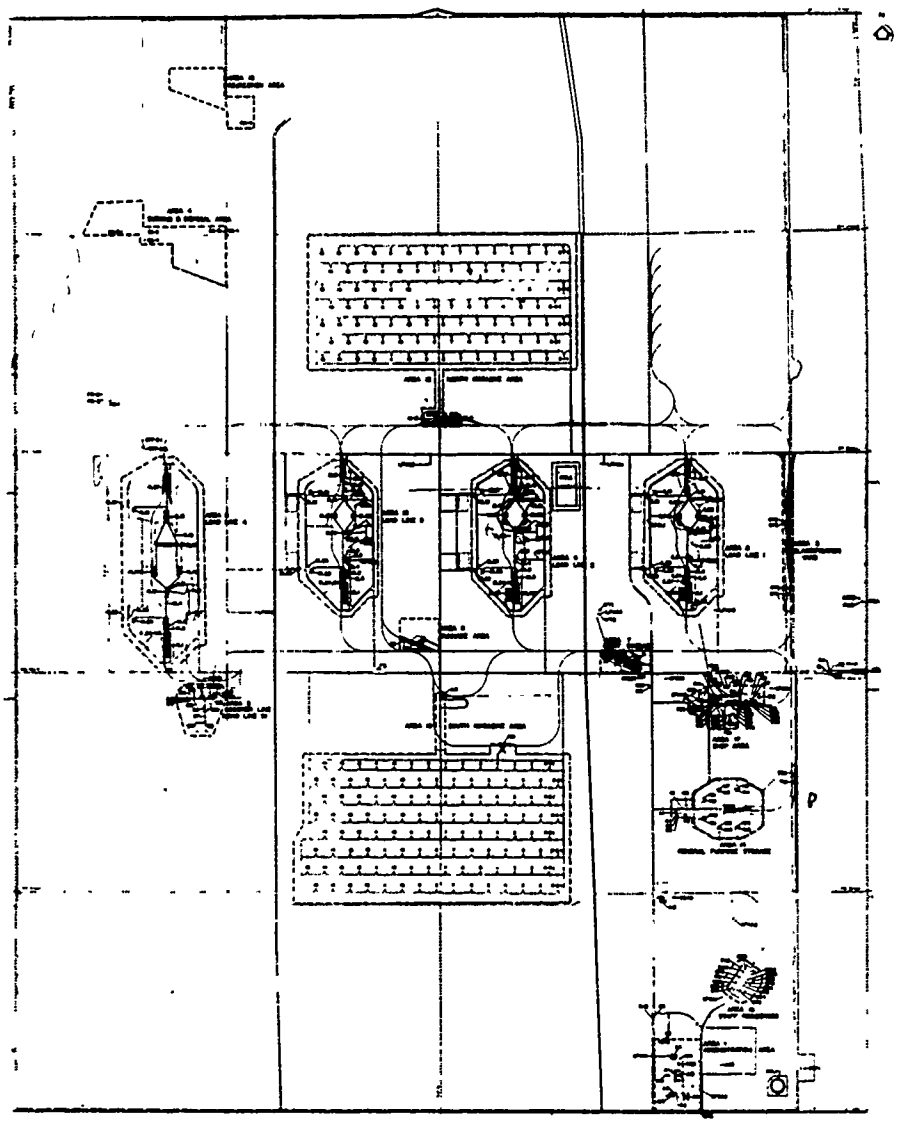

Figure 2: Cornhusker AAP. Current site plan, dated 4-17-78, prepared by Mason & Hanger-Silas Mason Co., Inc. (Source: Contractor files, Cornhusker AAP)

Cornhusker AAP and awarded a contract to the Silas Mason Company to rehabilitate and operate the plant for the production of 3.5" and 4.5" rockets and 155-mm shells. During the Vietnam War the contractor, then called Mason & Hanger-Silas Mason Co., produced bombs, micro-gravel mines, and 8" shells. They maintained the plant in layaway between wars, as they continue to do today. Currently, Cornhusker AAP comprises 643 buildings. All but about 100 of these date from the original construction period, but due to the plant's "surplus" status following World War II they contain little original equipment.

WORLD WAR II

When war broke out in Europe in the fall of 1939, the United States had almost no industrial capacity for manufacturing military ammunition. As historians Harry C. Thomson and Lida Mayo observe in their authoritative work on American munitions production:

> Only a handful of small plants were making propellant powder and high explosives, and there were virtually no facilities for the mass loading and assembling of heavy ammunition. American industry was just beginning, through educational orders, to learn techniques for forging and machining shells and producing intricate fuze mechanisms. The only sources for new artillery ammunition were Frankford and Picatinny Arsenals, while a few ordnance depots were equipped to renovate old ammunition. Private [military] ammunition plants did not exist, and, because of the specialized nature of the process, there were no commercial plants that could be converted to ammunition production.
>
> To meet this situation the Ordnance Department took steps in the summer of 1940 to create something new in American economic life — a vast interlocking network of ammunition plants owned by the government and operated by private industry. More than 60 of these GOCO

(government-owned, contractor-operated) plants were built between June 1940 and December 1942.[1]

Cornhusker AAP was one of the last of these plants to be built.[2]

Site Selection and Former Land Use

The site for the Cornhusker AAP was tentatively selected in 1940 by Brigadier General (then Colonel) Joel G. Holmes, who later wrote:

> . . . the Ordnance Corps was then engaged in expanding its system of loading plants. There had been already located several plants in the East and we were now moving westward. One site west of the Mississippi had already been selected at Burlington, Iowa, for the Iowa Ordnance Plant. Now, for strategic reasons, it became necessary to move even farther to the west. . . .
>
> Several railroad representatives contacted me in Washington and told of . . . a site in the Platte River Valley of Nebraska near a city named Grand Island. I immediately investigated and found their reports to be true. Here was a perfect site. It was on level ground. There was more than ample water. It was necessary to drill only 100 feet for water. In some plants the deep wells went to nearly 2,000 feet before an adequate supply of water could be obtained. Transportation facilities were ideal. The proposed site was located on not one but two main line railroads, the Burlington and the Union Pacific, and good access highways ran right past the site. It was also found that the cities of Grand Island and Hastings and other neighboring communities could supply us with the labor potential that was needed. All in all, it was one of the best sites for an Army Ordnance loading plant ever located in this country. Its ample water and good transportation facilities more than met the specifications.[3]

Among the "strategic reasons" alluded to by General Holmes were requirements for:

(a) a non-coastal location as a defense against attack;

(b) remoteness from large centers of population;

(c) remoteness from other ammunition plants for reasons of security;

(d) availability of large tracts of land to allow required safe distances between structures in production areas and storage areas.

These criteria had been outlined in July of 1940 by a committee chaired by Col. Harry K. Rutherford,[4] and were formally issued by the Office of the Quartermaster General in May 1941.[5] At that same time, the Corps of Engineers prepared a detailed report on the Grand Island site. On 26 February 1942, Congressman Harry B. Coffee of Nebraska announced the pending construction on the site of a bomb loading plant to be operated by the Q. O. Ordnance Corporation, a wholly-owned subsidiary of the Quaker Oats Company of Chicago.[6] To the seeming incongruity of a food producer operating a munitions plant, Thomson and Mayo state that such arrangements were common, and go on to explain:

> In selecting such contractors the Ordnance Department did not attach any great importance to the nature of their peacetime functions, but gave first consideration to their managerial ability, reputation for efficient operation, integrity, and financial stability. The idea was that such firms knew the fundamentals of mass production and good business management, had competent plant managers on their staff, and could soon learn all they needed to know about the special problems of loading shells and bombs. "One of the lessons Ordnance learned in the Second World War," wrote General Campbell, "was that any up-to-date, alert manufacturing company with a strong executive, engineering, and operating staff could take an ammunition plant and operate it effectively, even though the plant was of a character entirely foreign to the previous activity of the company."[7]

The government originally purchased a 4- by 5-mile tract of farm land -- about 12,800 acres -- at a cost of $912,233.[8] Of the various farmhouses, barns, and outbuildings that had formerly occupied the land, only one barn (Building 204B, used for storage) and one farmhouse (Building 172A, residence for the Commander's Representative) still remain.[9] Both are

undistinguished wood frame structures, typical of local farm buildings, and are in good physical condition. The house has recently been covered with vinyl siding.

