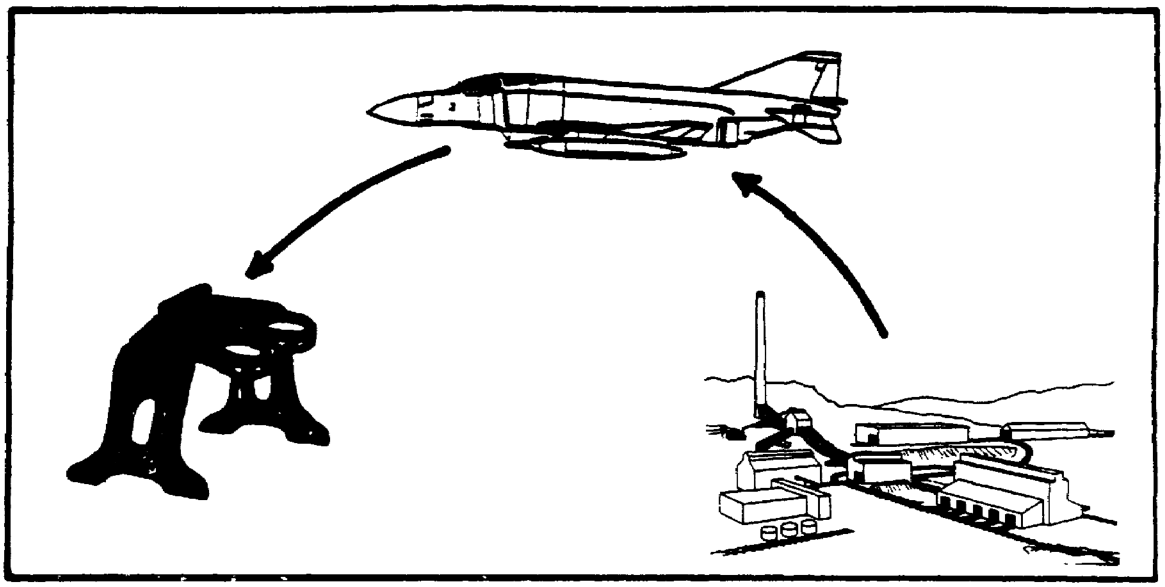
SUBCOURSE IT 0673 | EDITION A

US ARMY INTELLIGENCE CENTER

ANALYZE PROCESSING INDUSTRIES ON AERIAL IMAGERY



THE ARMY INSTITUTE FOR PROFESSIONAL DEVELOPMENT

ARMY CORRESPONDENCE COURSE PROGRAM

AIPD

READINESS/ PROFESSIONALISM THRU GROWTH

ANALYZE PROCESSING INDUSTRIES ON AERIAL IMAGERY

Subcourse Number IT 0673

Edition A

US Army Intelligence Center
Fort Huachuca, AZ 85613-7000

Credit Hours 6

Edition Date: September 1991

SUBCOURSE OVERVIEW

This subcourse is designed to teach you basic procedures involved with identifying and analyzing processing industries. Contained within this subcourse is instruction on how to identify and analyze processing industries.

There are no prerequisites for this subcourse.

This subcourse reflects the doctrine which was current at the time the subcourse was prepared.

TERMINAL LEARNING OBJECTIVE

TASK: You will identify procedures for identifying and analyzing processing industries.

CONDITIONS: You will have access to extracts from FM 30-10, STP 34-96D24-SM-TG, and TM 30-260.

STANDARDS: You will identify and analyze processing industries in accordance with FM 30-10, STP 34-96D-SM-TG, and TM 30-260.

NOTE: Replace the following pages with the attached photo pages for better viewing: 5-11, 33--39, 65--67, 87--89, 93--98, and 101--127.

TABLE OF CONTENTS

LESSON ONE

IDENTIFY PROCESSING INDUSTRIES IN GENERAL

MOS Manual Tasks: 301-338-2804
301-338-3701

OVERVIEW

TASK DESCRIPTION:

In this lesson you will learn how to identify processing industries in general.

LEARNING OBJECTIVE:

ACTIONS: Describe the information and procedures required to identify processing industries in general.

CONDITIONS: You will be given access to extracts from FM 30-10, STP 34-96D24-SM-TG, and TM 30-260.

STANDARDS: Identification of processing industries in general will be in accordance with FM 30-10; STP 34-96D24-SM-TG, and TM 30-260.

REFERENCES: The material contained in this lesson was derived from the following publications:

FM 30-10.
STP 34-96D24-SM-TG.
TM 30-260.

INTRODUCTION

Processing industries are those which subject the accumulated raw materials from extraction industries to mechanical, chemical, or heat treatment industries. These industries render the raw materials suitable for further processing or create a product from which finished goods or equipment can be manufactured. Sometimes these industries are located near extraction industries which you studied in ACCP subcourse IT 0672. Processing industries are characterized by large complex buildings, storage equipment/buildings, handling equipment, and outdoor equipment such as stacks, blast furnaces and kilns. In lesson two of this subcourse you will learn to further identify and analyze mechanical, chemical, and heat industries.

PART A: CHARACTERISTICS OF PROCESSING INDUSTRIES

1. Processing Industries are characterized by the presence of facilities for storage and handling of large quantities of input materials. The industry input materials key (Figure 1-1) shows input materials will appear as large or variable quantities. However, this does not lead you directly to processing industries, even though large fuel quantities indicate a probable link to processing. Continuing down the key to "structures" you see large complex structures and dams which are associated with processing industries.

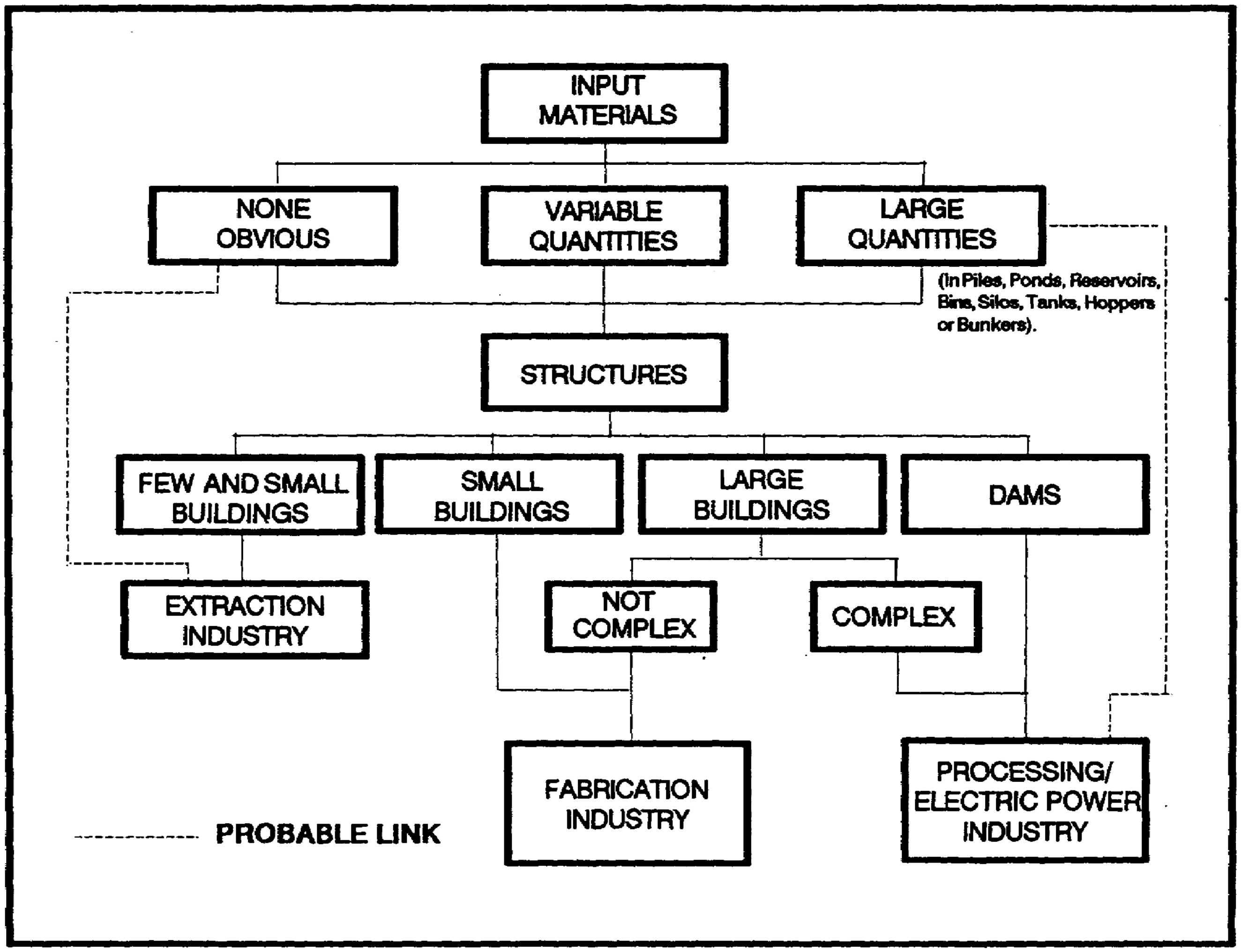


Figure 1-1. Industry Input Materials Key.

2. In the <u>industry outdoor equipment key</u> (Figure 1-2) you will find outdoor equipment associated with industries. Notice the first level shows the type of handling equipment you will find at each industry. Outdoor equipment for processing industries includes: cranes, conveyors, and mobile equipment. Further down the key you also note pipelines and tanks. These appear in large or small amounts which further identify the processing industry as either chemical, mechanical or heat processing industries. Additional outdoor equipment associated with the processing industry is located under the specific industry. This additional outdoor equipment includes: furnaces, kilns, dams chimneys, and stacks.

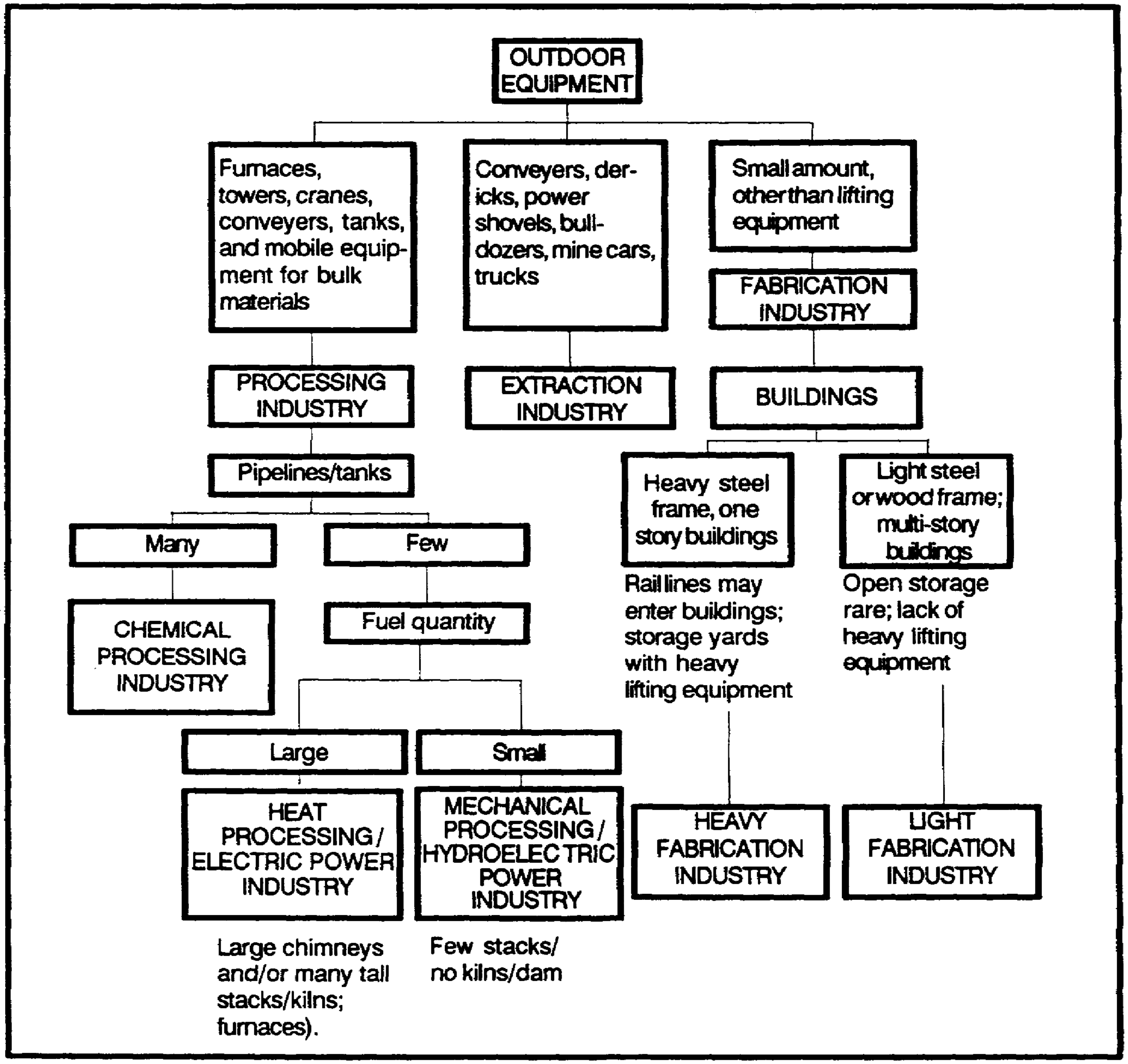


Figure 1-2. Industry Outdoor Equipment Key.

3. <u>Bulk and waste materials</u> are also characteristics of processing industries. The bulk and waste materials key (Figure 1-3) will assist you in the identification of bulk materials and waste by comparing the bulk or waste to the tone of the photo. Using this key you should be able to limit the type of industry you have by comparing the tone of the material on your photo to the chart. For example: A black or dark grey tone indicates either coke or slag which could belong to either coke and iron production, aluminum reduction, or ore smelting.

BLACK	DARK GREY	MID-GREY	LIGHT GREY	WHITE	MAJOR INDUSTRIES
—	COKE				Coke and iron production; aluminum reduction; and many smelting operations.
—	SLAG				Ore smelting.
—	COAL	—			Power production, boiler houses; gas production; ammonia from coal; and coke production.
	PULP WOOD	—			Cellulose plants. (Mottled appearance)
	—	SLAG	—		Coke, iron and steel; and mining operations.
	LIGNITE	—			Power production, boiler houses.
	—	IRON ORE			Coke, iron and steel.
	—	SCRAP STEEL			Steel production and scrap yards. (Mottled appearance)
	—	GRAVEL	—		Extraction and building materials.
	—	COAL ASH			Power production waste.
	—	RED MUD	—		Bayer alumina waste.
		CLAYS	—		Building materials, pottery.
		SAND	—		Extraction, building materials.
		—	FERTILIZER	—	Fertilizer production. (Roof and area stains)
		—	ORE CONCENTRATION	—	Ore concentration waste.
		—	BAUXITE	—	Bayer alumina; refractory brick production.
			GYPSUM		Gypsum extraction and processing; building materials.
			LIMESTONE	—	Coke, iron and steel; soda ash; aluminum; building materials; smelting; and chemical industries.
			CEMENT	—	Cement production. (Roof and area stains)
			PHOSPHATE ROCK	—	Extraction; processing; and phosphoric acid production.
			POTASH	—	Extraction and fertilizer production.
			—	SULFUR	Extraction and sulfuric acid production.
			—	SALT	Extraction; chlorine; caustic soda; and soda acid production.

Figure 1-3. Bulk Materials and Waste Identification Key.

PART B: BASIC IDENTIFICATION FEATURES

1. There are several <u>basic recognition features</u> used in identifying processing industries. These features are broken down into six categories.

- Storage facilities
- Handling facilities
- Processing equipment
- Heat or power source
- Buildings and structures
- Waste materials.

2. These <u>six basic categories</u> are further broken down in order to assist you in identifying specific equipment and features which belong to each processing industry.

a. Storage facilities are used for large quantities of bulk input materials. These facilities include piles, ponds, reservoirs, silos, tanks, bins, hoppers, and bunkers (Figures 1-4 and 1-5).

Figure 1-4. Silos and Tanks.

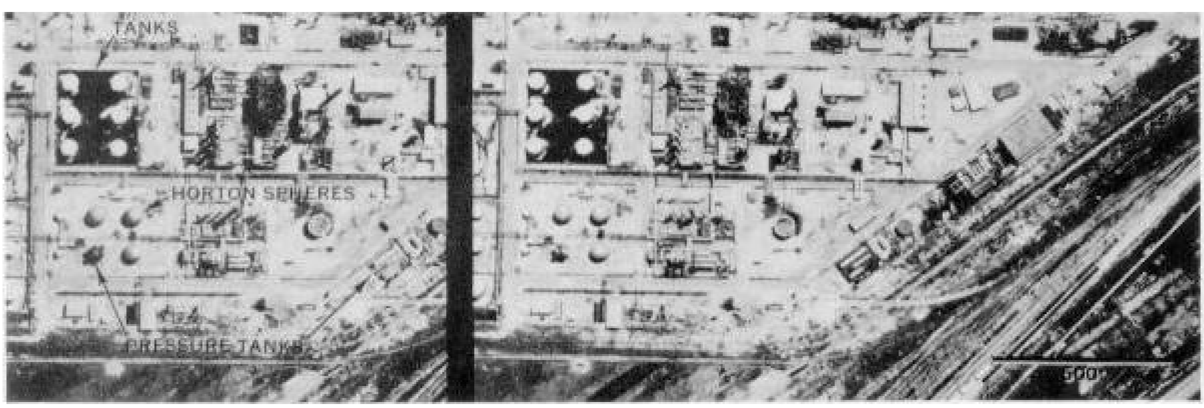


Figure 1-5. Pressure and Storage Tanks.

b. Handling facilities are used to transport the bulk materials to their assigned destination for processing or storage. This equipment includes conveyors, pipelines, cranes, and mobile equipment (Figures 1-6 and 1-7).

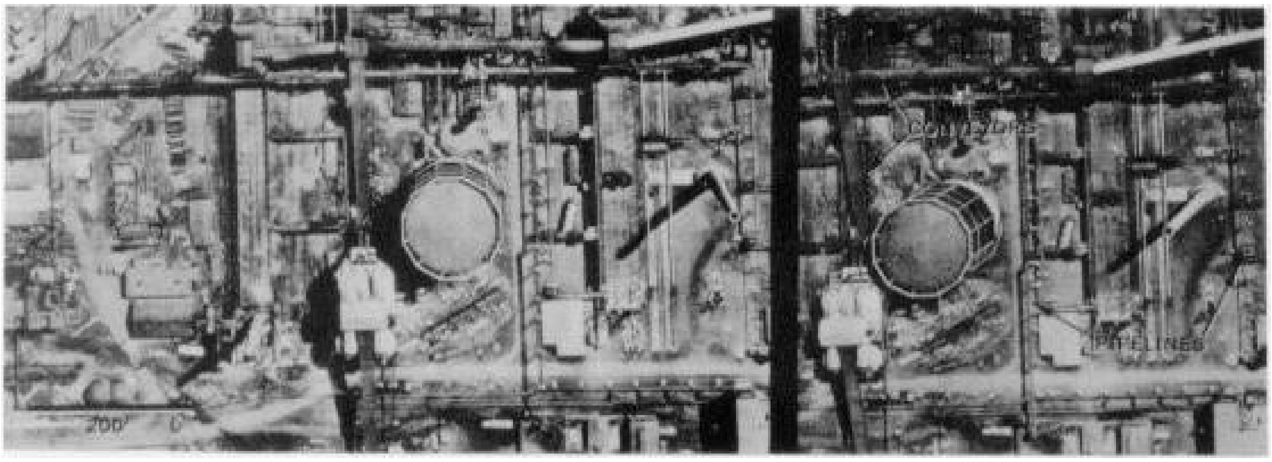


Figure 1-6. Pipelines and Conveyors.

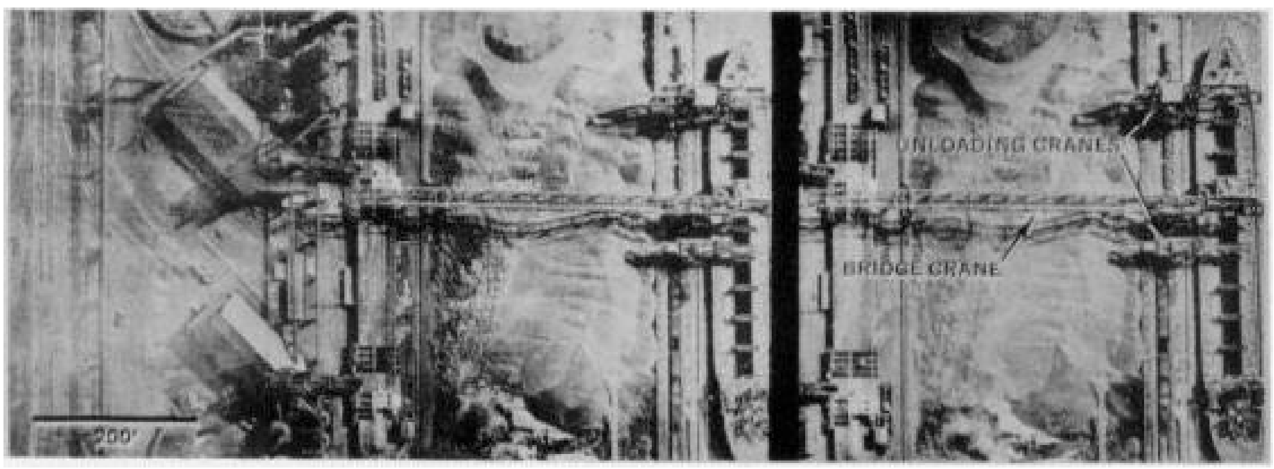


Figure 1-7. Cranes.

c. Processing equipment is usually distinguished by large outdoor components including: blast furnaces, kilns, processing tanks, and cooling towers (Figures 1-8 thru 1-10).

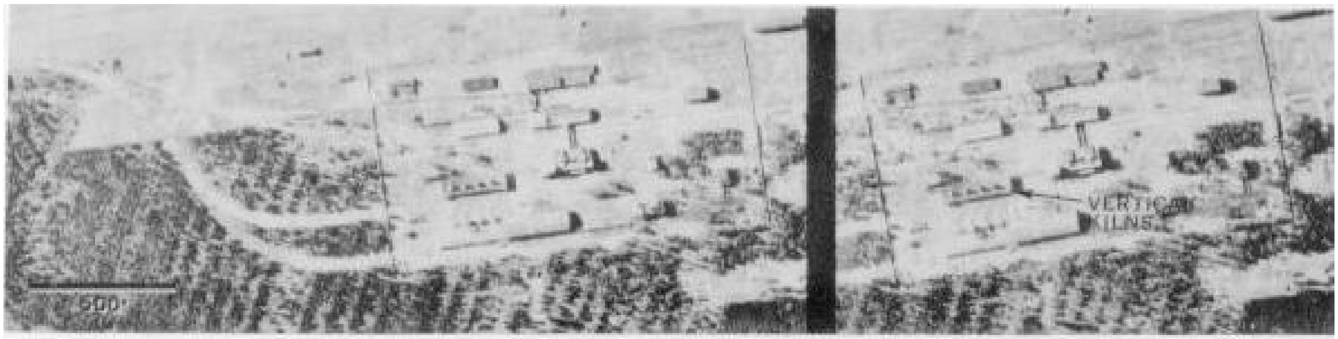


Figure 1-8. Vertical Kilns.

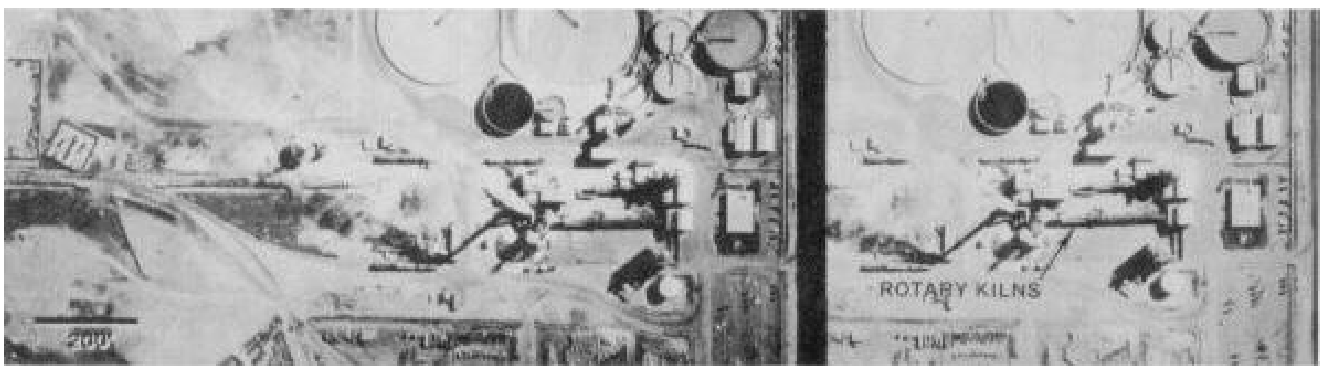


Figure 1-9. Rotary Kilns.

Figure 1-10. Processing Tanks.

d. Processing involves large quantities of power. Heat or power sources are indicated by electric substations (transformer yards), boiler houses, oil tanks, and cooling towers (Figures 1-11 and 1-12).

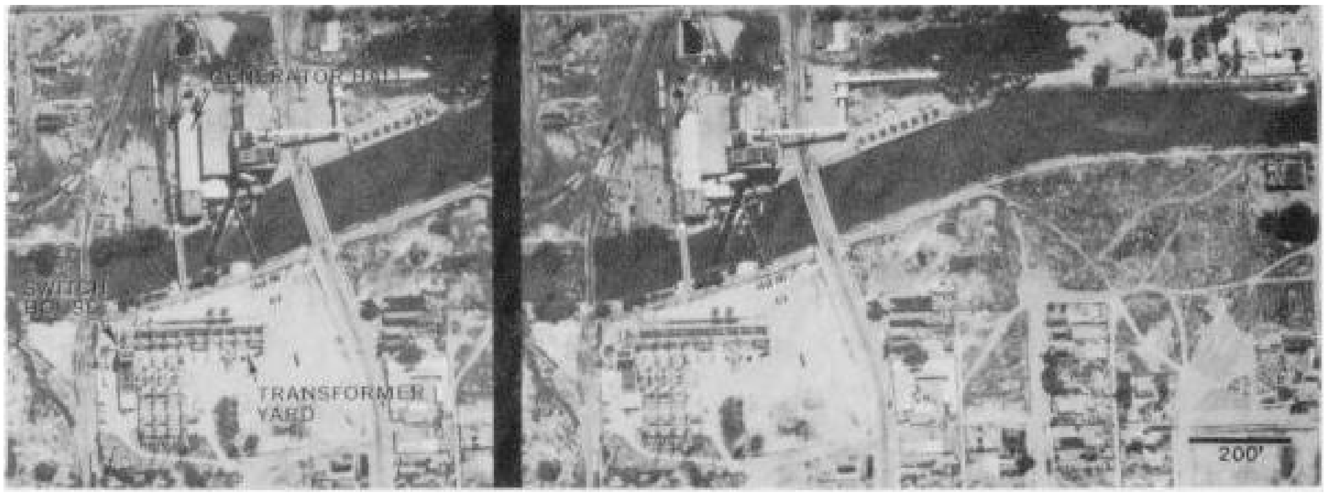


Figure 1-11. Transformer Yard.

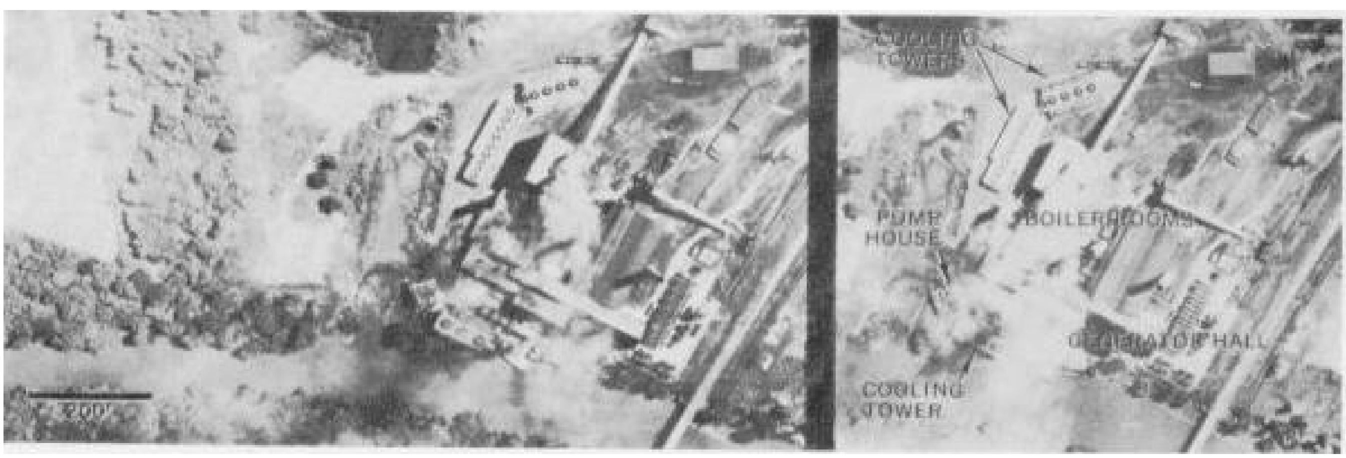


Figure 1-12. Boiler Rooms, Cooling Tower and Generator Hall.

e. Buildings and structures located in a processing industry are usually large and complex with tall chimneys or numerous stacks (Figure 1-13).

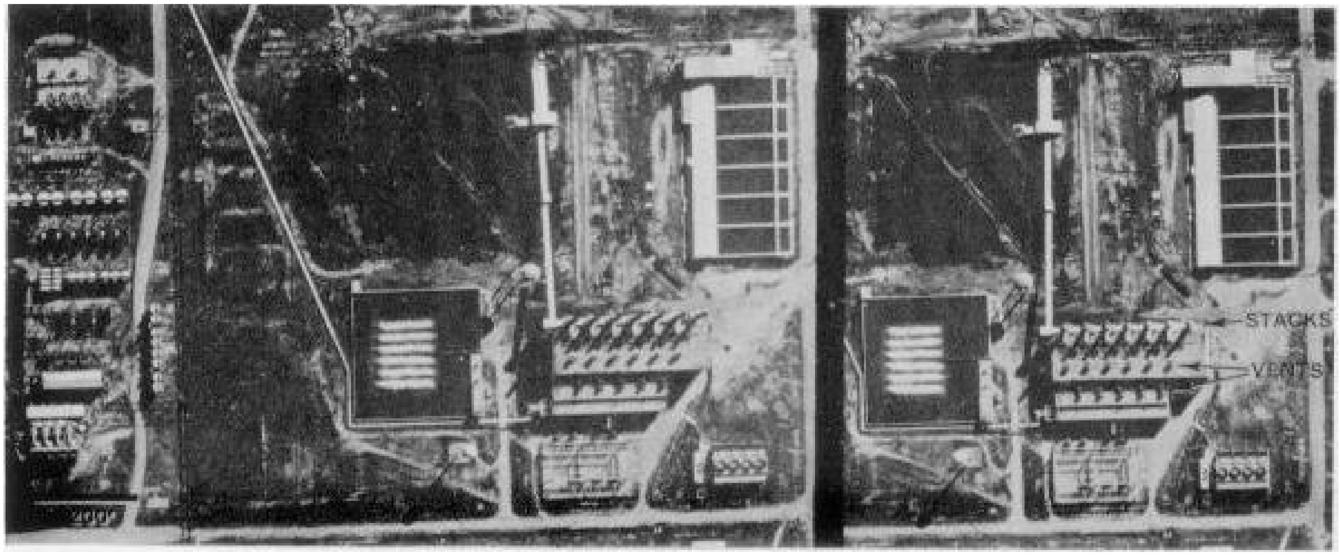


Figure 1-13. Chimneys, Stacks, and Vents.

f. Waste materials in processing industries are usually found in piles or ponds (Figure 1-14).

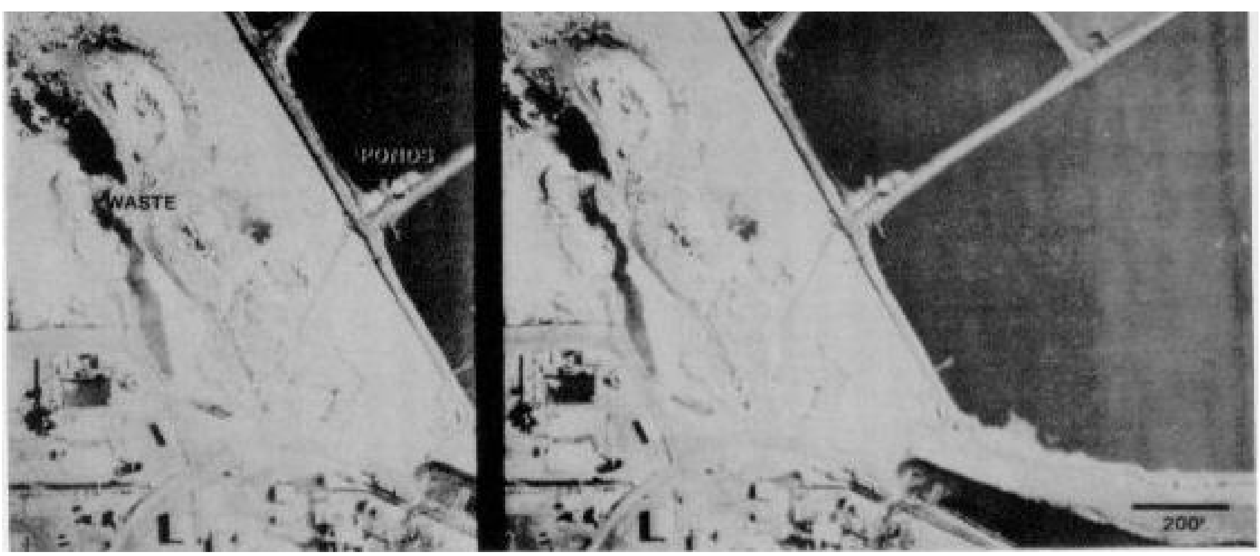


Figure 1-14. Piles and Ponds.

LESSON ONE

PRACTICE EXERCISE

The following items will test your grasp of the material covered in this lesson. There is only one correct answer to each item. When you have completed the exercise, check your answers with the answer key that follows. If you answer any item incorrectly, study again that part of the lesson which contains the portion involved.

1. What types of structures are usually associated with processing industries?

   A. Small buildings.

   B. No buildings.

   C. Large complex structures and dams.

   D. Few and small buildings.

2. Using Figure 1-15. What type of storage is indicated at the arrow?

   A. Piles.

   B. Silos.

   C. Bins.

   D. Bunkers.

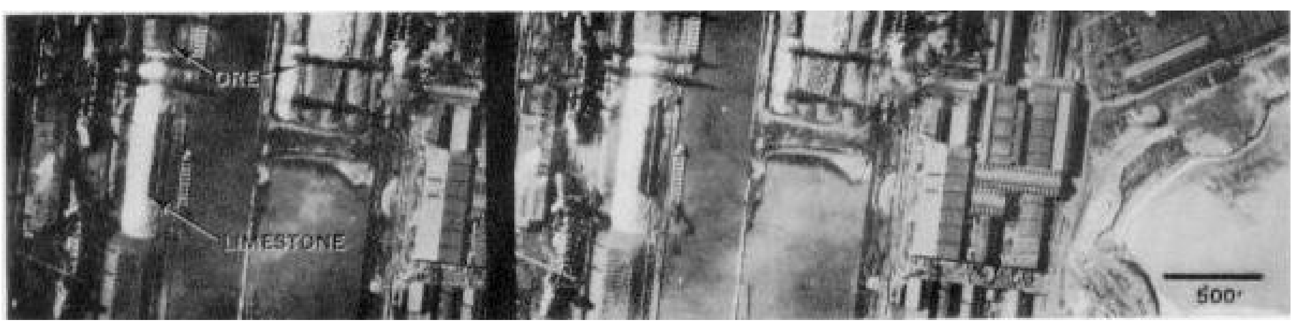


Figure 1-15.

3. Using Figure 1-16. What heat or power source is indicated at the arrows?

   A. Oil tanks.

   B. Cooling towers.

   C. Substation.

   D. Boiler house.

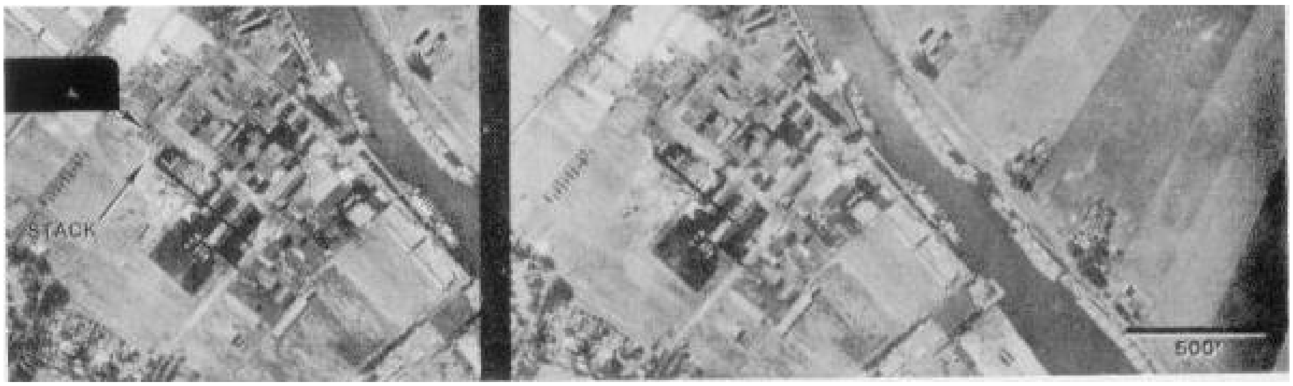


Figure 1-16.

4. What are three types of processing industries?

   A. Heat, fabrication, and processing.

   B. Chemical, heat, and mechanical.

   C. Mechanical, heat, and extraction.

   D. Extraction, fabrication, and processing.

LESSON ONE

PRACTICE EXERCISE

ANSWER KEY AND FEEDBACK

ITEM	CORRECT ANSWER AND FEEDBACK
1.	C. Large buildings and dams are usually associated with processing industries (page 2, para 1 and fig 1-1).
2.	A. Piles are the type of storage indicated by the arrows (page 5, para 2a).
3.	D. Boiler house is the heat or power source indicated by the arrows (page 8, para d and fig 1-12).
4.	B. Chemical, heat, and mechanical are the three types of processing industries (page 3, para 2).

LESSON TWO

ANALYZE PROCESSING INDUSTRIES

MOS Manual Tasks: 301-338-2804
301-338-3701

OVERVIEW

TASK DESCRIPTION:

In this lesson you will learn to analyze processing industries.

LEARNING OBJECTIVE:

ACTIONS: Describe the information and procedures required to analyze processing industries.

CONDITIONS: You will be given access to extracts from STP 34-96D24-SM-TG, FM 30-10, and TM 30-260.

REFERENCES: The material contained in this lesson was derived from the following publications:

FM 30-10.
STP 34-96D24-SM-TG.
TM 30-260.

INTRODUCTION

Processing industries are divided into three subcategories: heat, chemical, and mechanical. These three subcategories are all closely related. As an imagery analyst (IA) you should be able to distinguish these industries by their specific recognition features.

PART A: ANALYZING PROCESSING INDUSTRIES

1. In order to analyze specific processing industries you must first understand the production flow of a processing industry (Figure 2-1). In the production flow, input materials from the extraction industry are sent to the processing industry. This industry, depending on the input material, will be either a mechanical, chemical, or heat industry. At the specific processing industry a by product or end product is produced and is then ready for shipment or storage.

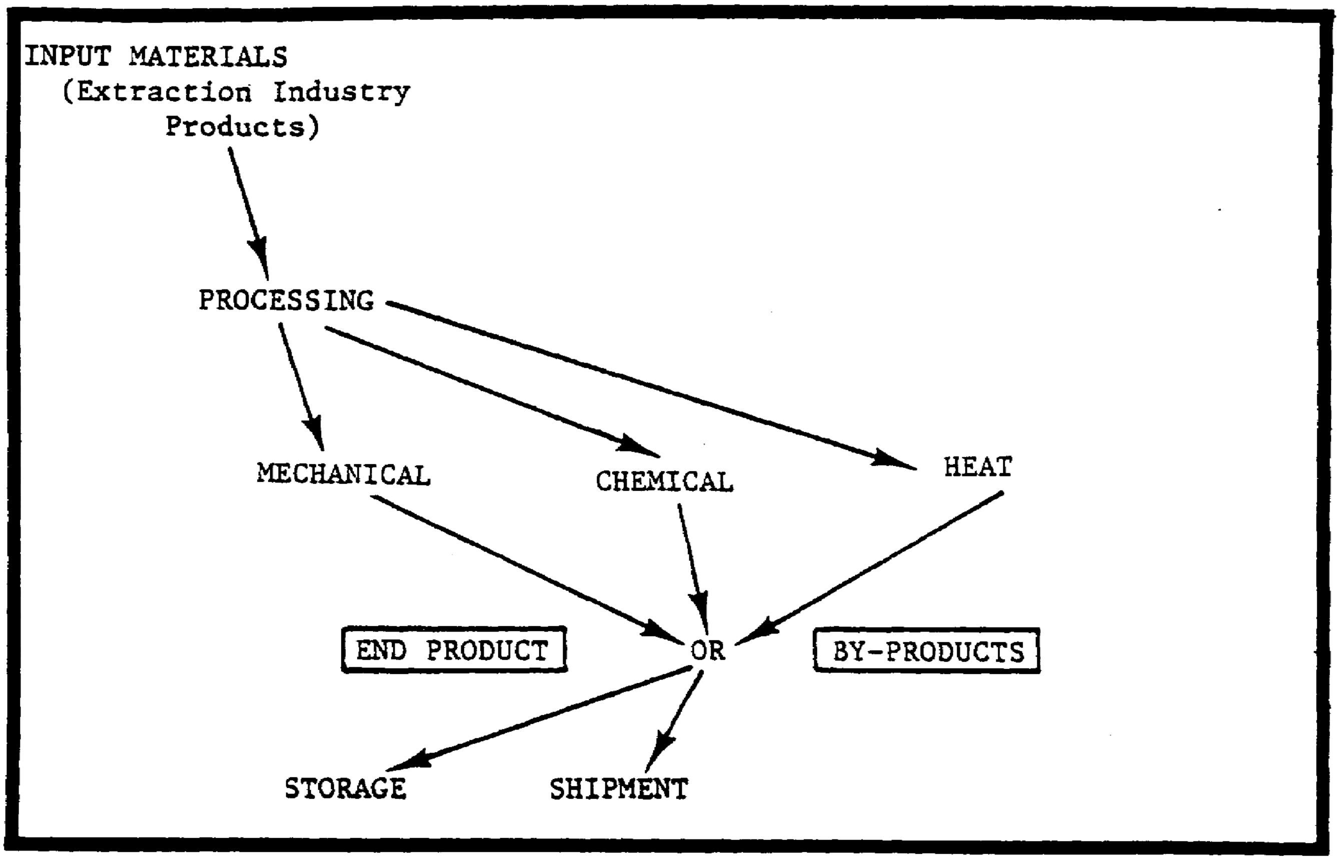


Figure 2-1. Processing Industry Production Flow.

2. The <u>processing industry schematic</u> shows the relationship between the industry itself, the three subcategories, and their associated or specific industries (Figure 2-2).

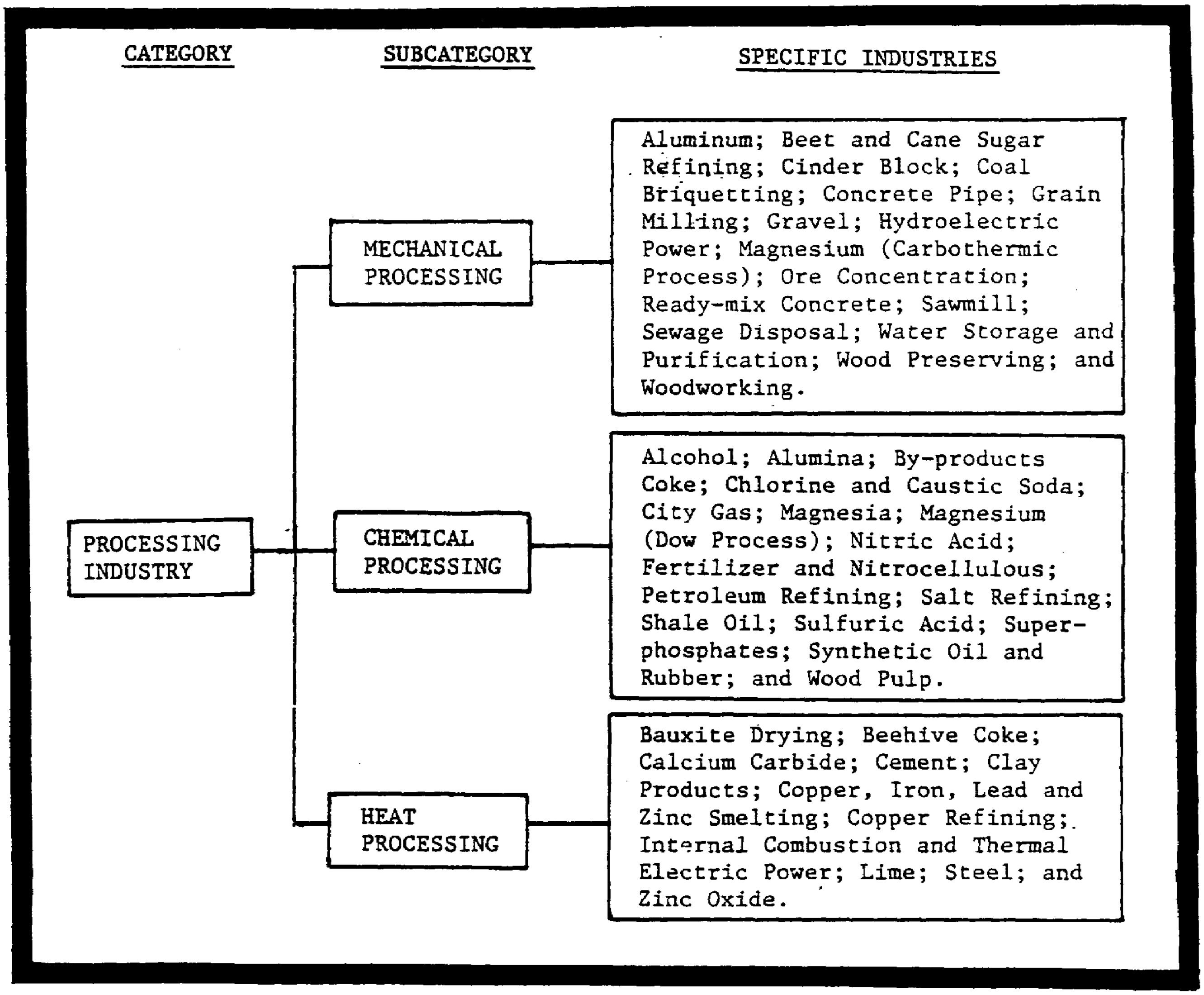


Figure 2-2. Processing Industry Schematic.

3. Several construction features are common throughout the processing industries. You must be able to identify water coolers (Figure 2-3), roof types (Figure 2-4), and storage tanks (Figure 2-5), which will aid you in the analysis of a processing industry. Some of these may be more common in one type of processing industry than another. For example: storage tanks are found especially in chemical processing industries.

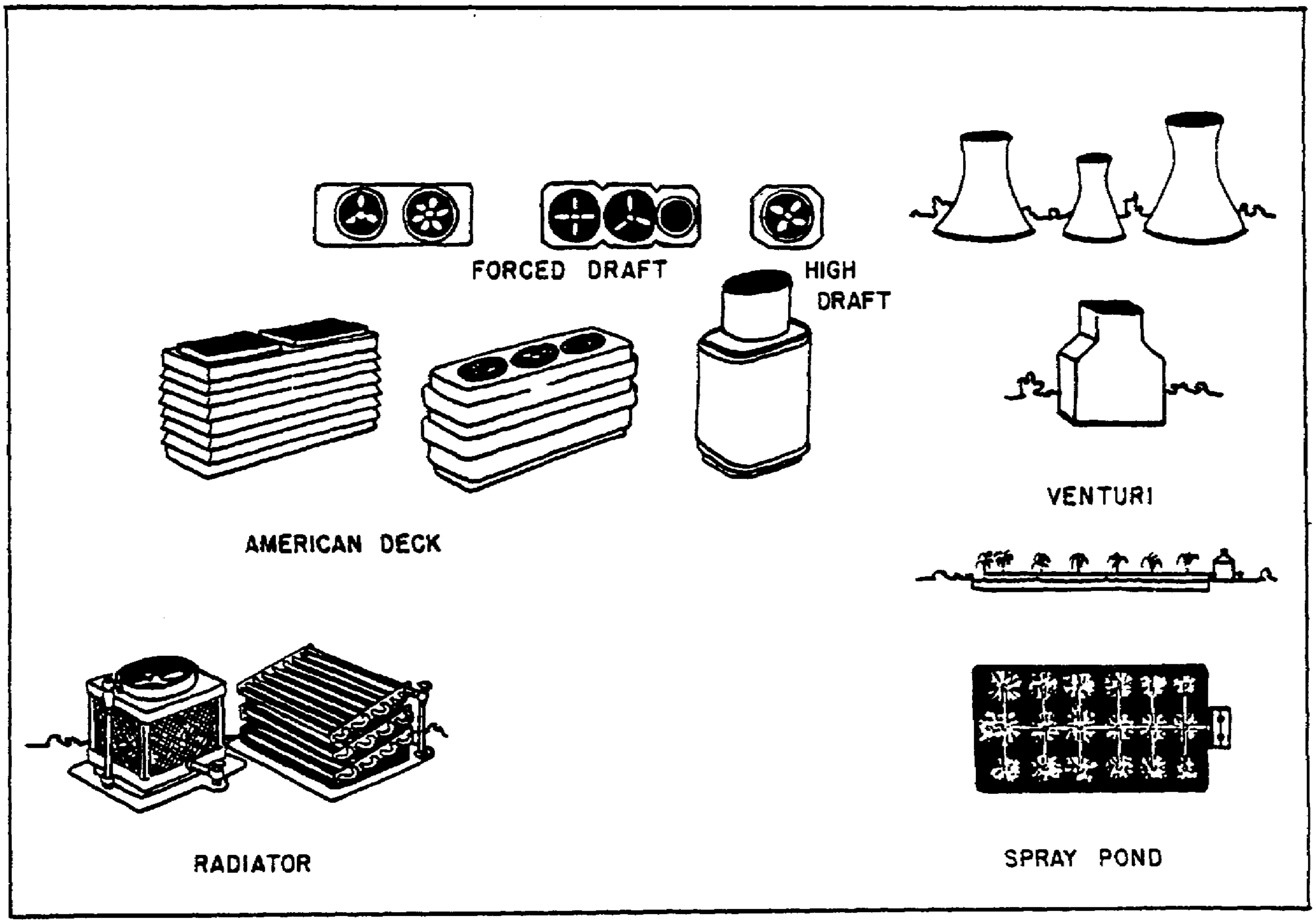


Figure 2-3. Water Coolers.

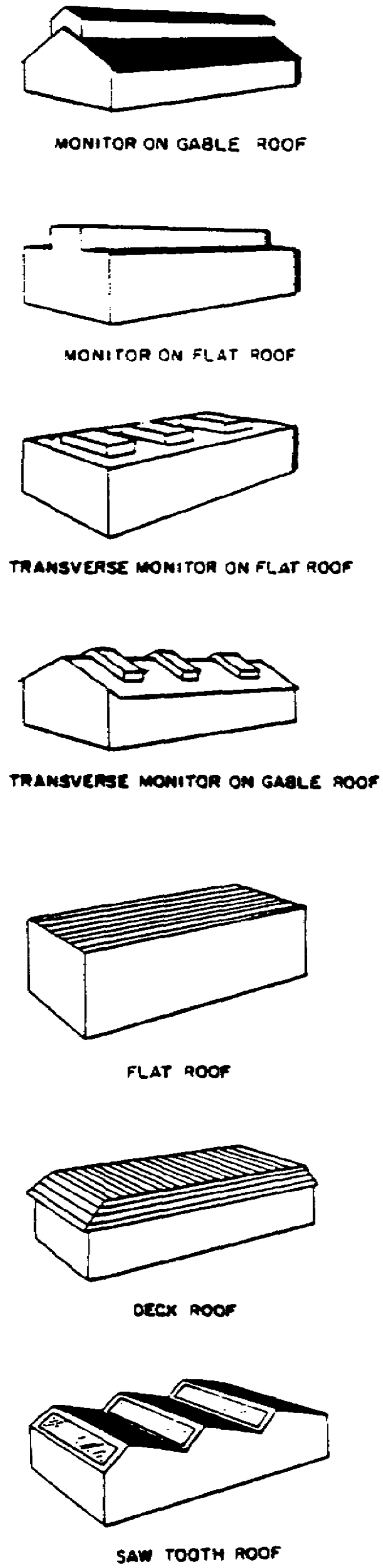


Figure 2-4. Roof Types.

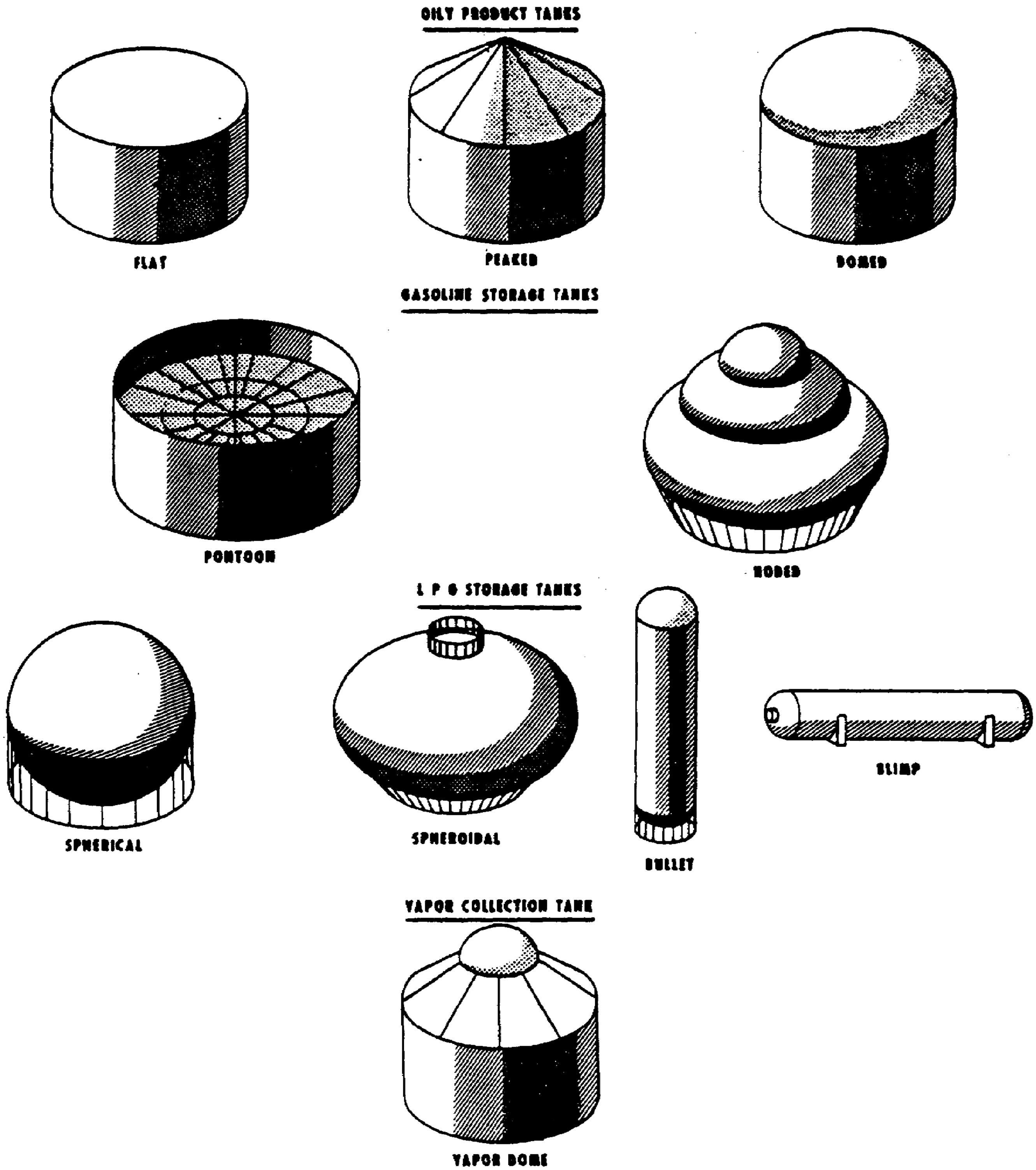


Figure 2-5. Storage Tanks.

PART B: MECHANICAL PROCESSING INDUSTRIES

1. Mechanical processing industries primarily are those engaged in the sizing, sorting, separating or otherwise changing the physical form or appearance of raw materials. Like other processing industries, mechanical processing industries have facilities for handling and storage of large quantities of bulk materials and waste, large quantities of power, and large complex buildings. Specific identification features include:

- Few pipelines or closed tanks
- Small quantities of fuel
- Few chimneys or stacks
- Dams (hydroelectric power only).

2. The image components for a mechanical processing industry are divided into four major categories:

- Equipment
- Buildings
- Dams
- Open storage and waste.

a. Equipment is presented under the following headings: chimneys, stacks, and vents; silos, tanks, hoppers, and bunkers; pipelines, conveyors, cranes, and mobile equipment; and complex equipment.

(1) Chimneys, stacks, and vents all serve similar purposes--to dispose of heat, waste gases, and fine dust. Stacks are built of masonry or sheet metal and vary in diameter and height. There are two types of vents--short, round vents, usually covered, and monitor-like vents (Appendix A, page 101, Figures A-1 thru A-10).

NOTE: The few stacks and vents associated with mechanical processing industries rarely aid in analyzing and industry.

(2) Silos, tanks, hoppers, bins, and bunkers are all used for storage. However, some of the low, open tanks have special processing functions. Silos, tall covered cylindrical containers usually found in groups, hold dry bulk materials. Covered round tanks, for storage of water and fuel oil, are relatively few in mechanical processing industries. Low, open round tanks such as Dorr thickeners and mixers are typical of ore concentration and water purification. Tanks also may be square or rectangular, open or closed, buried or above ground. Hoppers, bins, and bunkers hold bulk goods temporarily and help indicate the flow of materials (Figures A-17 thru A-37).

(3) Pipelines, conveyors, cranes, and mobile equipment are used to handle or transport materials. Pipelines appear as slender connecting lines between buildings and equipment. Conveyors, either inclined or horizontal, housed or open, handle bulk materials between storage areas

and processing buildings. They usually appear wider than pipelines and have flat surfaces (Figures A-38 thru A-52).

NOTE: Pipelines are common but not found in great numbers in mechanical processing industries.

(4) Complex equipment is rare in the mechanical processing industry, but whenever present it aids in analyzing the industry. This category includes such equipment as transformer yards, sawdust burners, and fluorine recovery units (Figures A-53 thru A-59).

b. Dams across rivers restrict the flow and raise the water level and provide the necessary head for power generation. Additionally, they usually create a reserve of water. Almost always hydroelectric power plants have dams associated with them (Figures A-60 and A-61).

c. Buildings are presented in three subdivisions based on function. These subdivisions are processing, storage, and administration. The image components are somewhat different for each subdivision. Certain buildings associated with other image components will provide the identity of the industry.

(1) The majority of processing buildings are not distinctive although many can be identified in association with adjacent image components. For example, the similar parallel aluminum pot rooms are associated with a rectifier building and transformer yard (Figures A-62 thru A-73).

(2) Storage buildings are usually served by rail lines or roads, and their images are not as complex as those of processing buildings (Figures A-74 and A-75).

(3) Administrative buildings usually are built to one side of the plant area near the main entrance and are served by walks and driveways. The grounds around them may be landscaped and parking areas are provided for small-type automobiles (Figures A-76 and A-77).

d. Open storage and waste may appear as piles or ponds. Piles range from the regularly shaped, orderly piles of stacked lumber and logs, to the irregular piles of coal, sawdust, and sewage waste. Ponds may hold tailings, water, or sewage sludge (Figures A-78 thru A-81).

REMEMBER: The silos, tanks, hoppers, and bins, as well as piles and ponds, all pertaining to storage, are of primary importance in analyzing mechanical processing industries. Low, open processing tanks are particularly useful because they indicate specific functions, such as sewage treatment. Conveyors are widely used and especially helpful when analyzing the succession of processes and operations. A few specially designed processing buildings aid in the analysis of industrial facilities.

widely used and especially helpful when analyzing the succession of processes and operations. A few specially designed processing buildings aid in the analysis of industrial facilities.

3. <u>Aluminum, magnesium, and ore</u> (lead, zinc, copper, and nickel) are all considered mechanical processing industries. However, a combination of mechanical, chemical, and heat processes are involved. To better analyze these industries the production flows of specific ore industries are described for you in the following pages.

a. Ore reduction flow (classical smelter).

(1) Coming direct from the mine, the ore will go to the receiving and handling area for unloading and storage. It will then be moved to the bedding plant where ore concentrates are mixed and limestone is added. Limestone acts as a flux, forming a slag with the impurities, in the subsequent smelting operations.

(2) In the bedding plant ore is roasted to remove as much free sulfur as possible, and then sintered to form the ore fines into a clinker suitable for smelting.

(3) Prepared ore is then moved to the furnace building where it is subjected to smelting in either a blast furnace or Bessemer converter. In this process the metal is separated from the waste products (slag), the metal normally is cast and shipped, and the dark colored slag is dumped.

(4) As many of the ores processed will have a high sulfur content, it is necessary to ensure adequate and safe venting of the gases that will result from roasting, sintering, and furnace operation. Shown in Figure 2-6 is the resultant flue system, dust catcher, and waste gas stack which form an excellent identification feature for this industry.

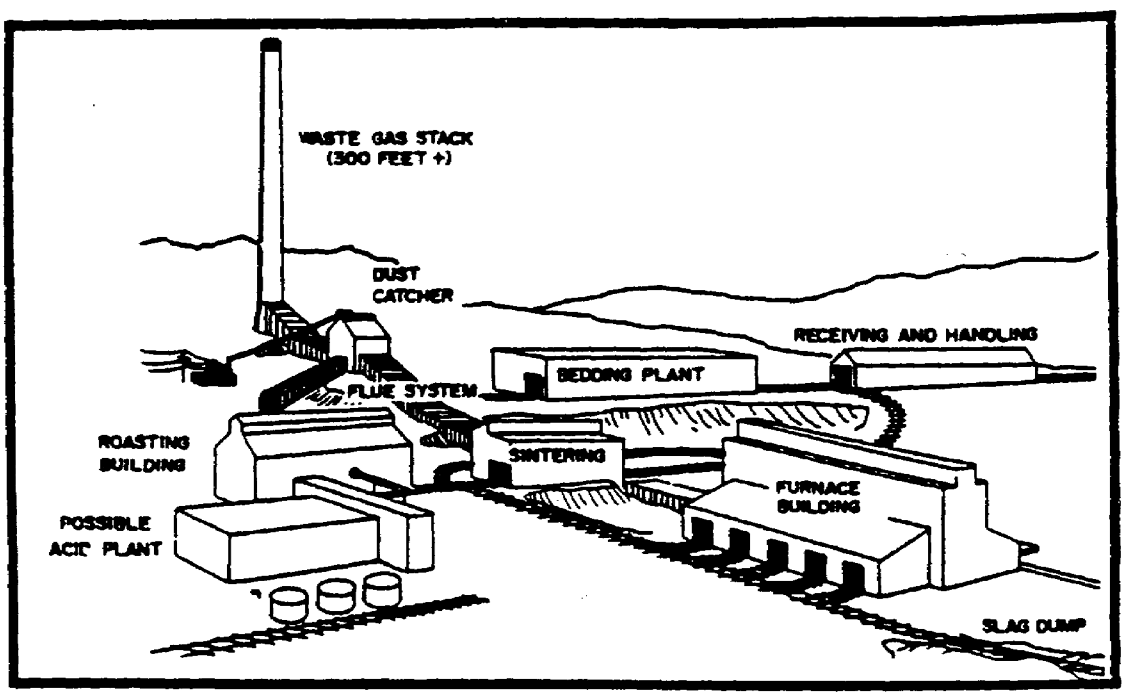


Figure 2-6. Ore Reduction Plant (Classical Smelter).

b. Ore reduction flow (electrolytic).

(1) Cryolite (a vital ingredient in the reduction of aluminum) and alumina (the basic raw material of aluminum) are received normally by rail and handled by conveyor to storage silos between the potline buildings.

(2) The third ingredient in the production of aluminum is carbon, which is formed into electrodes by a melting and molding process in the carbon electrodes and paste plant. The most frequently used source for this process is petroleum coke, which may either be stored in open stockpiles or in a storage building.

(3) All these ingredients are brought together in the electrolytic furnaces in the potline buildings. Cryolite is melted in the furnace by the passage of an electrical current; alumina is added and oxygen is released when the alumina melts. The oxygen combines with carbon from the electrodes to form carbon dioxide gas, which is vented. Molten aluminum is formed, tapped from the furnace, and made into ingots or pigs in the casting buildings.

NOTE: Large quantities of electricity are required to support this process. Therefore substation facilities and transformer yards will be present.

(4) Cryolite releases fluorine gas during the reduction process. This is recovered (fluorine recover) and reused in the synthetic production of cryolite. The fluorine recovery building is a good indicator of an ore reduction plant (Figure 2-7).

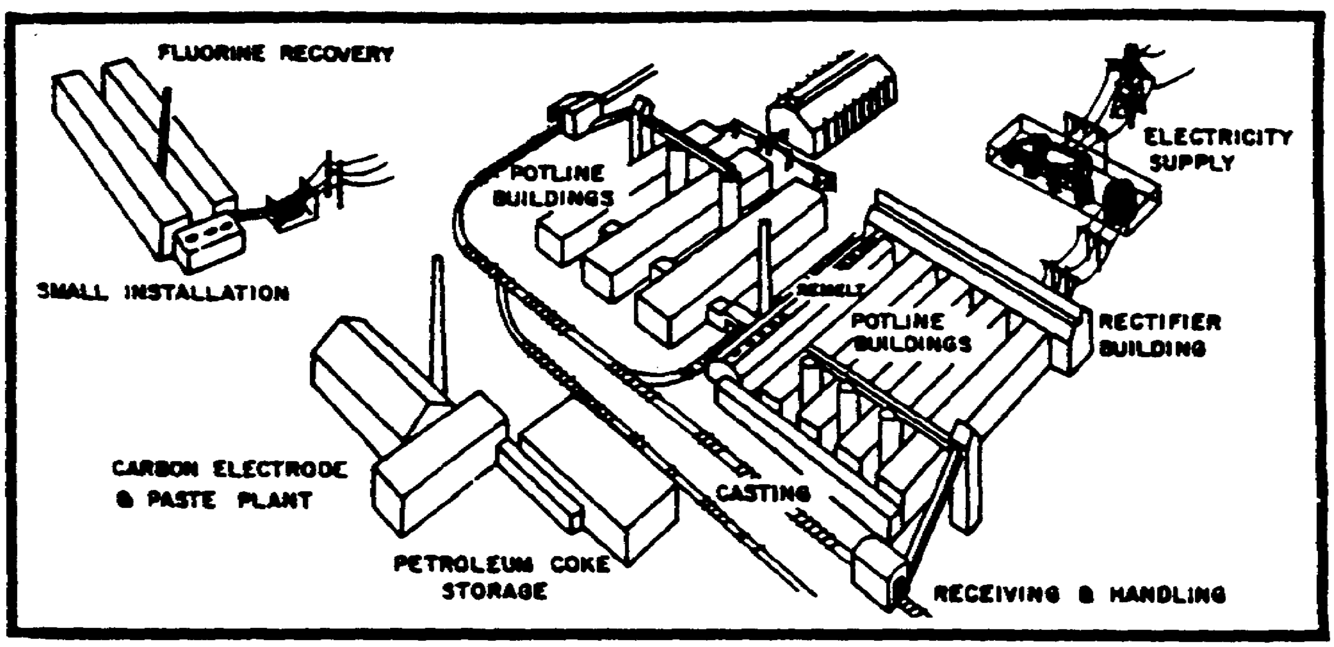


Figure 2-7. Ore Reduction Plant (Electrolytic).

c. Alumina processing industries. Aluminum metal cannot be smelted from its ore, or bauxite, using the same methods as for smelting other metals. Before aluminum can be produced, alumina must first be separated from waste impurities in bauxite ore. The separation method is called the Bayer alumina process and involves a chemical process.

(1) Major recognition features of alumina processing industries (Figure 2-8):

(a) Bauxite storage. Large, low shed, or open stockpiles. Rail or dock unloading facility nearby. Conveyor system linking it to crushing and grinding facility.

(b) Crushing and grinding building. Conveyor leading into it from storage shed. Dusty white appearance.

(c) Autoclave (Digester) building. Long building. Vents or stacks on roof. Steam lines leading into it.

(d) Filter press building. Long, low structure. May have sawtooth roof. Located between autoclave and precipitator buildings.

(e) Settling tanks. Large, low, open tanks. Located near filter press building.

(f) Precipitator building. Large, tall, rectangular structure with sawtooth roof. Contains a large number of tall, silo-like tanks.

(g) Rotary kilns. Long, pipe-like tubes. May have stack(s) associated.

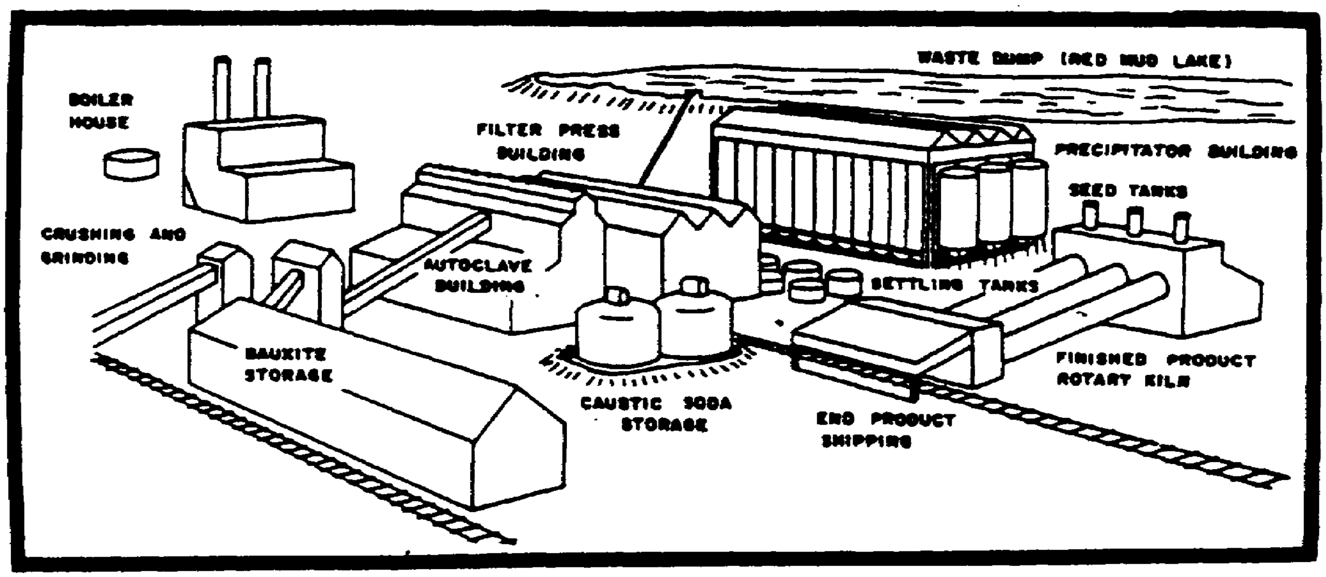


Figure 2-8. Alumina Processing.

(2) There are a number of secondary features in the alumina process that may cause some confusion and complicate analysis. These features include:

(a) Waste reprocessing facility for the capture of alumina that has slipped through the original processing and might have been discarded. This reprocessing facility will be readily identifiable by the presence of a second set of rotary kilns and settling tanks.

(b) Reprocessing of the diluted sodium hydroxide (caustic soda) solution left in the precipitator tanks after the removal of aluminum hydroxide crystals. This diluted solution is held temporarily in storage tanks near the precipitator building. The storage tanks may be confused with the seed tanks though the former are shorter and wider.

(c) From the storage tanks the diluted caustic soda solution is piped into evaporators where excess water is removed. These evaporators will be close to the storage tanks and will appear as small boilers complete with small stacks.

(d) After being treated in an evaporator, the newly concentrated caustic soda is pumped back into the concentrated caustic soda tanks near the autoclave building.

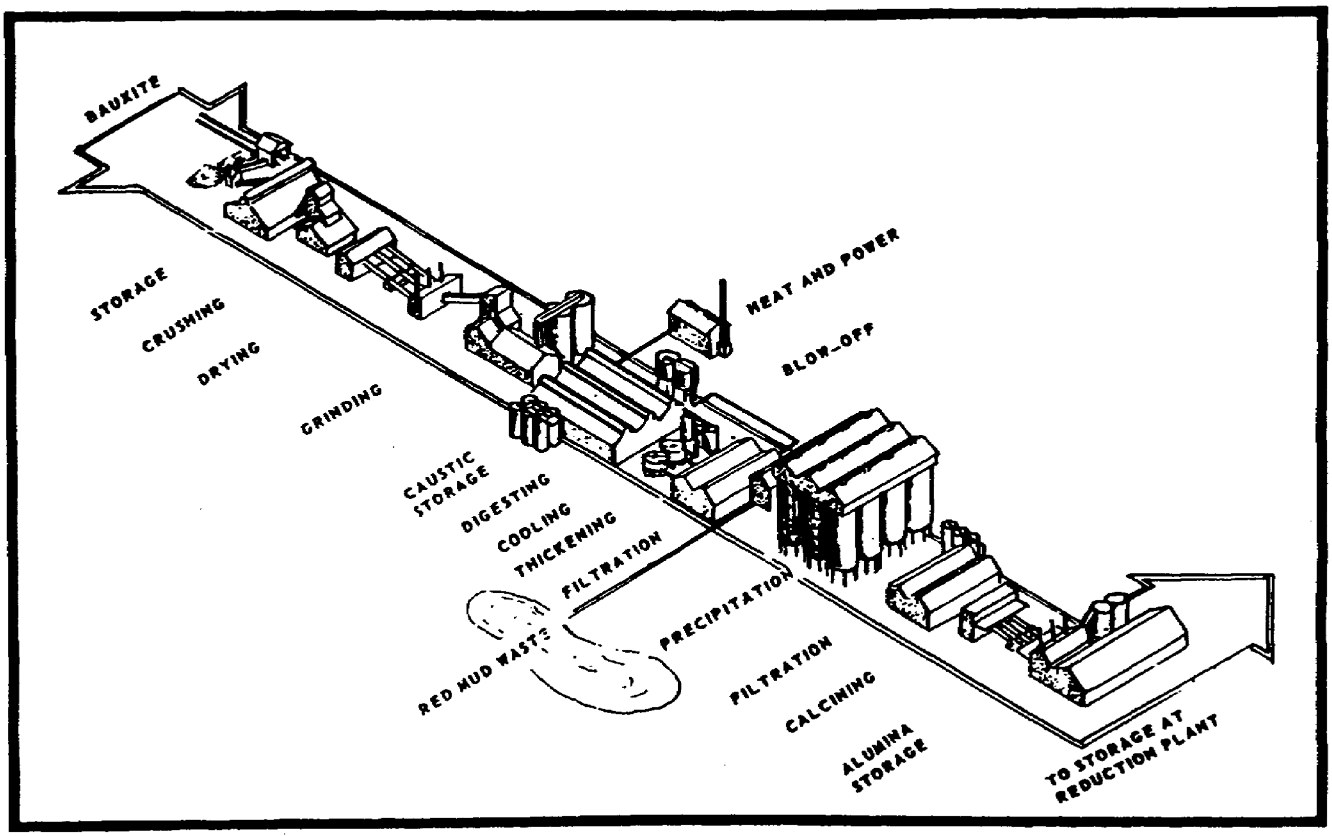


Figure 2-9. Alumina Processing Plant Flow.

(3) The alumina processing flow is described in the following paragraphs. Refer to Figure 2-9 as you read the following steps in the production flow.

(a) Bauxite is unloaded onto open stockpiles or stored in bins inside a large, long, low shed. A conveyor transports the ore to the crushing and grinding building where It is reduced to a fine powder.

(b) The powdered bauxite is conveyed to the digester building where it is mixed with concentrated caustic soda and cooked under steam pressure in an autoclave building. The concentrated caustic soda is stored in closed tanks adjacent to the digester building, and steam is supplied by a boiler house located nearby. Under the influence of heat and pressure the alumina dissolves from the ore and chemically bonds with water to form aluminum hydroxide. This then goes into solution with the caustic soda to create a sodium aluminate liquor. The waste impurities, primarily silica, and ferrous oxide, stay in solid suspension.

(c) The liquid is piped to the filter press building where porous metal filters remove the suspended impurities.

(d) The impurities are piped into settling tanks where water and caustic soda are recovered for reuse. The waste (red mud) is pumped to a waste pond and discarded.

(e) The liquid is passed to the precipitator building comprised of a series of large size and tall silo tanks and a large rectangular structure which is usually covered with a sawtooth roof. Aluminum hydroxide is precipitated out of the sodium aluminate liquid inside these tall silo tanks. Small granules of aluminum hydroxide (seed crystals) are introduced into the tank at the top and as they drift down, cause aluminum hydroxide to crystallize out of the solution and settle at the bottom. The seed crystals are supplied from seed tanks located adjacent to the precipitation building. Regularly, precipitated aluminum hydroxide crystals are drawn from the silo tanks and washed in settling tanks prior to being sent to the rotary kilns for drying. The caustic soda solution remains in the precipitator tank until it is needed for reuse.

(f) After being washed in settling tanks, the aluminum hydroxide crystals are conveyed to the rotary kilns. These are long, pipe-like furnaces mounted on an incline and slowly rotated on their long axis. Aluminum hydroxide is introduced at the upper end and is slowly tumbled down its length, drying, and in the process changes from a hydroxide to an oxide by the loss of oxygen and hydrogen. Alumina is taken out of the bottom of the rotary Kiln and sorted in silos or in an alumina storage building.

d. Aluminum reduction by the electrolytic process is shown in Figure 2-10. The removal of oxygen from alumina is performed electrolytically; large amounts of electric power, carbon, cryolite, and alumina are required to produce aluminum.

(1) Major recognition features of aluminum reduction (electrolyte process) (Figure 2-10):

(a) Substation. Connected to rectifier building by heavy copper bus bars (Annotation 1).

(b) Rectifier building. Long, single-story structure (Annotation 2).

(c) Carbon electrode and paste plant. Small with roof vents and a stack, dark appearance (Annotation 8).

(d) Large and small storage silos (Annotations 4 and 5).

(e) Pot lines/rooms. Long series within narrow, vented buildings (Annotation 3).

(f) Casting building (Annotation 6).

(g) Fluorine recovery units will be small boxlike objects located between pot lines and connected to them by pipes.

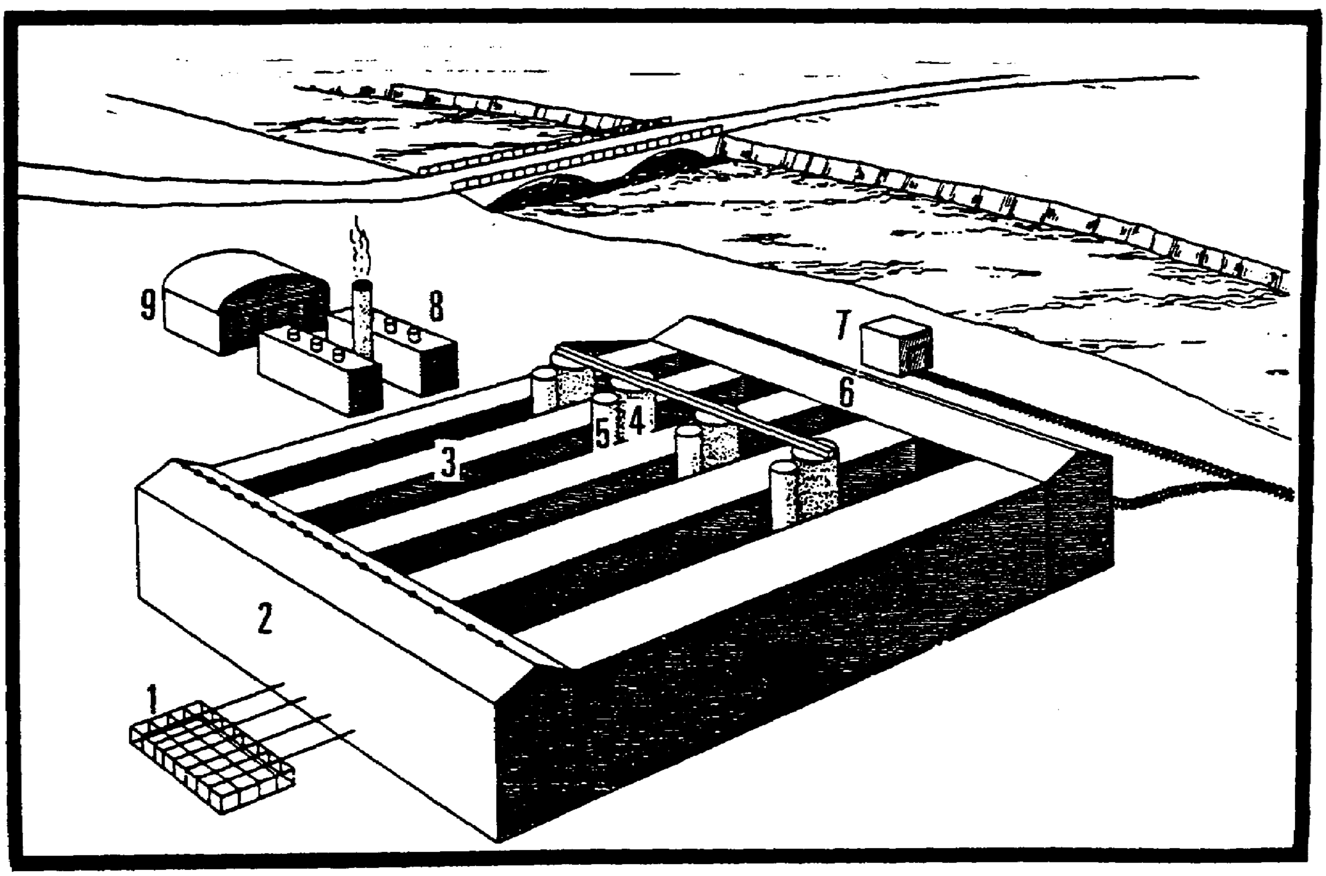


Figure 2-10. Aluminum Reduction-Electrolytic Process.

(2) The following processes are performed in structures annotated in Figure 2-11.

(a) The demand for large amounts of electric power means plants are often located near large hydroelectric power plants to take advantage of abundant cheap power (Annotation 1).

NOTE: 10 to 15 kilowatts of electric power are needed to produce one pound of aluminum metal.

(b) Alternating current (AC) from the source is received at the plant's substation (Annotation 1) and directed into a rectifier building (Annotation 2) where the AC current is converted to direct current (DC). Direct current is requisite for operating the electrolytic furnaces. Four pounds of bauxite ore are needed to produce two pounds of alumina, and two pounds of alumina are reduced in an electrolytic furnace to produce one pound of aluminum metal. The furnace uses carbon electrodes, and in the process of producing one pound of aluminum metal, 3/4 of a pound of carbon is consumed by the oxygen freed by the alumina.

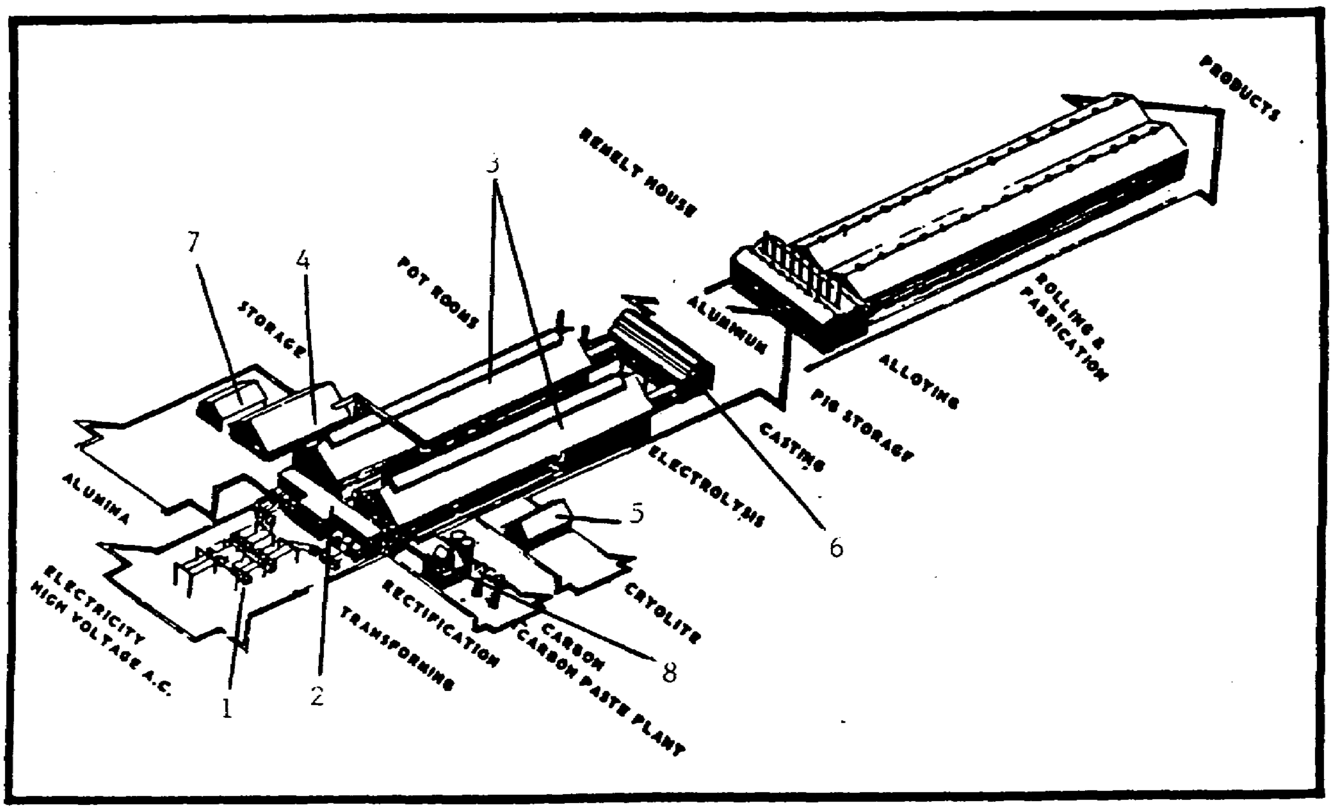


Figure 2-11. Aluminum Reduction Plant Flow.

(c) Most aluminum reduction plants manufacture their own carbon electrodes from petroleum coke. In the carbon electrode and paste plant (Annotation 8) purified petroleum coke is melted and poured into molds to form the electrodes.

(d) The petroleum coke can be stored either in open stockpiles or within a petroleum coke storage building (Annotation 9).

(e) Cryolite is usually synthetically produced either at a separate facility or in a facility collocated with the aluminum reduction plant. If cryolite is shipped to the reduction plant, it is unloaded at the receiving and handling building (Annotation 7) and conveyed to a series of small silos (Annotation 5) for storage.

(f) Alumina is transported from the alumina plant and unloaded at the receiving and handling building and from there conveyed into the large silos (Annotation 4).

(g) Electric furnaces, called pot lines or rooms, are the heart of the aluminum reduction plant (Annotation 3). These furnaces consist of insulated steel boxes, lined with carbon. Cryolite is the first raw material to be charged into the electrolytic furnace. Cryolite melts as the current is introduced; then alumina is added. As the alumina melts, it gives up its oxygen which, in turn, combines with the carbon electrodes to form carbon dioxide gas. The gas is vented out of the furnace while the liquid aluminum metal sinks.

(h) Periodically, the molten aluminum is tapped from the furnaces into a ladle and then poured into ingot molds in the casting building (Annotation 6). Once cooled, these ingots (or pigs) can be shipped to a mill or foundry for further processing.

(i) A fluorine recovery facility and a small internal combustion and/or thermoelectric power plant may be present. Cryolite releases fluorine gas during the reduction of alumina. This gas may be recovered and reused in the synthetic production of cryolite.

e. Magnesium reduction plants are limited worldwide and small and difficult to analyze. The process is accomplished by electrolysis (Figure 2-12).

(1) Magnesia is taken to pellet preparation where-it is mixed with various materials. The pellets are then melted in the presence of chlorine gas and magnesium chloride is formed. This is then, placed in the electrolytic cells in the presence of hydrogen and heated, allowing the oxygen and chlorine to be freed, leaving pure magnesium. The magnesium is normally cast for shipping in the electrolysis building.

(2) Low voltage direct current is required for the electrolytic process, which is obtained from conventional sources. Rectification to direct current will be accomplished in an annex to the electrolysis building.

(3) Waste material in this process is treated to neutralize the acids and then dumped.

(4) A chlorine plant may be found in association with magnesium reduction.