Construction

On 4 March 1942, the Corps of Engineers issued a contract to A. Guthrie and Co., Inc., of St. Paul, Minnesota, and R. J. Tipton Co., of Denver, Colorado, for architecture-engineering and construction management services at Cornhusker AAP.[10] The Nebraska Ordnance Plant, already under construction at Wahoo, furnished plans for buildings and equipment, which Guthrie and Tipton, in consultation with Q. O. Ordnance and the Army Ordnance Department, adapted to the new site. Where the Wahoo plans had called for four bomb loading lines, only three were originally built at Cornhusker (Figure 1). The ammonium nitrate plant was similarly reduced from eight production units to six (Figure 9). Additionally, Guthrie and Tipton obtained plans for the four dormitories in the Administration Area (of the four, only Building A-6 remains in 1983) from the Lone Star Ordnance Plant in Texarkana, Texas; and they designed a few buildings, including boiler houses and ramps between production buildings, especially for Cornhusker.[11]

A federal court gave the government possession of the land effective 27 March 1942, and construction, starting with railroad spurs from the Burlington and Union Pacific main lines, officially began on that date.[12] Guthrie and Tipton let subcontracts for the construction of the three bomb loading lines to the Winn-Senter Construction Company and the Hettelsater Construction Company, both of Kansas City.[13]

The buildings of the Cornhusker AAP were grouped by function into separate "Load Lines" and storage and support "Areas" laid out to facilitate transportation of raw materials and finished ammunition. The Load Lines, the actual ammunition production areas, were separated from one another by distances sufficient to preclude the possibility of a catastrophic incident at one line causing sympathetic explosions and/or structural damage at adjacent lines.[14] Such required distances were calculated using standard spacing formulae, developed by the Ordnance Department, relating distances in feet to quantities of explosives in pounds. The semi-underground "Richmond"-type magazines (Figure 3) in the storage areas were similarly spaced according to standard formulae and oriented so that the force of a possible explosion would travel out into unoccupied space[15] (see Figure 2).

Individual Load Line layout reflected industrial production and concerns for safety. The typical configuration was an extended, linear arrangement of widely spaced buildings interconnected by enclosed "ramps" that housed conveying systems. For example, Load Line II, one of the three original bomb loading lines, had a cumulative length of about five-eighths of a mile (Figure 4). Its major buildings included Receiving and Inert Storage Warehouses (Buildings L-1, L-1W), a Bomb Preparation Building (Building L-2), a Nose Pour Building (Building L-6), Explosive Screening (Building L-9) and Melt/Pour Buildings (Building L-10 -- in 1983, both screening and melt/pour facilities were considered as one building, numbered L-10) (Figure 5), Cooling Bays (Buildings L-11E, L-11W), a second set of Screening and Melt/Pour facilities (Buildings L-13, L-14),[16] and Packing and Shipping Buildings (Building L-18) with various appurtenant wings (e.g., L-18E, and, on Line IV, L-27). Service or support facilities

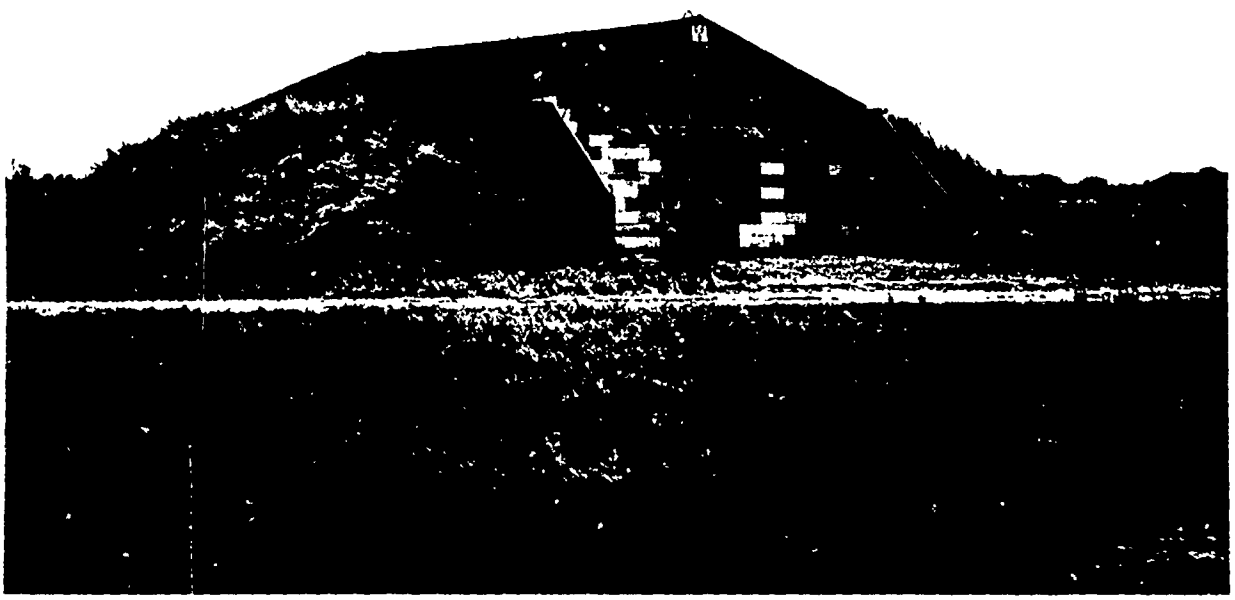

Figure 3: View looking southwest of typical "Richmond" Magazine (Building C-4-8), North Magazine Area. (Source: Field inventory photograph, Robert Ferguson, MacDonald and Mack Partnership, 1983)

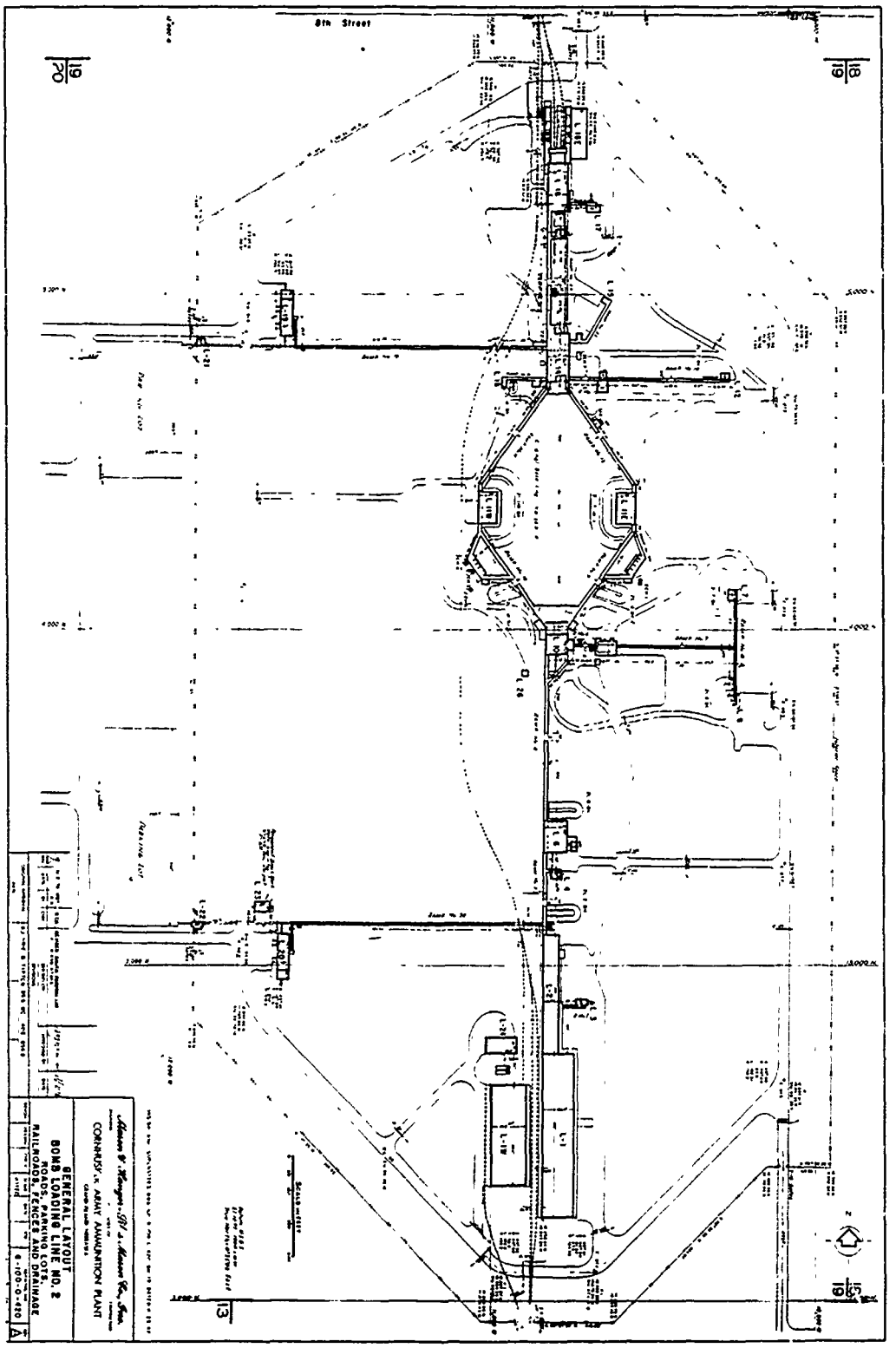

Figure 4: Cornhusker AAP, Load Line II. Current plan, prepared by Mason & Hanger-Silas Mason Co., Inc., most recent revision dated 11/2/76. (Source: Contractor files, Cornhusker AAP)