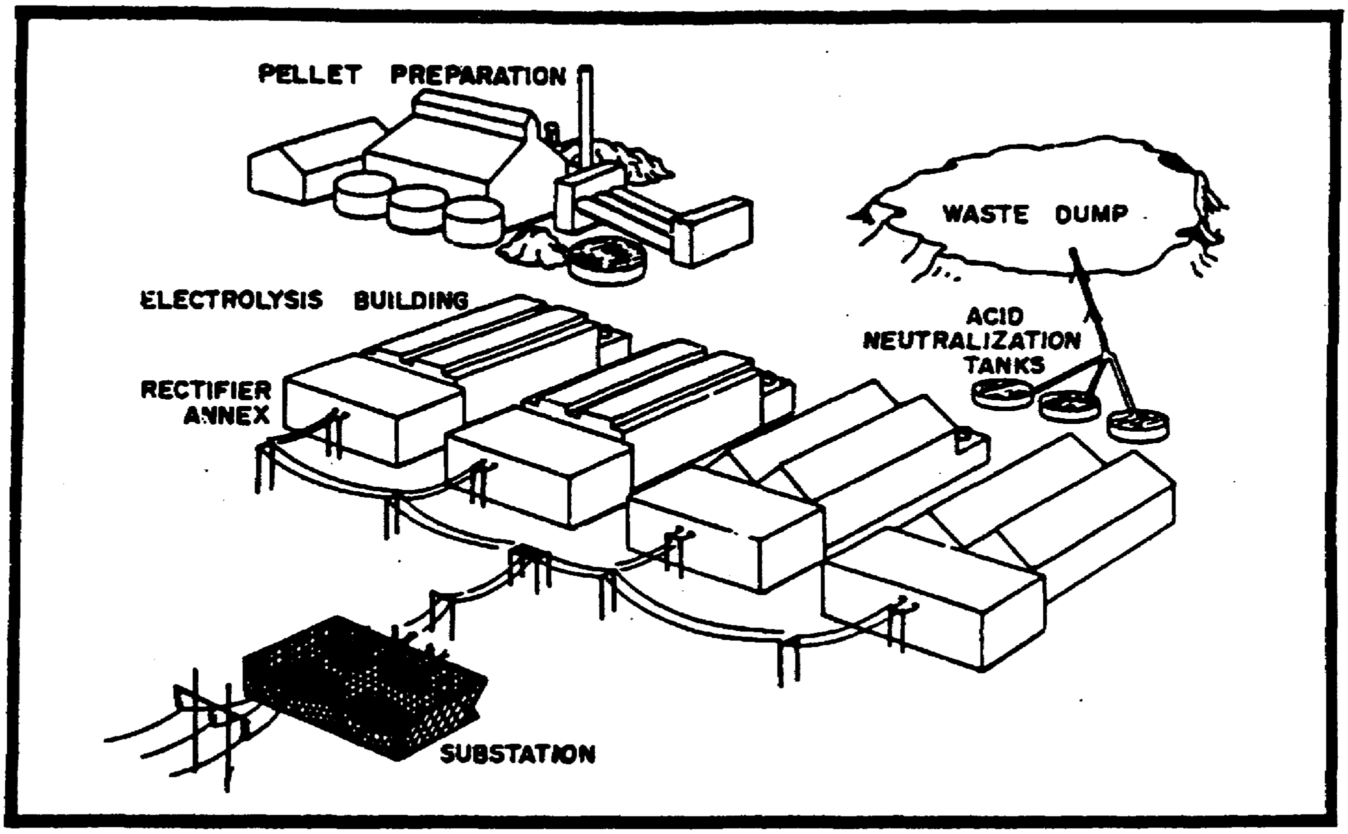


Figure 2-12. Ore Reduction Plant (Carbothermic Magnesium).

f. Ore concentration is used to raise the percentage of metal in the ore to a point where melting becomes economical (Figure 2-13).

(1) The ore is crushed to the consistency of flour and a chemical reagent is added, which coats the metal and not the impurities.

(2) The ore and reagent mix is then taken to the concentration/flotation building and placed in a vat containing water. Air is pumped through the mixture for agitation.

(3) The waste material becomes saturated and sinks to the bottom of the vat while the lighter coated metal floats to the top and is removed.

(4) The concentrated ore is then washed in settling tanks to remove the reagent prior to filtering and drying the shipment.

(5) The waste material is removed from the vats and sent to the tailings/dewaterers (dorr thickeners) where excess water and reagent are removed for reuse.

(6) The waste material is moved to the dump.

(7) Settling tanks are normally the most outstanding image components in identifying an ore concentration plant.

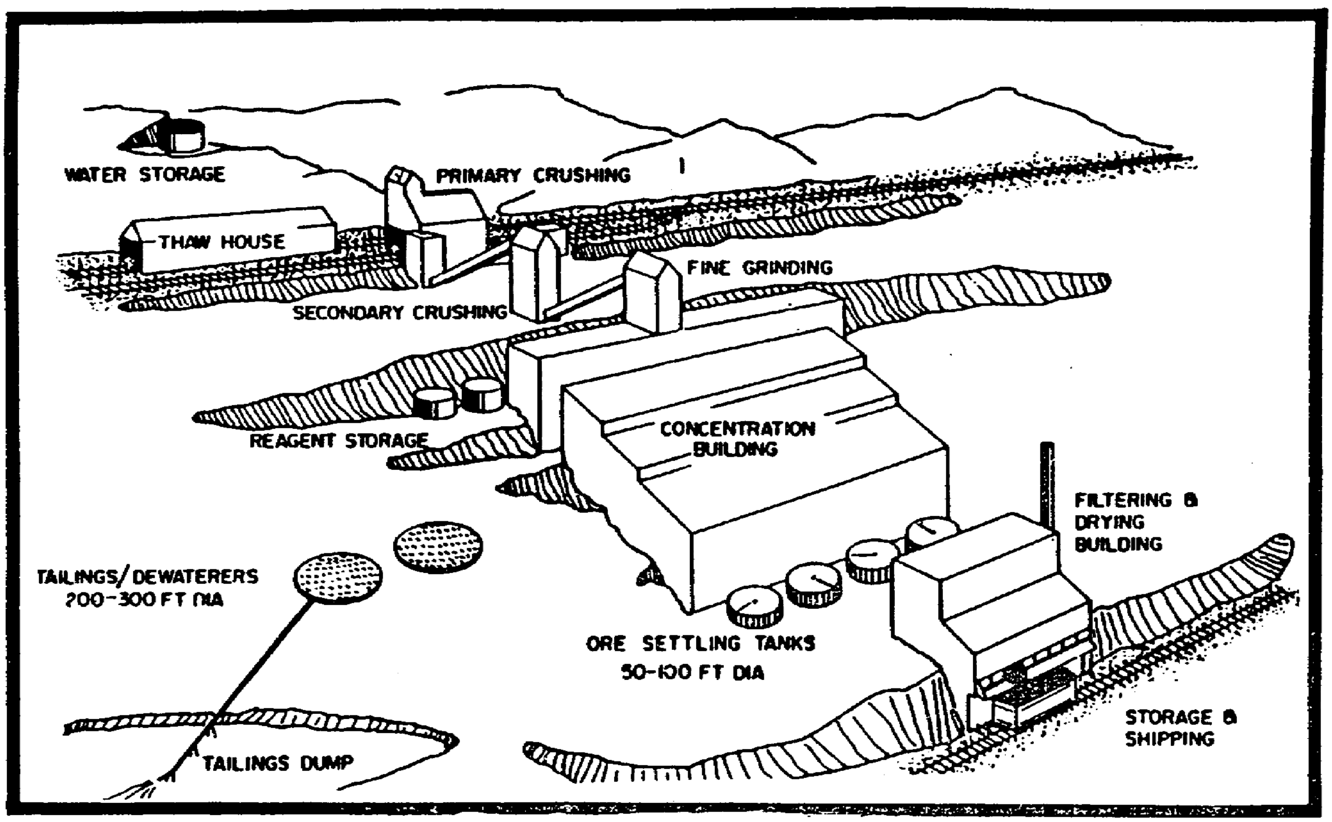


Figure 2-13. Ore Concentration (Benefication).

g. The horizontal retort smelter (Figure 2-14), is used exclusively for the reduction of zinc. Zinc has the unusual property of vaporizing only a few degrees above its melting temperature and is, therefore, obtained from ores by vaporization in a retort furnace. Both electrolytic and blast furnace methods may also be used for zinc production.

(1) The ore is received and stored prior to roasting, in which process sulfur is removed from the ore and zinc sulfide is converted into zinc oxide. Some plants may also sinter the ore before proceeding to the reduction process.

NOTE: Flue gasses from the processes may be treated to remove either zinc oxide or cadmium metal, or in some plants, both. A sulfuric acid plant may also use the flue gases for acid production.

(2) The treated ore is then moved to a mixing building, where is it is mixed with pulverized coke or coal and stored to await reduction.

(3) The prepared ore and fuel mix is then placed in the retort furnace, and zinc is obtained by vaporization and from its ore's condensation. In this process a slag is formed, and this will frequently be visible in association with each furnace building.

NOTE: As both the retorts and condensers are made of clay and subject to constant thermal stress and handling, they frequently need replacing. Many horizontal retort smelters will, therefore, have their own pottery plants for the production of these items.

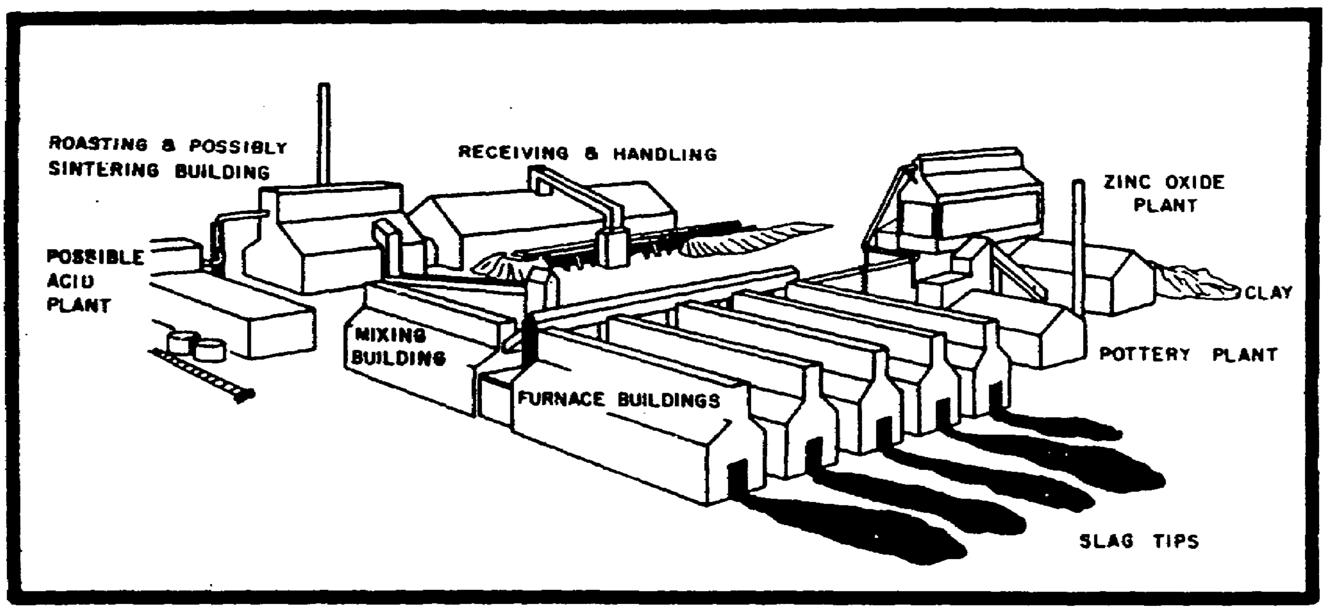


Figure 2-14. Ore Reduction Plant (Horizontal Retort Smelters).

4. Sugarbeet and cane sugar refining, hydroelectric power, cinder block, coal briquetting, gravel, grain milling, ready-mix concrete, sawmill, sewage and water purification, wood preserving, and wood working are also primarily considered mechanical industries.

a. Specific features which should help you quickly identify these industries are listed in Figure 2-15.

INDUSTRY	KEY ID FEATURES
Beet and Cane Sugar Refining	Silos or bunkers, Processing buildings, Molasses tanks, Warehouses, Boilerhouses, Multistory buildings
Hydroelectric Power	Dam, Generator hall, Transformer yard
Cinder block, Concrete	Crushing buildings, Piles of concrete blocks, Sand and gravel piles, Conveyors, Mixing equipment
Coal briquetting	Coal storage piles, Crushing buildings, Conveyors
Gravel	Conveyors, Storage piles
Grain milling	Conveyors, Silos
Sawmill	Log conveyors, Water tower, Logs, Lumber, Sawmill
Sewage and water purification	Sedimentation tanks, Pumping stations, Incinerator buildings, Resevoirs
Wood preserving and Wood working	Lumber, Processing buildings, Rail cars

Figure 2-15. Key Identification Features.

b. Examples of specific industries and their key features are located on the following pages (Figures 2-16 thru 2-28).

(1) Beat and cane sugar refining plant consists of silos, bunkers, processing buildings, molasses tanks, warehouses, and boiler houses (Figures 2-16 and 2-17).

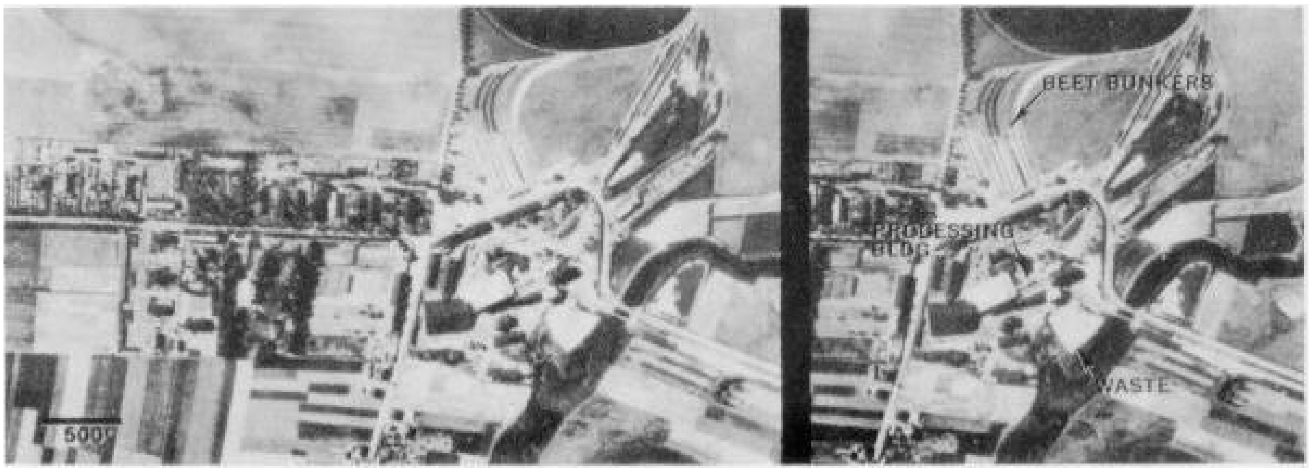


Figure 2-16. Sugar Beet Refining.

NOTE: The light tone of the waste is caused by the lime used to precipitate impurities in one of the refining processes. These impurities are filtered from the sugar syrup and discarded.

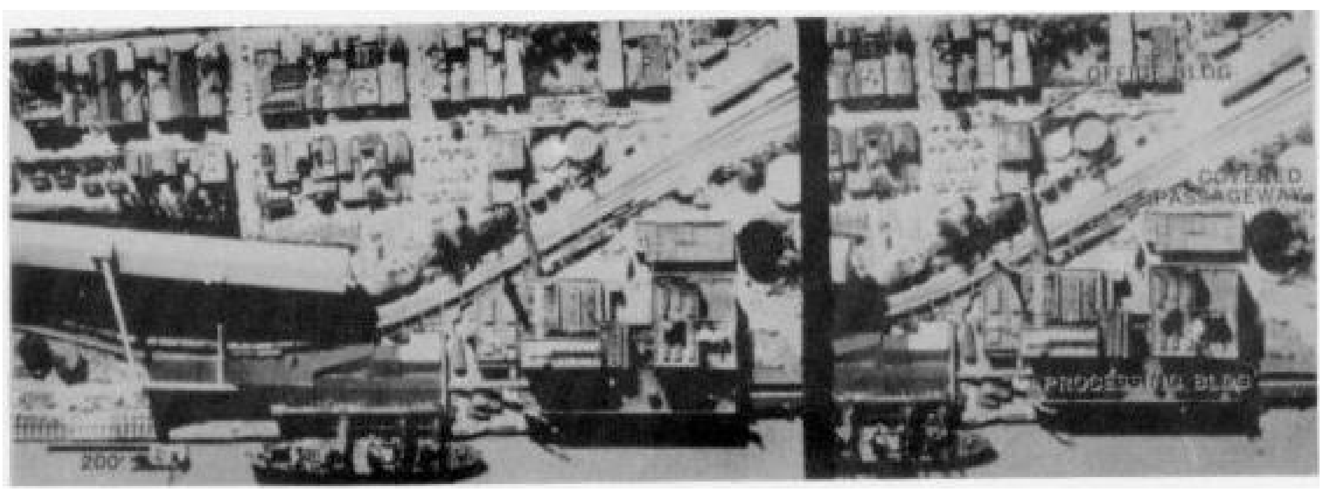


Figure 2-17. Cane Sugar Refining.

NOTE: The flat roof, multistory brick building houses the offices of the plant. A covered passageway extends to the large processing building. The office building and adjacent parking lot are located to one side of the plant area.

(2) Hydroelectric Power. Specific identification features include dams, generator halls and transformer yard (Figure 2-18).

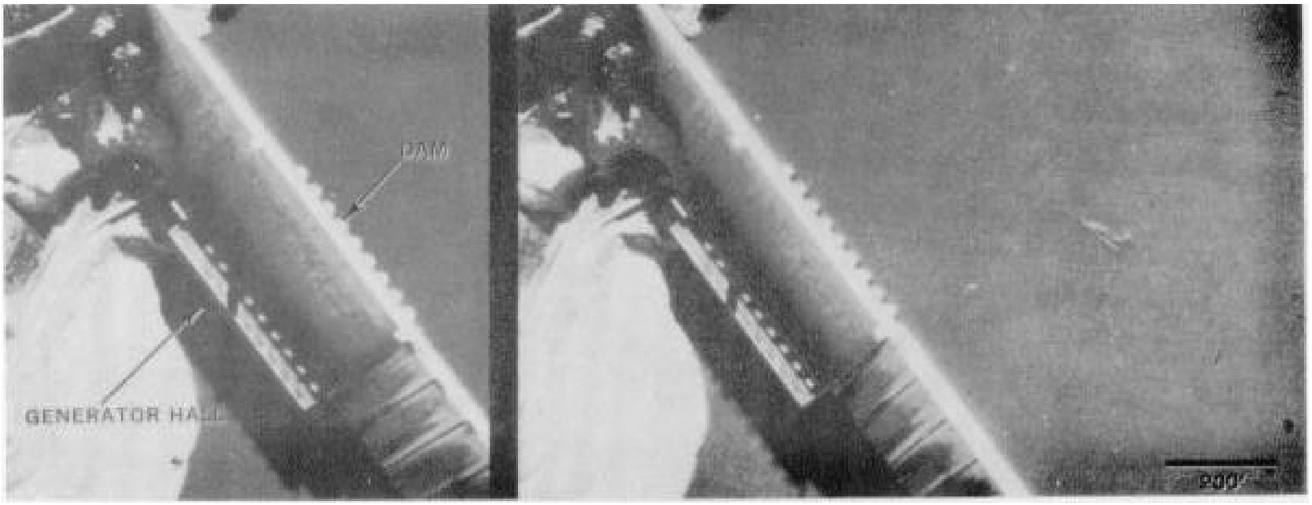


Figure 2-18. Hydroelectric Power Plant.

NOTE: The flat roof building, parallel with the dam, houses the turbines and generators. Power lines from the standards on the roof transmit the current to an adjacent transformer yard.

(3) Cinder block and concrete plants. Specific identification features include mixing equipment, concrete blocks, conveyors, and sand and gravel piles (Figures 2-19 and 2-20).

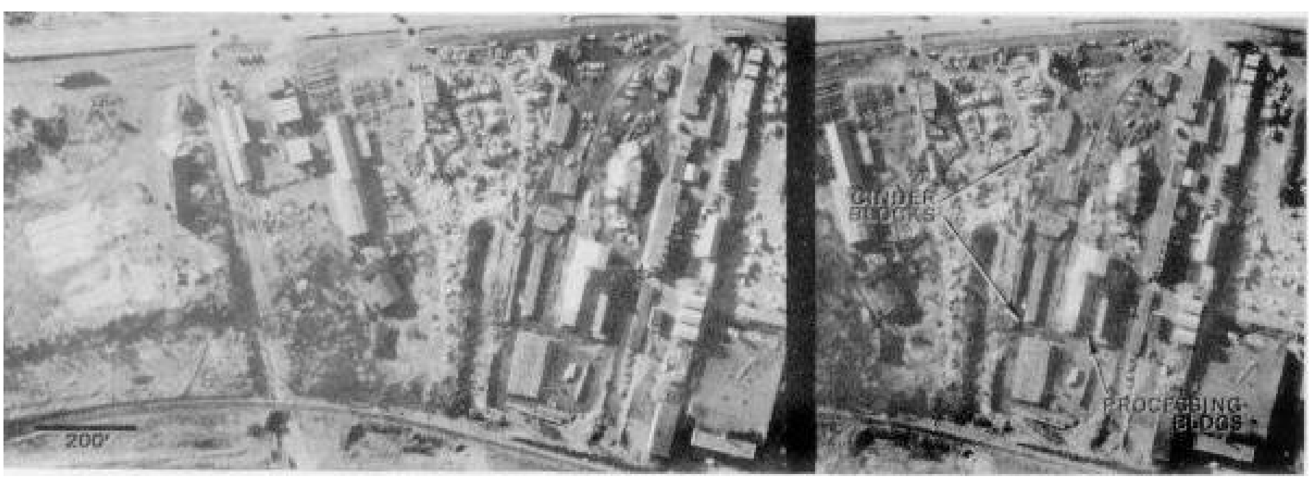


Figure 2-19. Cinder Block Industry.

NOTE: Cinder blocks are cast and cured in the processing building and then stored in the open in large compact stacks.

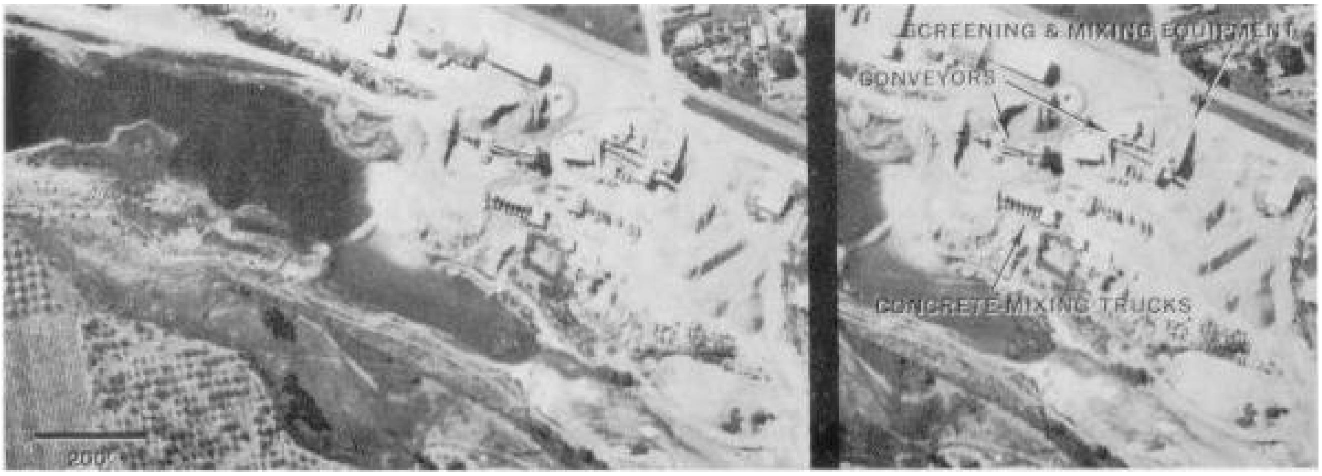


Figure 2-20. Concrete Plant.

NOTE: Sand and gravel are carried to these two tall structures by conveyors and trucks. Sand, gravel, cement and water are dumped into concrete mixing trucks, which mix the concrete and transport it to the construction site.

(4) Coal Briquetting. Specific identification features include coal storage piles, conveyors, and crushing buildings (Figure 2-21).

Figure 2-21. Coal Briquetting Plant.

NOTE: Briquetted coal from the drying chambers is cooled and stored in cooling and storage building for use in the adjacent synthetic oil plant.

(5) Gravel. Specific identification features include: gravel storage piles, conveyors, and hoppers (Figure 2-22).

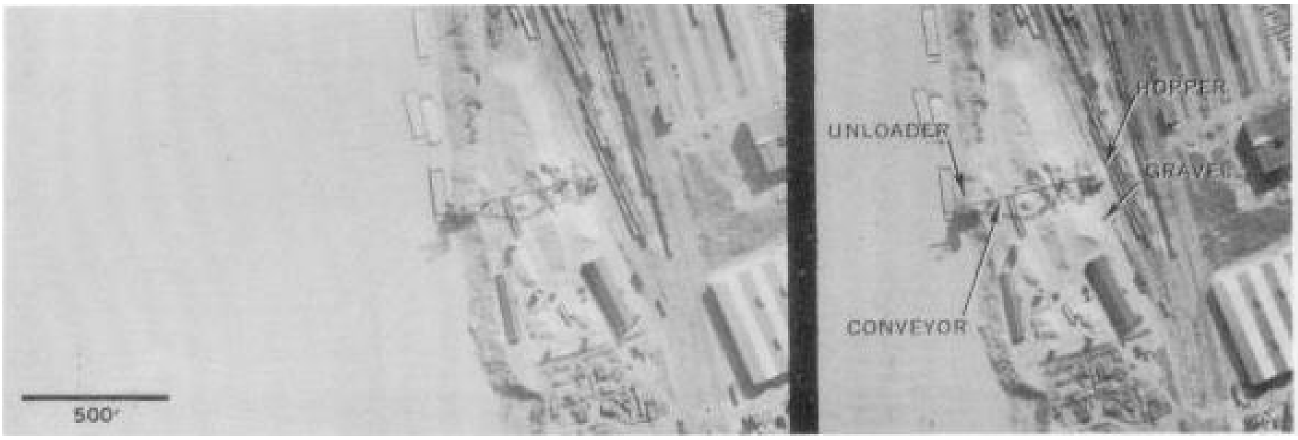


Figure 2-22. Gravel Sites.

NOTE: Gravel, either from the stockpile or directly from the barges, is loaded into the gravel hopper, which is the square elevated container. Railroad gondola cars pass beneath the hopper on three rail lines, and gravel is dumped into them.

(6) Grain Milling. Specific identification features include: silos, conveyors, and grain mill (Figure 2-23).

Figure 2-23. Grain Mill.

NOTE: Grain is conveyed from the silos to be processed in the grain mill, which is a tall, flat roof building. The height provides for the gravity flow of grain and milled products from floor to floor.

(7) Sawmill. Specific identification features include log and lumber piles, log conveyors and sawmill (Figure 2-24).

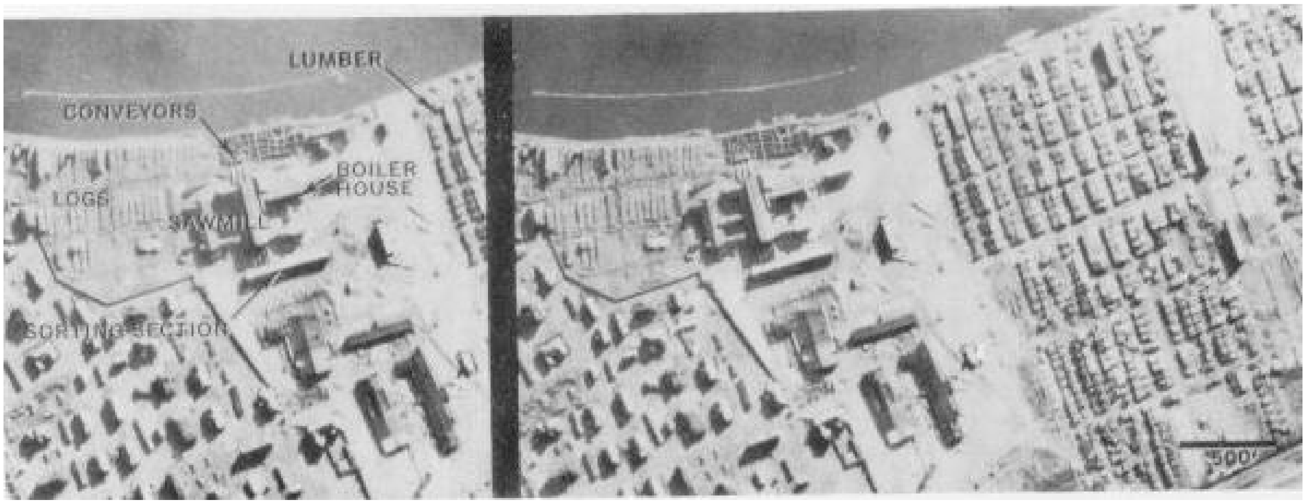


Figure 2-24. Sawmill.

NOTE: Logs from the river or from storage enter the sawmill on three conveyors, and cut lumber passes to the sorting section at the other end. On one side slabs are cut into usable lumber; on the other is a boiler house.

(8) Sewage disposal and water purification. Specific identification features include sedimentation tanks, pump houses or stations, incinerator buildings and reservoir (Figure 2-25 and 2-26).

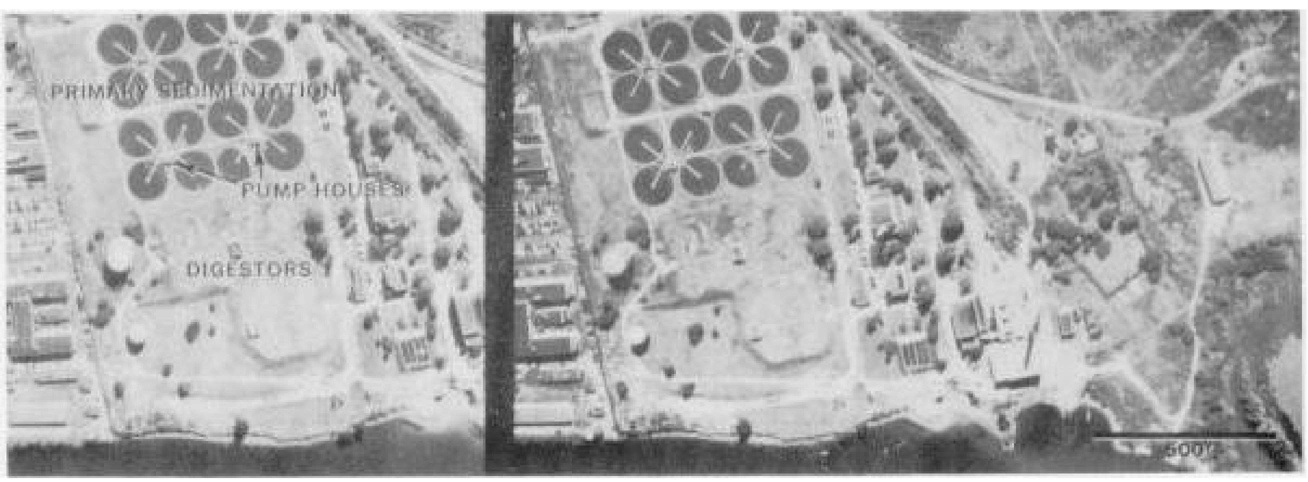


Figure 2-25. Sewage Disposal.

NOTE: Pump houses are small, flat roof buildings which shelter pumping equipment which handles the sewage.

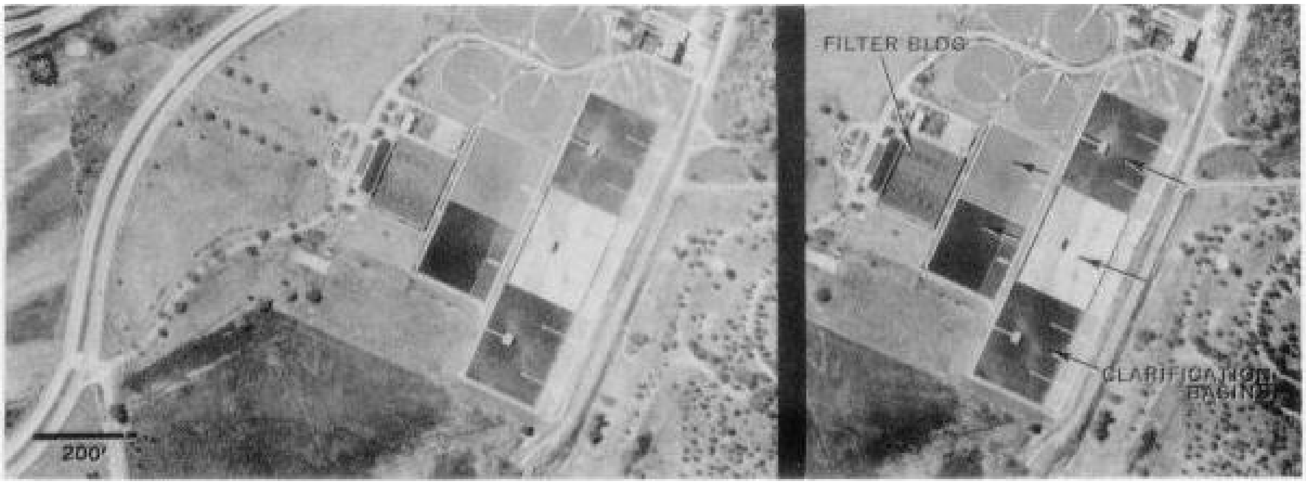


Figure 2-26. Water Purification.

NOTE: Water from the clarification basins goes to the rapid sand filter building which is rectangular. In this building water is pumped through sand filters to remove any remaining suspended material. The filtered water is then stored in a buried reservoir.

(9) Wood preserving and woodworking. Specific identification features include lumber, railcars, processing buildings and sawdust piles (Figures 2-27 and 2-28).

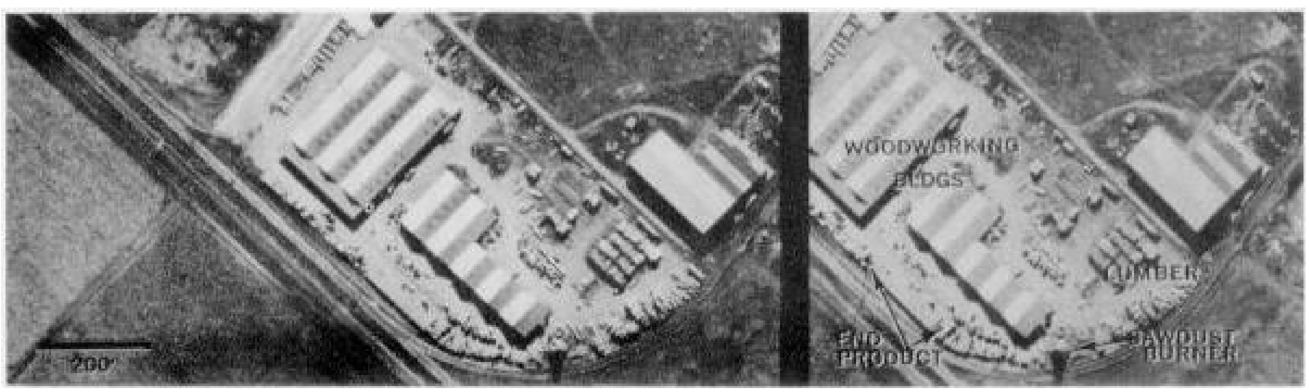


Figure 2-27. Woodworking.

NOTE: Buildings at woodworking plants are distinctive and may vary in form and size. Here, as is common, they are of light construction and have gable roofs. The open storage of lumber and the box-like end products, as well as the sawdust burner identify the plant.

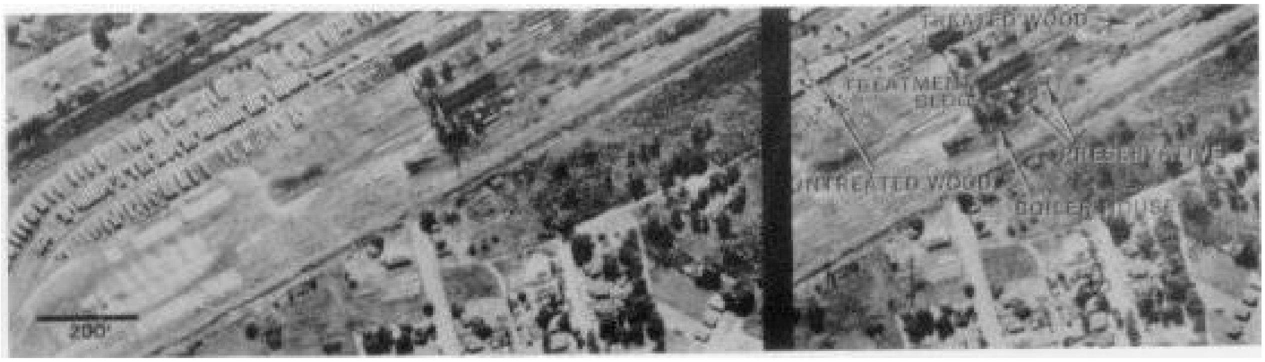


Figure 2-28. Wood Preserving.

NOTE: The wood treatment building has a monitor-type roof with rail lines entering it. It houses pressure cylinders in which wood is impregnated with liquid preservative. The building is recognized by the associated components: preservative tanks, stores of dark-toned treated and light-toned untreated wood, boiler house, and rail lines.

PART C: CHEMICAL PROCESSING INDUSTRIES

1. <u>Chemical processing industries</u> are those which use chemical processes to separate or rearrange the chemical constituents of raw materials, pressure, heat, and catalysts, or other chemicals are usually employed. General recognition features are:

- o Many closed or tall tanks or gas holders
- o Large complex buildings
- o Numerous pipelines with heat loops
- o Buildings are interconnected by pipelines (closed fluid flow)
- o Large outdoor processing equipment - towers
- o Provisions for large quantities of power of heat.

2. The <u>image components</u> are divided into three major categories: equipment, buildings, and open storage and waste.

a. Equipment is present under the following headings: chimneys, stacks, and vents; cooling towers; kilns; silos, tanks, hoppers, and bunkers; pipelines, conveyors, cranes, and mobile equipment; and complex equipment.

(1) Chimneys, stacks, and vents all serve similar purposes (as in mechanical processing industrious) --to dispose of heat, waste gases, and fine dust. Stacks are built of masonry or sheet metal, and vary in diameter and height. In many chemical plants stacks are common and help identify a single building or piece of equipment, such as boiler houses and pipe furnaces. Vents are common on processing buildings and dispose of heat, dust, and fumes (Figures A1 thru A10).

(2) Cooling towers are tall and narrow, rectangular, or polygonal. Water is cooled by exposure to the air and by evaporation in these structures, and then reused. The cooled water is then reused (Figures A-11 and A-12).

(3) Kilns are used to dry bulk materials. Rotary kilns look like slightly inclined tanks or long tubes, while vertical kilns appear as complex towerlike, tanklike, and boxlike structures (Figures A-13 thru A-16).

(4) Silos, tanks, hoppers, and bunkers are used for storage; some tanks have processing functions. Silos, tall, covered cylindrical containers, hold dry bulk materials. Tanks are subdivided into closed vertical, closed horizontal, and open. Covered round tanks hold a wide range of liquids as well as gases in specially designed gasholders. Horizontal tanks with round ends usually hold gases under pressure. Most of the low open tanks are used for processing. Spray ponds are usually square or rectangular. Tanks associated with other components aid in identification. Hoppers and bunkers hold bulk goods temporarily and reveal the flow of materials (Figures A-17 thru A-37).

(5) Pipelines, conveyors, cranes, and mobile equipment are used to handle or transport materials. Pipelines are found in all chemical plants and frequently seen in large numbers. Conveyors, either inclined or horizontal, housed or open, handle bulk materials between storage areas and processing buildings. They usually appear wider than pipelines and have flat surfaces. Cranes handle bulk raw materials such as coal, bauxite, and oyster shells (Figures A-38 thru A-52).

(6) Complex equipment is frequently used in chemical plants; it appears towerlike, tanklike, or boxlike. Towerlike equipment is represented by gas retorts and shell stalls. Boxlike equipment includes hydrogenation stalls (Figures A-53 thru A-59).

b. Buildings are divided into three subdivisions based on function. These three subdivisions are processing, storage, and administration. The image components are different for each subdivision. Certain buildings in association with other image components will provide the identity of the industry.

(1) Processing buildings are divided on the basis of relative size into small, medium, and large. The majority of them are not distinctive, although many can be identified in association with adjacent image components (Figures A-62 thru A-73).

(2) Storage buildings usually are served by rail lines or roads, and their images are not as complex as those of processing buildings (Figures A-74 and A-75).

(3) Administrative buildings usually are built to one side of the plant area near the main entrance and served by walks, driveways, and parking areas. The grounds around them may be landscaped and parking areas are provided for small-type automobiles (Figures A-76 and A-77).

c. Open storage and waste may appear either as piles or ponds. Piles range from orderly stacks of pulpwood and sulfur to irregular piles or pyrite waste and limestone. Ponds may contain red mud and waste calcium chloride. This class is very useful in analyzing an industry (Figures A-78 thru A-81).

REMEMBER: The image components for complex equipment are of primary importance in analyzing chemical processing industries. Many of the tanks, both open and closed, used for storage and processing aid in identification. Open storage and waste are helpful in confirming the analysis of an industry. Pipelines and conveyors are especially useful when analyzing the succession of processes and operations.

3. Petroleum, Oil, and Lubricants (POL) Industries are all processing industries. Additionally, they are vital economic and military assets. Fuel, lubricants, plastics, various chemicals, and explosives are all derived from crude oil. Petroleum refineries are the prime targets within the industry since oil is worthless unless processed.

a. Refineries are one of the most complex and difficult targets to analyze accurately. Many important image components are small in size, and their supporting steel frameworks and myriads of piping tend to obscure them. Furthermore, the analysis of refineries is complicated by the nonlinear flow of the refining process itself.

b. In the industries previously discussed in this lesson, the flow of the processes involved has been linear; in other words, each step in the industrial process followed another. The arrangement of buildings and facilities in these industries reflects this linear flow. However, the flow of a refinery is much more intricate. The flowchart on the next page (Figure 2-29) illustrates this complexity. Items may be shunted from one process to another, skipping one step, bypassing another. Use the flowchart as an aid to visualizing the relationship between processing units during the detailed discussion of the various refining components.

c. A refinery is a custom-designed installation made to handle a particular type of crude oil, using certain techniques to produce particular products. A refinery layout may appear as a random side by side of components with the various important units scattered throughout the installation. With careful analysis, however, the IA can accurately recognize the functional areas of the plant.

d. Refining processes and specific components are discussed in the following pages. You should be able to understand the processing flow and specific identification features belonging to the refining process to help analyze the industry.

(1) Refining process. Crude oil is a mixture of a number of different hydrocarbons, long chains of hydrogen and carbon atoms linked together in various combinations. Each of these hydrocarbons has unique characteristics and can be put to a special use once separated from the others and purified.

(2) Petroleum refining is the process of separating and purifying the individual hydrocarbons in crude oil. The key to this operations is "boiling points." Each of the hydrocarbons has a different temperature at which it boils, thereby turning from a liquid to a vapor. Some, like the simple hydrocarbons methane, ethane, propane, and butane, has boiling points below normally atmospheric temperatures and, therefore, are normally found in the gaseous state. Others, like the heavy, complex, viscous molecules of asphalt, must be raised above 1,000° F before they will vaporize.

(3) Primary or crude distillation is the breakdown of crude oil into its basic hydrocarbon constituents. This is the first step in the refining of crude oil. The principal products of primary distillation are: light gases, low-grade gasoline, kerosene, diesel oil, heavy gas-oil, wax-oil, and a thick hydrocarbon residue.

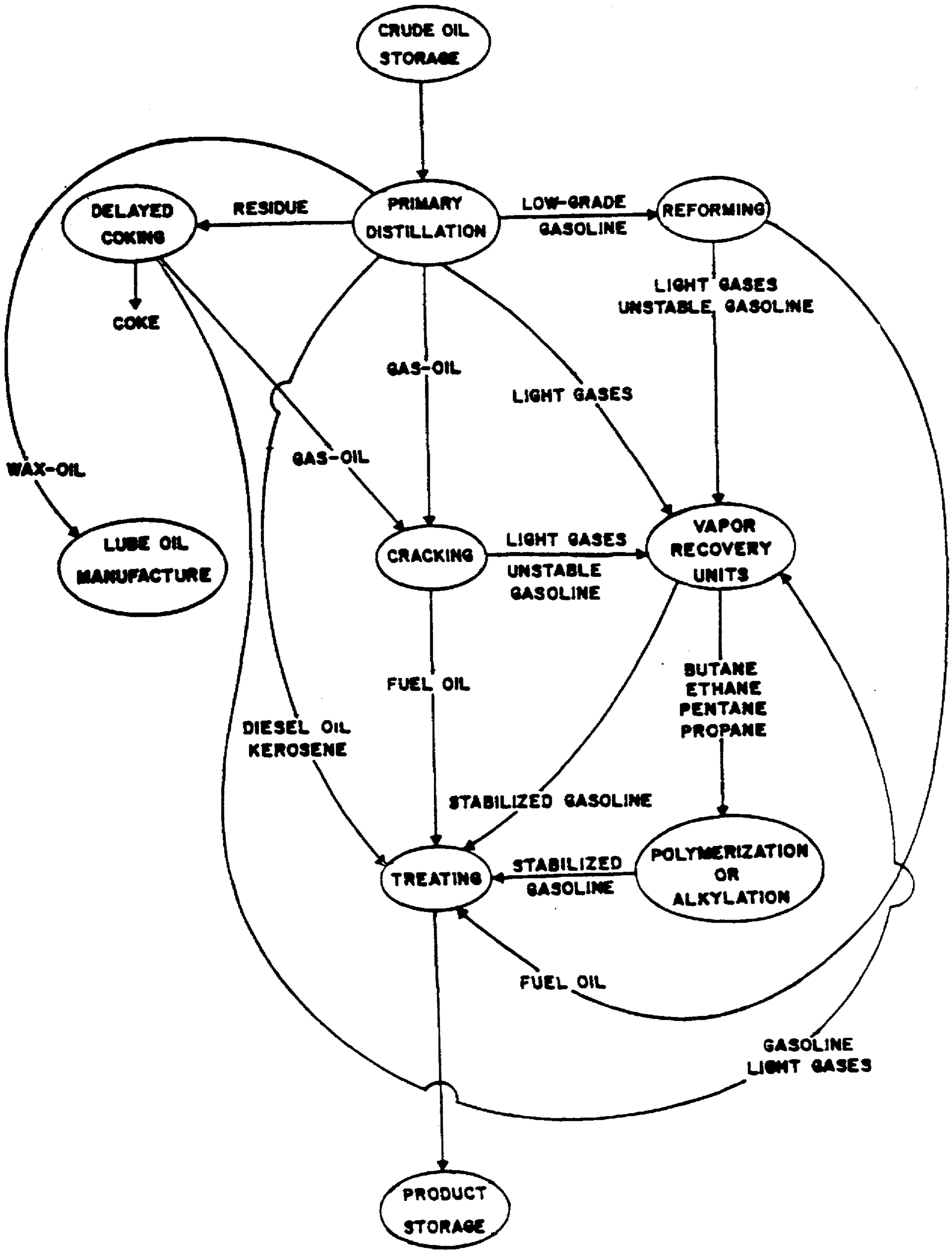


Figure 2-29. POL Production Flow.

(4) Primary distillation occurs in vacuum pipe stills. Heavy hydrocarbons will not boil at safe temperatures under atmospheric pressure. To distill them, a partial vacuum in created within the fractionating column. The special fractionators, called vacuum pipe stills, are easily recognized by their short, thick shape. They will appear very much like large "thermos bottles" sitting next to a pipe furnace (Figure 2-30). Major recognition features of vacuum pipe still include:

- One or more pipe furnaces
- One of more large fractionators
- Control building
- A small cooling/condensing pond
- Possibly an electric substation.

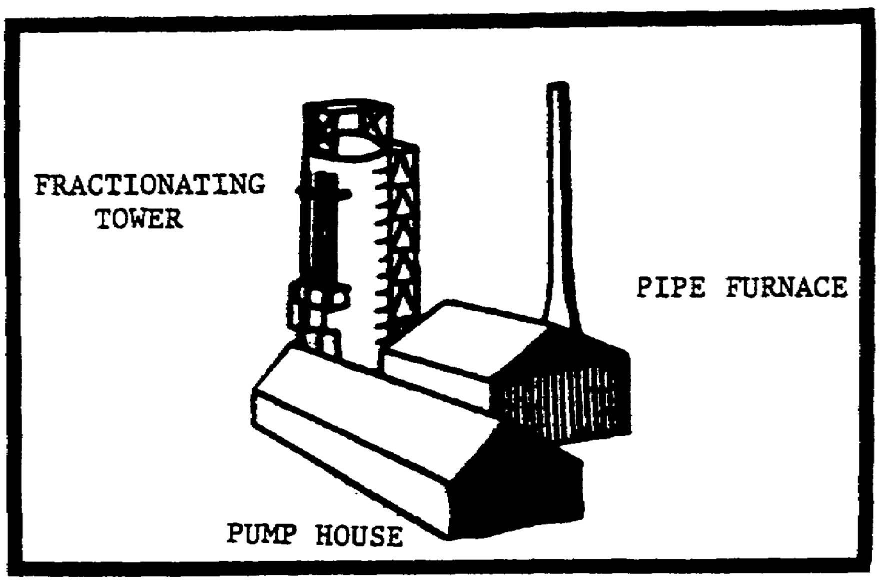


Figure 2-30. Vacuum Pipe Still.

(a) Pipe furnaces. First, the crude oil is heated in a pipe furnace (Figure 2-31). Here the crude oil is routed into an enclosed structure which contains a radiator like arrangement of piping and a burner. Oil is heated to a high temperature by the burner as it flows through the piping labyrinth. However, the hydrocarbons are prevented from vaporizing by the considerable pressure at which they are contained.

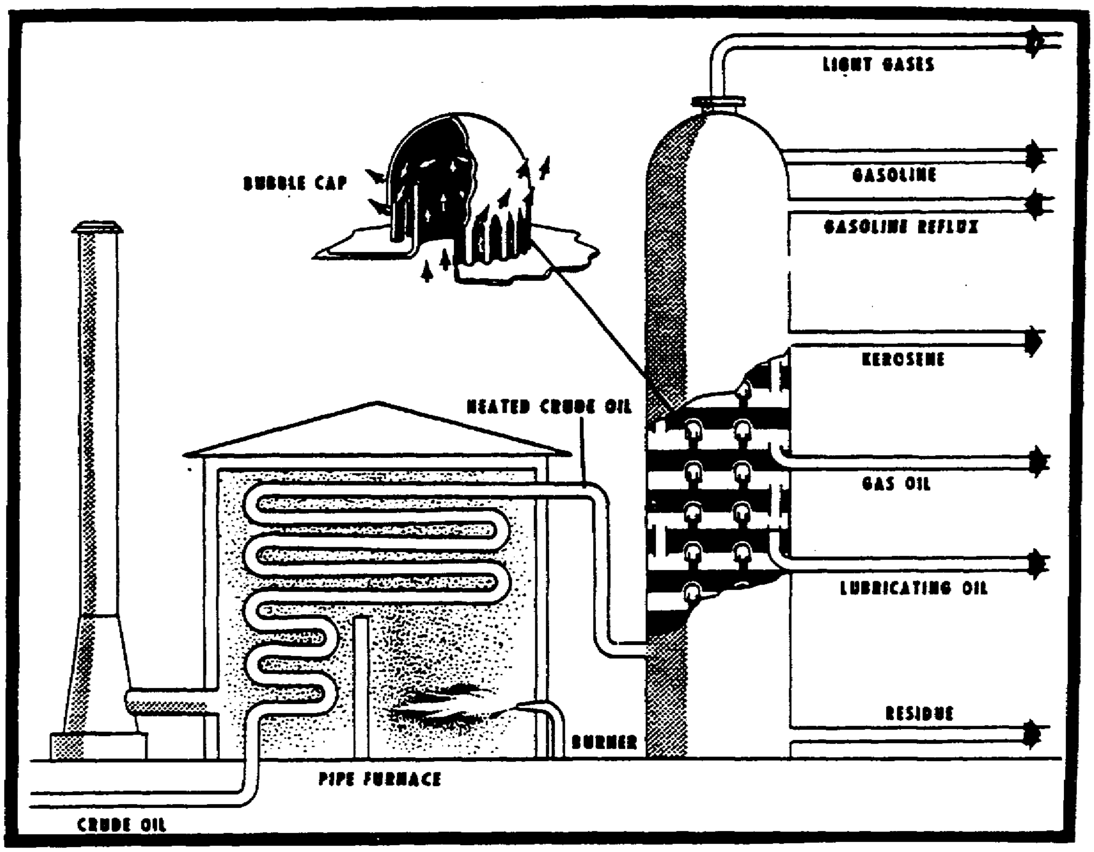


Figure 2-31. Pipe Furnaces.

(b) Fractionator. The oil is then discharged into the fractionator (also called fractionating column or distilling unit). The pressure is suddenly released and it flashes into a mixture of vapors. Cold gasoline (gasoline reflux) is piped into the top of the tower, cooling it and thus creating a temperature gradient: very hot at the bottom and growing cooler closer to the top. Specific hydrocarbons will condense out as they rise to a level with a temperature corresponding to their boiling point. They can then be piped out of the distilling unit for further processing. The typical fractionator is a tall, steel tower filled with perforated steel trays dividing it into sections (Figure 2-32). Gases can pass up through the perforations and the bubble caps, but the raised rims inside the bubble caps prevent condensed liquids from draining back down.

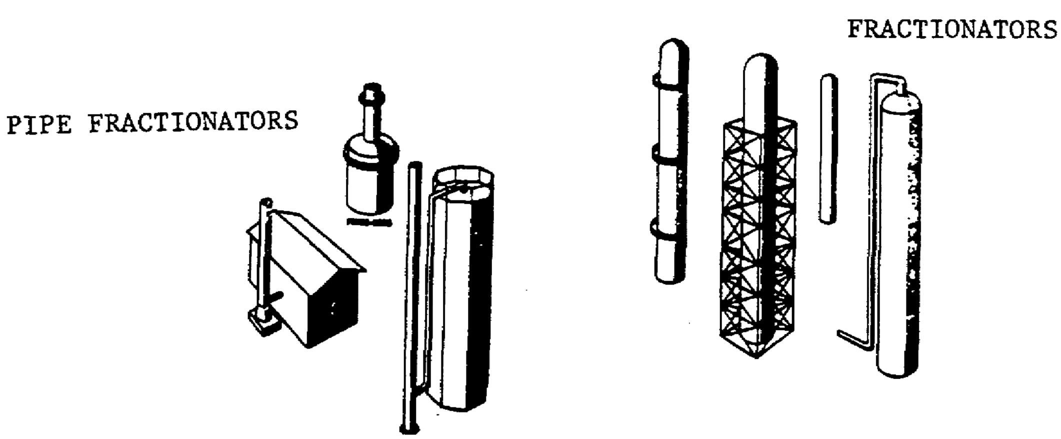


Figure 2-32. Petroleum Fractionating Columns.

(5) Secondary distillation. All the products of primary distillation go through a second distillation process. The secondary distillation units fall into these categories: catalytic reforming, vapor recovery (light ends), alkylation, polymerization, cracking, lubricating oil refining, and delayed coking.

(a) Catalytic reforming. One of the products of primary distillation is low-grade gasoline. Converting this low-grade gasoline into high quality motor fuel involves a process called catalytic reforming. The low-grade gasoline stock is heated in a pipe furnace and then passed through a fractionating column to remove heavy fuel oil residues and light gases. The fuel oil is passed on to the treating unit and the light gases. The fuel oil is passed on to the treating unit and the light gases routed to the catalytic reforming unit (Figure 2-33). Major recognition features of catalytic reforming unit include:

- Pipe furnaces, most commonly a series of pipe furnaces alternating with reactors
- Three or more short, thin reactor columns
- One or two fractionators.

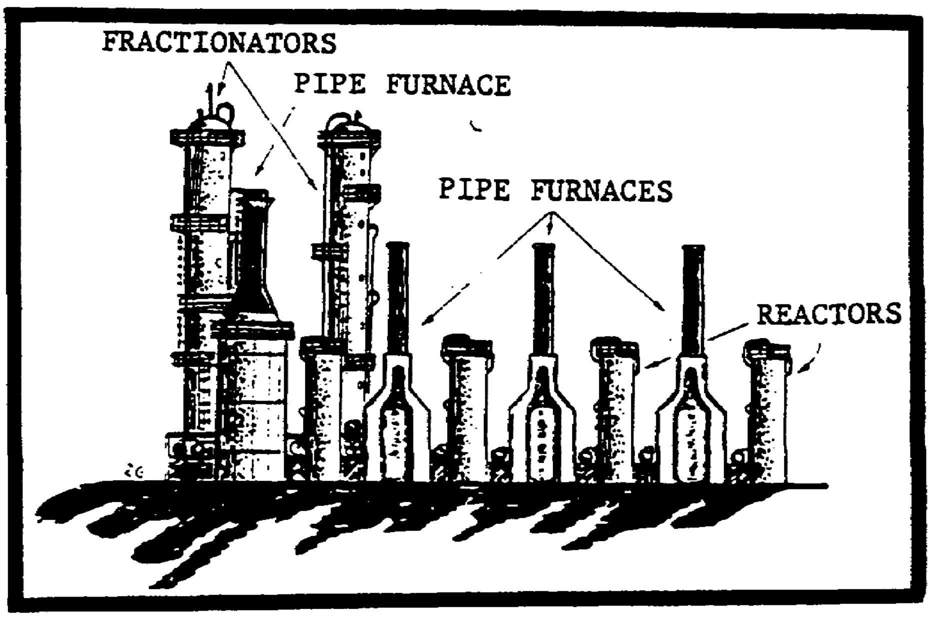


Figure 2-33. Catalytic Reforming Unit.

(b) The resulting intermediate gasoline is heated again in a pipe furnace and then routed through a series of reactors containing a catalyst (chemical that speeds up a reaction). The catalyst chemically alters the hydrocarbon molecules creating a high-grade gasoline with a more complex molecular configuration. After passing through the reactors, the reformed gasoline is introduced into another fractionating column where more gases are separated. The reformed gasoline is unstable and piped to the vapor recovery unit for stabilization (Figure 2-34).

(c) Vapor recovery (light ends) unit (Figure 2-34). Light gases are produced by a number of refining processes including primary distillation, cracking, catalytic reforming, and delayed coking. These gases are separated into butane, pentane, propane, and ethane in the vapor recovery units. The gasoline produced by cracking and catalytic reforming holds these gases in solution and is unstable. A series of small diameter distillation towers is used to accomplish the vapor recovery process. The vapor recovery unit removes these dissolved gases and so stabilizes the gasoline. The separated gases are piped from the vapor recovery unit to either an alkylation or polymerization unit and the stabilized gasoline is routed to the treating unit (Figure 2-29). Major recognition features of vapor recovery unit include:

- Two or four tall, thin factionators arranged in a line
- Absorber column (first tower) taller than others
- Gas flare may be present.

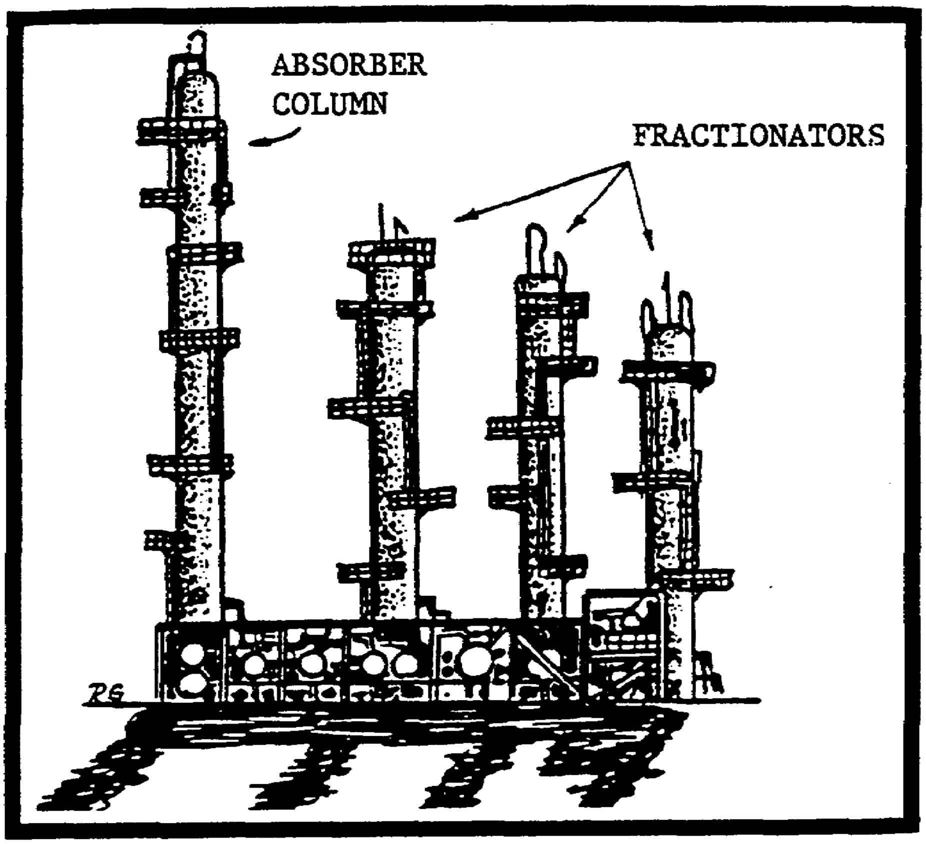


Figure 2-34. Vapor Recovery Unit.

(d) Alkylation unit uses a process which converts the separated gases from a vapor recovery unit (particularly propane, butane, and sometimes pentane) into high octane gasoline. These gases are compressed into a liquid and then passed through sulfuric acid (the catalyst) causing the separate gases to bond (Figure 2-35). The octane gasoline produced by an alkylation unit is piped to a treating unit for final processing. Major recognition features of alkylation unit include:

- Three to six tall, thin fractionators arranged in a line
- One tower may be taller than the others
- Spherical gas storage tanks(s) present.

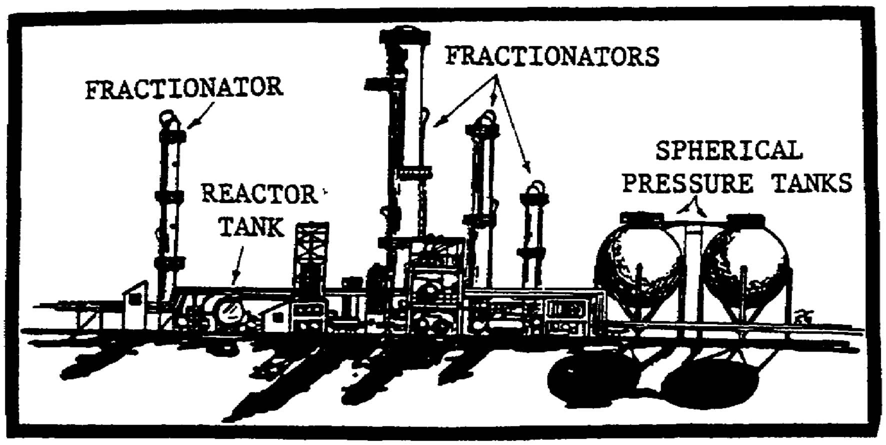


Figure 2-35. Alkylation Unit.

(e) Polymerization. This process is very similar to alkylation. It uses heat, pressure, and an acid catalyst to combine propane and propane gas, supplied by a vapor recovery unit, into high octane gasoline inside a reactor. The high octane gasoline produced by the polymerization unit is stable and routed to the treating unit (Figure 2-29). Major recognition features of polmerization unit (Figure 2-36) include:

- Five to 10 tall, thin fractionators
- One or two pipe furnace(s)
- Reactor columns, possibly enclosed in tall, rectangular steel structures or in buildings; or may be short, thick columns located among the fractionators
- Compressor house may be present.

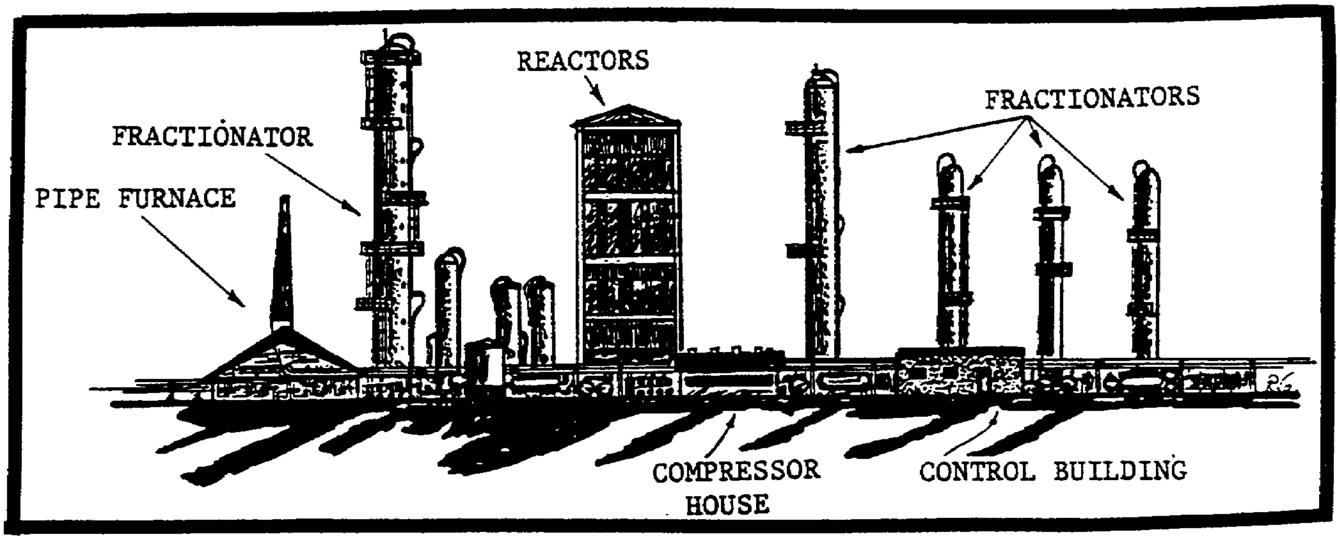


Figure 2-36. Polymerization Unit.

(6) Cracking. The primary distillation process separates but does not alter the hydrocarbon constituents of crude oil. Heavy gas-oil is one of the products of primary distillation and delayed coking (Figure 2-29). The amount of gasoline extracted from a given amount of crude oil can be increased by taking the heavy, complex gas-oil hydrocarbons and breaking them down (cracking) into lighter, simpler compounds. Cracking gas-oil creates unstable gasoline, light gases, and fuel oil by applying heat and pressure or catalytic action. The four common cracking units found in most refineries are thermal, fixed bed catalytic, thermofor catalytic, and fluid catalytic.

(a) Thermal cracking units. Using the oldest method, gas-oil is heated in a pipe furnace and then routed to a reactor (called a soaker) where it is subjected to pressure for several seconds. The combination of heat and extreme pressure splits the complex gas-oil molecules into smaller, simpler ones. The cracked gas-oil is then piped into a low pressure fractionator (called a flash chamber) where the lightest hydrocarbons flash into vapor and the heavier fuel oil condenses. The remaining vapors are pumped into another distilling tower where gasoline and light gases are separated, and more fuel oil condenses at the bottom. The fuel oil is routed to a treating unit while the unstable gasoline and light gases are piped to a vapor recovery unit: the gases are separated and the gasoline is stabilized (Figure 2-29). Major recognition features of thermal cracking units (Figure 2-37) include:

- One to three pipe furnaces, usually two, with one sometimes larger than the other

- A short, thick soaker reactor

- Tall thin flash chamber

- A taller fractionator

- Soaker, flash chamber, and fractionator will be in a line and may be obscured by a steel framework.

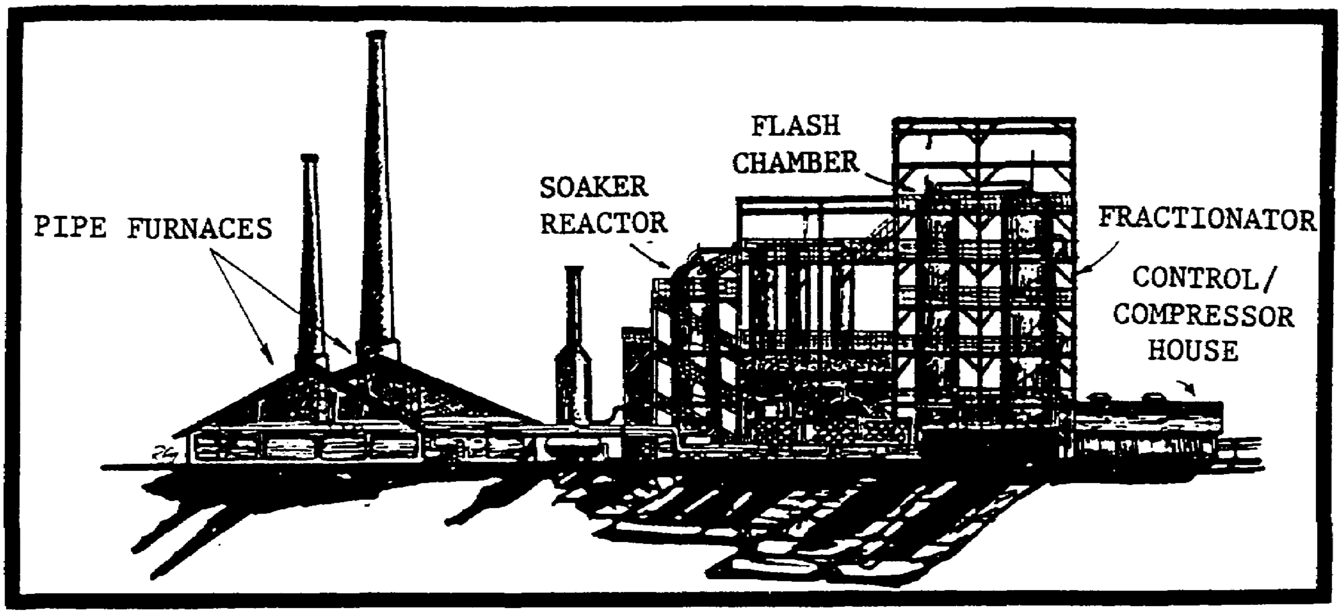


Figure 2-37. Thermal Cracking Unit.

(b) Fixed bed catalytic cracking unit. This catalytic cracking method is still seen in some of the older refineries. In this process, gas-oil is heated in a pipe furnace and then allowed to vaporize in a reactor/regenerator tank. These tanks are divided into sections by flat, perforated trays containing bauxite silica (the catalyst) pellets. The catalyst promotes the breakdown of gas-oil into lighter hydrocarbons. During the cracking process, the regenerator must periodically be shut down and taken off the line by closing the appropriate valves. The carbon is then burned off the catalyst by firing up the reactor like a furnace. While this catalyst "regeneration" is being done, other reactor/regenerator tanks take over the cracking operation. Once the carbon deposits are removed, the reactor/regenerator can be brought back on line and another taken off to undergo regeneration. After cracking, the gas-oil is routed to a fractionator where gases, gasoline, and fuel oils are separated. Major recognition features of fixed bed catalytic cracking unit (Figure 2-38) include:

- Pipe furnace
- Two, four, or six short reactor/regenerators grouped together in pairs and interconnected by overhead piping
- Fractionating column
- A control building may be present.

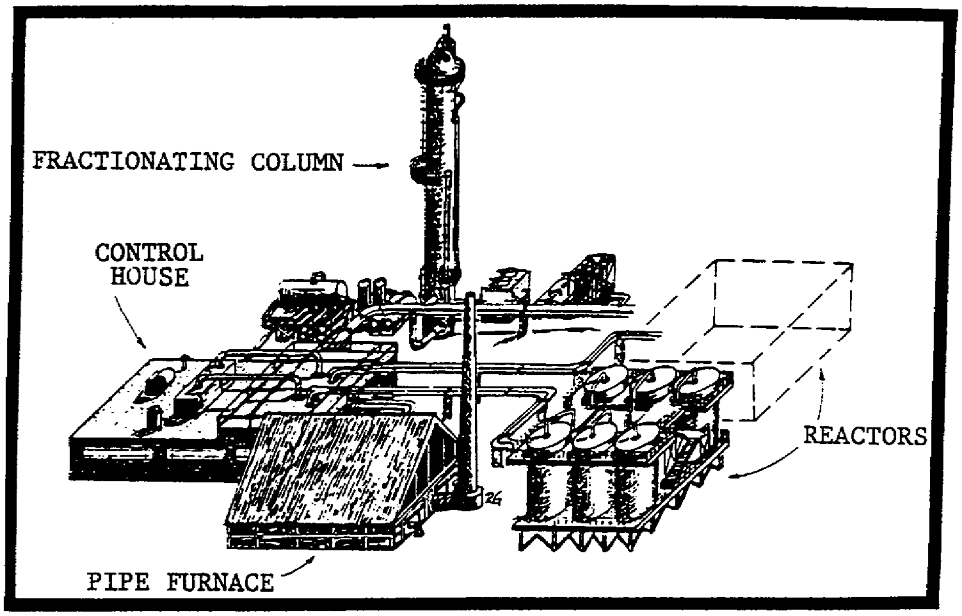


Figure 2-38. Fixed Bed Catalytic Cracking Unit.

(c) Moving bed catalytic cracker (also known as the thermofor catalytic cracking unit) operates in principle like the fixed bed separate units. The catalyst is transported between the reactor and regenerator via a bucket conveyor system. The carbon deposits are burned off the catalyst pellets in the regenerator. Major recognition features of moving bed catalytic cracking unit (Figure 2-39) include:

- Unusually tall, steel-frame superstructure
- Catalyst hopper (a small tank) visibly perched atop superstructure
- Low, rectangular regenerator kiln at base of superstructure
- Reactor tank, enclosed and obscured by the superstructure
- Regenerator kiln is a flat-roofed, rectangular building at the base of the cracking unit
- Pipe furnace
- Fractionator adjacent to the superstructure.

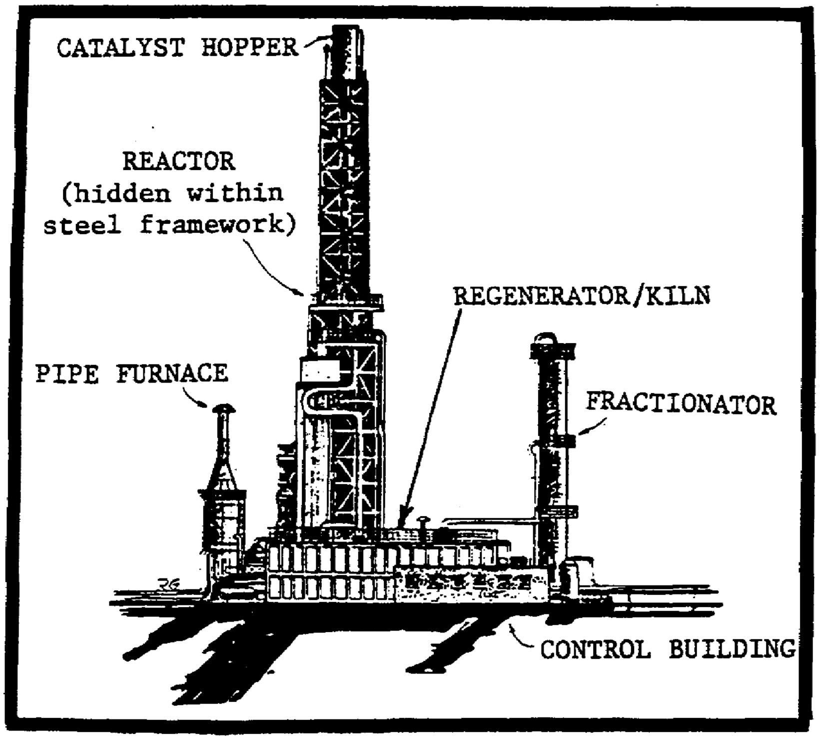


Figure 2-39. Moving Bed Catalytic Cracking Unit.

(d) Fluid flow catalytic cracking unit uses a finely powdered bauxite silica as the catalyst. It flows through the unit's reactor with the gas-oil charge in order to crack the hydrocarbons, thus the name, "fluid flow." Gas-oil is heated in the pipe furnace and then piped into the reactor where it vaporizes. The powdered bauxite silica catalyst is added to the heated gas-oil in the pipeline and enters the reactor with the charge. After flowing together through the reactor, the gas-oil vapors and the catalyst are separated centrifugally. The cracked gas-oil fractions are routed into the fractionator while the carbon-coated catalyst is piped up to the regenerator. In the regenerator, hot air burns off the carbon and revitalizes the catalyst. Some of the bauxite silica cannot be revitalized and must be replaced by fresh catalyst from a catalyst hopper. Major recognition features of catalytic cracking unit (Figure 2-40) include:

- A large, tall unit (often over 200 feet)
- Steel-frame superstructure which supports and obscures the components
- Large oblate regenerator mounted on top of supporting superstructure
- Smaller reactor located beside regenerator
- One to three tall, thin, cylindrical catalyst hoppers which sit apart from the components and near regenerator
- Fractionating column near reactor
- Pipe furnace
- Small control building.

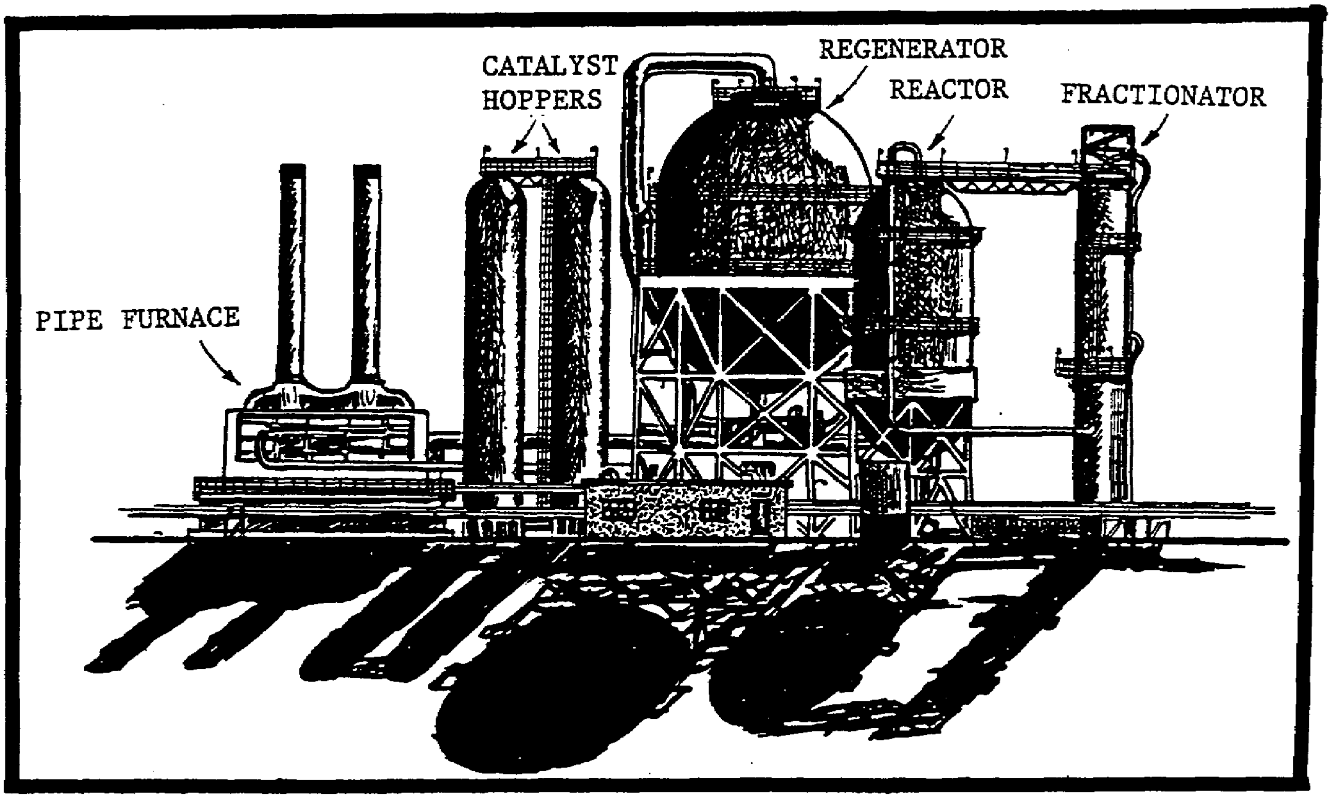


Figure 2-40. Fluid Flow--Catalytic Cracking Unit.

(7) Lubricating oil refining. Another major product of a refinery is lubricants. The heavy wax-oil components of crude oil are the raw materials of lubricating oil processing. These heavy hydrocarbons are separated during primary distillation and routed into the lube oil manufacturing area.

(a) The refining of lube oils and greases takes place in three to four small processing units. These units will be grouped together and contain a number of small distilling towers, small pipe furnaces, and a large rectangular building.

(b) Adjacent to the processing area will be a large number of small and medium-sized cylindrical storage tanks for the storage of finished products.

(c) Finally, a product packaging plant and shipping facility are usually present. These large rectangular buildings will be near the storage tanks and have road, rail, or water transportation available.

(d) Together, the processing area, the tank area, and the packaging plant give the lubricating oil section a unique appearance and make it rather easy to identify.

(e) Major recognition features of lubricating oil refining (Figure 2-41) include:

- A processing area containing small pipe furnaces, fractionators, and large rectangular buildings
- A storage area containing a large number of small to medium-sized cylindrical tanks
- A packaging plant with large rectangular buildings and shipping facility with transportation available.

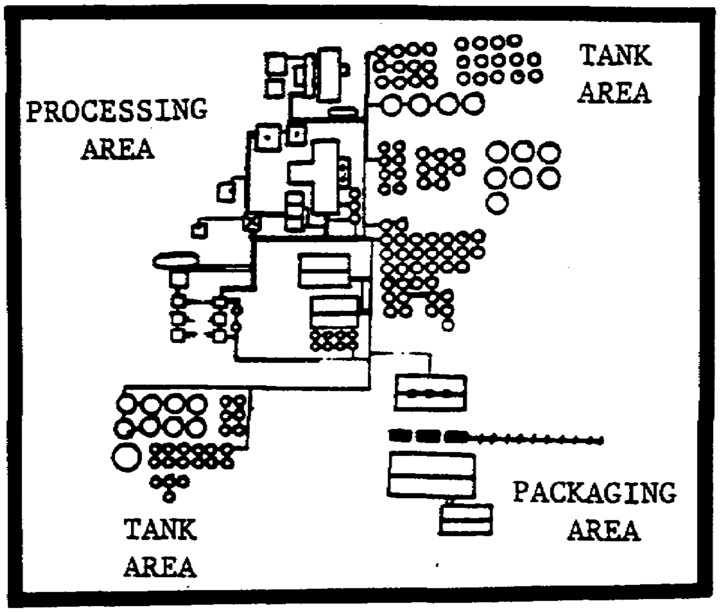


Figure 2-41. Lubricating Oil Refining.

(8) Delayed coking. Products of the delayed coking operation include coke, gas-oil, gasoline, and light gases.

(a) In the delayed coking process, residues from primary distillation are redistilled in a fractionator. The oily residuum then goes through a pipe furnace where it is heated into a hot liquid vapor mixture. This is then routed into a tall tank called a coke drum where petroleum coke precipitates.

(b) The vapors are withdrawn from the top of the coke drum and piped back into the fractionator where light gases, gasoline, and gas-oil are separated.

(c) After about 24 hours of operation, the coke drum becomes filled with coke. The coke is then removed by means of a rotary drill and dropped into a hopper or conveyor belt. The gas-oil is fed to a cracking unit while the light gases and gasoline are piped to a vapor recovery unit for separation.

(d) Major recognition features of delayed coking unit (Figure 2-42) include:

- Pipe furnace
- Fractionating tower
- Two or three tall, dark, cylindrical coke drums standing side by side
- Possibly drill derricks atop coke drums, or drilling rig located beneath drums and hidden from view
- Stockpiles of black petroleum coke or hopper cars loaded with coke.

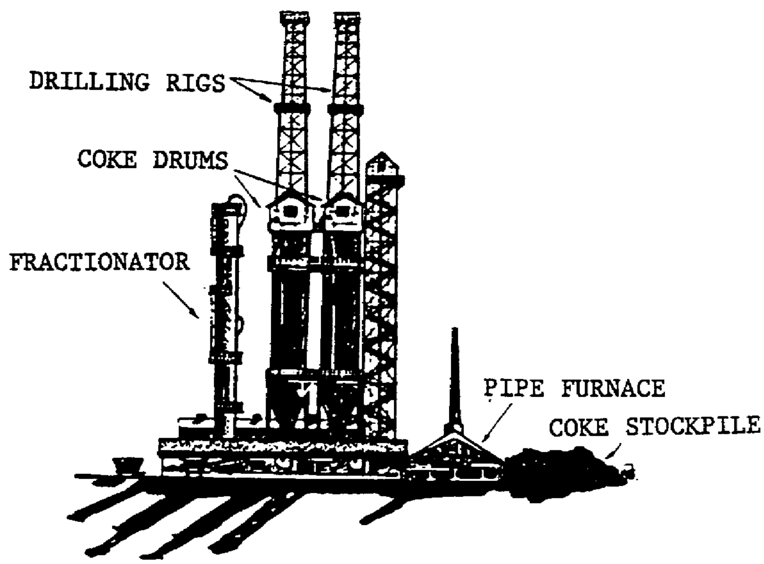


Figure 2-42. Delayed Coking Unit.

(9) Treating. Gasoline, kerosene, diesel oil, and fuel oil still contain undesirable constituents when they come out of the fractionating column or cracking unit. The treating process uses chemical reagents to remove these impurities. The liquid petroleum product and the reagents are mixed together in a tank. The chemicals react with the impurities to form solid or semisolid particles which settle to the bottom. The purified fuel can be drained off the top of the tank.

(a) Two types of treating units are the continuous and batch units. In the continuous treatment units, the fuel and chemical reagents are mixed in a small vertical tank (a mixer)(Figure 2-43), and piped into a long horizontal tank (a settler) where the impurities are allowed to precipitate (Figure 2-44).

(b) In the batch treatment method, a tall, large-diameter tank is used for both the mixing and settling operations. In the tanks, called batch agitators, chemical reagents and fuel are mixed and the impurities are allowed to settle (Figure 2-45).

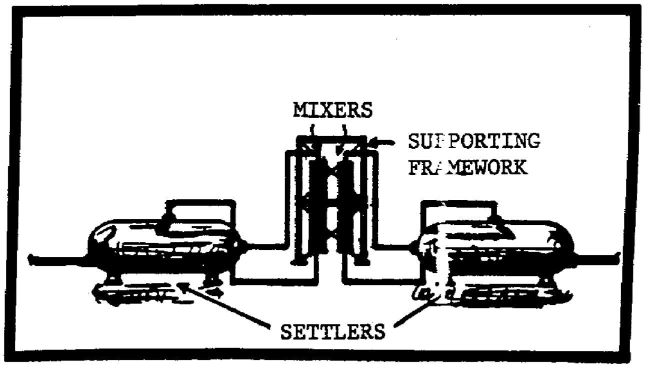


Figure 2-43. Continuous Treating Unit - Mixers and Settlers (Side View).

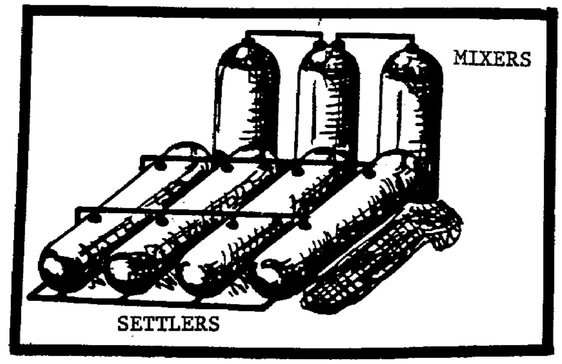


Figure 2-44. Continuous Treating Unit - Mixers and Settlers (Oblique View).

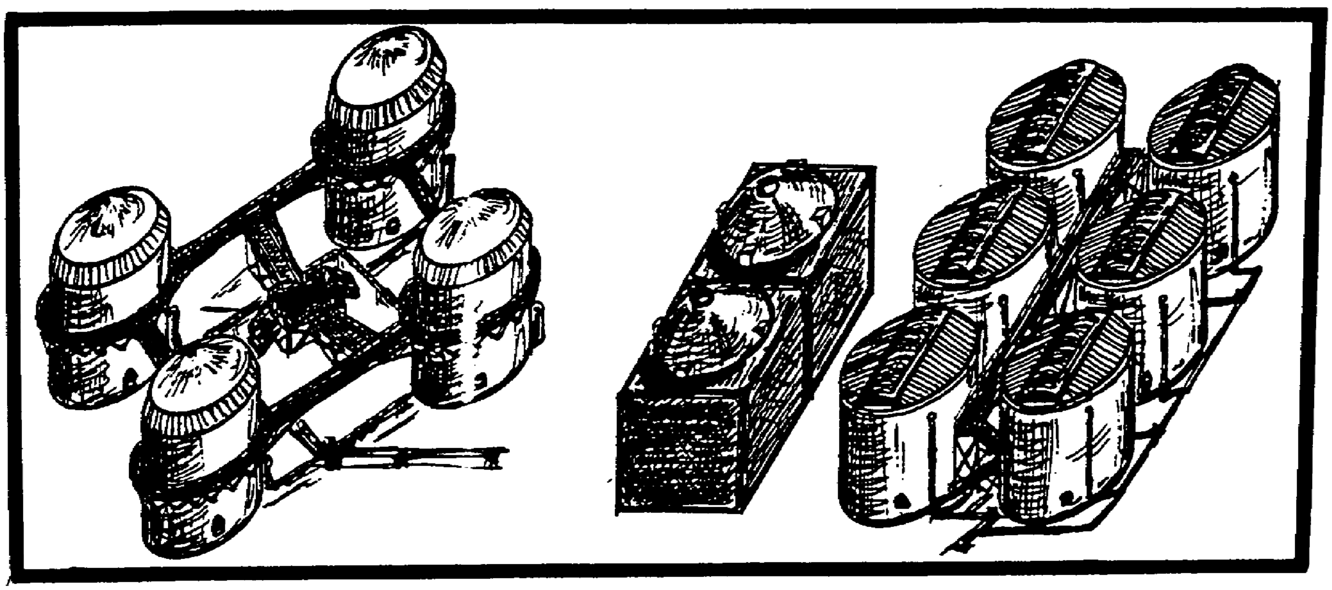


Figure 2-45. Batch Agitators of a Treatment Unit.