Figure 5: View looking north of the Screening and Melt/Pour facilities (Building 2L-10) on Load Line II, Cornhusker AAP. The Screen House (formerly 2L-9) is on the right and the Melt/Pour Tower (2L-10) on the left. (Source: Field inventory photograph, Robert Ferguson, MacDonald and Mack Partnership, 1983)

included explosive receiving, handling, and temporary storage buildings (Buildings L-7, L-8, L-12, L-15), and Change Houses (Buildings L-19, L-20) for the employees. All the buildings of a given Load Line were connected by enclosed ramps up to 800 feet long.

Booster production required a less extensive industrial plant (melt/pour facilities were not necessary) and involved far smaller quantities of explosives. The Booster Line (now called Load Line V) was therefore smaller in scale, and its buildings more closely spaced (Figure 6).

Most of the production buildings at Cornhusker AAP were originally designed in acordance with "permanent, fireproof" construction: concrete foundations and floors, internal concrete explosion walls, concrete or steel structural framing, and infill walls of structural clay tile (Figure 7). The finished structures, however, were often very different from the designs. Army historians Lenore Fine and Jesse A. Remington explain why:

> To those responsible for construction, materials presented the greatest single challenge of the war. Throughout 1941 markets had grown progressively tighter. After the outbreak of hostilities, the demand for steel, copper, rubber, and other construction staples far outstripped supply. . . . The situation worsened steadily, as scarcities developed in materials used as substitutes and in substitutes for substitutes. . . .
>
> Reduce to bare essentials. Substitute. Improvise. Comb the country for materials. Get the job done with the means at hand. These were the orders of the wartime day.[17]

The building contractors at Cornhusker, beset with "delays in construction . . . caused by difficulties in procurement" and orders "to economize on certain critical materials,"[18] used whatever they could get in a supply situation that could change daily. Thus the load lines, in particular, even though built to the same plans, varied from one another in materials

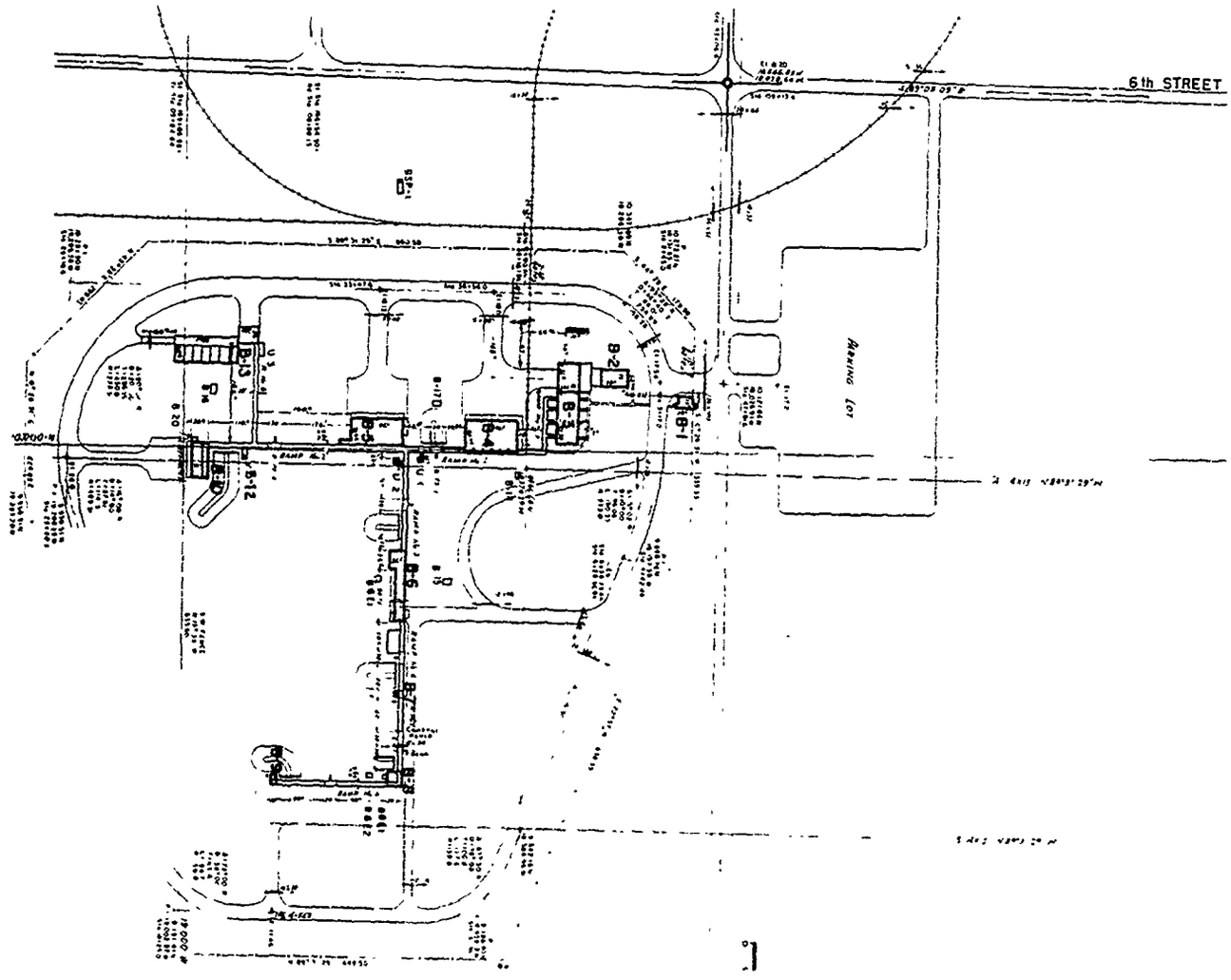

Figure 6: Cornhusker AAP, Booster Line (Load Line V). Current plan, prepared by Mason & Hanger-Silas Mason Co., Inc., most recent revision dated 10-24-73. (Source: Contractor files, Cornhusker AAP)

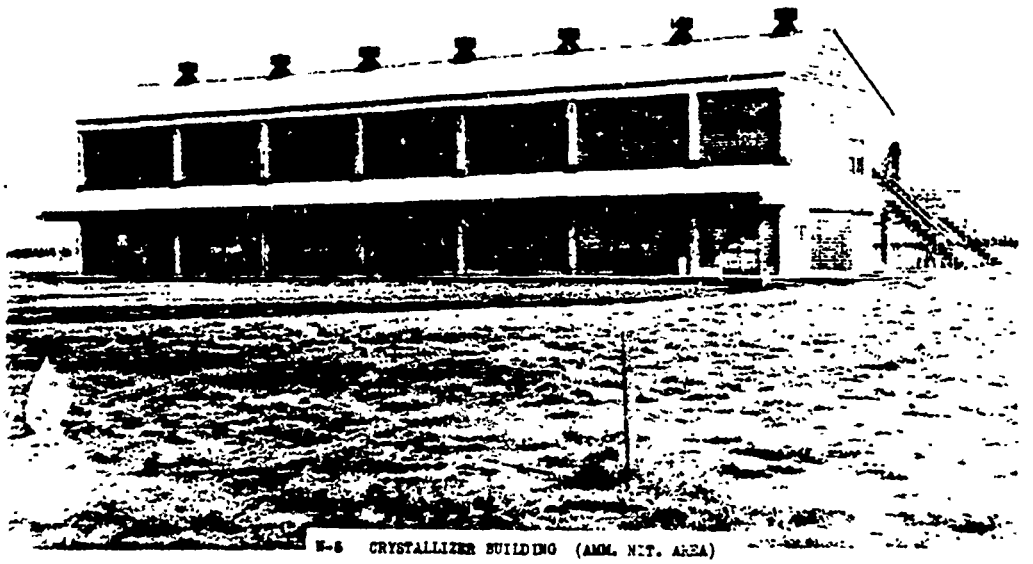

Figure 7: Exterior and interior views of Ammonium Nitrate Crystallizer Building (Building N-5), showing concrete frame, steel roof framing, and structural clay tile infill. Cornhusker Ordnance Plant Official Photos, U.S. Army Corps of Engineers, February, 1944. (Source: AMCCOM Historical Office, Rock Island Arsenal)