(c) Major recognition features of POL treating unit include:

- Rows of long horizontal settlers (tanks) and vertical mixers (tanks) will be visible. The mixers may be of various sizes, and the smallest may be obscured by supporting framework.

- Groups of tall, large-diameter batch agitators (tanks) with curved, domed, or stepped roofs.

NOTE: Storage tanks are a major image component of refineries. Most refineries contain a number of different varieties of POL storage tanks. The function or use of a tank can be determined by its size, shape, and location. Use Figure 2-5 with the following descriptions:

- Flat, peaked, and domed cylindrical tanks store crude oil or partially refined products. Crude oil storage tanks are very large, averaging 90 to 120 feet in diameter.

- Pontoon and noded tanks store gasoline or other highly volatile liquids. The floating top of the pontoon tank eliminates airspace, and therefore, wasteful evaporation. In the noded tank, evaporation is controlled by pressurization.

- Spherical, spheroidal, bullet, and blimp tanks store light gases in the liquefied state under pressure. The spherical and spheroidal tanks may vary in diameter from 20 to 50 feet.

- The vapor dome tank collects gases for later routing to the light ends unit.

e. Crude oil flow. This flow originates in the extraction industry at the oil fields and extends to the storage tanks, which are located near the POL processing facilities.

Oil fields are areas in which naturally occurring subsurface reservoirs of petroleum are tapped for the production of crude oil. Such fields are found throughout the world on many different types of terrain and in offshore locations as well. Equipment found in oil fields the world over is remarkably similar in design. This facilitates the identification of an oil field as such, and the various operations which are taking place. Oil field equipment is identified as being associated with one of the following four interrelated functions which are necessary for the production of crude petroleum. These functions include: drilling, production, field processing, gathering and field storage.

(a) Drilling. This is the process of drilling a hole (well) from the surface of the earth down to the rock-enclosed oil reservoir. The equipment consists essentially of a derrick, drilling tools, and a power source.

(b) Production. This operation involves tapping (draining) the oil reservoir. After the well has been drilled the oil may flow naturally, or it may have to be pumped to the surface. There are various devices for controlling naturally flowing wells, and many different types of pumping equipment.

(c) Field Processing involves the removal of such substances as salt water, sulphur, and gas from the crude oil before shipment. The equipment for field processing is varied and found at central locations and at the individual well heads.

(d) Gathering and Field Storage. In this process the oil from a number of wells in a field is collected by pipelines and conveyed to a central point for either shipment or field processing. The gathering system consists of pipes, pumps, and tanks. Oil is temporarily stored at different points in the gathering system. While awaiting shipment, oil is kept in large field storage or "lease" tanks (Figure 2-46).

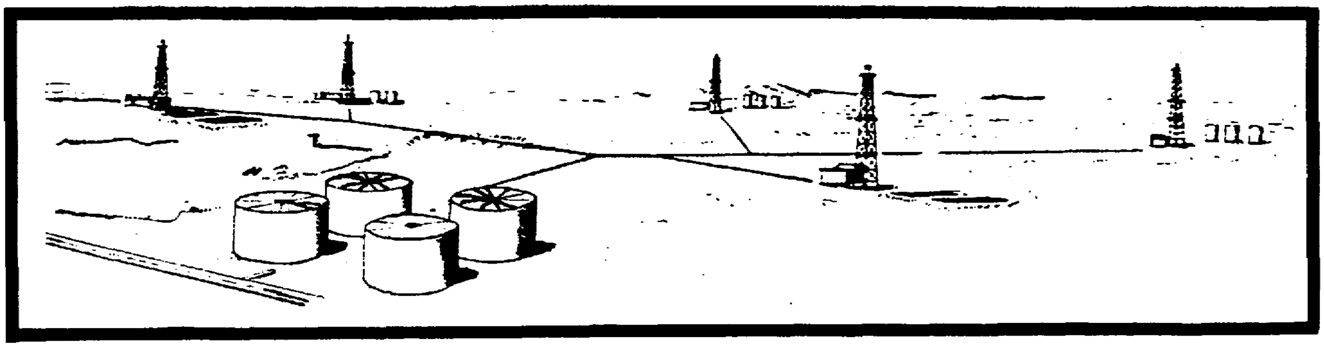


Figure 2-46. Oil Gathering and Storage.

f. Petroleum production flow. This process originates in the oil fields where the crude oil is stored until shipment. Once the crude oil arrives at the petroleum processing industry it then goes through several processing units where final products are then stored (Figures 2-47 and 2-48).

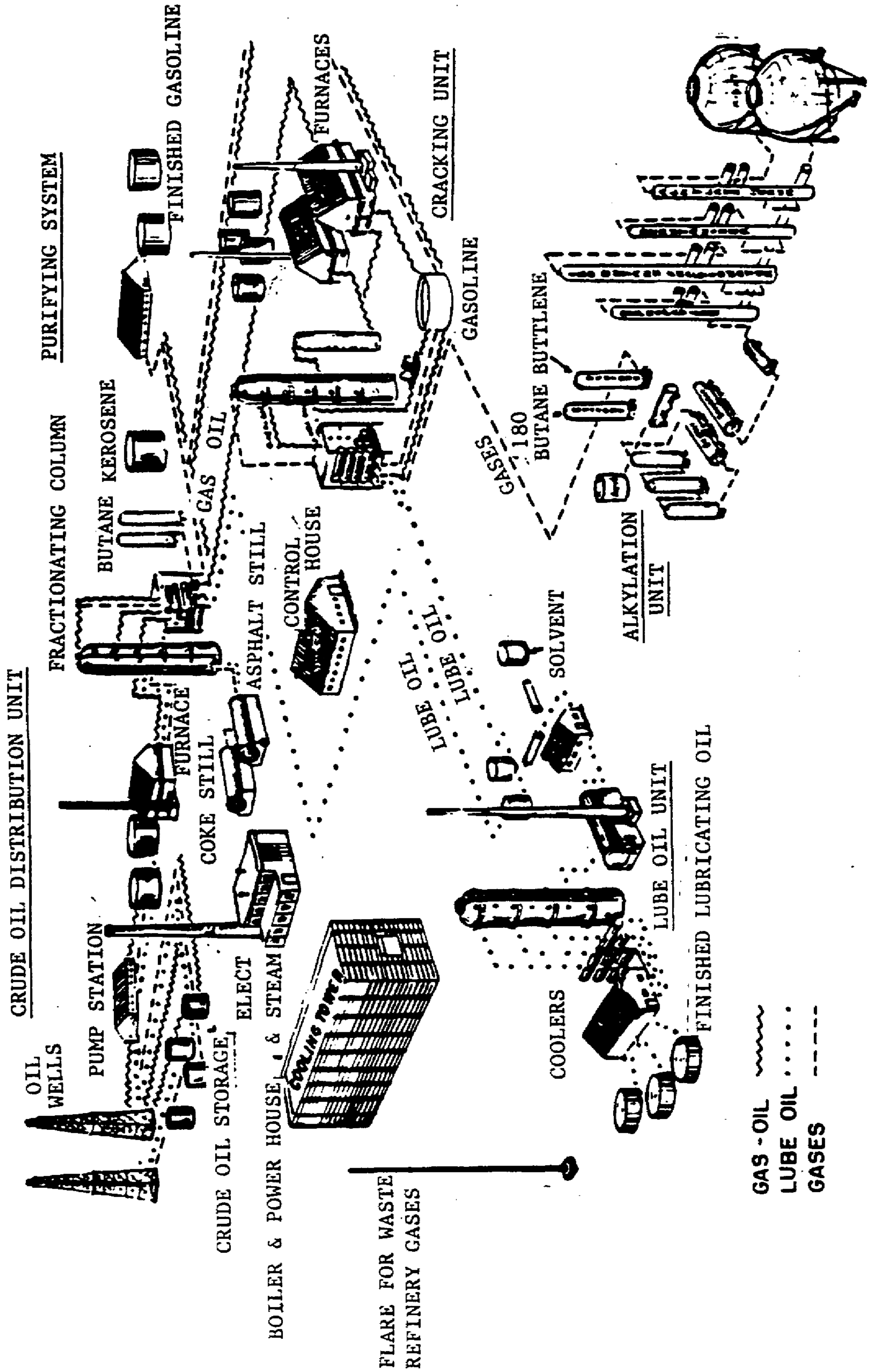


Figure 2-47. Petroleum Production Flow.

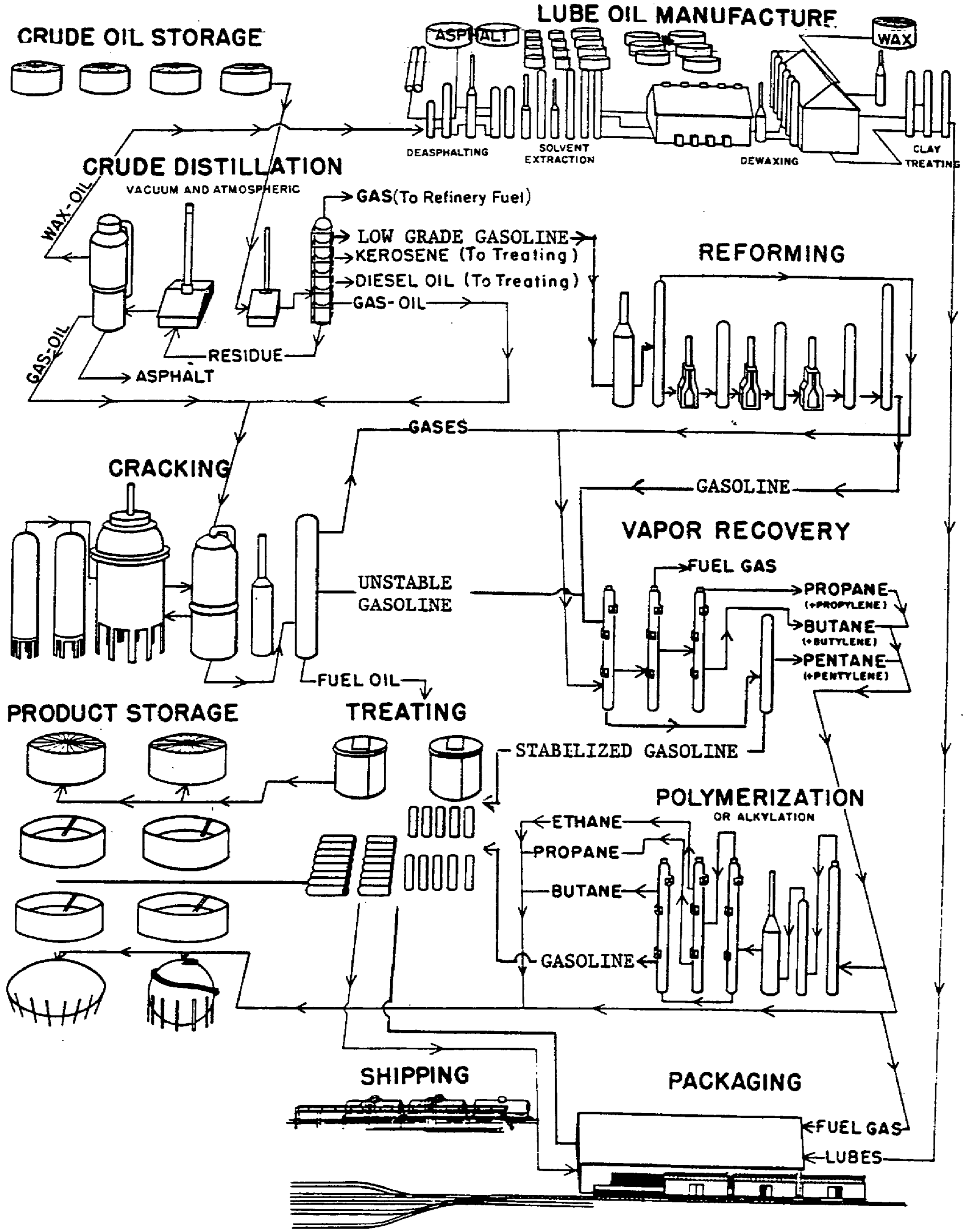


Figure 2-48. Petroleum Refinery Production Flow.

g. Once production is completed the products are then ready for distribution. A distribution center normally consists of a small group of storage tanks, frequently fixed or pontoon roofed, together with handling equipment, such as loading racks, road, or rail; one or two small buildings to include offices, garages, workshops; and frequently a large drive-in and turning space for road vehicles. These installations are normally situated in or around large residential or industrial areas (Figure 2-49).

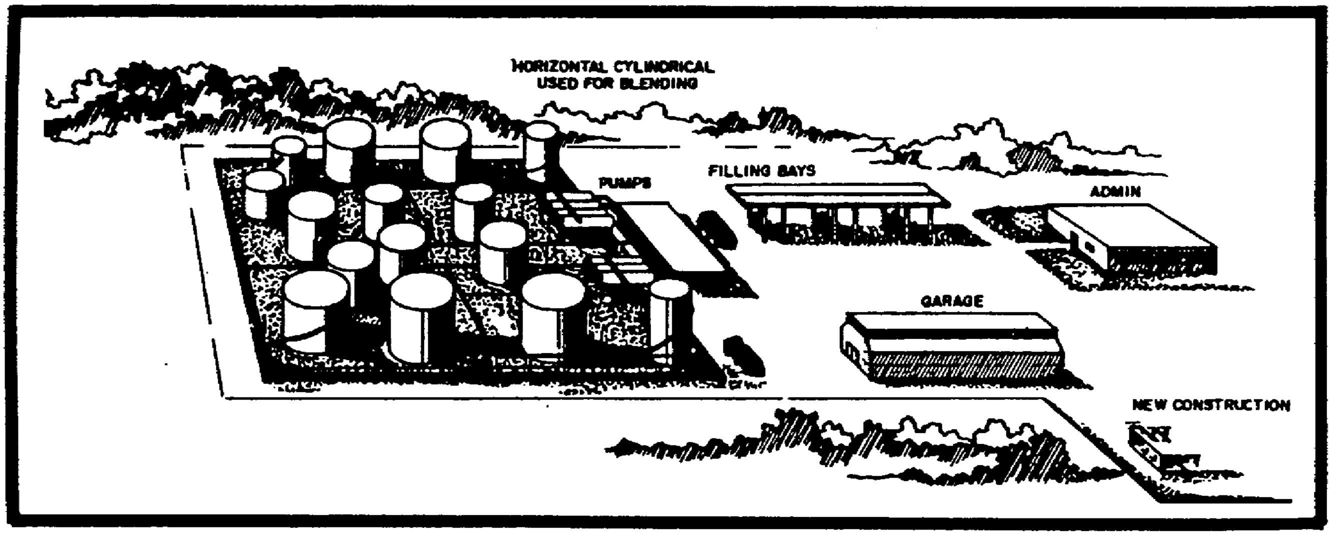


Figure 2-49. Petroleum Distribution.

4. Additional chemical processing industries include cellulose pulp (paper) production, ore concentration (magnesia from brines), soda ash, sulfuric acid, chlorine, caustic soda, ammonia, alcohol, plastics, solvents, rubber, and fertilizers.

a. Cellulose pulp (paper) production flow (Figure 2-50). The two most widely used raw materials for the production of cellulose pulp are pulpwood and cotton.

(1) Cotton is moved from the warehouse to a fiber shredding and cleaning process and then by conveyor direct to the digestion building. Pulpwood is moved from open stockpiles by conveyors to the debarking equipment.

(2) The stripped logs are then moved by conveyor to the chipping building, where they are reduced to chips; these may be stored in chip storage silos nearby.

(3) The cotton fibers or the chipped wood pulp will then be mixed with caustic soda and cooked with steam in the autoclave building (not shown). The wood or fiber is dissolved except for the cellulose fibers and the resulting solution is moved to washing and bleaching where these are separated from the waste materials.

(4) The cellulose fibers are washed and bleached and then moved to rolling and drying where they are rolled into paper, dried, stored, and shipped.

(5) The waste material is sent to a chemical recovery area where it is treated to recover the chemicals which are used.

NOTE: A water treatment facility is frequently located in the area to purify the large quantities of water used in this industry.

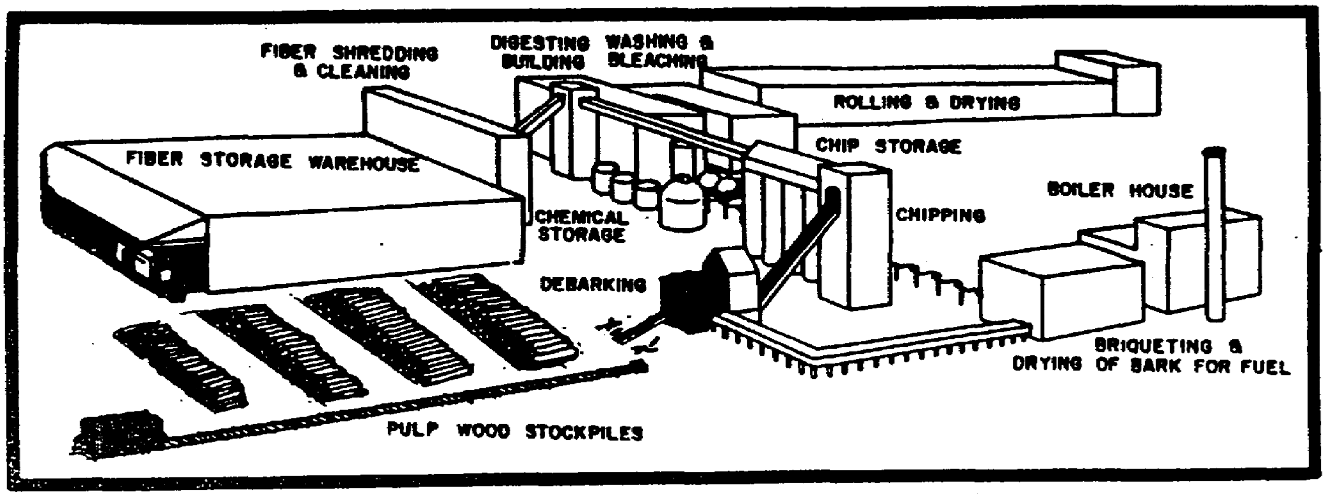


Figure 2-50. Cellulose Pulp (Paper) Production.

b. Magnesia from brine (seawater) plants (Figure 2-51) are normally located close to the coast for obvious reasons.

(1) The seawater is pumped to tanks where the grit and sediments are allowed to settle and milk of lime is added to remove bicarbonate hardness.

(2) The clarified seawater then goes to the flocculator tank where an exact amount of lime is added to react with the magnesium chloride and magnesium sulphate. Magnesium hydroxide is formed and precipitated of solution and withdrawn as a slurry into clarifiers (dorr thickeners) to be washed with fresh water which has been treated for removal of bicarbonate hardness. The magnesium hydroxide settles to the bottom and water overflows carrying impurities with it.

(3) The slurry is moved countercurrent to the water. After completion of the cycle, magnesium hydroxide is removed and filtered to remove excess water.

(4) The magnesium hydroxide is charged into a rotary film for drying, leaving magnesium oxide (magnesia).

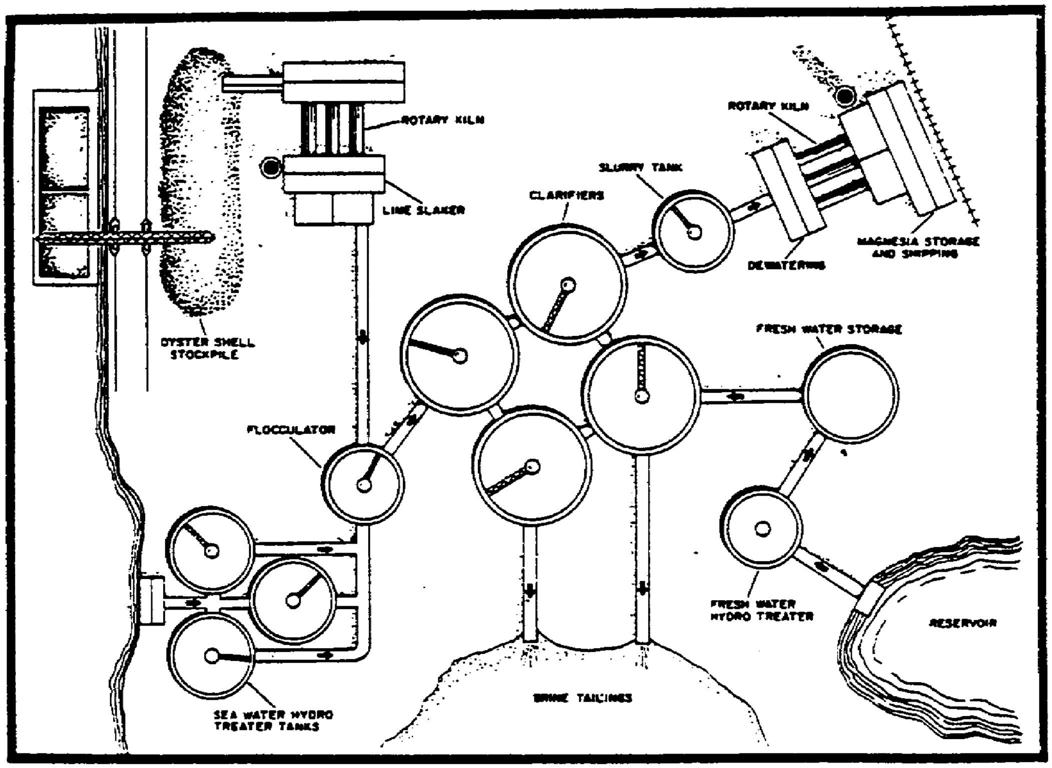


Figure 2-51. Ore Concentration (Magnesia from Brines).

c. The chemical processing facilities chart (Figure 2-52) will help you identify additional chemical processing industries. Use the chart with the following description to help you better visualize the industry.

(1) Input normally consists of loose solids in relatively small quantities.

(2) Output consists of a solid or liquid stored in closed containers.

(3) Storage is observed in open stockpiles, storage buildings, hoppers, bins, and silos.

(4) Processing includes closed tankage, visible piping, fractionating towers, heat exchangers, scrubbers, boilers houses and steam piping, frequently a large number of relatively small industrial buildings. These will be well ventilated, connected by piping, and will have limited road rail access.

(5) Storage and shipping consist of closed tankage, loading racks, good road/rail access, tank cars and tank trucks. A small pump house may be visible in the area.

(6) General features consist of small ground area, many small buildings, extensive outdoor piping, and complex processing equipment, small diameter closed tankage.

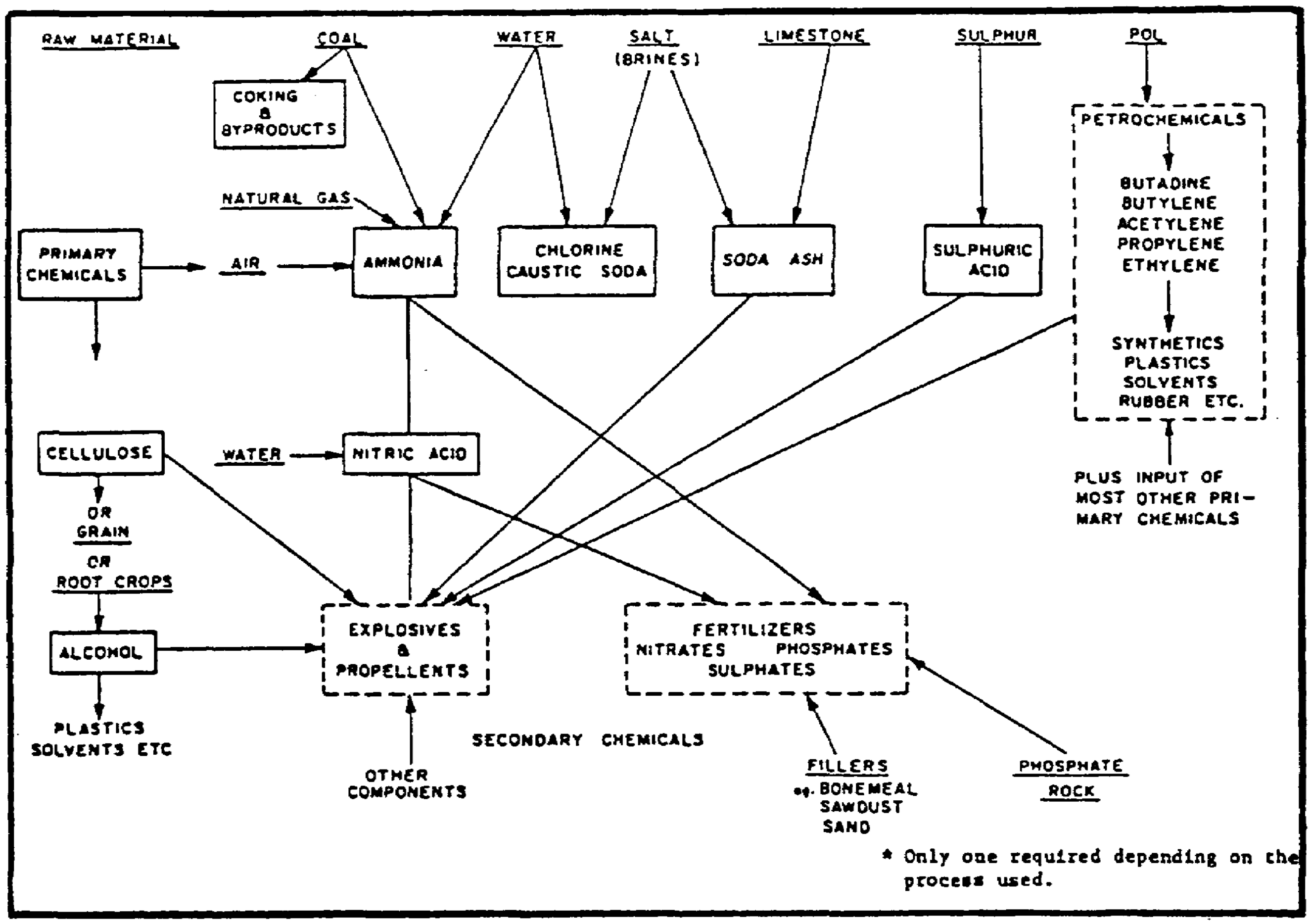


Figure 2-52. Chemical Processing Facilities.

5. Figures 2-53 thru 2-59 are examples of <u>chemical processing industries</u> on aerial imagery along with specific identification features of the industry.

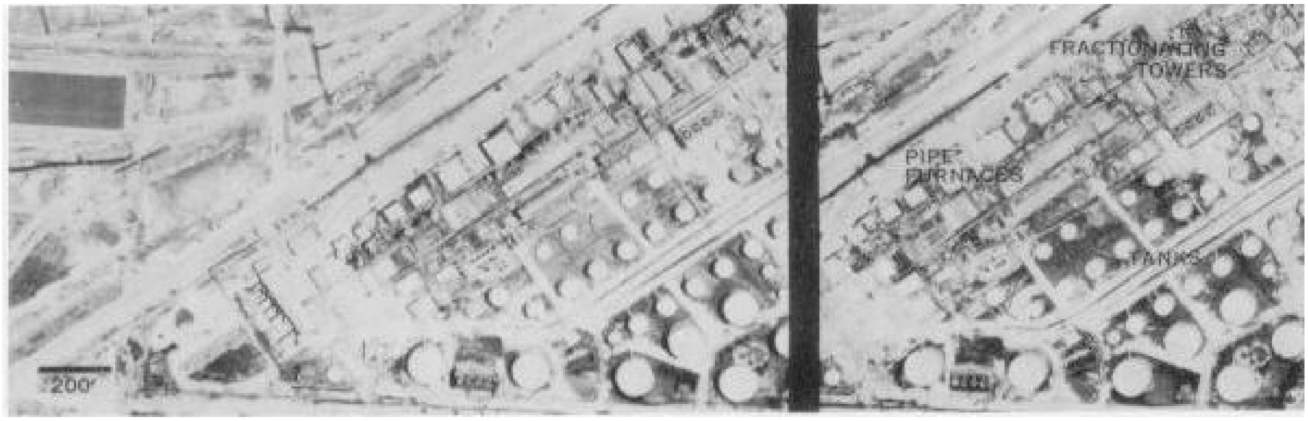


Figure 2-53. Petroleum Refinery.

NOTE: Petroleum heated in pipe furnaces is flashed to vapor in the base of these tall cylindrical fractionating towers. The vapor rises in the towers with different fractions condensing and collecting on perforated trays or plates. From various levels in the towers, different fractions are withdrawn to be stored in tanks. Fractionating towers may operate as separate units or be associated with thermal cracking units or catalytic cracking units.

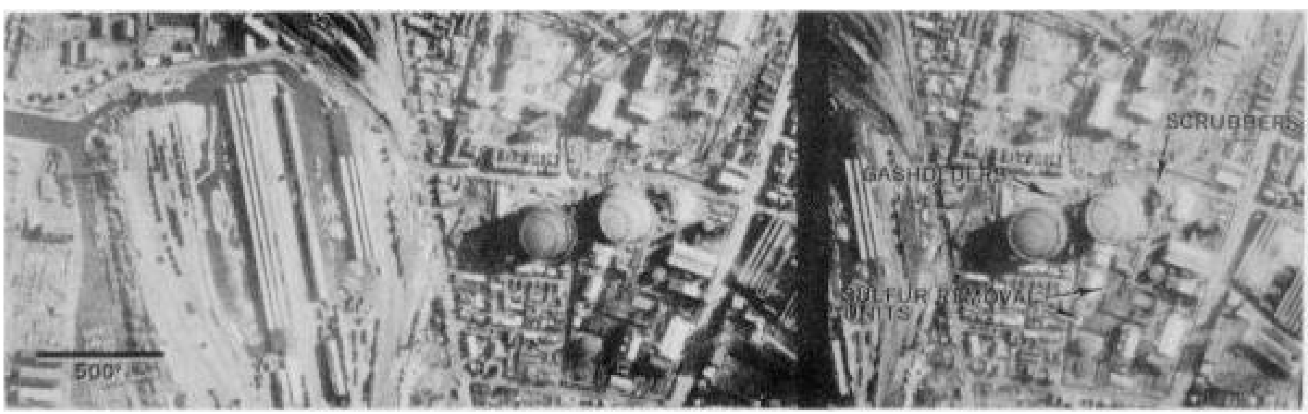


Figure 2-54. City Gas.

NOTE: The box-like elements on the top of the units are the lids of cases filled with a catalyst. Water gas from the scrubbers or one of the gasholders passes through these cases where the sulfur is removed. A crane removes the square tops so the catalyst can be replaced. The cases may be round.

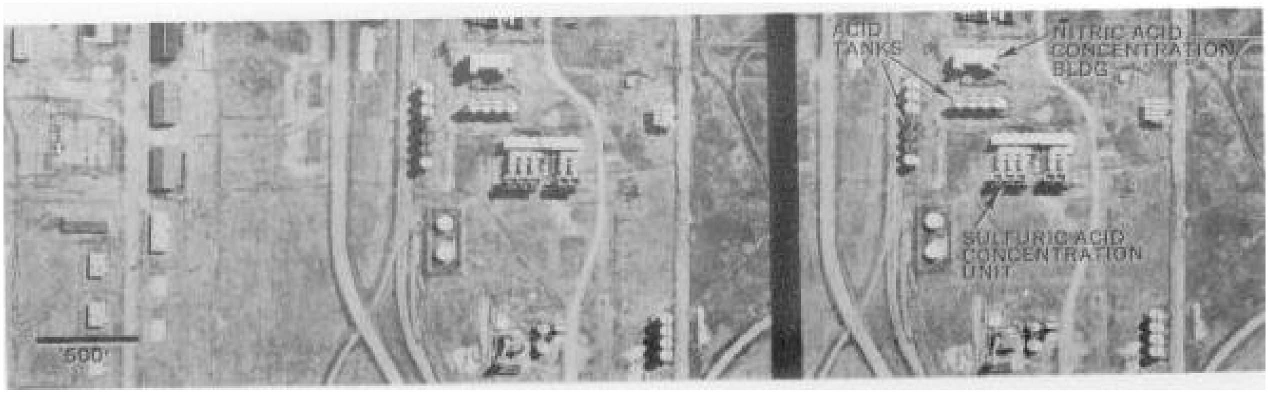


Figure 2-55. Sulfuric Acid Plant.

NOTE: Spent sulfuric acid from the nitric acid concentration building is concentrated in this complex unit. Steam issues from the five square open structures when the unit is in operation. The concentrated sulfuric acid is stored in tanks to be reused.

Figure 2-56. Nitric Acid and Fertilizer Processing Industry.

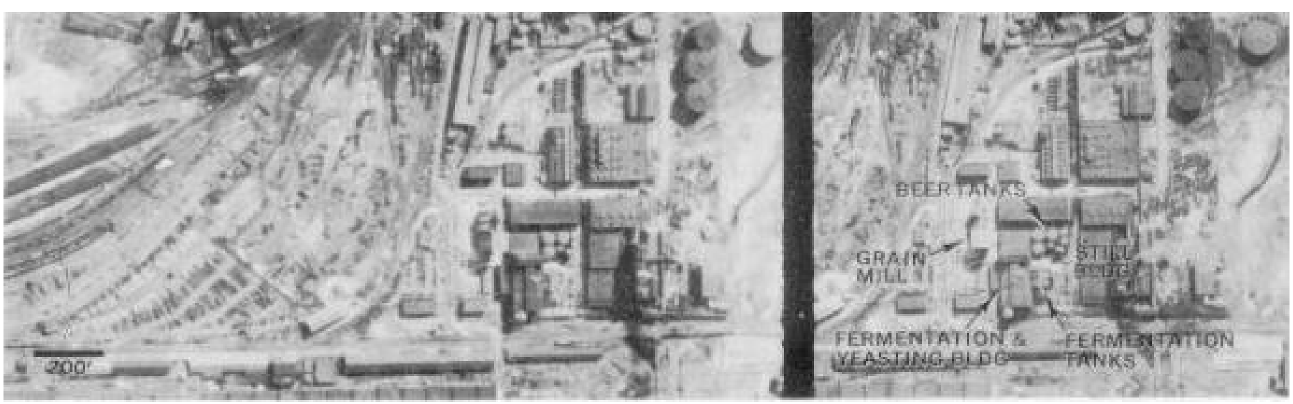


Figure 2-57. Alcohol Industry.

NOTE: Cracked grain from the adjacent mill and yeast are combined in fermentation tanks in building and in the open. Beer of low alcoholic content is formed and sent to the fermentation and yeasting building the still building or stored in tanks.

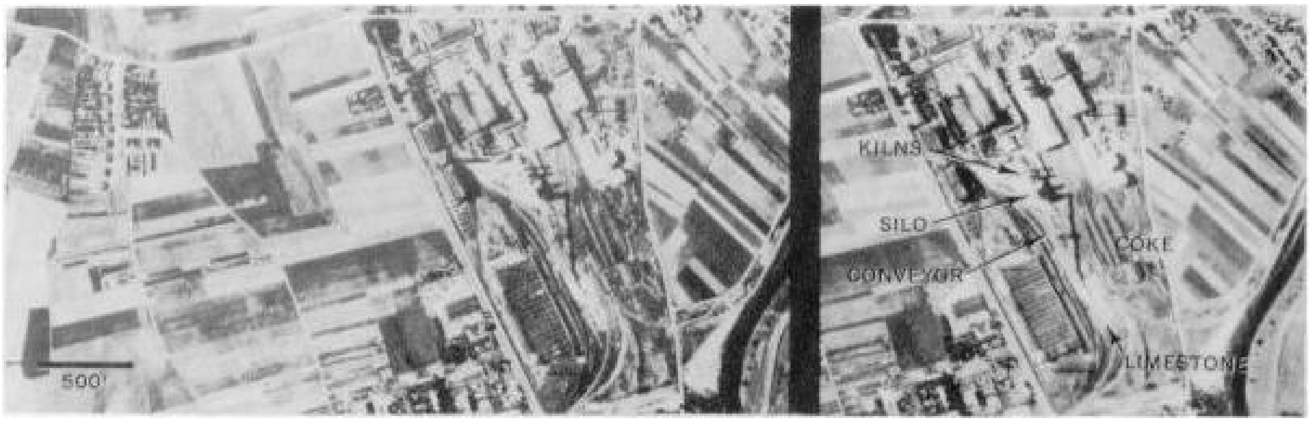


Figure 2-58. Soda Ash Plant.

NOTE: The inclined conveyor carries coke and limestone from open storage to the silo. The horizontal conveyor surmounting the kilns supplies them with coke and limestone from the silo.

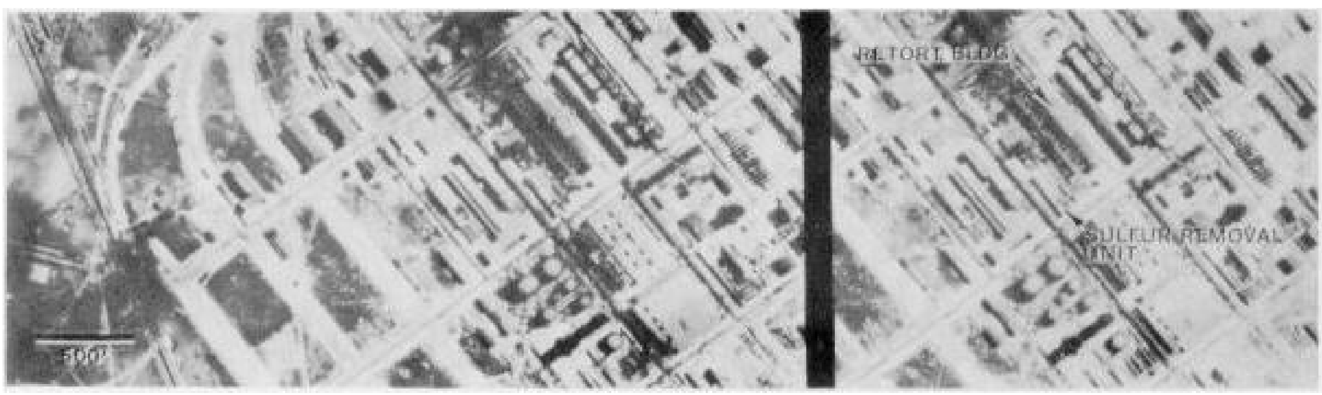


Figure 2-59. Synthetic Rubber Plant.

NOTE: Gases produced in the retorts are directed through this unit which removes the sulfur. The catalyst cases rise above the structure, and a gantry crane there removes the tops so that the catalyst can be replaced.

PART D: HEAT PROCESSING INDUSTRIES

1. Heat processing industries are those using primarily heat to refine, separate, or reform raw materials, or to derive energy from them. General recognition features are:

- Few pipelines or closed tanks
- Tall chimneys or many stacks
- Large quantity of fuel or coal
- Kilns.

2. The image components are divided into three major categories: equipment, buildings, and open storage and waste.

a. Equipment is presented under the following headings: chimneys, stacks, and vents; cooling towers; kilns; silos, tanks, hoppers, bins, and bunkers; pipelines, conveyors, cranes and mobile equipment; and complex equipment.

(1) Chimneys, stacks, and vents serve similar purposes to that of mechanical and chemical processing industries--to dispose of heat, waste gases, and fine dust. Stacks are characteristic of heat processing industries; they may be built of masonry or sheet metal and vary in diameter and height. Huge, free-standing masonry stacks are associated with nonferrous smelters and dispose the noxious fumes high in the air. Open hearth steel furnaces have numbers of stacks arranged in a row. Vents are common on processing buildings and used to dispose of heat, dust, and fumes. Open monitor-like vents are characteristic of roaster, furnace, and casting buildings, where the heat and noxious fumes are excessive (Figures A-1 thru A-10).

(2) Cooling towers are tall and narrow, rectangular, round or polygonal. Water is cooled by exposure to the air and by evaporation in these structures, and then reused (Figures A-11 and A-12).

NOTE: Spray ponds or cooling towers frequently distinguish thermoelectric power plants from boiler houses.

(3) Kilns are used to dry or calcine bulk materials, and to fire or partially vitrify brick and other clay products. Rotary kilns look like slightly inclined tanks or long tubes; vertical kilns appear as towerlike structures. Both types may be sheltered in buildings. Beehive and oval kilns are used for clay products (Figures A-13 thru A-16).

(4) Silos, tanks, hoppers, bins, and bunkers are used for storage. Silos, tall, covered cylindrical containers, hold dry bulk materials. Round tanks hold fuel or water. Spray ponds, found at many plants, usually appear as square or rectangular low tanks. Hoppers and

bins hold bulk goods temporarily. Bins associated with ore trestles are common at smelters (Figure A-17 thru A-37).

(5) Pipelines, conveyors, cranes, and mobile equipment are used to handle or transport materials. Pipelines are common but not in great numbers. Conveyors, either inclined or horizontal, housed or open, handle bulk materials between storage areas and processing buildings. They usually appear wider than pipelines and have flat surfaces. Overhead traveling cranes handle ores and finished products. Mobile equipment, such as bulldozers and trucks, handle bulk materials (Figures A-38 thru A-52).

(6) Complex equipment includes the pipe-like cooling tubes at zinc oxide plants, and the blast furnaces, hot stoves, and dust collection equipment found with iron smelters as well as transformer yards and outdoor boilers (Figures A-53 thru A-59).

b. Buildings are presented in three subdivisions based on function. These subdivision are processing, storage, and administration. The Image components are somewhat different for each subdivision. Certain buildings associated with other image components will provide the identity of the industry.

(1) Processing buildings are divided on the basis of relative size into small, medium, and large. The buildings are better ventilated, and larger and more massive in appearance than those in the other categories (Figures A-62 thru A-73).

(2) Storage buildings are served by rail lines or roads. Covered ore bins found at smelters are among the more important storage buildings associated with heat processing industries (Figures A-74 and A-75).

(3) Administrative buildings usually are built to one side of the plant area near the main entrance and served by walks, driveways, and parking areas. The grounds around them may be landscaped (Figures A-76 and A-77).

c. Open storage and waste appear as piles. Very few ponds will be seen in this category. Piles of coal, limestone and ore, as well as metal products, often stored in crane-served yards, and large and conspicuous waste piles frequently are associated with the metal smelting and refining industries (Figures A-78 thru A-81).

REMEMBER: The size and arrangement of stacks are of primary importance in analyzing heat processing industries. Large complex equipment such as blast furnaces are specific identification features of heat processing industries. Open storage and waste, as well as the design and arrangement of some of the buildings, are helpful in confirming the analysis of an industry. Conveyors and pipelines are especially useful when analyzing the succession of processes and operations.

3. <u>Coke, Iron, and Steel Production</u>. Steel is the single most essential metal in a modern economy. Total world steel production is 10 times greater 'than combined production of all other metals. In the US, steel satisfies 40 percent of the total demand for industrial raw materials. The production of steel is directly linked to that of coke and iron. Coke is the fuel which supplies the heat required to reduce iron ore to molten iron (pig iron) in a blast furnace. The carbon content of pig iron must then be reduced by one of several processes in order to convert it to steel.

a. Coke production. Coke is a solid carbon product resulting from the destructive distillation of coal, particularly bituminous soft coal. This distillation is accomplished by heating coal in an oven in the absence of air. During this process coal, tar, and gas are liberated. Major recognition features of a coke production industry (Figure 2-60) include:

- Large coal stockpile
- Coal preparation facility
- Coaling tower
- Long, narrow coke oven battery with tall exhaust stacks
- Quenching towers
- By-products area
- Gasometer.

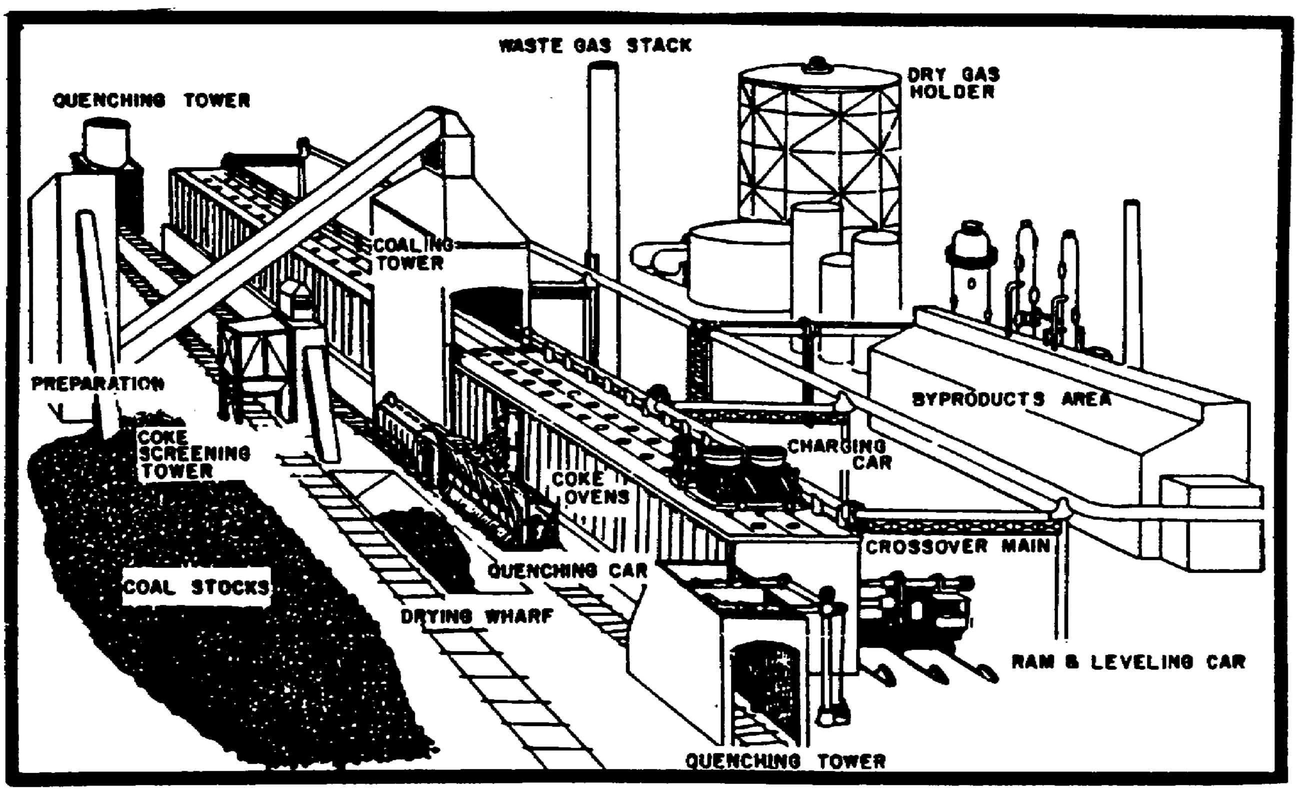


Figure 2-60. Coke Production Industry.

(1) Using Figure 2-61 follow the production flow of the coke industry.

(a) Stockpiles: Vast amount of coal are consumed in the daily operation of a coke oven (Annotation 1, Figure 2-61).

(b) Coal preparation facility: From the stockpile, coal is conveyed to a coal preparation facility (Annotation 2) where it is crushed and screened.

(c) Coaling tower: The prepared coal is then transported by bins until it is charged into the coke ovens (Annotation 4).

(d) Coke oven banks: The coaling car charging lorry (Annotation 5) picks up a load of coal from the coaling tower, and running on tracks on top of the bank of coke ovens, loads each coke oven. The coal is dropped from the charging lorry into the oven through charge holes. Once the oven is charged, the charge hole covers are replaced to ensure no air enter the oven. Now the coal is made into coke.

(e) Regenerators: Beneath the coke oven banks (and often underground) are regenerators. The regenerators are a series of separate compartments. Each compartment is a labyrinth of firebrick passageways.

(f) Gasometer: Coke oven gas, blast furnace gas, or natural gas is piped from a gasometer (Annotation 13) into the regenerators and burned. Waste gases are vented from exhaust stacks (Annotation 11) into the atmosphere. There are flames not only in the regenerators but in the hollow walls separating the individual coke ovens as well. Thus a tremendous amount of heat causes the coal to be reduced to coke and by-products.

(g) By-products area: The by-product gases are carried off by the ascension pipes (Annotation 3) and the collector main (Annotation 12). These by-products, coal and tar, are routed to the by-products area (Annotation 14). Useful raw materials are separated, and the coke gas is piped to the gasometer for use as fuel.

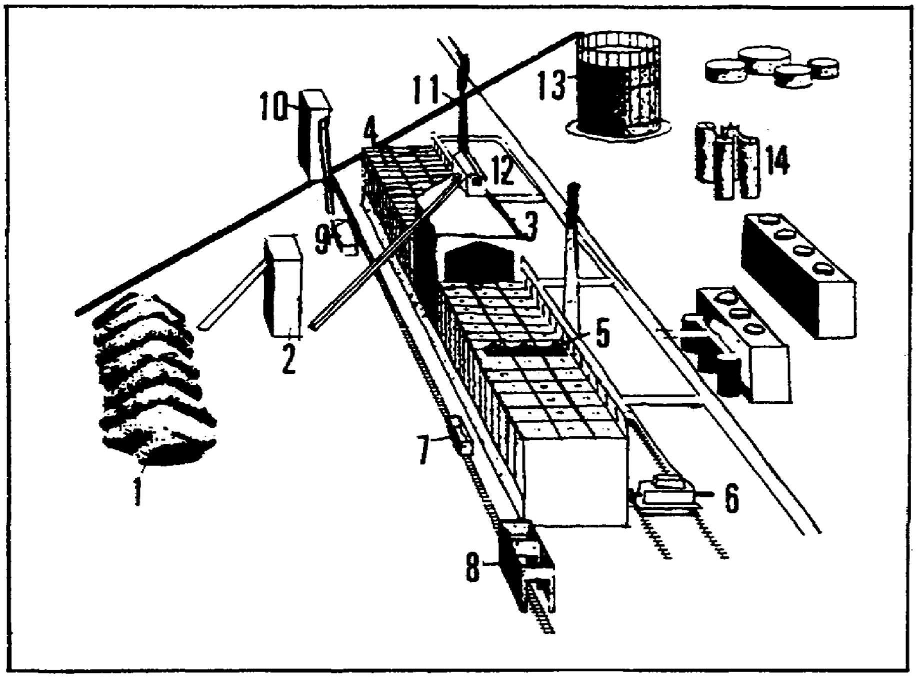


Figure 2-61. Coke Production.

(2) Final stages of production (Figure 2-61). The charge of coal is kept in the coke oven approximately 18 hours to produce a high grade of coke. Each coke oven is equipped with a removable door at each end. These doors are removed by a machine on each side of the bank of ovens. Once the doors of the oven are removed, the rammer (Annotation 6) which is on the side opposite the quenching car (Annotation 7), rams the charge of coke into the quenching car.

(a) Quenching tower: As the hot coke is exposed to the air, the coke bursts into flames. This necessitates moving the quenching car immediately to the quenching tower (Annotation 8) where tons of water are dumped on the coke to quench the flames and cool the coke. When quenching is taking place, a dense cloud of steam is formed and released into the atmosphere through the quenching tower stack.

(b) Drying wharf: After quenching, the coke is taken to the drying wharf (Annotation 9) where it remains until dry.

(c) Coke screening tower: It is conveyed to the coke screening tower (Annotation 10) where it is crushed and screened for use in the blast furnace.

b. Iron production. Three raw materials--coke, iron ore, and limestone--are required for iron production. These three items are placed inside a blast furnace where they are subjected to a high pressure stream of super-heated air. This hot air ignites the coke which in turn produces more heat, liquefying the iron ore and limestone. The iron ore is reduced to pig iron through the loss of its oxygen to be carbon. Additionally, the limestone acts as a flux and absorbs any impurities contained in the molten iron. Both the molten pig iron and limestone flow to the bottom with the limestone and its impurities floating atop the iron as a slag.

(1) Major recognition features of iron production industry:

- Stockpiles of limestone (white or light gray in tone), iron ore (medium to light gray in tone), and coke (black in tone)
- A stock trestle
- Blast furnace
- Groups of tall, cylindrical hot stoves
- Blast house(s) and blast mains
- A roasting and sintering plant (some plants)
- Layering yard (some plants).

(2) Iron processing flow (Figure 2-62):

(a) Stockpiles. Coke is transported from the coke screening tower to the blast furnace area where it may be stored in bins in the stock trestle or stockpiled on the ground- (Annotation 2). Limestone and iron ore are transported from mines and unloaded into raw material stockpiles (Annotation 1).

(b) Roasting and sintering plant. If the iron ore has a high sulfur content, it goes to a roasting and sintering plant (Annotation 16). The iron ore is first roasted to remove sulfur and sintered to fuse iron ore particles so they will not be blown out of the blast furnace and lost.

(c) Layering yard. If several iron ores of different composition and quality are used, they must be combined to assure a uniform charge for the blast furnace. This mixing of ores takes place in the layering yard (Annotation 17). Thin layers of different ores are laid atop one another in established proportions by a gantry crane or special layering machinery.

(d) Stock trestle. Ore is taken, as needed, from the layering yard (or stockpile if no treatment is necessary) and placed in bins in the stock trestle. Limestone usually does not need any special treatment beyond crushing. However, some plants powderize their raw limestone to increase its quality. This operation can be recognized by the presence in the stock trestle alongside the coke and iron ore.

(e) Blast furnace. From the stock trestle, the charge (measured amount of iron ore, limestone, and coke) is carried up and into the blast furnace (Annotation 5) via a conveyor device called a skip hoist (Annotation 3). The tall, tapering shape of the blast furnace may be hard to recognize because of obscuring pipes and fittings.

(f) Hot stoves. Next to the blast furnace is a group of three or four tall, interconnected cylinders called hot stoves (Annotation 10). Burning gas heats the firebrick-lined labyrinthine interior of the hot stove. Once it has reached a high temperature, fuel is shut off and high pressure air is introduced. This air picks up heat from the firebrick lining and is routed into the bottom of the blast furnace where it is directed up through the charge. After approximately 30 minutes, the air flow is shut off and fuel is reintroduced to reheat the unit while another stove assumes the heating task. Thus, with three to four hot stoves, a constant supply of super-heated air is assured. Annotation 13 is a waste gas stack for the hot stoves.

(g) Blast house. The high pressure air required by the blast furnace is supplied by the blast house (Annotation 12). The long, single-story structure contains a number of compressors which pump air to the hot stoves through a large pipe called a blast main (Annotation 11).

(h) Dust catcher, The reduction of iron ore to pig iron results in a tremendous amount of volatile blast furnace gas and dust particles. This is directed out of the blast furnace through the down-comer pipe (Annotation 6) into a dust catcher (Annotation 7). The gas is turned, expanded, and slowed down in the large, tank-like dust catcher allowing most of the heavier dust particles to drop to the bottom.

(i) Gas scrubber. The exhaust gases move to a gas scrubber, also called the Cottrell precipitator (Annotation 8). Here, the waste gas passes through a series of fine water spray curtains, washing the finer dust particles out of the gas.

(j) Dorr thickener. These particles go down into a Dorr thickener (Annotation 9) where any iron particles are recovered for reprocessing. The cleaned gas is then either vented into the atmosphere or stored for later use as a fuel.

(k) Casting shed. The blast furnace operates continuously, but the iron is tapped from the bottom every four to six hours. This operation takes place in the casting shed (Annotation 4), a small shelter that houses the lower section of the blast furnace. The pig iron is tapped from the furnace into a football-shaped car called a ladle or submarine car (Annotation 14) for transport to the steel production area.

(l) Slag dump. Slag is also tapped periodically and transported to a slag dump in a slag car or slag pot (Annotation 15).

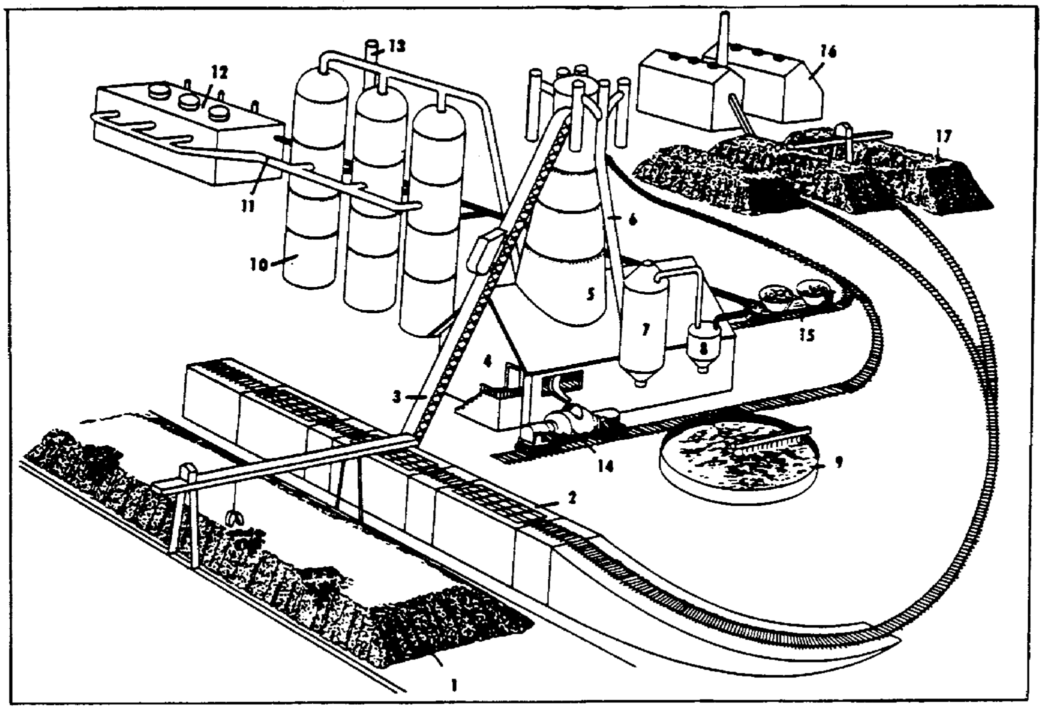


Figure 2-62. Iron Processing.

c. Steel Production. Steel is an alloy or iron. The iron produced in a blast furnace, pig iron, contains a relatively high carbon content which makes it hard but brittle. To create steel, the carbon content of pig iron must be reduced and impurities removed. At the same time, small amounts of alloy metals such as chromium, nickel, or tungsten are introduced to add special desired characteristics (for example, hardness, corrosion resistance, and high tensile strength). The four common steel production processes reduce the carbon content and remove impurities by combustion. Heated gas and air or oxygen are burned in the presence of the molten iron and excess carbon and impurities are consumed along with the fuel (Figure 2-63).

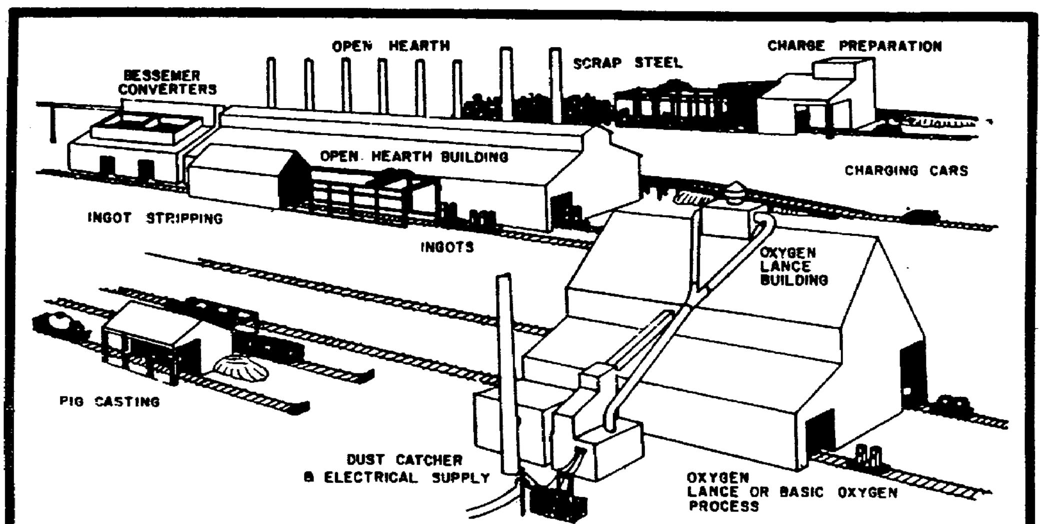


Figure 2-63. Steel Production.

d. Several processes exist for the conversion of iron to steel. The four most common are the electric arc furnace, Bessemer converter, open-hearth furnace, and basic oxygen furnace.

NOTE: Regardless of the steel process used, the steel manufacturing operation involves four basic steps: producing the steel and pouring ingot; stripping and soaking the ingot; rolling the ingot into blooms, billets, or slabs; rolling a finished or semifinished product.

(1) Electric arc furnaces account for only a minute part of the steel produced worldwide, but they produce the finest quality steel. These furnaces are relatively small facilities that have a minimum of imagery components, making it hard to identify them from photography. Major recognition features of electric arc furnace include:

- Scrap steel pile
- Transformer yard which supplies electric power
- Vents or monitors on the building housing the furnace
- Possibly a dust catcher.

(2) Bessemer converters are the oldest of the steel processes still in use. Steel is produced quickly but is of a low quality. Many of the phosphoric impurities cannot be removed so the steel retains some brittleness.

(a) The Bessemer converter is a large, open-mouthed vessel pivoted on trunnions (Figure 2-64). Air ducts or pipes enter the converter through the trunnions. To charge the converter, it is tilted forward, and molten iron is poured in. The vessel is then returned to the vertical position, and a high pressure stream of air is pumped through the air ducts and forced up through the mass of molten iron. As the air passes through the hot metal, carbon and other impurities are burned off, creating a cloud of smoke and sparks that vent from the open mouth of the converter vessel. The smoke and sparks escape through an opening on the roof. The converter is often housed in the same building as the open-hearth furnace or in a smaller, similar structure.

(b) Major recognition features of a Bessemer Converter:

- Housed in an open-hearth furnace building or a smaller, similar structure
- Large roof opening
- Large, white smoke cloud spewing from the roof openings.

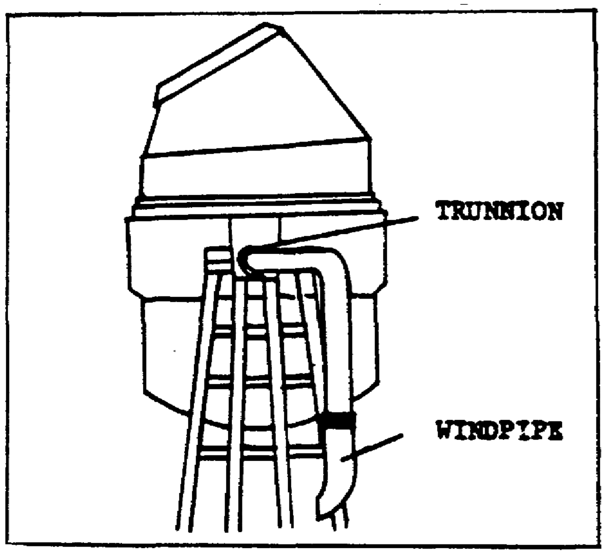


Figure 2-64. Bessemer Converter.

(3) Open-hearth furnaces are 'the most common method of steel production throughout the world because large amounts of high quality steel are produced economically.

(a) The open-hearth is a large, enclosed shallow basin, containing from 60 to 300 tons of molten metal at one time. This charge of molten iron is composed of 50 percent pig iron and 50 percent scrap steel. Measured amounts of limestone flux and certain alloy metal are added to this batch.

(b) On each side of the basin is a set of two heating chambers filled with layers of open brickwork. Each set of heating chambers includes one to preheat air and one to preheat gas. These chambers operate on the same principle as the hot stoves. Gas and air are piped through one set of heating chambers where they pick up heat from the hot brickwork. The preheated gas and air are directed into the open-hearth chambers where they mix and ignite with a high temperature. Hot exhaust gases are then piped out of the open-hearth chamber and passed through alternate chambers to heat them.

(c) Major recognition features of open-hearth furnaces include (Figure 2-65):

- Usually the largest single building in the steel complex
- Large, long steel frame structure
- Tall stacks along one side usually indicating the number of hearths
- White smoke emanating from stacks is characteristic of atmospheric open-hearth process, while red or orange smoke is indicative of the oxygen open-hearth.
- Scrap steel stockpile and charge preparation building.

NOTE: Open-hearth furnaces are the largest buildings in a steel mill complex, easily identified by a row of stacks along one side of the building.

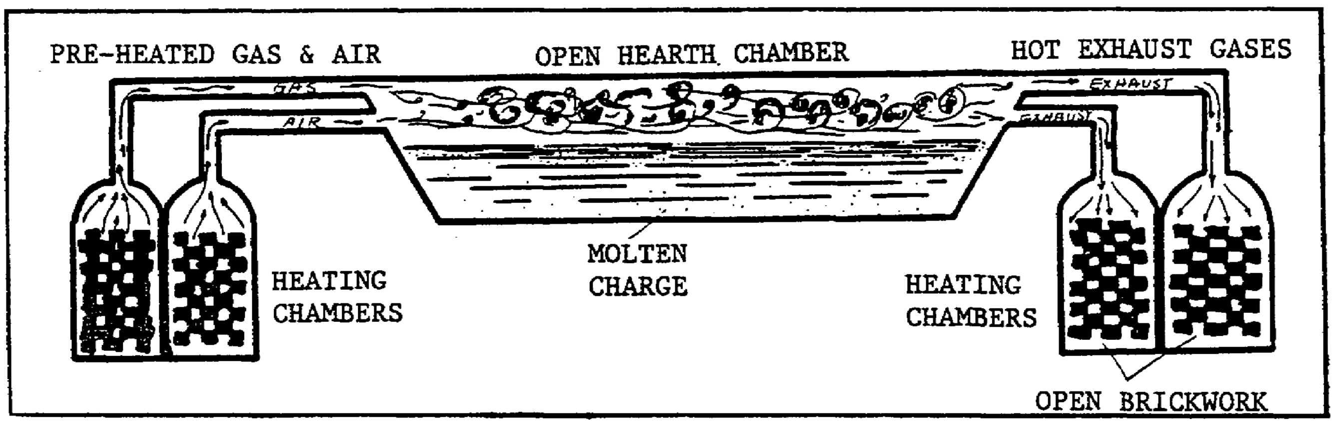


Figure 2-65. Open-Hearth Layout.

(d) When the brickwork in the first set of heating chambers begins to cool, the gas and air flow is reversed and the alternate, hot set performs the preheating task. The combustion of the gas and air within the open-hearth chambers burns off the excess carbon and some impurities while the limestone removes the rest of the impurities and forms a slag.

(e) The fuel is normally either blast furnace gas or coke gas, and the air is supplied by compressors located beneath the open-hearth floor. A variation on the basic open-hearth method is the oxygen open-hearth where oxygen is substituted for atmospheric air. This substitution cuts the production time from 10 hours to five. After the steel process is completed, a clay plug at the end of the hearth basin is blown out with a shaped charge and the steel drained out into a large ladle.

(4) Basic oxygen furnace (oxygen lance) is the newest of the steel production methods and rapidly growing in importance because of its speed and efficiency. Major recognition features of BOF include:

- Very tall monitor roof
- Multistoried steel frame with a large flue exiting from the roof
- Dust catcher and exhaust stack unit
- Oxygen storage tanks.

(a) The basic oxygen furnace (BOF) is a pear-shaped or spherical steel vessel mounted on trunnions similar to the Bessemer converter (Figure 2-66).

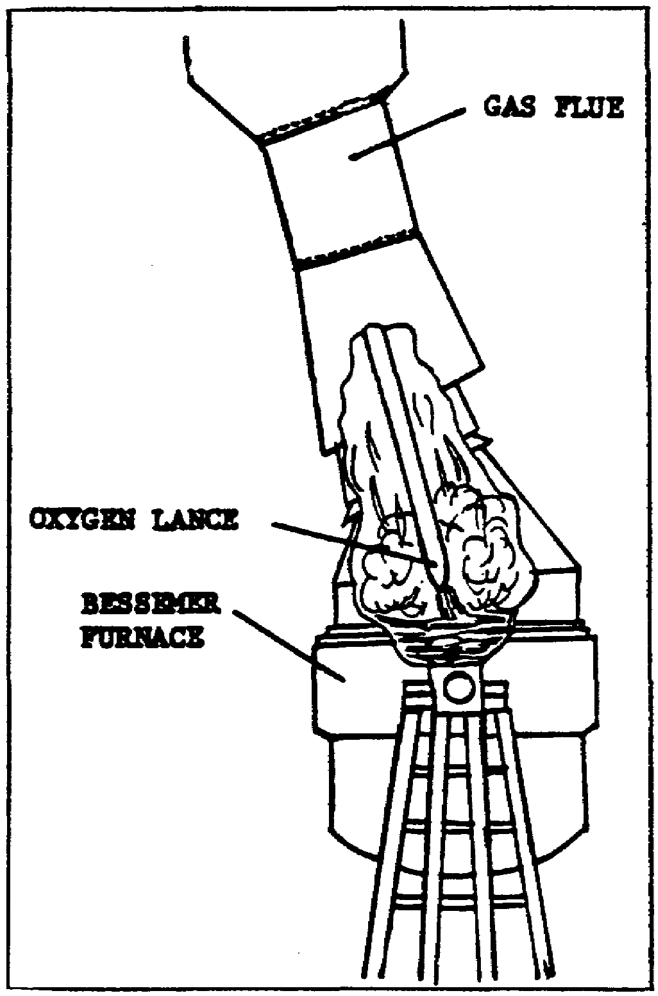


Figure 2-66. BOF.

(b) Like the converter, the BOF is rotated forward for charging through an open mouth and returned to the vertical position for operation. However, in the BOF, a water-cooled lance is lowered into the vessel, and a stream of pure gaseous oxygen is directed on the molten charge.

(c) The smoke and dust resulting from the oxidation of the impurities and carbon in the iron are collected in a large hood and flue assembly that is fitted over the mouth of the BOF.

(d) These pollutants are directed from the furnace building and into a large dust catcher. The efficiency of the BOF over the converter is the result of the higher efficiency of oxygen over atmospheric air as a refining agent, the recent developments in automatic controls and data processing, and better quality controls.

e. Steel Processing/Fabrication: After the molten steel is tapped from the furnace, it is poured into ingot molds mounted on little flat railcars in the pig casting building (Figure 2-63). Once the ingot is cast it goes through the steps of stripping, soaking, and rolling (Figure 2-67).

(1) Major recognition features of a steel forming and finishing plant include:

- Stripping area
- Building under an overhead or tower crane
- Situated on rail network
- Soaking pits
- Long, low steel-frame structure
- Erected across and abutting the mill
- Short stacks
- Roughing mill
- Short, single-story, steel-frame structure
- Abuts soaking pots; usually forms a "T" or "L"
- Bloom and billet storage area
- Rolling and finishing mill
- Reheat furnaces with three or four short stacks on or alongside the mill
- Long, steel-frame building
- Arranged side-by-side or in staggered series.

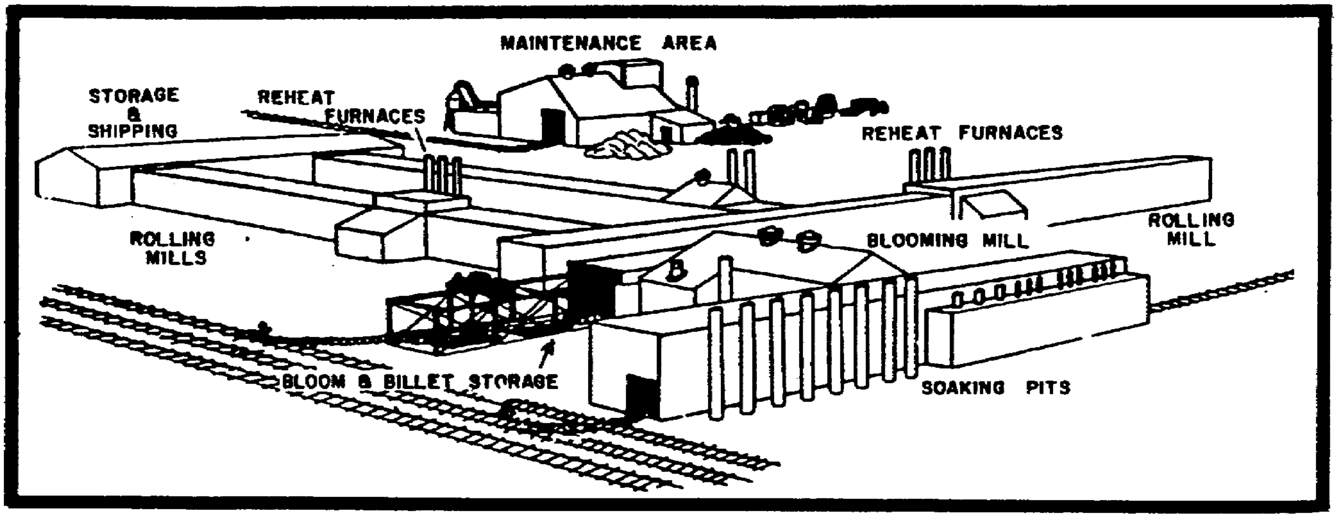


Figure 2-67. Steel Forming and Finishing.

(2) Processing flow of steel processing/fabrication plant:

(a) Stripping areas. Stripping is the removal of the ingot mold from the red-hot ingot. Before an ingot can be rolled into a shape, it must have uniform temperatures. A freshly stripped ingot has a solid exterior but an extremely hot, molten interior. If such an ingot were prematurely rolled, its molten content would spew out under the pressure of the rolling machinery.

(b) Soaking pits. To prevent this, the ingot must be soaked in a special, pot-like furnace until its exterior and interior stabilize at a uniform temperature throughout.

(c) Roughing mill. It then goes to the roughing mill for initial rolling. In machinery similar in operation to an old-fashioned clothes wringer, the ingot is pressed into one of three basic shapes: bloom, billet, or slab. A bloom is a large bar of steel with a square of rectangular cross-sectioning greater than 36 square inches. A billet is similar to a bloom but smaller. A slab is wider and flatter than a bloom.

(d) Bloom and billet storage yard. Shaped ingots not immediately needed are temporarily stored outside in a bloom and billet storage yard (Figure 2-67).

(e) Rolling and finishing mill. For additional forming, the shaped ingot is passed on to the rolling and finishing mills (Figure 2-67). Before the shaped ingots are rolled further, they are placed in a reheating furnace (Figure 2-67). The temperature is maintained through periodic reheatings in other reheat furnaces situated along the mill's length. Steel sheet, rod, beams, rails, wire, and nails can be produced in mills.

(f) Finished product storage area. A mill complex will usually end in a finished product storage area.

(g) Controlled cooling warehouse. Some special products such as structural steel and railway rails, require controlled cooling conditions to minimize distortion from contraction. A controlled cooling warehouse will be present to accommodate such products. It can be recognized by its large roofed monitors and vents which allow good ventilation.

f. The charge for a blast furnace consists of coke, iron ore, limestone, air, and water used as a cooling agent. The layering yard and roasting and sintering areas are involved in the preparation of iron ore, limestone, and coke prior to it being charged into the blast furnace (Figure 2-68).

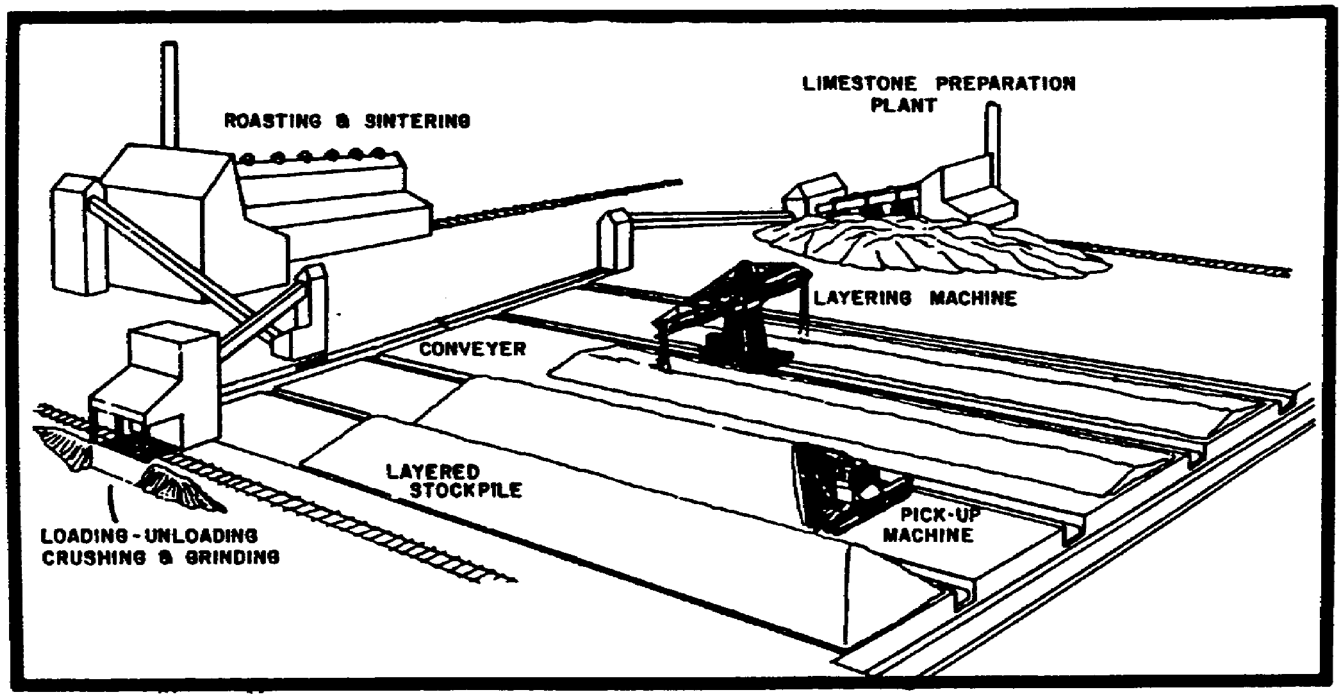


Figure 2-68. Preparation for the Blast Furnace (Layering Yard).

(1) Various grades of iron ore, which have been previously crushed, are mixed in the layering yard prior to roasting and sintering. Coke dust may also be added at the sintering stage.

(2) Limestone is prepared for the blast furnace by either slacking or calcining. Both processes are rare at a steel plant, lime preparation normally being accomplished at the mine site.

(3) All these processes are optional and will not be seen at all coke, iron, and steel works. Layering is only required where various grades of ore are used and mixed. Roasting is used to remove impurities from low grade ores and sintering to form ore and coke fins Into clinker or sinter as a preparation for the blast furnace.

4. Other heat processing industries are depicted in Figures 2-69 thru 2-73.

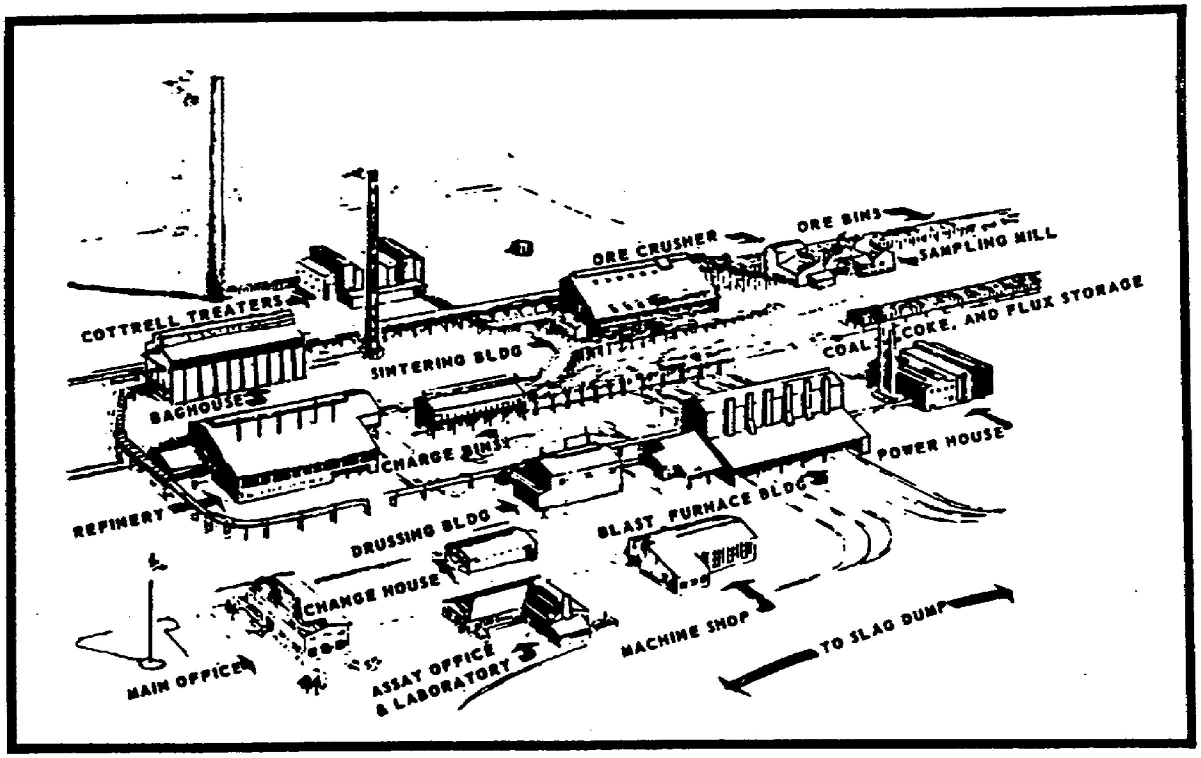


Figure 2-69. Lead Smelter and Refinery.

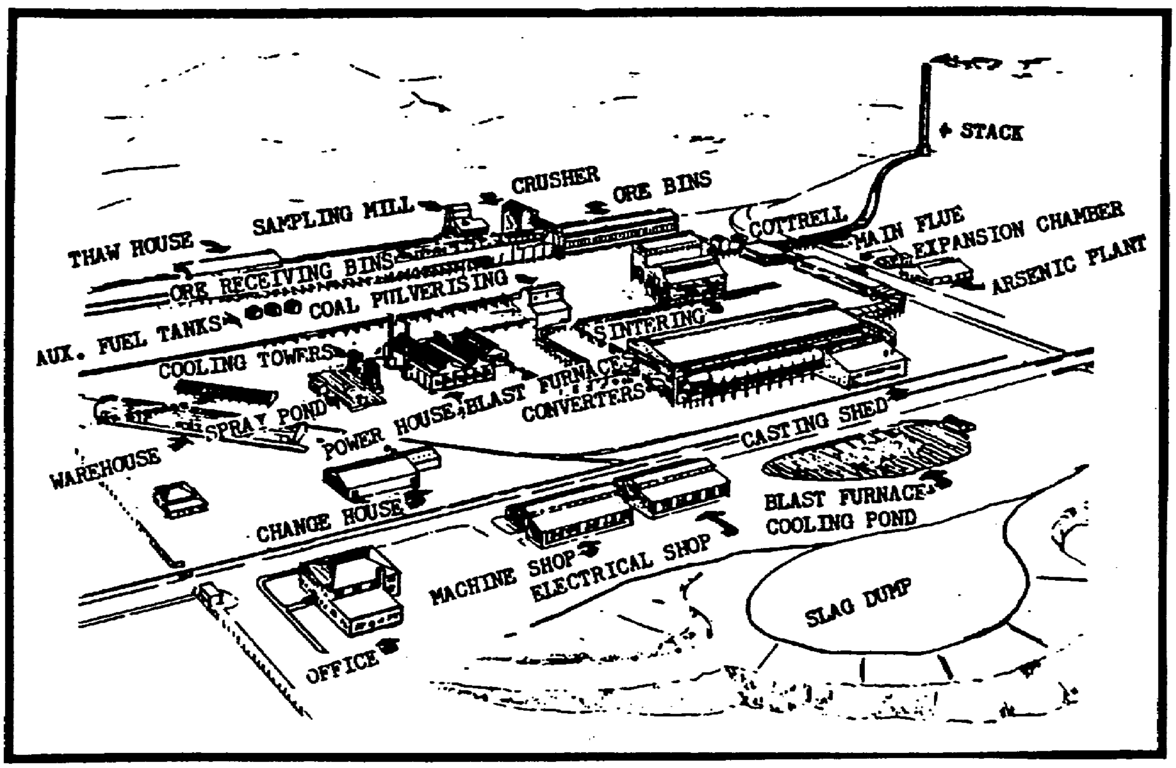


Figure 2-70. Copper Smelter.

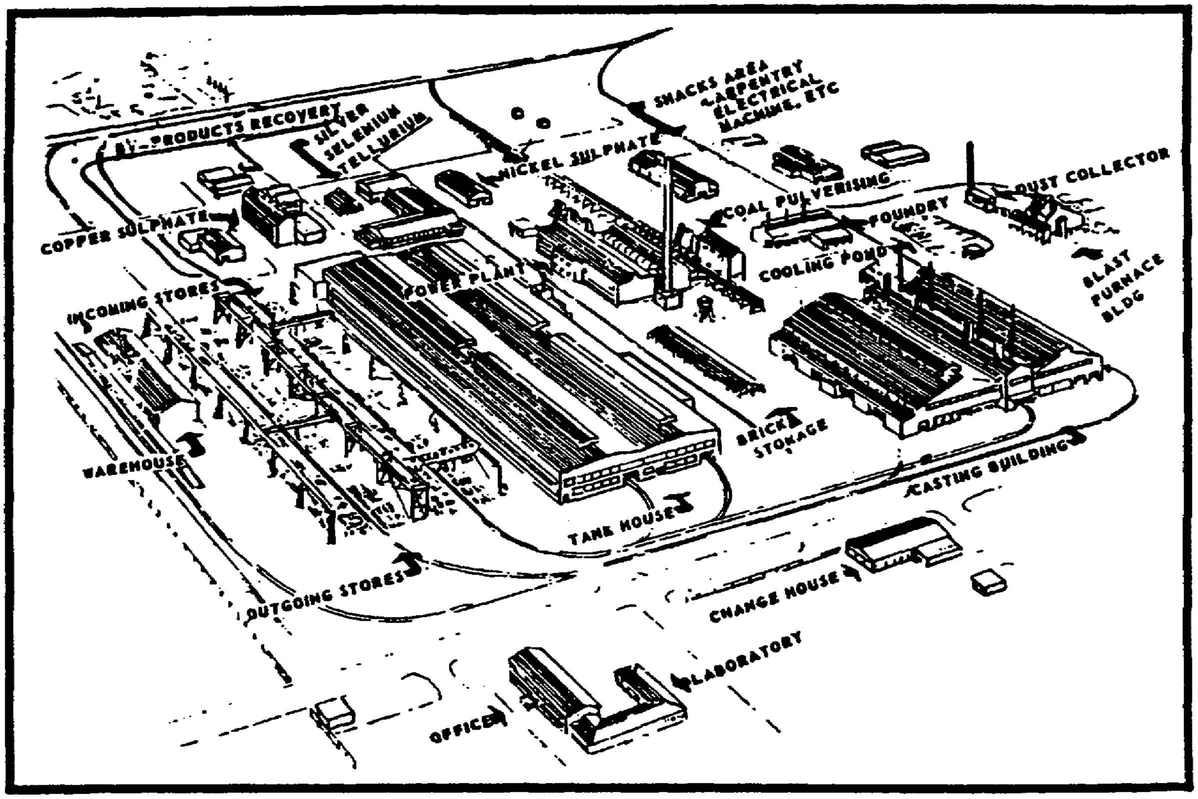


Figure 2-71. Copper Refinery.

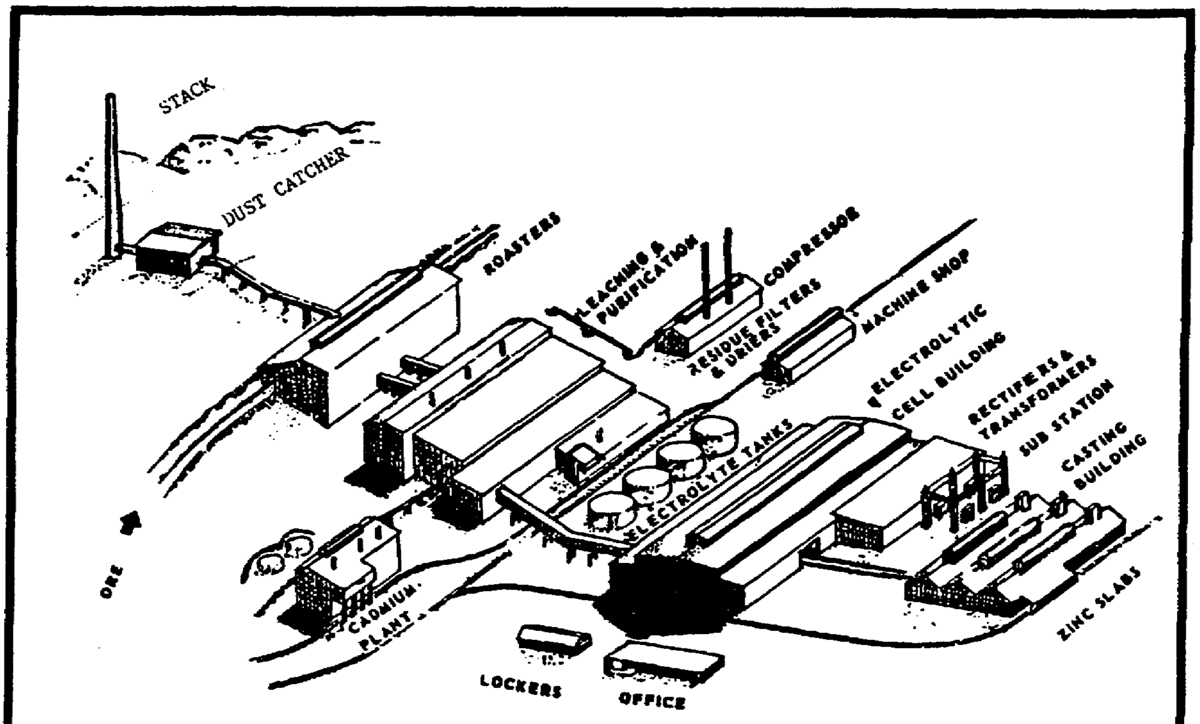


Figure 2-72. Electrolytic Zinc Plant.