(Figure 8). Walls in Load Lines II and V were primarily of tile; in Lines I, III and IV, concrete block was used. Indeed, many instances could be found of the use of concrete, steel, and wood for framing, and tile, concrete block, brick, and asbestos panels for infill, in the same building.[19] The temporary shops and the buildings in the Administration Area were framed and clad in wood; staff residences were prefabricated units supplied by the National Homes Corporation of Lafayette, Indiana.[20]

Building construction was substantially complete by October 1942, and Load Line III produced the plant's first 1000-lb. bomb on 11 November. By December, the other two load lines and the Booster Line were in full production.[21] In August 1944, increased ammunition demands necessitated the construction of a fourth bomb loading line at Cornhusker AAP. Load Line IV, larger than the original lines, was designed by John Latenser & Sons of Omaha, and constructed by the Rentler Co., Inc. of Grand Island, under the supervision of the Corps of Engineers. Production began in March 1945, but at 1:30 PM on Saturday, 26 May, just after a heavy electrical storm, an explosion destroyed the Melt/Pour Building (Building 4L-10), killing nine employees. The cause of the explosion was never determined.[22]

Technology

In planning the national munitions network, engineers at Picatinny Arsenal and the Ogden Ordnance Depot had prepared typical production line layouts and equipment lists, along with manuals on shell and bomb loading procedures. These documents were made available through the Office of the

Figure 8: Interior view of Booster Assembly Building (Building B-5), showing wood framing substituted for steel. Cornhusker Ordnance Plant Official Photo, U.S. Army Corps of Engineers, February, 1944. (Source: AMCCOM Historical Office, Rock Island Arsenal)

Chief of Ordnance, which had the responsibility of coordinating production among the various plants then in the planning stages. The operating contractor's history of one of the early plants (Ravenna AAP, 1940) goes on to explain:

> As the work of designing these loading plants progressed, the Ordnance Department adopted a policy of specializing on certain given items of ammunition at certain given plants or . . . of distributing the loading program among the various loading plants in such manner as to require only two, three, or four of the indicated items to be loaded in any individual loading line.[23]

As one of the last loading plants to be built, Cornhusker AAP was thus both standardized in construction and specialized in capability. The plant was intended only for loading bombs, with the ancillary production of boosters -- which help to ensure a high-order detonation of the "bursting" explosive charge -- and ammonium nitrate, used in various mixtures with TNT, to conserve TNT and vary the explosive characteristics. During World War II Cornhusker produced 90-, 220-, and 260-lb. fragmentation bombs, and 1000- and 2000-lb. demolition bombs. Later in the war, one line was converted to add 105-mm shells to the plant's loading capabilities.

The load-assemble-and-pack process at Cornhusker AAP consisted primarily of the final assembly of component parts and materials into complete ammunition. This process, common to all load-assemble-and-pack facilities, has been described in the following way:

> The explosives, shell or bomb casings, cartridge cases, fuzes, primers, boosters, and detonators are received from outside manufacturers. They are then inspected and stored, until required, in the loading departments. The loading and assembling of these materials is carried on

as an assembly-line process. Various departments or so-called "load lines" are maintained for the processing of each particular type of ammunition. Thus, a plant may have, in addition to one or more shell- or bomb-load lines, separate lines for loading such component parts as detonators, fuzes, primers, and boosters. In some cases, however, these smaller components are received from other plants, already loaded with the explosive charge and ready for final assembly into the completed projectile.

The main loading operation for shells and bombs is generally performed by either the melt-load or the press-load process. On the load line, the shell or bomb casings are cleaned, inspected and painted. Large-caliber shells and bombs are usually filled by the melt-load process, the major operation of which consists in screening, melting, and pouring the main explosive or bursting charge into the shell or bomb cavity. The most commonly used bursting charge is TNT, which is readily melted either alone or with ammonium nitrate. After the TNT has hardened, the booster and fuze are inserted. Some large-caliber shells are shipped to combat zones unfuzed, and the fuze is assembled in the field prior to firing the shell. In the case of fixed and semifixed rounds of ammunition, the projectile is assembled to the cartridge case, which contains the propellant charge and artillery primer. The final operations involve labeling and packing or crating for storage or shipment. Inspection is carried on continuously at each stage of the operation.

The operations performed on the lines loading shells by the press-load process differ somewhat from those where the melt-loading process is used. The main explosive charge is loaded into the projectile in a dry, rather than molten state, and consolidated into the shell by means of a hydraulic press. Press loading is most generally applied to smaller-caliber shells, such as those used in 20-mm and 40-mm cannon.

The process of loading such component parts as fuzes, boosters, detonators, and primers is largely confined to very simple assembly work. Artillery primers, the bodies of which are metal tubes filled with a specified amount of black powder, are generally loaded on a volumetric loading machine. The heads, containing a small percussion element which ignites upon friction from the firing pin, are staked to the loaded bodies. Most of the operations on the primer-load lines are mechanized.

The method of loading detonators, fuzes, and boosters varies somewhat from plant to plant, but in general the

> operations involve a large amount of bench assembly work. On the booster-loading line, for instance, each minute task is performed at long tables having numerous stations. Although most of the operations are performed by hand, small crimping and staking machines are used at the tables to assemble the various parts.[24]

The Booster Line at Cornhusker AAP loaded tetryl, pelletized in presses to reduce sensitivity, but the bomb-loading lines used the melt-load process exclusively. The empty bomb casing, cleaned and fitted with the "plumbing" -- copper tubing at nose, side, and tail locations to accept the various fuzes and boosters required -- was filled with molten explosive and allowed to cool. A second pour filled any cavities developed during the cooling. Finally, the bombs were sealed with wax, closed, and painted with a yellow ring on the nose to mark completion, before shipping.[25]

Cornhusker responded to technological innovation by adopting the volumetric-multiple-pour machine procedure for loading shells and fragmentation bombs. In the three-story Melt/Pour Building (Building L-10), explosive flows "by gravity from the transporters to melter, to the Dopp kettle [a hot-waterjacketed kettle at the second-floor level that maintains the molten explosive at a constant temperature], to the tempering tanks, to the pouring machine and into the [bombs]."[26] The "mechanical cow," as the volumetric-multiple-pour machine was called, was installed at Cornhusker AAP during the second quarter of 1944.[27] Previously, the molten explosive was drawn from the Dopp kettles directly into the bomb casings on the first floor, an inefficient, labor-intensive endeavor prone to error.

Other changes made during World War II involved the type of explosive used, and the production and use of ammonium nitrate. Throughout the first years of the war, due to a shortage of TNT, most shells and bombs were loaded with amatol, a mixture (usually 50/50) of TNT and ammonium nitrate, as a bursting charge. Facilities for producing crystalline ammonium nitrate from ammonia and nitric acid were built at most loading plants, including Cornhusker (Figures 7, 9, and 10). However, these facilities proved capable of higher production than had been projected, and a nationwide surplus of ammonium nitrate developed. By early 1943, increased TNT production permitted a changeover to straight TNT loading, and the ammonium nitrate plant at Cornhusker closed on 5 May, less than two months after it had opened.[28]

Fragmentation bombs in particular were usually loaded with Composition B, a compound of TNT and the more powerful but very sensitive RDX, or cyclonite. Other fillings, used for demolition and general-purpose bombs, included minol and tritonal, both of which contained TNT and aluminum powder.[29] The Nebraska Ordnance Works at Wahoo did the pioneer work in loading both Composition B and tritonal, and trained personnel from Cornhusker AAP and other plants in these techniques.[30]

All loading operations stopped at Cornhusker AAP on 15 August 1945, the day after the Japanese surrender. Following a hasty decontamination and cleanup of the plant, the government terminated the Q. O. Ordnance Corporation's contract on 1 September 1945.[31] The government declared the plant "surplus," and crews from other ordnance plants cannibalized it, removing all equipment from the load lines. A later plant historian writes:

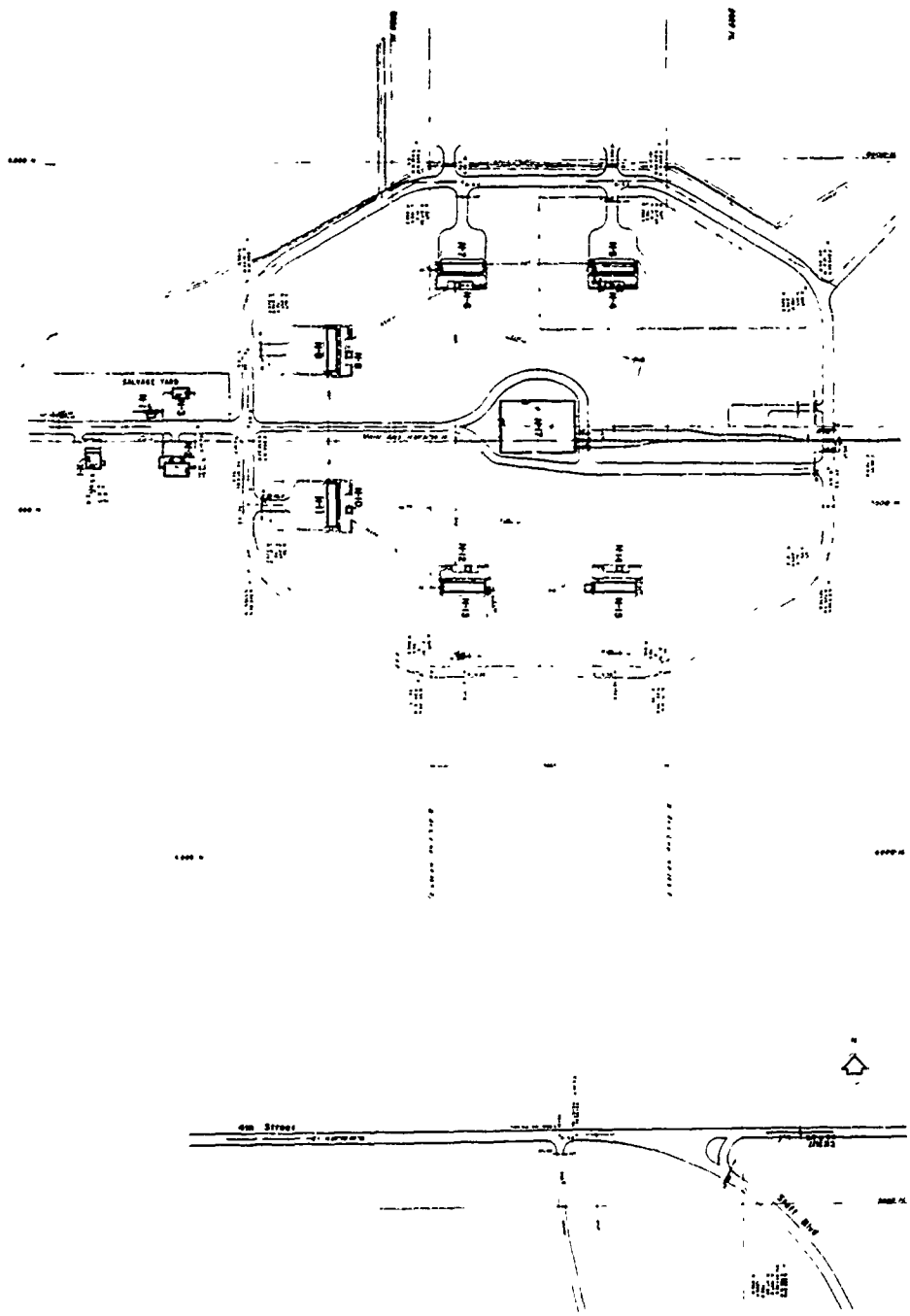

Figure 9: Cornhusker AAP. Ammonium Nitrate Plant, now called General Purpose Storage Area. Current Plan, prepared by Mason & Hanger-Silas Mason Co., Inc., most recent revision dated 8-17-73. (Source: Contractor files, Cornhusker AAP)

N-4 EVAPORATOR BUILDING AND N-5 CRYSTALLIZER BUILDING WITH EXPLOSION BARRICADE BETWEEN

Figure 10: Exterior view of Evaporator Building (Building N-4) and Crystallizer Building (Building N-5), Ammonium Nitrate Plant. Cornhusker Ordnance Plant Official Photo, U.S. Army Corps of Engineers, February, 1944. (Source: AMCCOM Historical Office, Rock Island Arsenal) The last remaining evaporator buildings were demolished in 1983.

> Cannibalization was so complete that electrical wiring, drinking fountains, light fixtures, even doors and windows were removed from the Line Buildings. Only the shells of the buildings were left in place, and no program of maintenance was designed to keep them in usable condition.[32]

The government first put the plant up for sale, but in 1946 changed its status from "surplus" to "standby," and leased out the line buildings for grain storage, beginning in 1947. This arrangement of leasing in exchange for maintenance was the first of its kind for a government plant, and was used as a model for others. The ammonium nitrate plant was leased to the Military Chemical Company, later the Emergency Export Corporation, which produced ammonium nitrate fertilizer for distribution through the government's foreign aid program until April 1948.[33]

KOREAN WAR

Near the end of World War II, ordnance engineers began experiments with a heavier version of the 2.36" bazooka-launched rocket that had proven effective against tanks in both theatres of the war. The new 3.5" rocket was ready for testing and acceptance by 1950; faced with heavy tank combat in Korea, the Army ordered the new weapon into immediate production.[34] The stripped condition and disrepair of the load lines at Cornhusker AAP made that plant an ideal site for a pilot reactivation program.[35] Therefore, in February and March 1950, the government cancelled the grain-storage leases at Cornhusker and invited bids for the rehabilitation and renovation of Load Line I to produce the 3.5" rocket.[36]

The proposal selected from among 19 competing firms was that of the Silas Mason Company of New York, a firm with long experience in constructing and operating military plants and bases. The Mason & Hanger Company, Silas Mason Co.'s parent firm, had entered the war effort in World War I, building training camps, storage and distribution depots, and, as primary subcontractor, one powder plant -- the Old Hickory Plant near Nashville, Tennessee.[37] In World War II, Mason & Hanger and Silas Mason had built four ordnance plants, one of which -- the Louisiana Ordnance Plant at Shreveport -- they also operated.[38] Silas Mason Co. operated several Army ammonium nitrate plants in the years after World War II, and by 1950 had just completed construction and begun operations at the Burlington (Iowa) Atomic Energy Commission (AEC) Plant, producing nuclear weapons.[39]

Silas Mason's proposal for Cornhusker AAP involved complete renovation of the buildings of Load Line I and installation of a highly automated production line. The contract was awarded on 6 April 1950, and rocket production on the finished line began in January 1951. By this time, Silas Mason had also received contracts for rehabilitating the other three Load Lines, the Booster Line, and all the plant's support facilities. The largest of these projects was construction of a new Melt/Pour Building (Building 4L-10) (Figure 11) on Load Line IV (to replace the one that had exploded in 1945), and installation there of a mechanized line for loading 155-mm shells.[40] Further contracts, awarded in 1953, called for conversion of Load Line II for loading still heavier 4.5" rockets. Production of these rockets began in May 1953.[41]

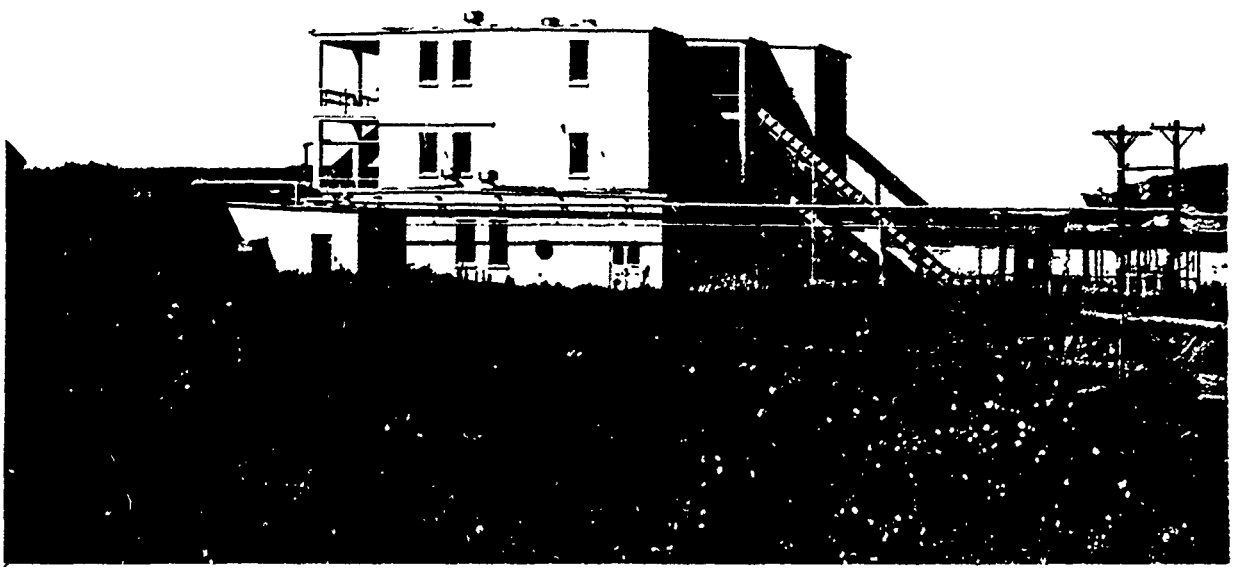

Figure 11: View looking northwest of new Melt/Pour Building (Building 4L-10) on Load Line IV, Cornhusker AAP. (Source: Field inventory photograph, Robert Ferguson, MacDonald and Mack Partnership, 1983)