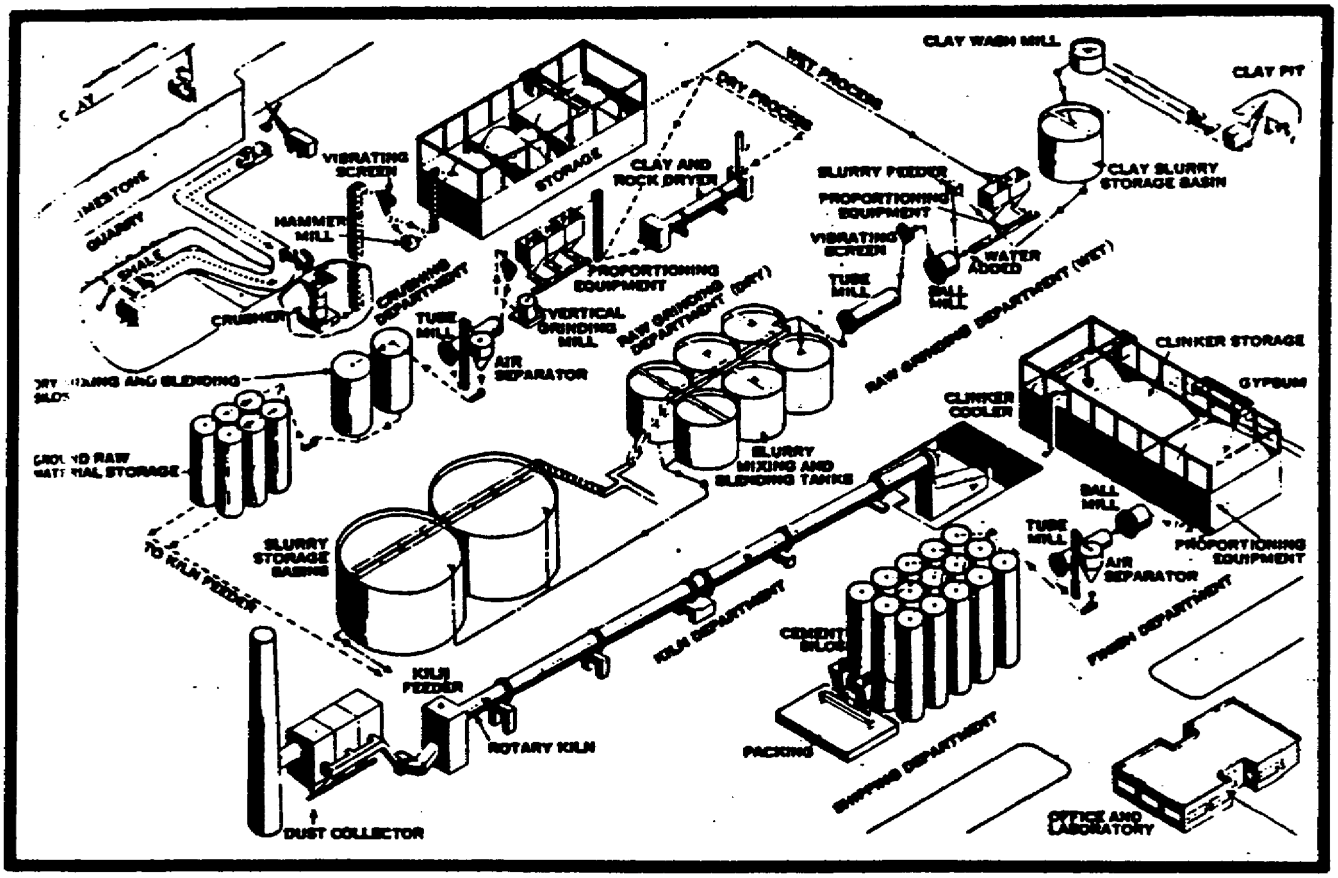


Figure 2-73. Wet Cement Production.

LESSON TWO

PRACTICE EXERCISE

The following items will test your grasp of the material covered in this lesson. There is only one correct answer to each item. When you have completed the exercise, check your answer with the answer key that follows. If you answer any item incorrectly, study again that part of the lesson which contains the portion involved.

1. Which of the following is considered a mechanical processing industry?

   A. Petroleum.

   B. Salt Refining.

   C. Saw mill.

   D. Cement.

2. What type of outdoor equipment is typical of a chemical processing industry?

   A. Mine cars.

   B. No kilns.

   C. Kilns.

   D. Many pipelines.

3. Which of the following is not considered a heat processing industry?

   A. Coke production.

   B. Iron production.

   C. Steel production.

   D. Ore concentration.

4. Refer to Figure 2-74. What type of storage facility is shown?

   A. Warehouses.

   B. Silos.

   C. Bunkers.

   D. Bins.

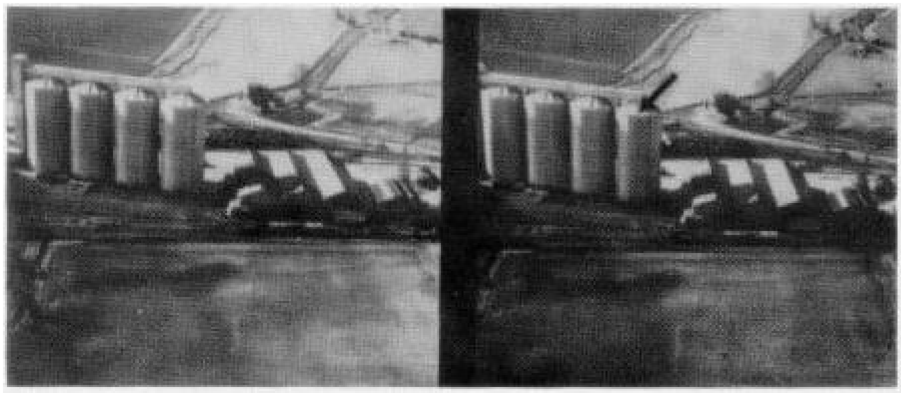


Figure 2-74.

5. Refer to Figure 2-75. What piece of equipment is indicated at the arrow?

   A. Cooling tower.

   B. Blast furnace.

   C. Processing building.

   D. Generator hall.

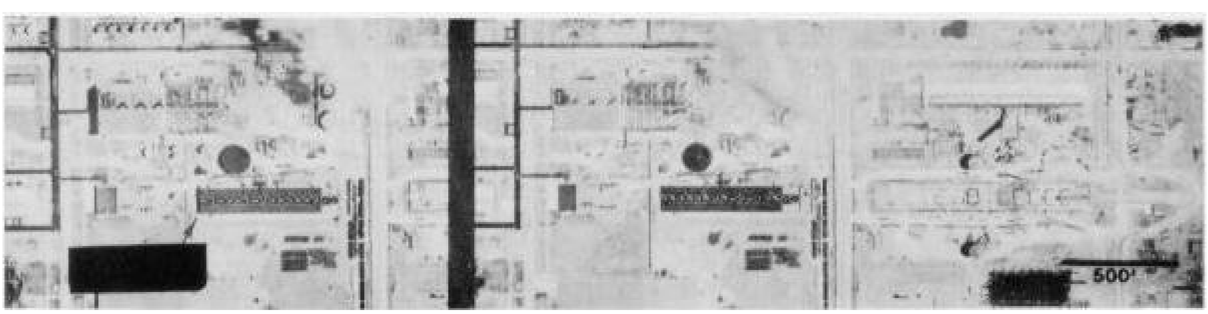


Figure 2-75.

6. Refer to Figure 2-76. What type of processing industry is present?

A. Gravel.

B. Limestone.

C. Cinder block.

D. Sawmill.

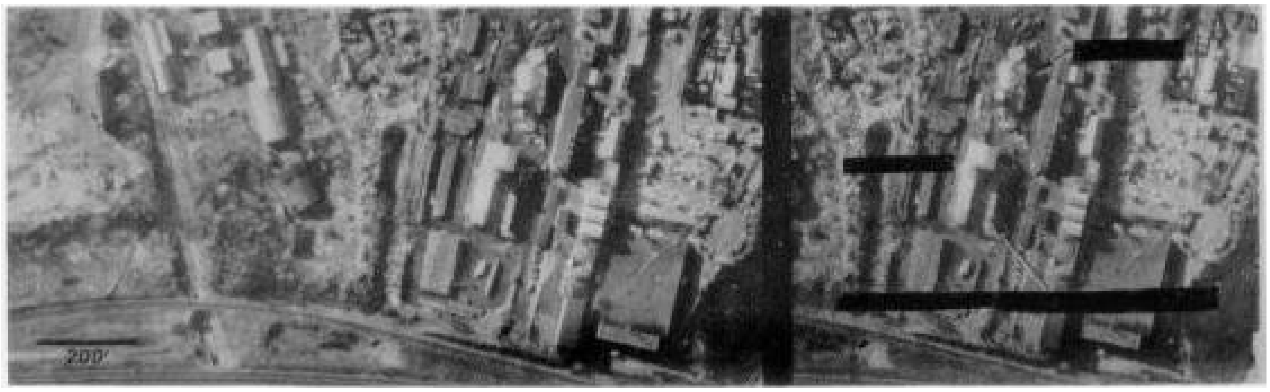


Figure 2-76.

7. Refer to Figure 2-77. What is the specific identification feature of this heat processing industry?

A. Railcars.

B. Warehouses.

C. Vents.

D. Blast furnaces.

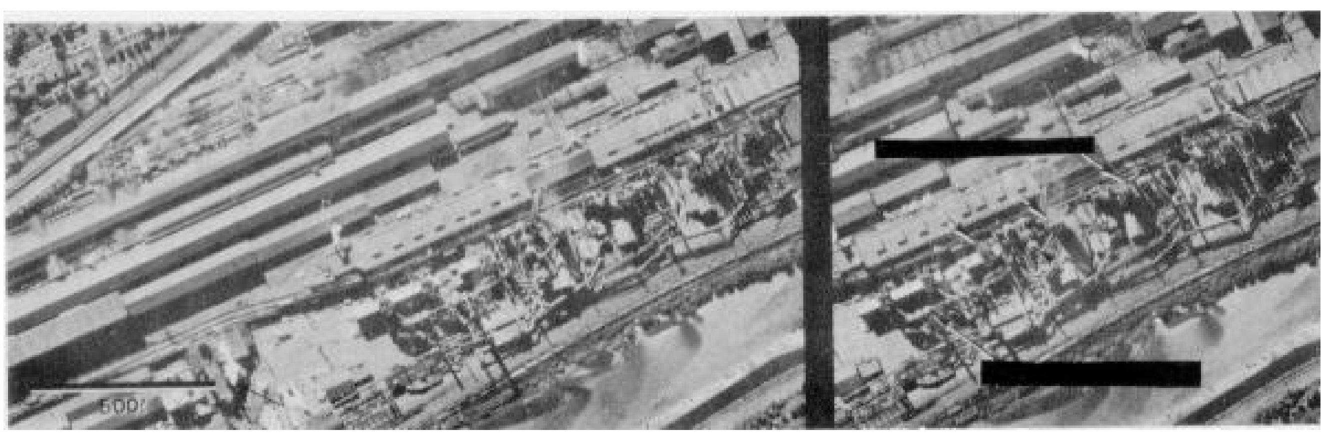


Figure 2-77.

8. Refer to Figure 2-78. What is indicated at the arrow?

A. Transformer yard.

B. Dam.

C. Warehouse.

D. Processing building.

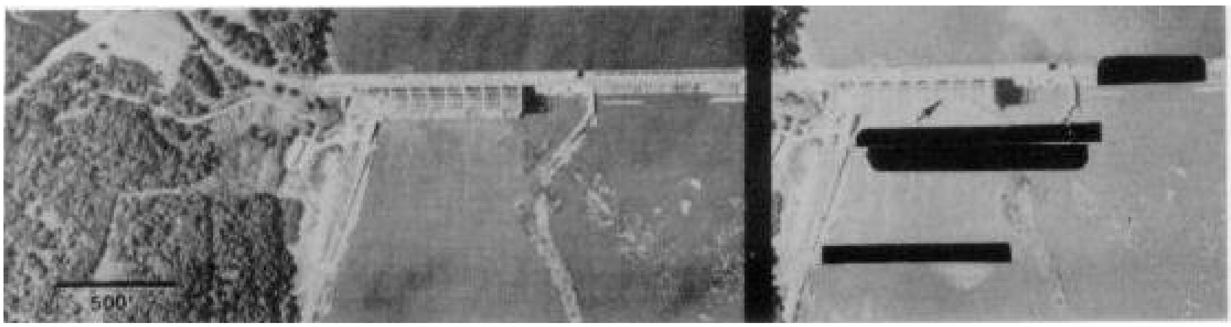


Figure 2-78.

LESSON TWO

PRACTICE EXERCISE

ANSWER KEY AND FEEDBACK

Item	Correct Answer and Feedback
1.	C. A sawmill is considered a mechanical processing industry (page 15, fig 2-2).
2.	D. Many pipelines are typical outdoor equipment of chemical processing industries (page 39, para 1).
3.	D. Ore concentration is not considered a heat processing industry (page 15, fig 2-2).
4.	B. Silos are the storage facility shown in fig 2-74 (page 106, fig A-17).
5.	A. A cooling tower is indicated at the arrow on fig 2-75 (page 104, fig A-12).
6.	C. A cinder block industry is present on fig 2-7 (page 34, fig 2-19).
7.	D. Blast furnaces are specific identification features of a heat processing industry (page 69, remember).
8.	A. A transformer yard is indicated at the arrow on fig 2-78 (page 118, fig A-53).

APPENDIX A

PROCESSING INDUSTRY RECOGNITION FEATURES

STACKS

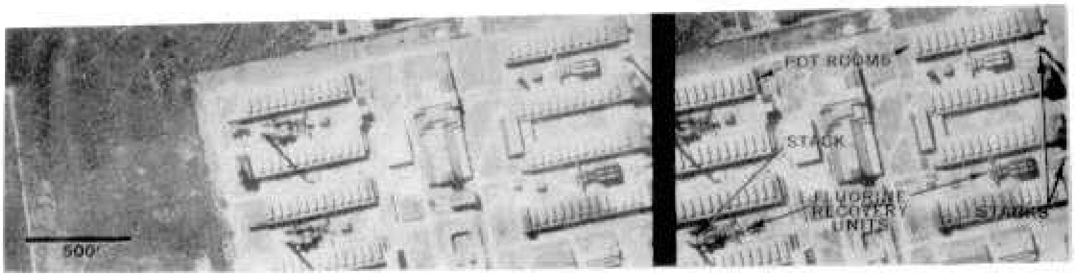


Figure A-1. Free-standing Stacks.

NOTE: At times a tall stack is used to dispose of the noxious gases which originate in the aluminum pot rooms. The gases are first sent from the pot room through the fluorine recovery unit.

Figure A-2. Stack for Sewage Incinerator.

NOTE: Solid wastes from the digestors are burned in a furnace. The smoke and waste gases are dispersed by a stack which helps create a draft. Incinerators are not always found at sewage disposal plants.

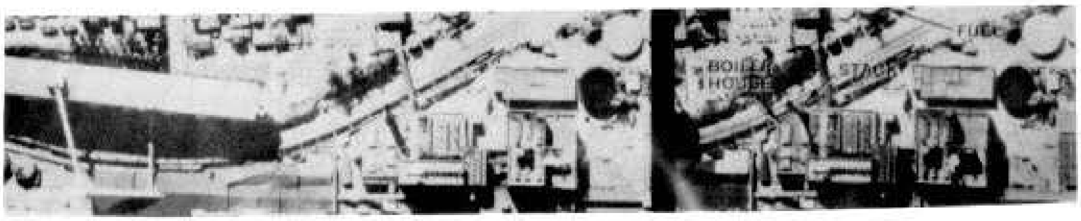


Figure A-3. Stack for Boiler House.

NOTE: The boiler house provides heat and steam needed in refining sugar. A tall brick stack is used here to dispose of the smoke and waste gases and to help create a draft for the boilers. Oil may be the fuel since no coal storage is evident. A boiler house may be found in many industries.

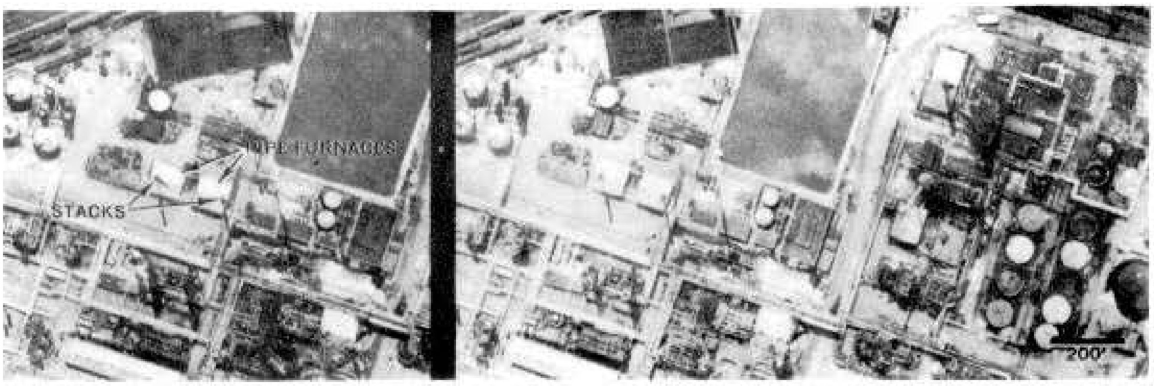


Figure A-4. Stacks for Pipe Furnaces.

NOTE: Each pipe furnace is served by a tall stack which disposes of smoke and waste gases, and helps create a draft. Some pipe furnace stacks are free standing.

FLARES.

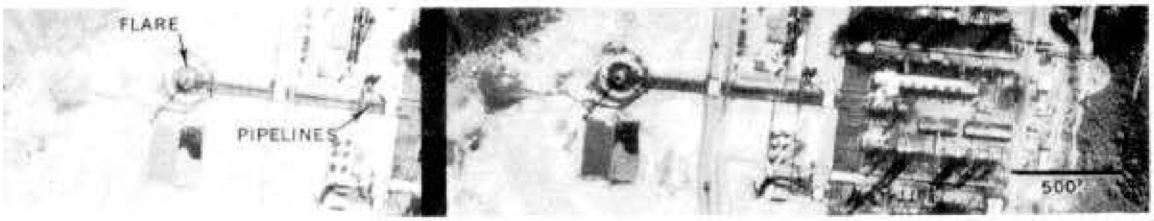


Figure A-5. Flare.

NOTE: At this petroleum refinery flammable waste gases are piped to a tall slender stack. The gases are ignited at the top of the stack and burned. Many refineries do not have flares.

VENTS

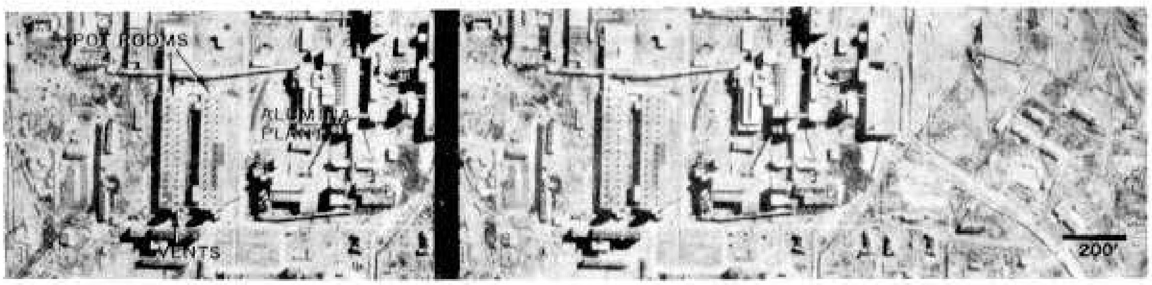


Figure A-6. Vents on Pot Rooms.

NOTE: Fumes and heat from the electrolytic cells escape through the vents on the roof. Vents are seen on many processing buildings.

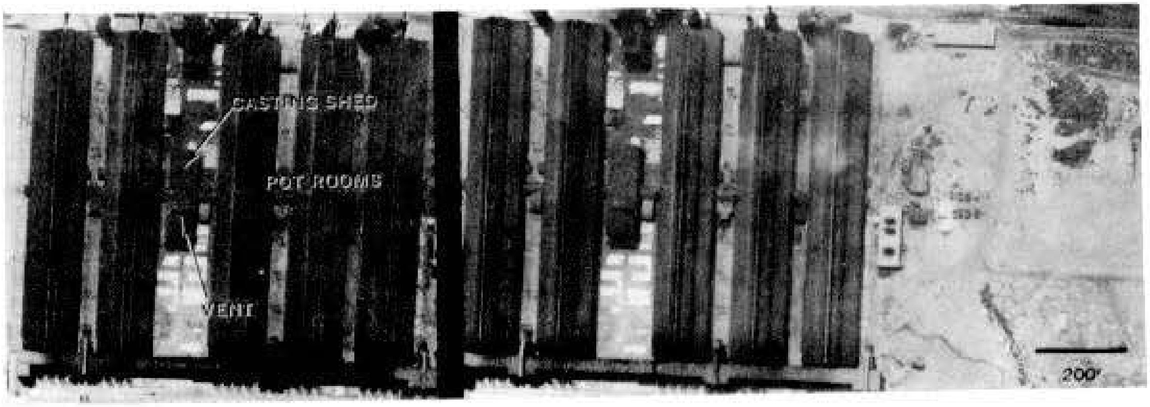


Figure A-7. Vents on Pot Rooms and Casting Shed.

NOTE: The fumes and heat from the electrolytic cells and the heat from casting molten aluminum escape through the monitor-like longitudinal and transverse vents.

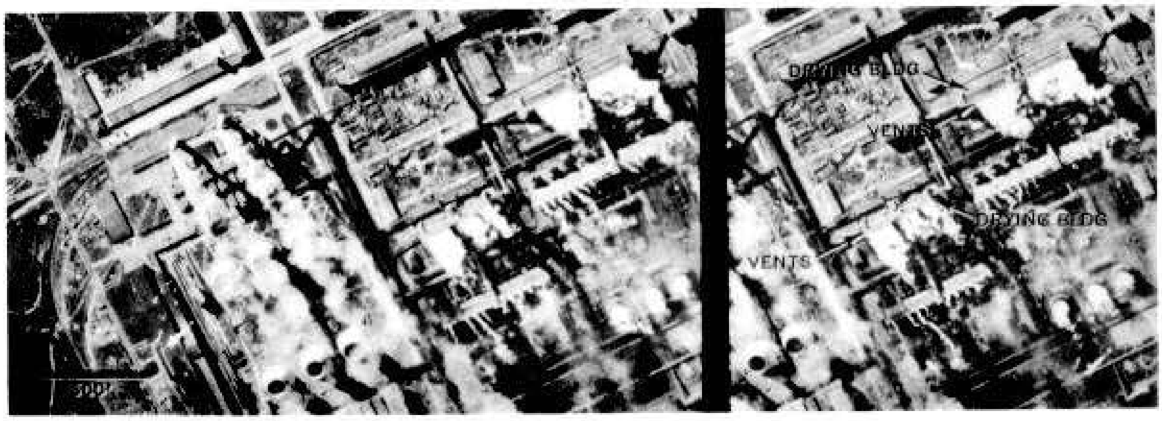


Figure A-8. Vents on Coal Drying Building.

NOTE: The excess moisture in the brown coal is vaporized in driers, and the steam is dispersed through these small vents.

Figure A-9. Vents on Chlorinator and Electrolytic Cell Buildings.

NOTE: Heat and fumes from the electrolytic cells escape through the longitudinal vents which look much like monitors. Covered round vents are used on the chlorination sections.

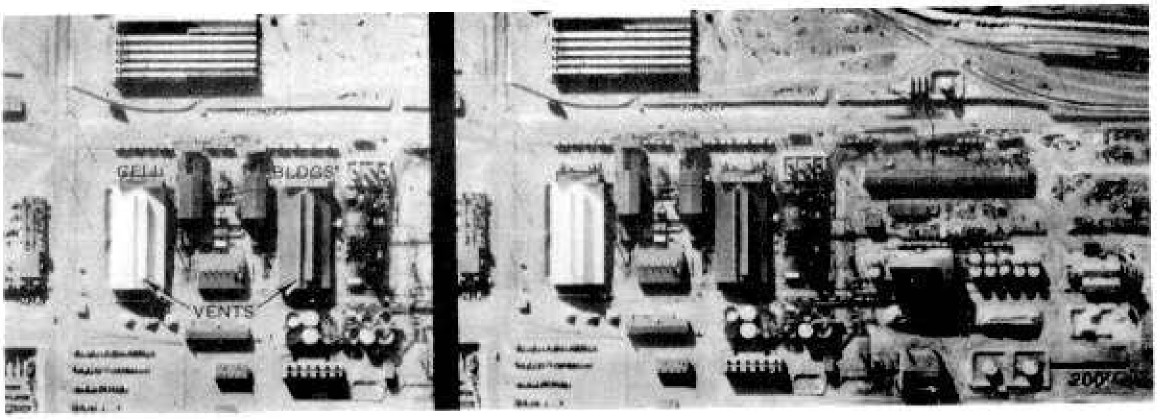


Figure A-10. Longitudinal Vents on Cell Buildings.

NOTE: The monitor-like vents permit fumes from the electrolytic cells to escape. Similar vents are seen on many processing buildings.

<u>COOLING TOWERS.</u>

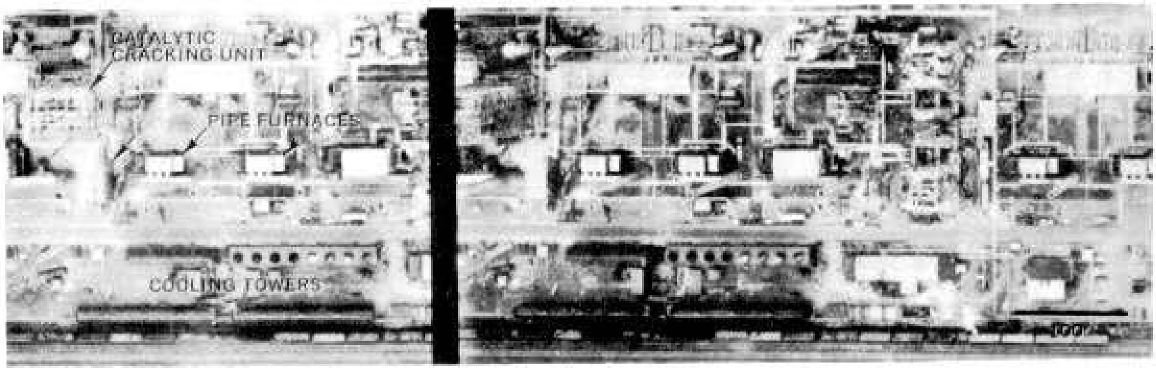


Figure A-11. Cooling Towers.

NOTE: The long narrow structures contain baffles over which water is cascaded. Exposure to the air and evaporation cool the water so that it can be reused. Fans are placed in the top of one structure to induce a draft.

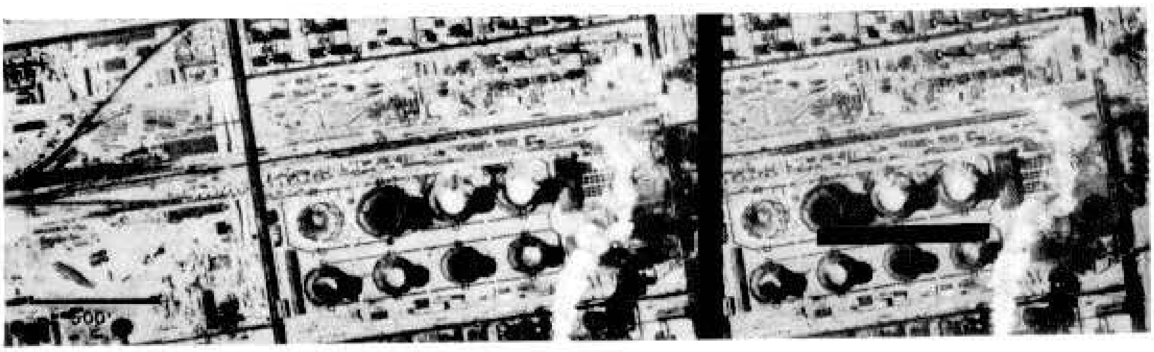


Figure A-12. Cooling Towers.

NOTE: When the cooling water used in various processes becomes heated, it is cooled and reused. The water is sprayed toward the center of these tall round structures from the nozzles arranged around the inside. The large base covers a water basin. The towers in operation have steam rising from them.

KILNS.

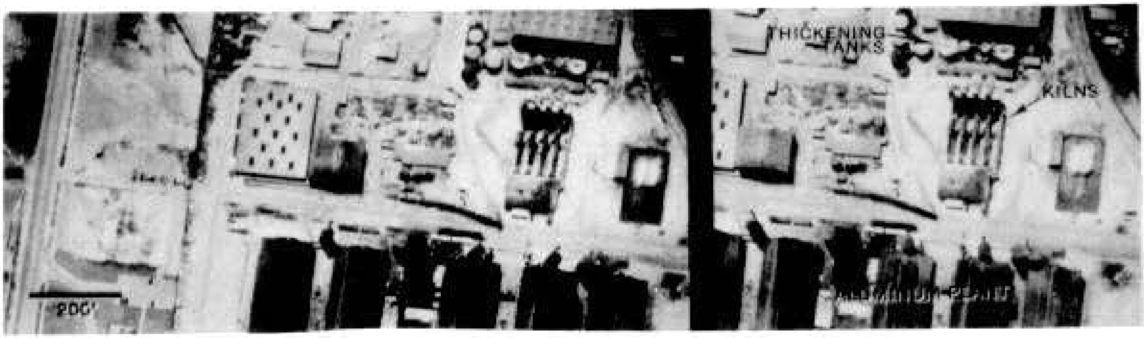


Figure A-13. Rotary Kilns.

NOTE: The kilns rotate as the material moves from the higher end to the lower or discharge end.

Figure A-14. Housed Rotary Kilns.

NOTE: Crushed limestone and shale are calcined in kilns which are sheltered in the long rectangular building. Waste heat and gases are dispersed by the stack.

Figure A-15. Vertical Kilns.

NOTE: Skip hoist charge limestone into the top of these tower-like vertical kilns which protrude through the arch roof of the kiln building. The charge is calcined and the lime is conveyed to the carbide furnace building where it is mixed with carbon and heated in an electric furnace to produce calcium carbide.

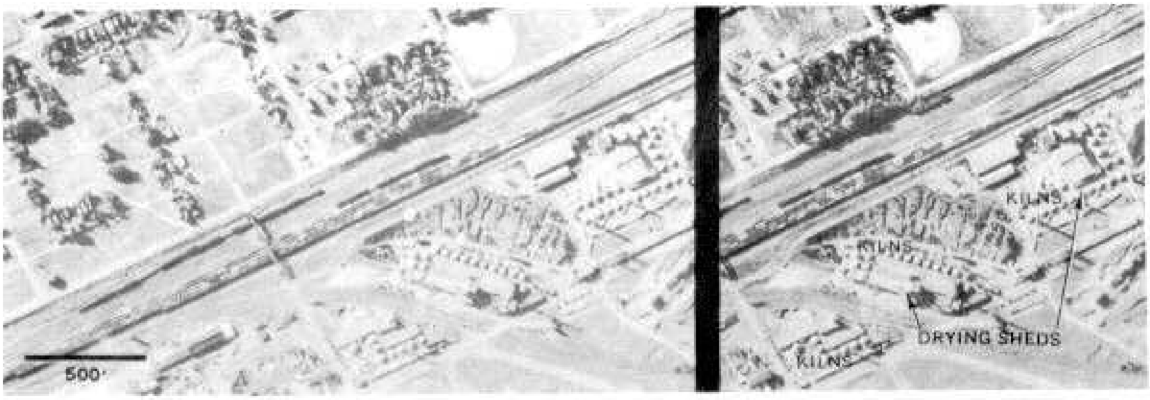


Figure A-16. Beehive Brick Kilns.

NOTE: Clay formed into bricks and cured in the drying sheds is fired in these round downdraft periodic kilns to partially vitrify and harden the material. Smoke and waste heat are dispersed by tall masonry stacks which serve several kilns. Coal is the fuel.

SILOS.

Figure A-17. Grain Silos.

NOTE: Grain which will be processed in the adjacent mill is stored in these tall cylindrical containers. The taller sections of the structures house elevators for lifting grain. A conveyor connects the two buildings.

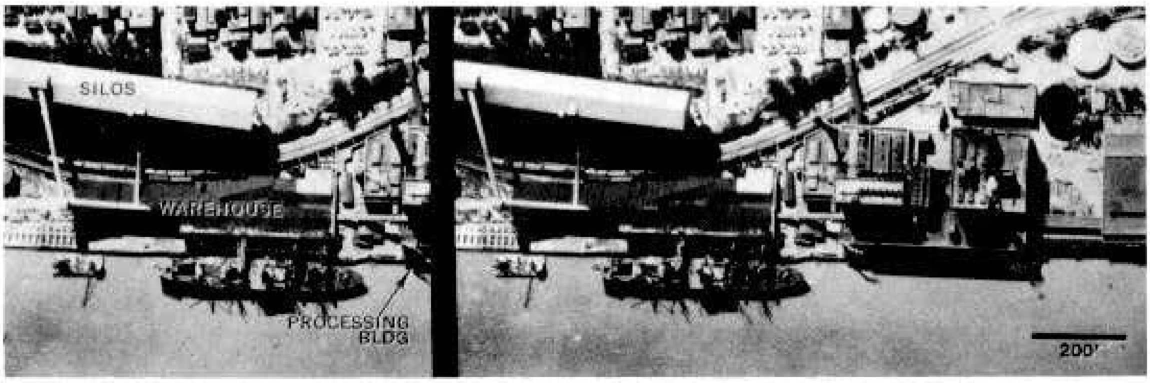


Figure A-18. Silos at Sugar Refinery.

NOTE: Raw cane sugar is conveyed from ships and stored in these silos, as well as in the warehouse, until it can be processed. Although the battery of silos is covered by a gable rook, the curved sides can be seen.

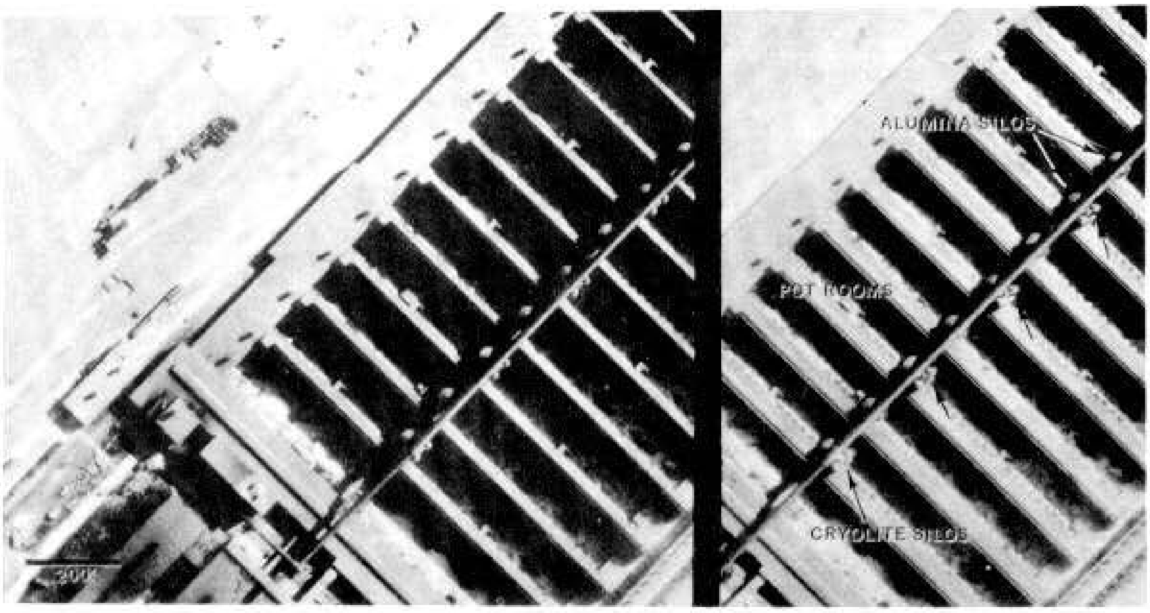


Figure A-19. Cryolite and Alumina Silos.

NOTE: Cryolite, the electrolyte used in the reduction cells, is stored in these small silos. They are not always present since the cryolite may be stored in the pot rooms.

Figure A-20. Silos.

NOTE: These containers, taller than normal storage tanks, hold magnesium oxide until it is processed with other raw materials, including peat, coal and magnesium chloride, into charge stock in the adjacent wet-mixing and kiln building.

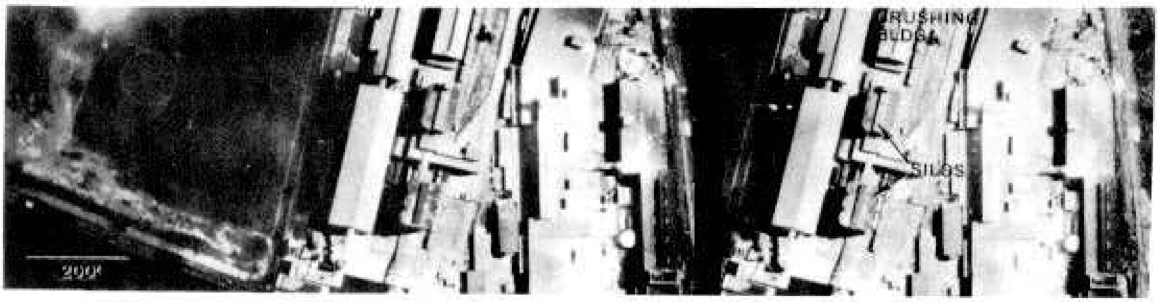


Figure A-21. Cement Silos.

NOTE: Cement clinker from the kilns is pulverized and conveyed to the tall cylindrical containers for storage until it is shipped out by rail or barge.

BUNKERS.

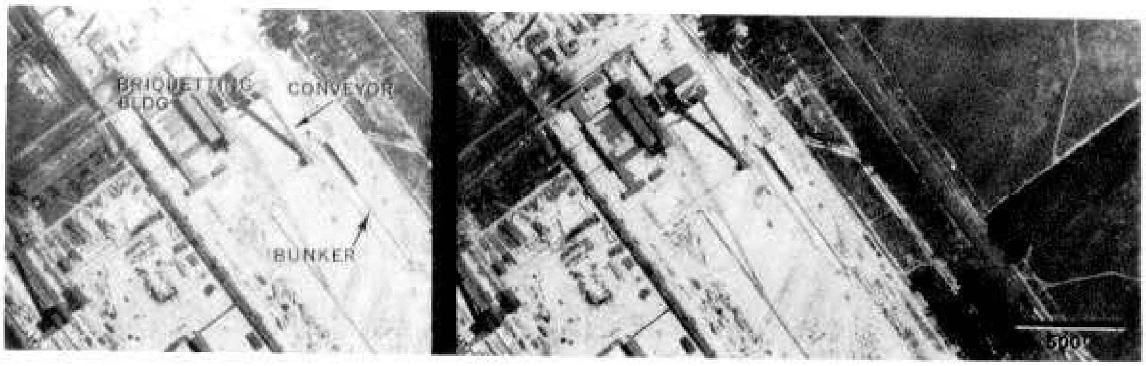


Figure A-22. Coal Bunkers.

NOTE: This long, narrow container is below ground level so that railroad cars can dump coal directly into it. A conveyor takes coal from the bunker to the briquetting buildings. This bunker has a light tone because it has not yet been used to store coal.

BINS.

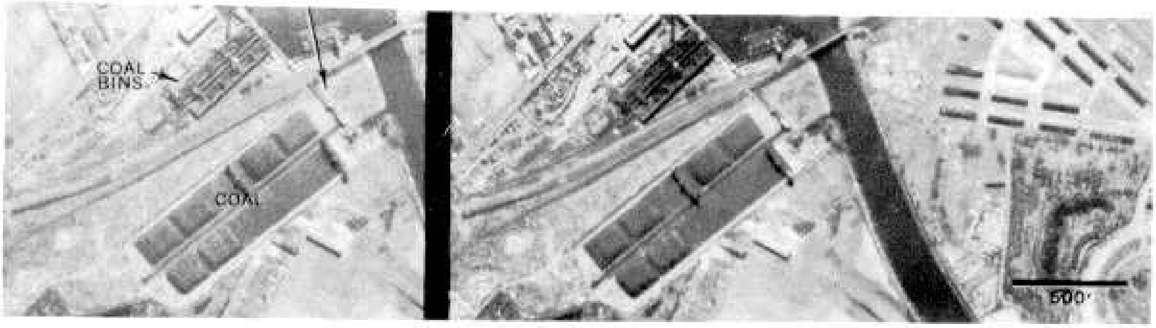


Figure A-23. Coal Bins.

NOTE: Coal to be used a fuel is delivered by barge or rail and stored in bins as well as in piles. From storage the coal is conveyed to the boilers.

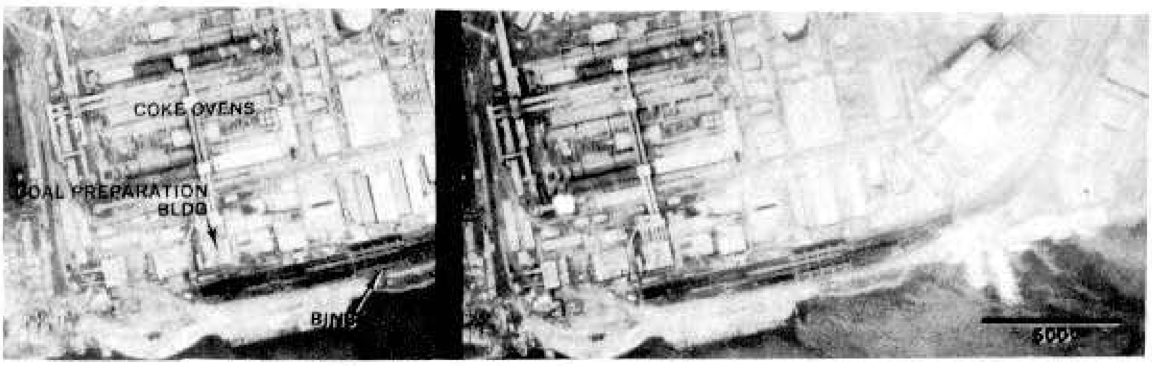


Figure A-24. Bins for Coal.

NOTE: Coal is delivered by railroad cars and dumped through the trestle into the bins below. Conveyors carry the coal to the coal preparation building.

HOPPERS.

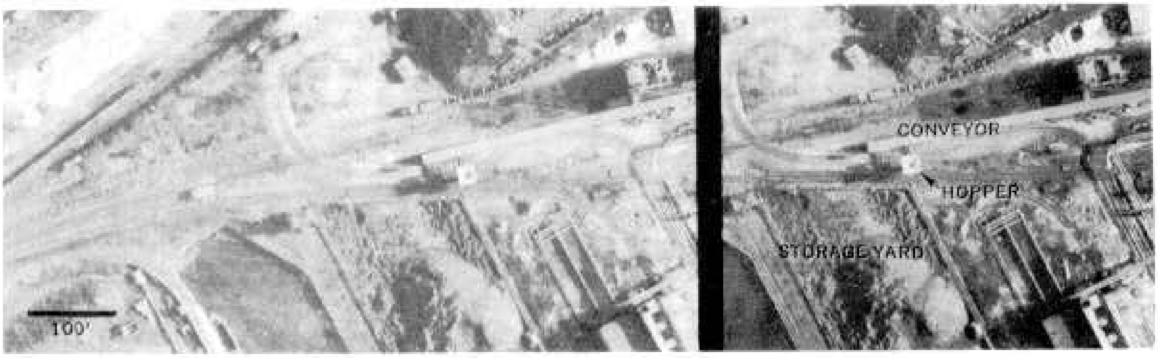


Figure A-25. Coal Hoppers.

NOTE: The coal from the open storage yard is transferred by a bridge crane to this square hopper. The coal is fed from the hopper into a covered conveyor which carries it to the coaling tower.

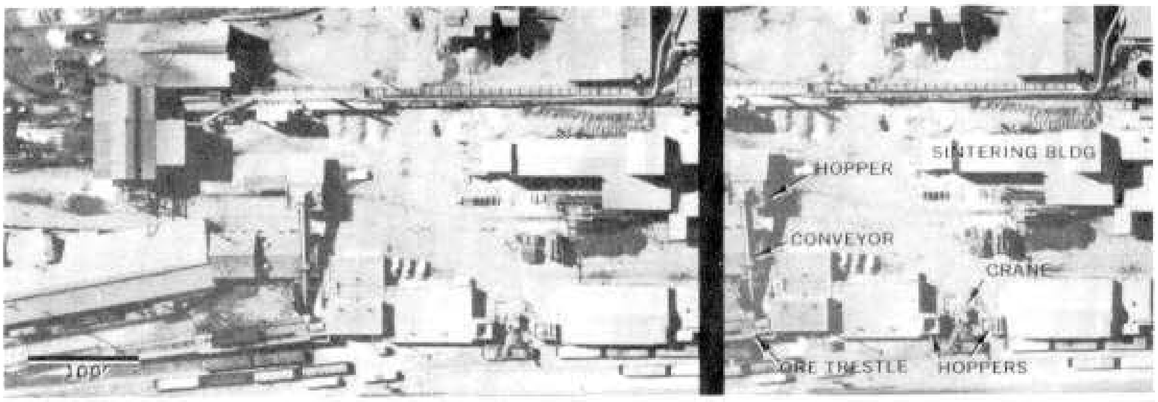


Figure A-26. Flux and Ore Concentrate Hoppers.