The two kinds of rockets produced at Cornhusker AAP were similar except for size. The rounded ogive, or head, containing a cone-shaped metal liner to direct the force of the explosion, was loaded with Composition B by the melt-load process, through a volumetric-multiple-pour machine. Because RDX had a higher melting point and was more sensitive than TNT, the steam probe and second pour method could not be used to correct cavities formed by shrinkage of the explosive during cooling. The rocket lines at Cornhusker, therefore, used the "single pour controlled cooling" process which Silas Mason had developed at the Burlington AEC Plant. In this process, the filled rocket heads or shells were conveyed slowly through linear cooling ovens in a tempered water bath, allowing the explosive to cool gradually.[42]

Like the empty head, the "motor" end of the rocket, with fins to provide stability in flight, was received from other plants and loaded at Cornhusker. The propellant charge, received complete and properly sized, required no melting. The loaded motor and head were then assembled with the inertia-type fuze and the booster, and the finished rocket was painted and packed for shipping.[43] The assembly process was further automated by the introduction of complete-round-assembly machines in 1953.[44]

When Load Line IV stopped production in May 1954, it became the first Army ordnance plant line to be thoroughly reconditioned and "laid away" in chemical preservatives. This procedure later became standard, and was used to lay away the other lines when Cornhusker AAP was placed in "standby" status on 17 April 1956.[45]

VIETNAM WAR

With increased U.S. involvement in Vietnam, the Army reactivated Cornhusker AAP in September 1965. The consolidated Mason & Hanger-Silas Mason Co. performed the engineering and contracting work themselves, as they had during the Korean War, and began loading 500-, 750-, and 1000-lb. bombs in February 1966. Cornhusker remained the only Army plant to load bombs throughout the Vietnam War.[46]

The primary explosive used during this period was tritonal, for which Mason & Hanger-Silas Mason installed new melting equipment. They also adopted the explosive rod scrap method, developed at Louisiana AAP during World War II, whereby triangular-section rods cast from scrap tritonal were inserted into the core of the bomb after the first pour. During the cooling, these rods partially melted and filled any cavities as they developed, making the second pour unnecessary.[47] In 1968, in an effort to conserve TNT, the lines were modified to load with minol, a mixture of aluminum powder with amatol instead of straight TNT.[48] Also beginning in 1968, the interiors of 750-lb. bombs were coated before loading with a hot-melt asphaltic compound to prevent accidental low-order detonations. The Navy had developed and used this technique following a disastrous explosion at Port Chicago, California on 17 July 1944.[49]

The other major change at Cornhusker AAP during the Vietnam War was the 1967 conversion of Load Line V, the former Booster Line, to produce micro-gravel mines. Called "wafer mines" because of their size and appearance, these were small flat fabric bags containing a mixture of the highly

sensitive explosives lead azide and RDX, with ground glass to increase the friction that would detonate the explosive when the mine was stepped on or otherwise disturbed. Intended to disable rather than kill, the mines could be deployed over a large area by air drops; Defense Secretary Robert McNamara called for their production and use to prevent Viet Cong guerillas from crossing the Demilitarized Zone separating North and South Vietnam.

Mason & Hanger-Silas Mason produced the micro-gravel mines at Iowa and Cornhusker AAPs. The mines, however, proved nearly as dangerous to their producers as to their intended victims. Accidental explosions plagued the production lines, despite the precaution of keeping the explosive, at all stages of production and packaging, submerged in a shock-reducing liquid (at Cornhusker, freon) which would evaporate when the mines were deployed. Fortunately, no lives were lost on the mine production line at Cornhusker. This production stopped on 23 September 1968, just over a year after it had begun.[50]

Loading of bombs continued until 1973. Load Line IV, modified to load 8" shells in 1967-68, returned to bomb production in 1972. The Vietnam Peace Agreement was signed on 27 January 1973; by 12 October all production lines at Cornhusker AAP were closed. The Mason & Hanger-Silas Mason Co. completed the "layaway in a high-state-of-readiness" in September 1974, and continues to maintain the plant today.[51]

NOTES

1. Harry C. Thomson and Lida Mayo, The Ordnance Department: Procurement and Supply (Washington, D.C.: Office of the Chief of Military History, Department of the Army, 1960), pp. 104-105.

2. William Voight, Jr., "The Ordnance Organization in World War II" (unpublished report prepared for the Ordnance Department, 1945), p. 84.

3. "Brochure: Cornhusker Ordnance Plant, Grand Island, Nebraska, 1941-1957" (unpublished brochure prepared by Mason & Hanger-Silas Mason Co., Inc., 1957, unpaginated).

4. Lenore Fine and Jesse A. Remington, The Corps of Engineers: Construction on the United States, Washington, D.C.: Office of the Chief of Military History, U.S. Army, 1972, pp. 134-137.

5. St. George Cooke, "History of the Rehabilitation and Reactivation of the Cornhusker Ordnance Plant, Grand Island, Nebraska, by the Silas Mason Company," Vol. I: "The First Year: Background to Production," April 9, 1950 - April 9, 1951, p. 32.

6. Cooke, p. 34.

7. Thomson and Mayo, p. 113.

8. "Brochure."

9. According to S. C. Fisher, Commanding Officer's Representative, 20 September, 1983, and verified by field observation.

10. Cooke, p. 34.

11. Major James C. Stewart, "Completion Report on the Cornhusker Ordnance Plant," U.S. Army Corps of Engineers, November 25, 1942, pp. 3, 7, 10, 14, 27, 36. See also Voight, p. 83.

12. Cooke, p. 35.

13. Cooke, p. 36. Curiously, Stewart (Subcontractors List, no page no.) does not mention these, or any, construction subcontractors. Fine and Remington (p. 565) attribute construction management at Cornhusker to "the Gordon Hamilton Construction Company of Kansas City, Missouri." None of the other sources mention this company.

14. According to the Ordnance Department's Safety Officer, "the guiding principles which were followed in laying out [a] plant are: 1. Hazardous operations have been separated from each other by barricades or by placing them in separate buildings. 2. Operating buildings have been separated from each other by safe distances to prevent the spread of fires or explosions. 3. Operating buildings have been grouped into separate production

lines whose sizes and capacities are based on efficient and economical operation. Examples are fuze-loading manufacturing lines, complete rounds loading lines, and anhydrous ammonia manufacturing lines. The lines are separated from each other by distances which not only will give protection against the spread of fires and explosions, but also will prevent exlosions in one line from structurally damaging buildings in other lines. 4. Equipment layouts in operating buildings have been made with a view toward eliminating hazards from electrical installations, mechanical or static sparks, and fires from lightning or other causes. 5. Change houses and bomb proof shelters have been provided where necessary for the comfort and safety of operating personnel." (Major George D. Rogers, "Military Explosives," National Safety News, 44 (July, 1941), p. 22.

15. A discussion of the design and spacing of magazines is presented in LTC. C. H. Cotter, "Naval Ammunition Depot Near Hawthorne, Nev., Built to Serve the Pacific Coast," Engineering News-Record, 105 (November 20, 1930), pp. 803-805. Information regarding the orientation of the Richmond Magazines at Cornhusker AAP was obtained from S. C. Fisher during a tour of the facility on 20 September 1983.

16. Both of these buildings are subsumed under Number L-14 on Mason & Hanger-Silas Mason Co. maps in 1983, but the original numbering is retained on the buildings themselves. The numbering of the first Screen/Melt/Pour set is similarly inconsistent: No. L-9 is retained on Load Line III, but not on I and II. The change in numbering presumably reflects the changing mission of these lines. Load Line IV, built later, is slightly different in layout; the numbering continues to reflect the clear separation of L-9 and L-10 on this line.

17. Fine and Remington, p. 522.

18. Voight, pp. 84-85.

19. These variations were noted during the field survey in September 1983, and the explanation was offered by Charlie Fisher and Bill Hannan at that time. Although no contractor records from the original construction period are available, the sources cited seem to support the explanation.

20. Stewart, Subcontractors list (no page no.).

21. Cooke, p. 37; "Brochure."

22. Cooke, pp. 37-38; "Brochure."

23. "History of the Operating Contractor's Organization and Operation of the Ravenna Ordnance Plant, Apco, Ohio" (unpublished report, prepared by the Atlas Powder Co., Wilmington, Delaware), Vol. I (August 28, 1940 - June 30, 1943), p. 50. This discussion of the planning process is based on pp. 45-50.

24. "Hourly Earnings in the Ammunition-Loading Industry, 1944," Monthly Labor Review, 60 (April, 1945), pp. 840-841.

25. This discussion of bomb loading is based on information obtained from W. T. Hannan, Departmental Engineer, during a tour of the facility on 21 September 1983; and on Mike Lowry, "Safety No. 1 at CAAP," Grand Island Independent, Saturday, Nov. 1, 1969.

26. L. A. Quayle, "Volumetric Pouring Machine," Mechanical Engineering, 67 (September, 1945), p. 605.

27. The "mechanical cow" was used primarily for shell-loading. Voight (p. 83) mentions its use on fragmentation bombs at Cornhusker AAP.

28. Voight, pp. 83-84, 230.

29. Constance McLaughlin Green, Harry C. Thomson, and Peter C. Roots, The Ordnance Department: Planning Munitions for War, Washington, D.C.: Office of the Chief of Military History, Department of the Army, 1955, pp. 462-464.

30. Voight, pp. 230-231. See also Green, Thomson, and Roots, p. 464.

31. "Brochure."

32. "Brochure."

33. "Brochure." See also Cooke, pp. 39-40.

34. Cooke, pp. 77-78.

35. Ann Arnold Lemert, First You Take A Pick & Shovel: The Story of the Mason Companies, Lexington, Kentucky: The John Bradford Press, 1979, p. 196.

36. "Brochure."

37. Lemert, pp. 35-43.

38. Lemert, pp. 113-129.

39. Lemert, pp. 130, 160-170.

40. "Brochure;" Cooke, pp. 82-86; Lemert, pp. 196-197.

41. "Brochure."

42. Lemert, pp. 195-196.

43. Cooke, p. 79. Further information was obtained from production photographs in the Mason & Hanger-Silas Mason Co. files at Cornhusker AAP, and from W. T. Hannan, Departmental Engineer.

44. "Historical Report, 1 January 1953 to 30 June 1953," prepared by the Silas Mason Company, Cornhusker Ordnance Plant, Grand Island, Nebraska (unpaginated); "Production Department" section.

45. Lemert, p. 197; "Brochure."

46. R. J. Hammond, Profile on Munitions, 1950-1977 (unpublished report, on microfiche, AMCCOM Historical Office, Rock Island Arsenal), pp. 47-48. See also Lemert, pp. 206-207.

47. According to W. T. Hannan, 21 September, 1983; and Lemert, p. 207.

48. Lemert (p. 207) places the conversion to minol loading in 1967, but the operating contractor's history ("Annual Historical Supplement, Cornhusker Army ammunition Plant, 1 January 1968 - 31 December 1968, pp. 12-15) clearly shows 1968, as does Hammond (p. 48).

49. Hammond, p. 49. See also "Annual Historical Supplement," p. 12.

50. This discussion of micro-gravel mine production is based on Lemert, pp. 202-207, and on an interview with S. C. Fisher, 20 September, 1983. The dates of first and last production are found in "DARCOM Installation and Activity Brochure [Cornhusker AAP]," 30 June 1980, p. 3.

51. "DARCOM Brochure," pp. 3-4; field observation.

Chapter 3

PRESERVATION RECOMMENDATIONS

BACKGROUND

Army Regulation 420-40 requires that an historic preservation plan be developed as an integral part of each installation's planning and long-range maintenance and development scheduling.[1] The purpose of such a program is to:

- Preserve historic properties to reflect the Army's role in history and its continuing concern for the protection of the nation's heritage.
- Implement historic preservation projects as an integral part of the installation's maintenance and construction programs.
- Find adaptive uses for historic properties in order to maintain them as actively used facilities on the installation.
- Eliminate damage or destruction due to improper maintenance, repair, or use that may alter or destroy the significant elements of any property.
- Enhance the most historically significant areas of the installation through appropriate landscaping and conservation.

To meet these overall preservation objectives, the general preservation recommendations set forth below have been developed:

Category I Historic Properties

All Category I historic properties not currently listed on or nominated to the National Register of Historic Places are assumed to be eligible for

nomination regardless of age. The following general preservation recommendations apply to these properties:

a) Each Category I historic property should be treated as if it were on the National Register, whether listed or not. Properties not currently listed should be nominated. Category I historic properties should not be altered or demolished. All work on such properties shall be performed in accordance with Sections 106 and 110(f) of the National Historic Preservation Act as amended, in 1980, and the regulations of the Advisory Council for Historic Preservation (ACHP) as outlined in the "Protection of Historic and Cultural Properties" (36 CFR 800).

b) An individual preservation plan should be developed and put into effect for each Category I property. This plan should delineate the appropriate restoration or preservation program to be carried out for the property. It should include a maintenance and repair schedule and estimated initial and annual costs. The preservation plan should be approved by the State Historic Preservation Officer and the Advisory Council in accordance with the above-referenced ACHP regulation. Until the historic preservation plan is put into effect, Category I historic properties should be maintained in accordance with the recommended approaches of the Secretary of Interior's Standards for Rehabilitation and

Revised Guidelines for Rehabilitating Historic Buildings[2] and in consultation with the State Historic Preservation Officer.

c) Each Category I historic property should be documented in accordance with Historic American Buildings Survey/Historic American Engineering Record (HABS/HAER) Documentation Level II, and the documentation submitted for inclusion in the HABS/HAER collections in the Library of Congress.[3] When no adequate architectural drawings exist for a Category I property, it should be documented in accordance with Documentation Level I of these standards. In cases where standard measured drawings are unable to record the significant features of a property or technological process, interpretive drawings also should be prepared.

Category II Historic Properties

All Category II historic properties not currently listed on or nominated to the National Register of Historic Places are assumed to be eligible for nomination regardless of age. The following general preservation recommendations apply to these properties:

a) Each Category II historic property should be treated as if it were on the National Register, whether listed or not. Properties not currently listed should be nominated. Category II historic properties should not be altered or demolished. All work on such properties shall be performed

in accordance with Sections 106 and 110(f) of the National Historic Preservation Act as amended in 1980, and the regulations of the Advisory Council for Historic Preservation (ACHP) as outlined in the "Protection of Historic and Cultural Properties" (36 CFR 800).

b) An individual preservation plan should be developed and put into effect for each Category II historic property. This plan should delineate the appropriate preservation or rehabilitation program to be carried out for the property or for those parts of the property which contribute to its historical, architectural, or technological importance. It should include a maintenance and repair schedule and estimated initial and annual costs. The preservation plan should be approved by the State Historic Preservation Officer and the Advisory Council in accordance with the above-referenced ACHP regulations. Until the historic preservation plan is put into effect, Category II historic properties should be maintained in accordance with the recommended approaches in the Secretary of the Interior's Standards for Rehabilitating and Revised Guidelines for Rehabilitation Historic Buildings[4] and in consultation with the State Historic Preservation Officer.

c) Each Category II historic property should be documented in accordance with Historic American Buildings Survey/Historic American Engineering Record (HABS/HAER) Documentation Level

II, and the documentation submitted for inclusion in the HABS/HAER collections in the Library of Congress.[5]

Category III Historic Properties

The following preservation recommendations apply to Category III historic properties:

a) Category III historic properties listed on or eligible for nomination to the National Register as part of a district or thematic group should be teated in accordance with Sections 106 and 110(f) of the National Historic Preservation Act as amended in 1980, and the regulations of the Advisory Council for Historic Preservation as outlined in the "Protection of Historic and Cultural Properties" (36 CFR 800). Such properties, should not be demolished and their facades, or those parts of the property that contribute to the historical landscape, should be protected from major modifications. Preservation plans should be developed for groupings of Category III historic properties within a district or thematic group. The scope of these plans should be limited to those parts of each property that contribute to the district or group's importance. Until such plans are put into effect, these properties should be maintained in accordance with the recommended approaches in the Secretary of the Interior's Standards for Rehabilitation and Revised

Guidelines for Rehabilitating Historic Buildings[6] and in consultation with the State Historic Preservation Officer.

b) Category III historic properties not listed on or eligible for nomination to the National Register as part of a district or thematic group should receive routine maintenance. Such properties should not be demolished, and their facades, or those parts of the property that contribute to the historical landscape, should be protected from modification. If the properties are unoccupied, they should, as a minimum, be maintained in stable condition and prevented from deteriorating.

HABS/HAER Documentation Level IV has been completed for all Category III historic properties, and no additional documentation is required as long as they are not endangered. Category III historic properties that are endangered for operational or other reasons should be documented in accordance with HABS/HAER Documentation Level III, and submitted for inclusion in the HABS/HAER collections in the Library of Congress.[7] Similar structures need only be documented once.

CATEGORY I HISTORIC PROPERTIES

There are no Category I historic properties at Cornhusker AAP.

CATEGORY II HISTORIC PROPERTIES

There are no Category II historic properties at Cornhusker AAP.

CATEGORY III HISTORIC PROPERTIES

There are no Category III historic properties at Cornhusker AAP.

NOTES

1. Army Regulation 420-40, Historic Preservation (Headquarters, U.S. Army: Washington, D.C., 15 April 1984).

2. National Park Service, Secretary of Interior's Standards for Rehabilitation and Revised Guidelines for Rehabilitating Historic Buildings, 1983 (Washington, D.C.: Preservation Assistance Division, National Park Service, 1983).

3. National Park Service, "Archeology and Historic Preservation; Secretary of the Interior's Standards and Guidelines," Federal Register, Part IV, 28 September 1983, pp. 44730-44734.

4. National Park Service, Secretary of the Interior's Standards.

5. National Park Service, "Archeology and Historic Preservation."

6. National Park Service, Secretary of the Interior's Standards.

7. National Park Service, "Archeology and Historic Preservation."

BIBLIOGRAPHY

Published Sources

Cotter, C. H. (LTC). "Naval Ammunition Depot Near Hawthorne, Nev., Built to Serve the Pacific Coast." Engineering News-Record, 105 (November 20, 1930), 803-805. Contains a discussion of the design and spacing of magazines.

Fine, Lenore, and Remington, Jesse A. The Corps of Engineers: Construction in the United States. Washington, D.C.: Office of the Chief of Military History, U.S. Army, 1972.

Green, Constance McLaughlin, Thomson, Harry C., and Roots, Peter C. The Ordnance Department: Planning Munitions for War. Washington, D.C.: Office of the Chief of Military History, Department of the Army, 1955.

Higham, Robin, ed. A Guide to the Sources of United States Military History. Hamden, Conn.: Archon Books, 1975.

"Hourly Earnings in the Ammunition-Loading Industry, 1944." Monthly Labor Review, 60 (April, 1945), 840-841. Contains an excellent overview of load, assemble and pack process.

Hoy, Suellen M. and Michael C. Robinson, eds. Public Works History in the United States. Nashville: American Association for State and Local History, 1982.

Jessup, John E. and Robert W. Coakley. A Guide to the Study and Use of Military History. Wash., D.C.: U. S. Government Printing Office, 1979.

Lemert, Ann Arnold. First You Take A Pick & Shovel: The Story of the Mason Companies. Lexington, Kentucky: The John Bradford Press, 1979. Company history of a major defense contractor since World War I.

Lowry, Mike. "Safety No. 1 at CAAP." Grand Island (Neb.) Independent, Saturday, Nov. 1, 1969. Contains a brief review, with photographs, of the 750-lb. bomb loading process.

National Park Service. "Archeology and Historic Preservation; Secretary of the Interior's Standards and Guidelines." Federal Register, Part IV (28 September 1983), 44730-44734.

_____. How to Complete National Register Forms. Wash., D.C.: U. S. Government Printing Office, 1977.

_____. Secretary of Interior's Standards for Rehabilitation and Revised Guidelines for Rehabilitating Historic Buildings, 1983. Wash., D.C.: Preservation Assistance Division, National Park Service, 1983.

Quayle, L. A. "Volumetric Pouring Machine." Mechanical Engineering, 67 (September, 1945), 599-606. Contains a comprehensive discussion of the development and operation of mechanized shell-loading processes.

Rogers, George D. (Major). "Military Explosives." National Safety News, 44 (July, 1941), 22-23, 77-80. Contains information regarding safety considerations for ammunition plant layout.

Thomson, Harry C. and Lida Mayo. The Ordnance Department: Procurement and Supply. Wash., D.C.: Office of the Chief of Military History, Department of the Army, 1960. Contains an excellent chapter on the construction and operation of government-owned, contractor-operated plants during World War II.

United States Army Materiel Readiness Command. Catalog of Common Sources, Fiscal Year 1983 No pl.: Historical Office, AMCCOM, Rock Island Arsenal, Rock Island, Ill.

Unpublished Sources

"Annual Historical Supplement -- Cornhusker Army Ammunition Plant -- Covering the Period 1 January 1968 through 31 December 1968." Report prepared by Mason & Hanger-Silas Mason Co., Inc. Contractor files, Cornhusker AAP.

"Brochure: Cornhusker Ordnance Plant, Grand Island, Nebraska, 1941-1957." Prepared by Mason & Hanger-Silas Mason Co., Inc., Contractor-Operator. Contractor files, Cornhusker AAP. Good summary of activities; useful in the absence of contractor records from the World War II period. The account of the plant construction is based on Cooke.

Cooke, St. George. "History of the Rehabilitation and Reactivation of the Cornhusker Ordnance Plant, Grand Island, Nebraska, by the Silas Mason Company," Vol. 1: the First Year: Background to Production, April 9, 1950 - April 9, 1951. Contractor files, Cornhusker AAP. Contains, amidst much pseudo-historical rambling, the most complete review of Cornhusker AAP's early history; very useful in the absence of contractor histories from the World War II period.

"DARCOM Installation and Activity Brochure [for Cornhusker Army Ammunition Plant]." Report prepared by DARCOM, 30 June, 1980. AMCCOM Historical Office, Rock Island Arsenal, Rock Island, Ill.

Hammond, R. J. Profile on Munitions, 1950-1977. n.d. Report, on microfiche, AMCCOM Historical Office, Rock Island Arsenal, Rock Island, Ill.

Historic American Buildings Survey/ Historic American Engineering Record, National Park Service. Guidelines for Inventories of Historic Buildings and Engineering and Industrial Structures. Draft, 1982.

"Historical Report, 1 January 1953 to 30 June 1953." Prepared by the Silas Mason Company, Cornhusker Ordnance Plant, Grand Island, Nebraska. Contractor files, Cornhusker AAP.

"History of the Operating Contractor's Organization and Operation of the Ravenna Ordnance Plant, Apco, Ohio." Vol. I (August 28, 1940 - June 30, 1943) - Vol. IX (July 1, 1945 - September 30, 1945). Prepared by Atlas Powder Company, Wilmington, Delaware. Government files, Cornhusker AAP. Since the operating contractor was also responsible for the design of this early loading plant, the planning and design process for these plants is covered in great detail.

Stewart, James C. (Major). "Completion Report on the Cornhusker Ordnance Plant." No pl.: U.S. Army Corps of Engineers, November 25, 1942. Contractor files, Cornhusker AAP.

Voight, William, Jr. "The Ordnance Organization in World War II." Report, c. 1945. Microfiche, AMCCOM Historical Office, Rock Island Arsenal.

"War Department Industrial Facilities Report -- Cornhusker Ordnance Plant, Grand Island, Nebraska." Prepared by U.S. Army Corps of Engineers, Office of the District Engineer, Omaha, Nebraska, February, 1944. Addendum 1, 1 August, 1944. Addendum 3, 15 May, 1947. AMCCOM Historical Office, Rock Island Arsenal, Rock Island, Ill.

"War Department Industrial Facilities Inventory -- Cornhusker Ordnance Plant, Grand Island, Nebraska." Addendum No. 2. Prepared by U.S. Army Corps of Engineers, Office of the District Engineer, Denver, Colorado, 1 April, 1945. AMCCOM Historical Office, Rock Island Arsenal, Rock Island, Ill. Covers the construction of Load Line IV in 1944-1945.