NOTE: Ore is conveyed from bins beneath the ore trestle into a covered hopper from which rail cars transport it to the sintering building. A crane unloads flux from rail cars into the other hoppers, and trucks transport it to the blast furnace building.

TANKS.

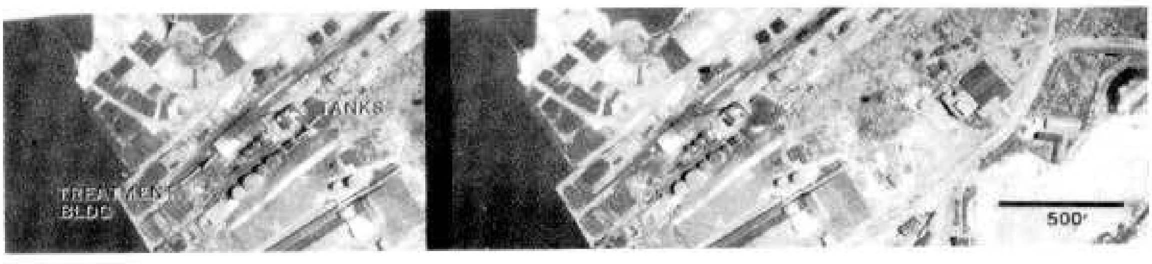


Figure A-27. Tanks for Wood Preservative.

NOTE: Liquid wood preservative is used in the adjacent wood treatment section. The heated preservative is forced into the wood under pressure. The treated wood has a dark tone and the untreated wood a light tone.

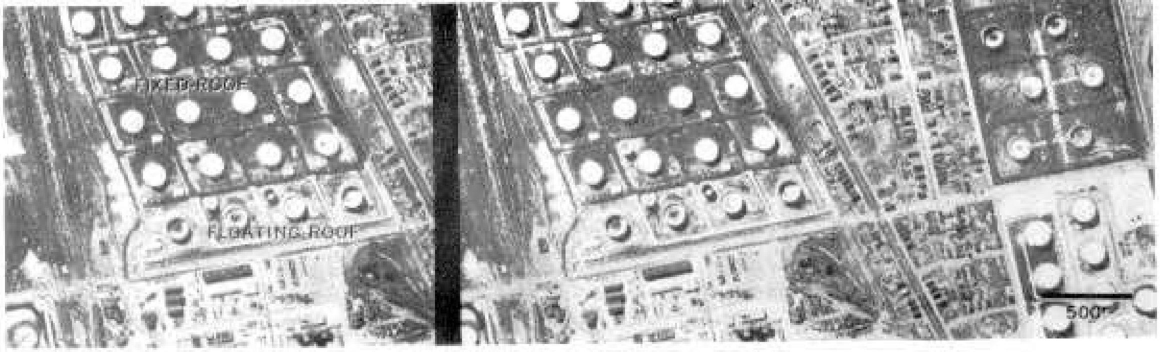
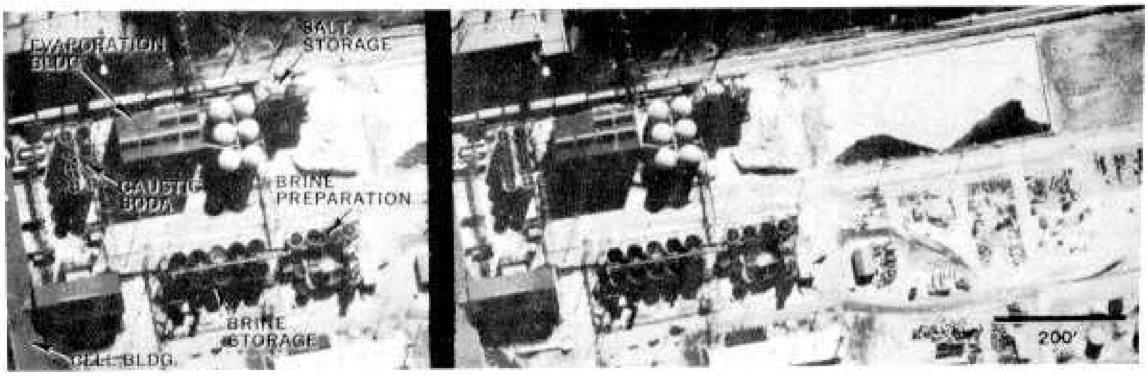


Figure A-28. Fixed Roof and Floating-Roof Storage Tanks.

NOTE: Crude oil is stored in the large revetted tanks with conical roofs. Highly volatile liquids are stored in the other revetted tanks on which the tops move up and down with the change of level of the liquid. This eliminates any air space and thus evaporation as well as the chance of explosions is reduced.



A-29. Open Storage and Processing Tanks.

NOTE: The two groups of open tanks are used for purification and storage of brine. The other open tanks, those with braces across the top, are used to store caustic soda solution from the electrolytic cell building as well as bulk salt. The large tank is in the midst of the brine preparation tanks is used to precipitate and remove impurities.

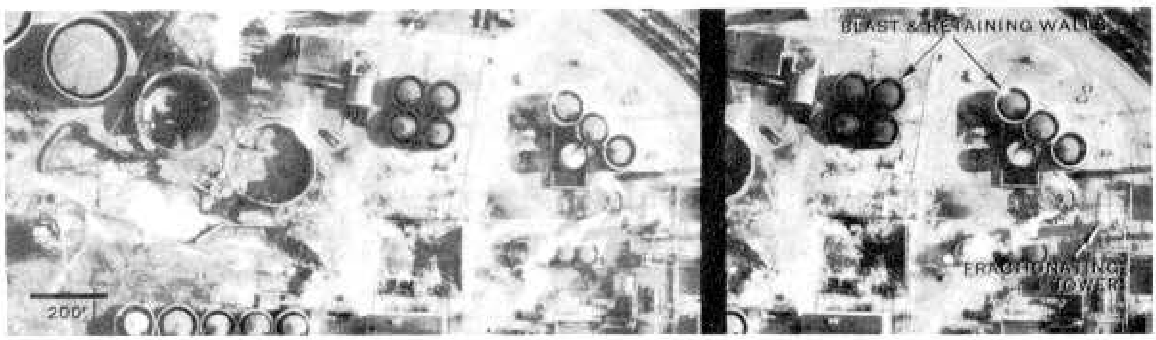


Figure A-30. Oil Tanks Protected by Blast and Retaining Walls.

NOTE: Tall, vertical blast walls are used here to protect the closely spaced tanks from external damage as well as to protect the surrounding area from their flammable contents. The enclosure is large enough to retain the contents of the tanks.

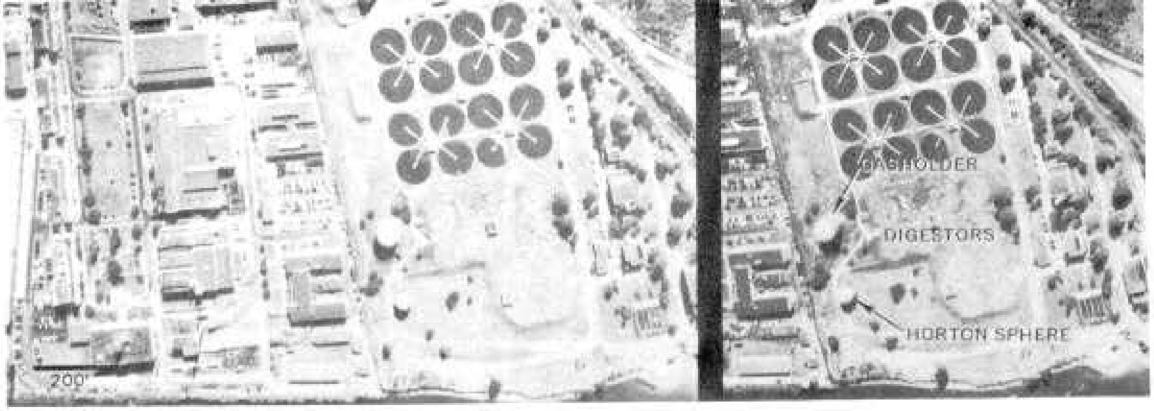


Figure A-31. Gasholders.

NOTE: When sewage solids are decomposed in the digestors, the gases methane, carbon dioxide and hydrogen sulfide are evolved. These gases are collected and stored in two containers. One is a wet-type gasholder which has telescoping sections sealed with water. The sections rise and fall inside a steel framework as the volume of gas fluctuates. The other container is a spherical pressure tank called a Horton sphere.

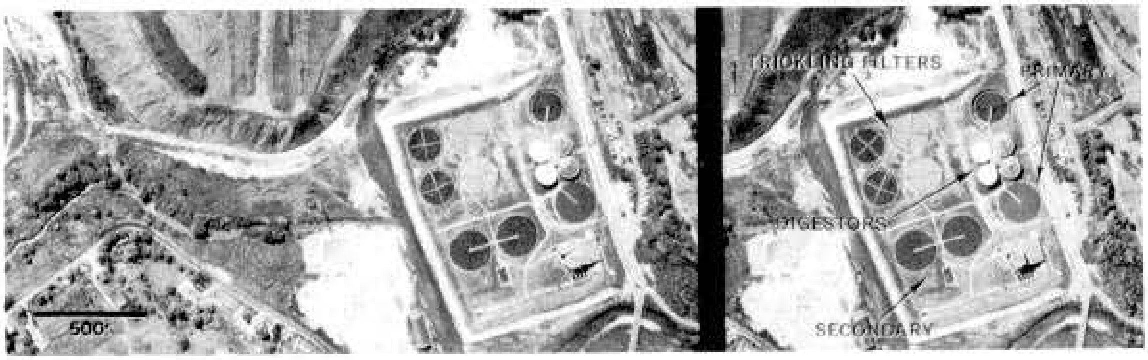


Figure A-32. Primary and Secondary Sedimentation Tanks.

NOTE: Incoming sewage is held in these open round primary sedimentation tanks. Here the heavier solids are removed to be treated in the digestors, while the liquid is directed through rotary trickling filter. The liquid portion later goes to secondary sedimentation tanks where fine suspended material is removed.

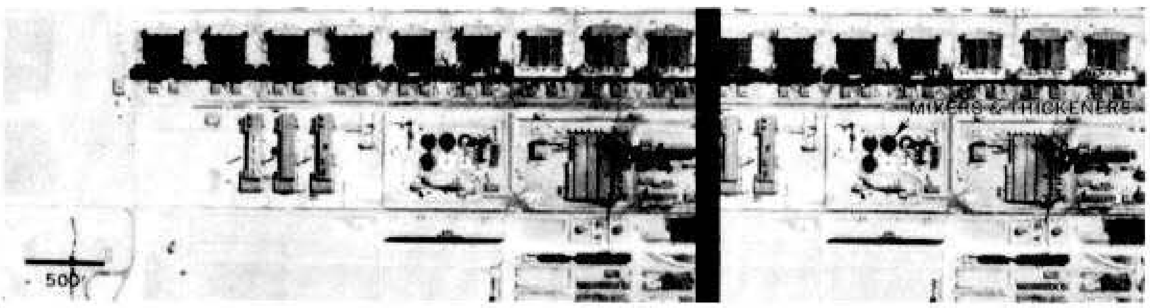
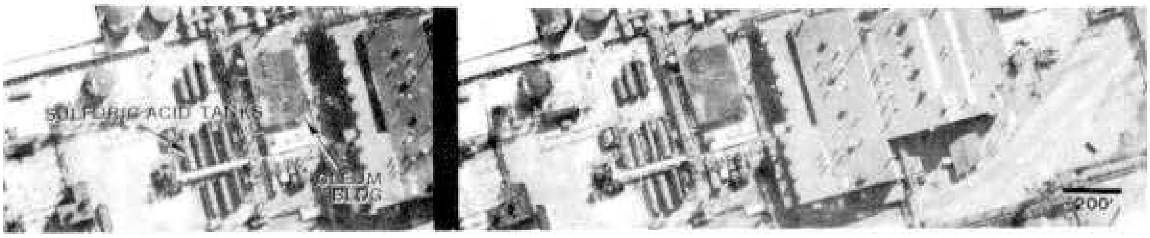


Figure A-33. Dorr Mixers and Thickeners.

NOTE: Dorr mixers and thickeners are at the acid neutralization section of magnesium plant employing Farben electrolytic process.

Figure A-34. Spherical Pressure Tanks.

NOTE: Tanks of this shape have the structure strength necessary to store gases or liquified gases under pressure. They are called Horton spheres and are always associated with alkylation units, although they may be associated with other installation.



A-35. Horizontal Tanks.

NOTE: Sulfuric acid from the absorbers as well as oleum and mixed acid from the oleum building are stored in these horizontal cylinders.

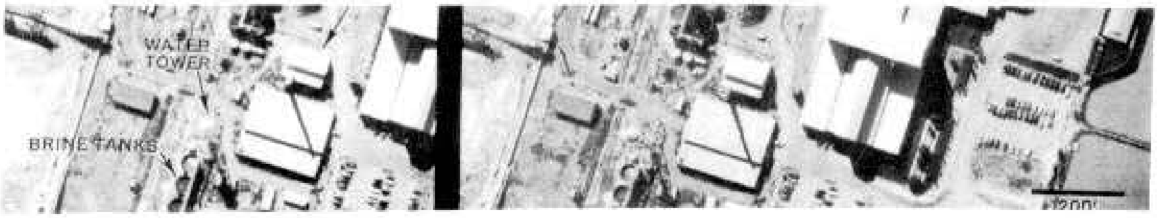


Figure A-36. Water Towers.

NOTE: Water is stored in this elevated tank so that a volume of water under pressure is available. Water towers may be seen at many plants.

A-37. Water Storage Tanks.

NOTE: This unusually large steel tank, in conjunction with the covered reservoir, is used for storage of water for a municipal water system.

PIPELINES.

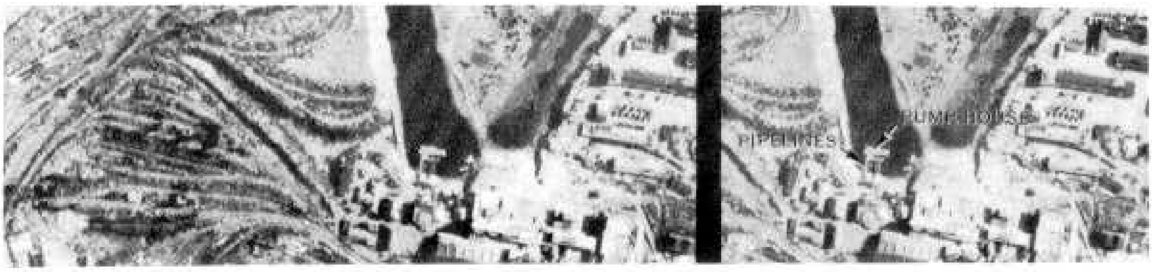


Figure A-38. Waterpipes.

NOTE: Water used in mixing cement slurry and for cooling purposes is piped from the pump house located on pilings above the water.

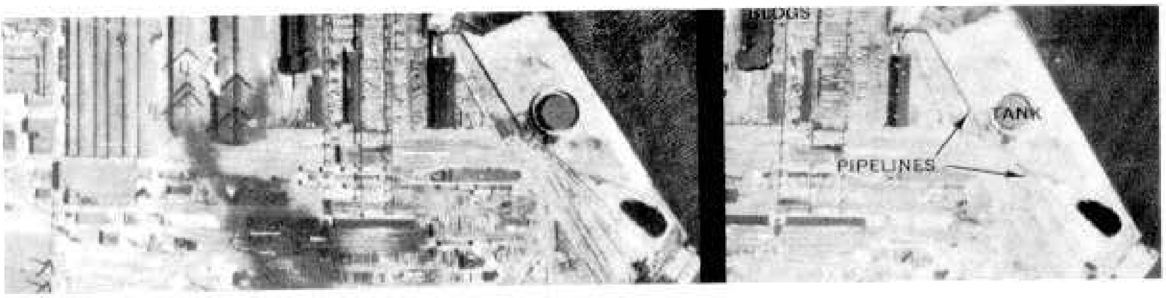


Figure A-39. Fuel oil pipelines.

NOTE: Fuel oil travels through pipelines from the wharf to the storage tank, which is surrounded by a retaining wall, and on to the casting building.

Figure A-40. Pipelines.

NOTE: These pipelines carry blast furnace gases and compressed air at blast furnaces.

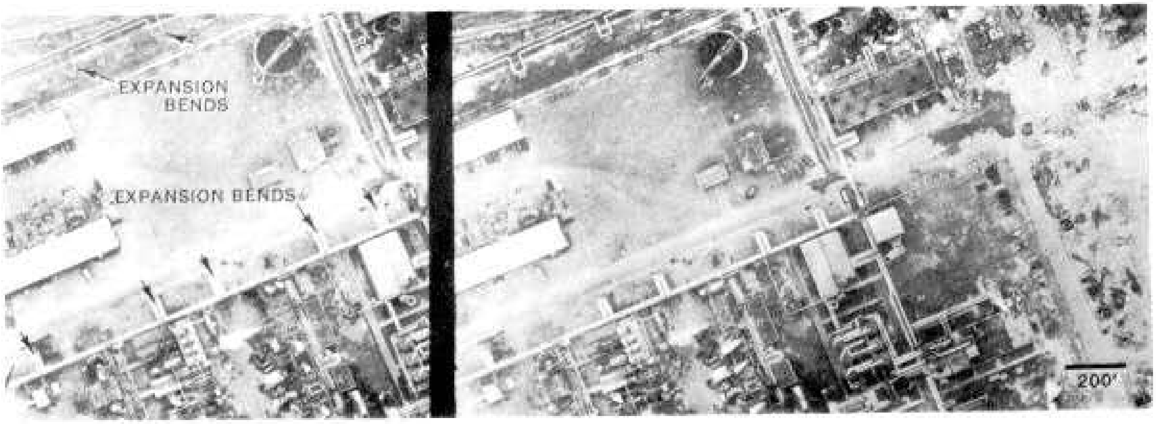


Figure A-41. Expansion Bends.

NOTE: Pipelines which carry hot liquids or gases frequently have either curved or right-angle bends at intervals to allow for expansion and contraction.

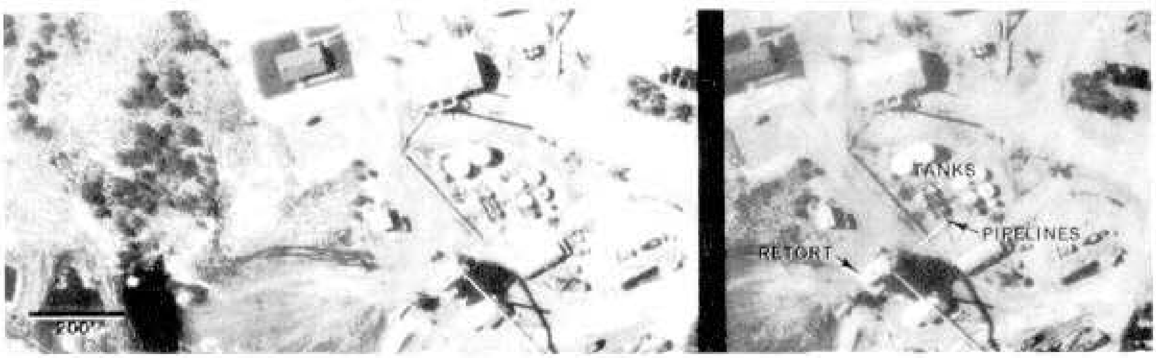


Figure A-42. Elevated Pipelines.

NOTE: Petroleum from the vertical retort is piped to the collection tanks and on to the petroleum refining section.

FLUES.

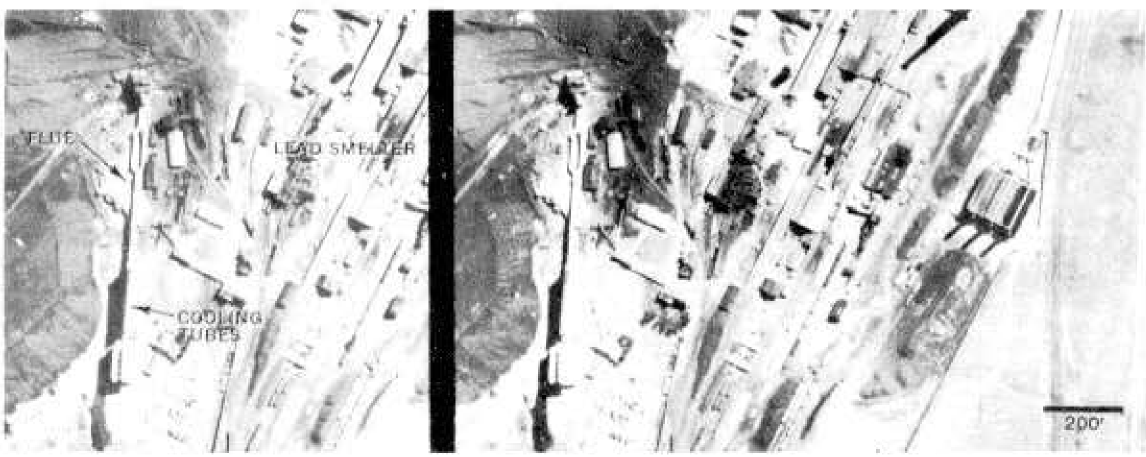


Figure A-43. Flues.

NOTE: These flues are used as cooling pipes and exhaust.

CONVEYERS.

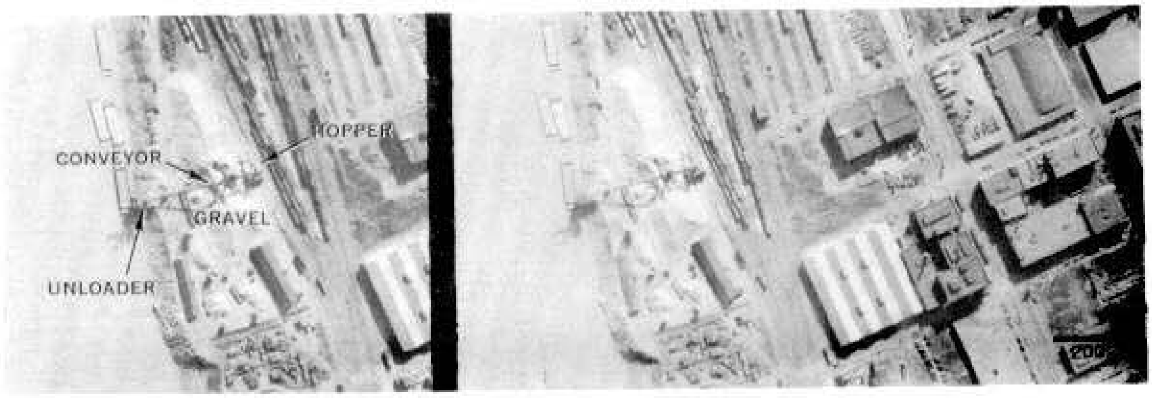


Figure A-44. Gravel Conveyor.

NOTE: A crane-like unloader on the river bank takes gravel from a barge and elevates it to the conveyor which carries the gravel to the hopper and storage pile.

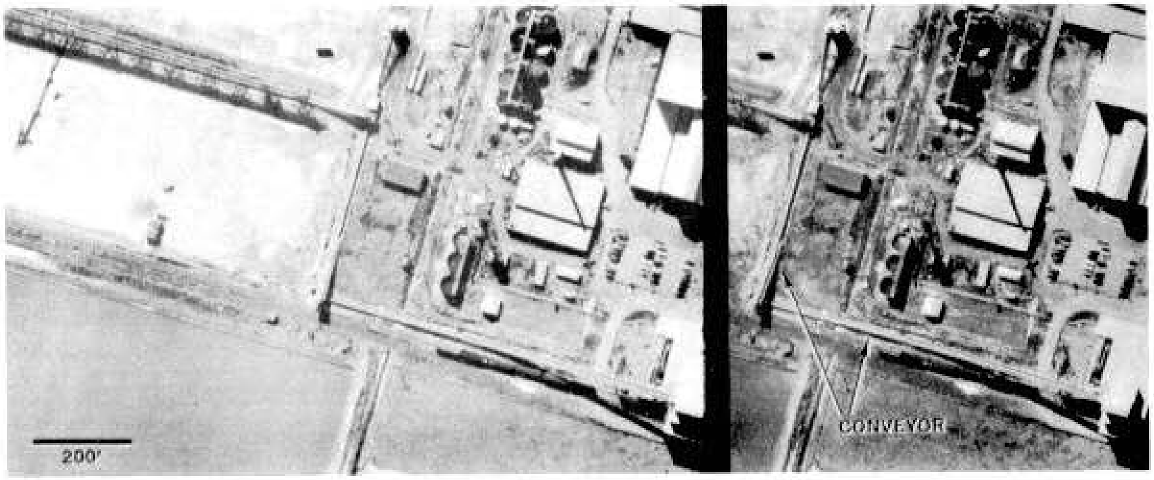


Figure A-45. Conveyor at Salt Refinery.

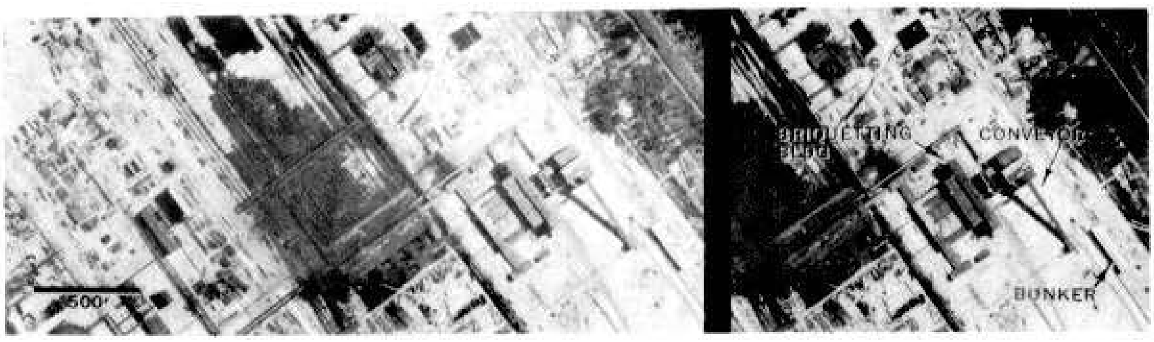


Figure A-46. Coal Conveyor.

NOTE: Coal from the bunker is delivered to the crushing and briquetting building by this inclined conveyor.

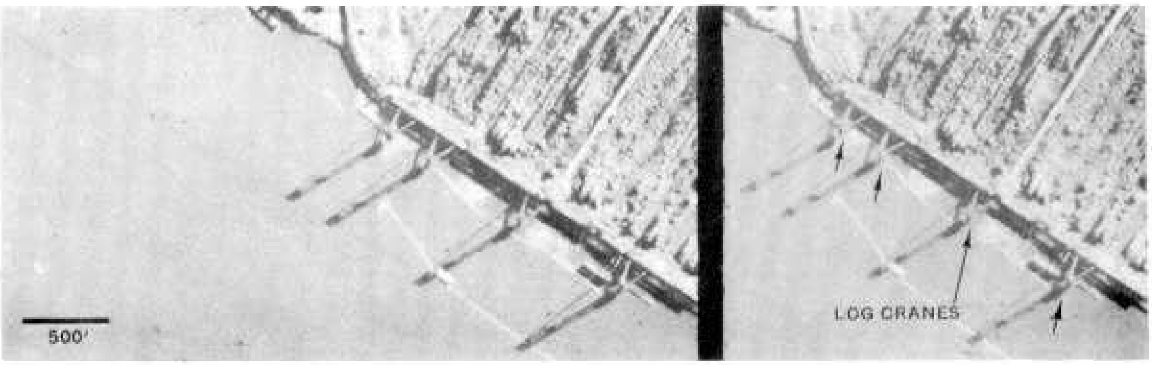


Figure A-47. Crane for Handling Logs at Wood Pulp Plant.

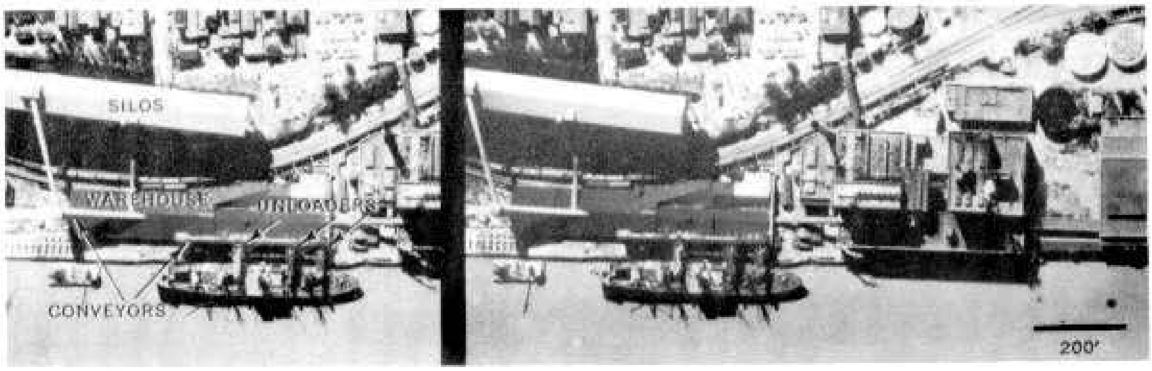


Figure A-48. Unloading Cranes or Conveyors.

NOTE: Raw cane sugar is unloaded from ships by special unloaders which are lowered into the hold. The bulk sugar is lifted to a conveyor belt which carries it to the silos and warehouse for storage.

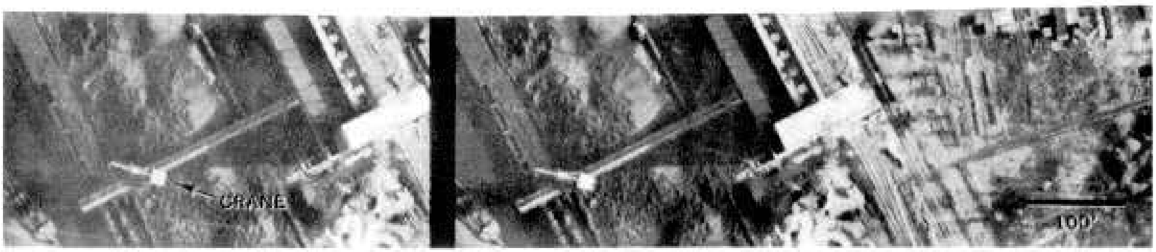


Figure A-49. Bridge Crane.

NOTE: The narrow open framework of the crane spans the storage yard and moves on rails. Here the travelling carriage is mounted on the top of the structure although it usually is below the span. Coal is transferred from barges and rail cars to the yard, and from the yard to the producer gas retort building and to a coal hopper.

MOBILE EQUIPMENT.

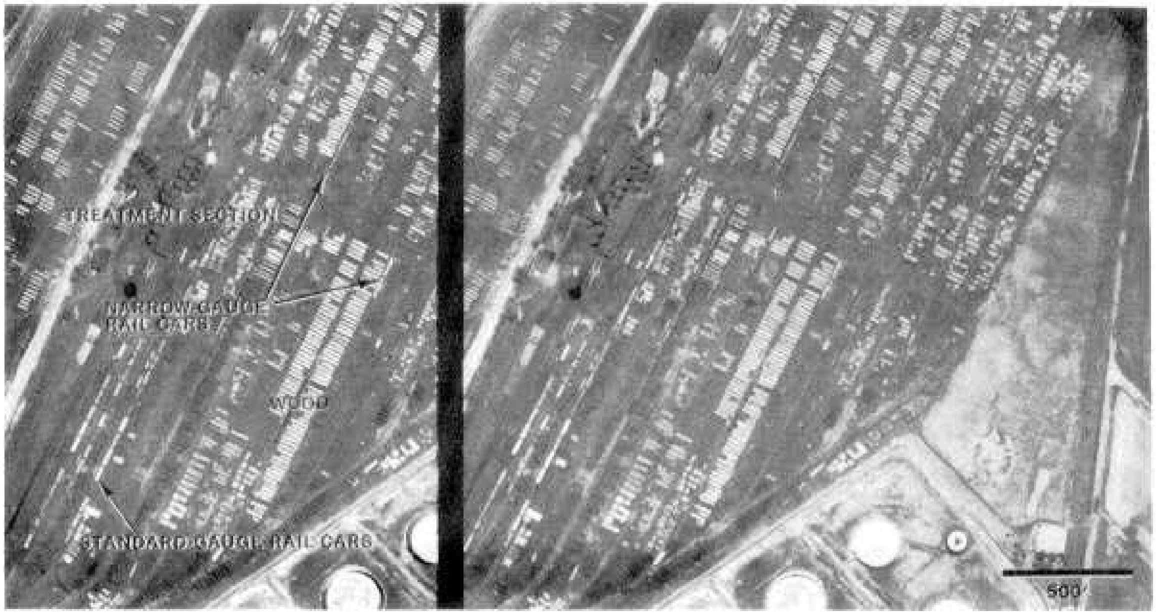


Figure A-50. Narrow Gauge and Standard Gauge Rail Cars.

NOTE: Cut timber from the storage area is loaded on narrow gauge rail cars and hauled to and from the treatment plant. These cars hold the lumber while it is being treated. Narrow gauge tracks serve the entire storage area. The untreated wood is delivered and treated wood shipped out on standard-gauge rail cars.

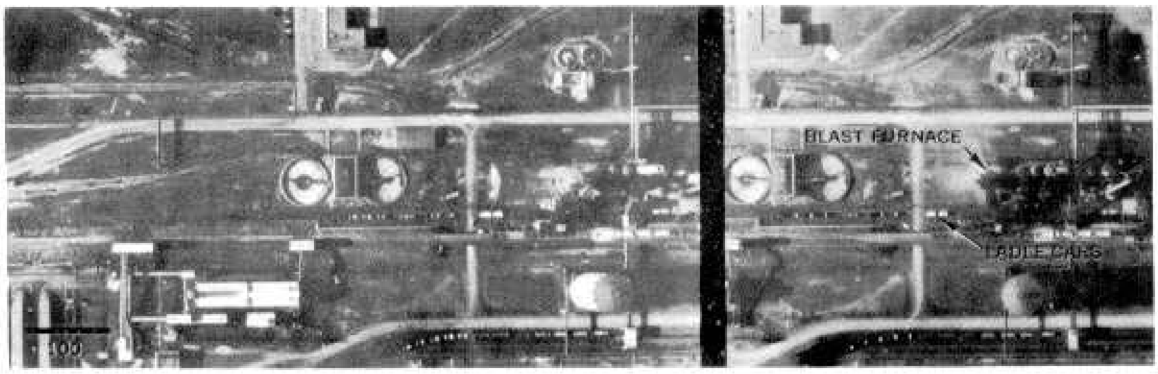


Figure A-51. Ladle cars.

NOTE: Molten iron is tapped from the blast furnace and flows into ladle cars. These cars then carry the iron to steel furnaces or to the pig casting building.

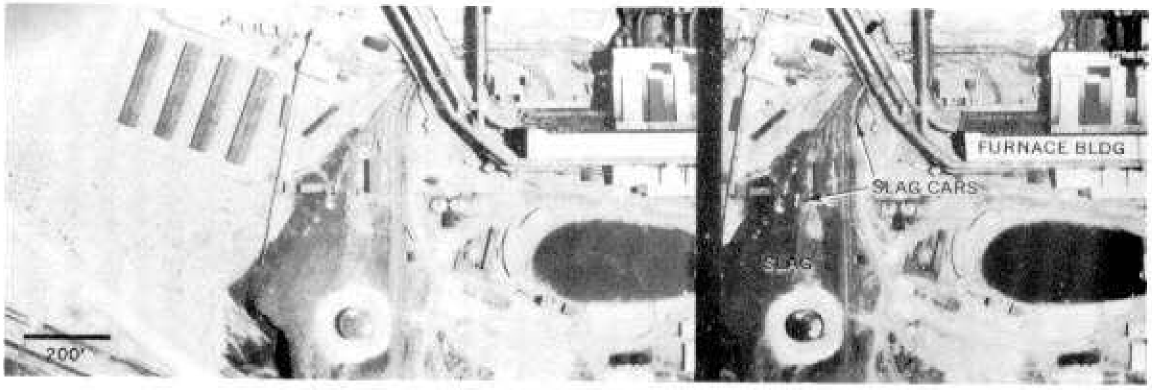


Figure A-52. Slag Cars.

NOTE: Impurities from the copper ore combine with the flux to form slag which is tapped from the furnace into small, cup-shaped rail cars which haul it to the dark-toned slag dump.

COMPLEX EQUIPMENT.

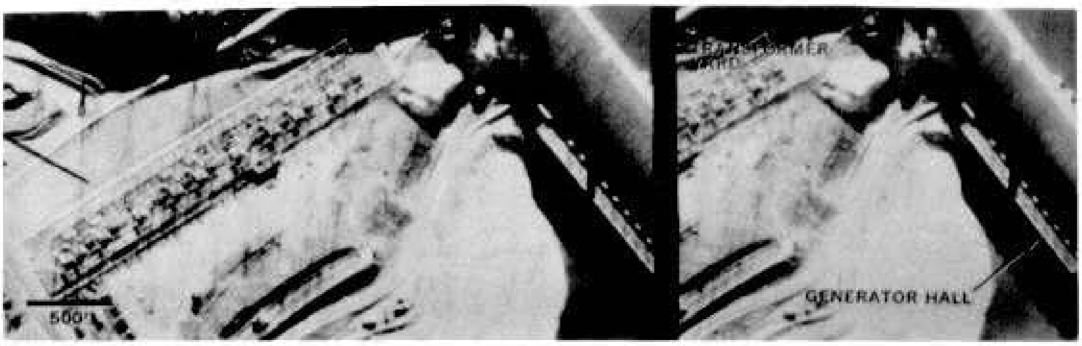


Figure A-53. Transformer Yard.

NOTE: The large group of box-like transformers in an open steel framework steps up the voltage for long-distance transmission.

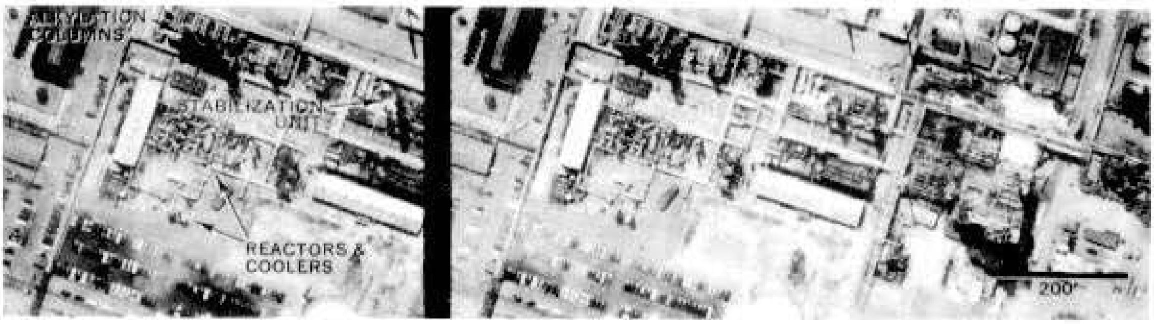


Figure A-54. Reactors and Associated Equipment.

NOTE: Before passing through the alkylation columns, light gases from the gas stabilization unit are chilled and treated with acid in these small tank-like pieces of equipment. They always are associated with alkylation columns. Their number, size and shape may vary.

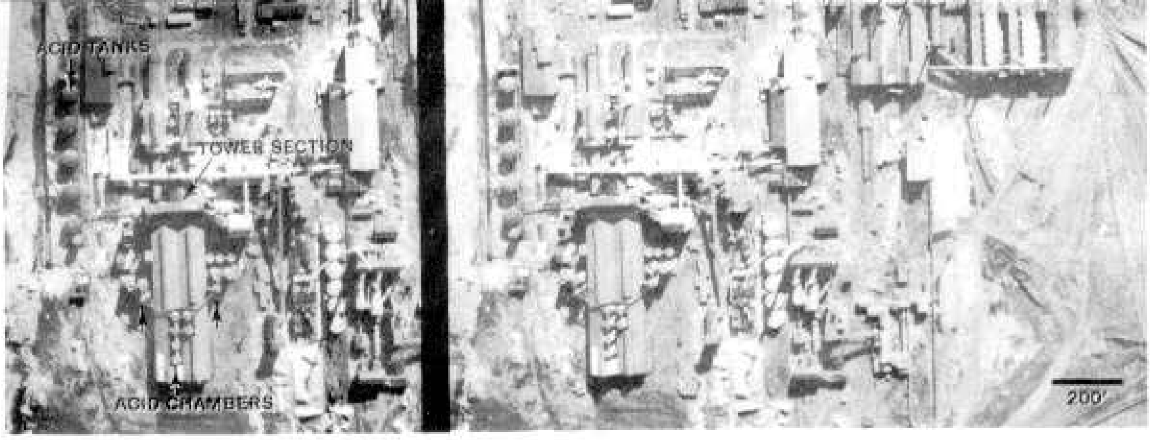


Figure A-55. Chambers for Sulfuric Acid.

NOTE: Gas from the tower section consisting mainly of sulfur dioxide is mixed with steam or water spray in these tall tapering Mills-Packard chambers. The sulfur dioxide is oxidized to sulfur trioxide and hydrated to sulfuric acid. This acid is collected and stored in tanks, and the spent gas is returned to the tower section.

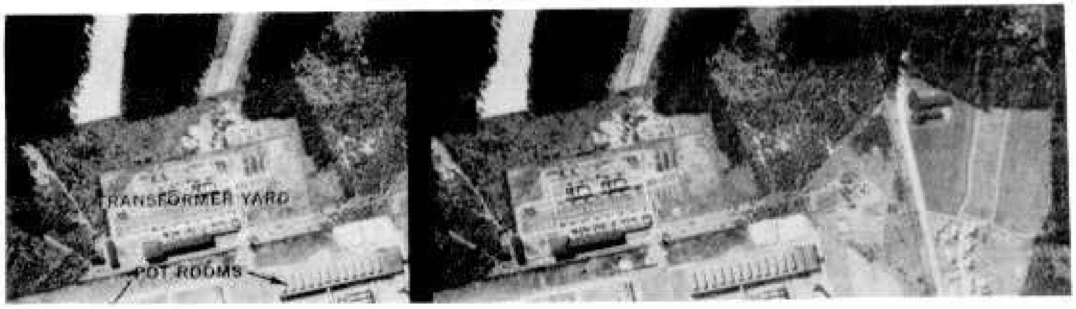


Figure A-56. Transformer Yard for Reducing High Voltage.

NOTE: Large quantities of electric power are needed to produce metallic aluminum. High voltage current passes through these box-like pieces of equipment, some inclosed by fire walls, and is stepped down or reduced in voltage.

Figure A-57. Sawdust Burner.

NOTE: Waste material from the woodworking building is blown through a pneumatic tube into this conical burner for disposal. Sawdust burners can be used at woodworking plants and sawmills when adequate space for waste piles are not available.

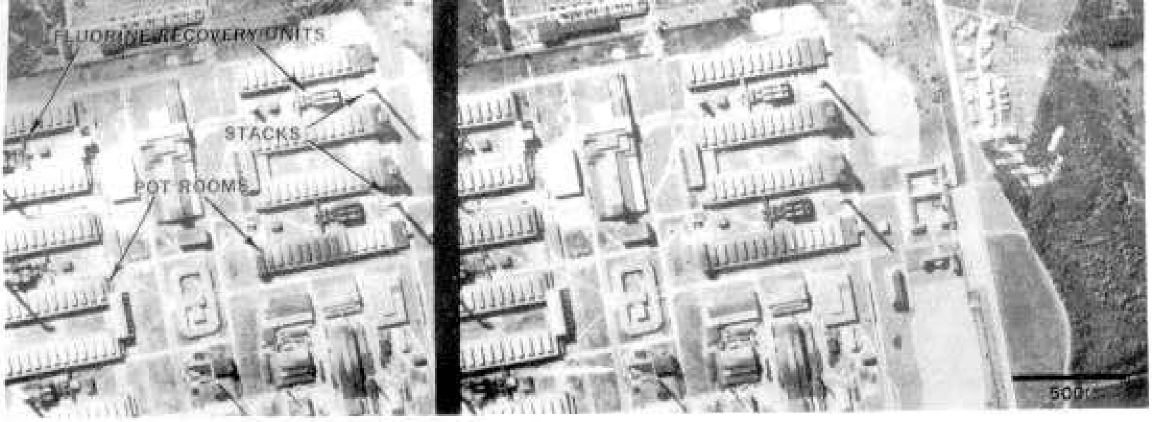


Figure A-58. Fluorine Recovery Units.

NOTE: Fumes are collected from the aluminum reduction cells and piped to these units which look like chemical equipment. Fluorine gas is removed from the fumes, and the waste gases are vented from tall stacks. Each unit serves two pot rooms.

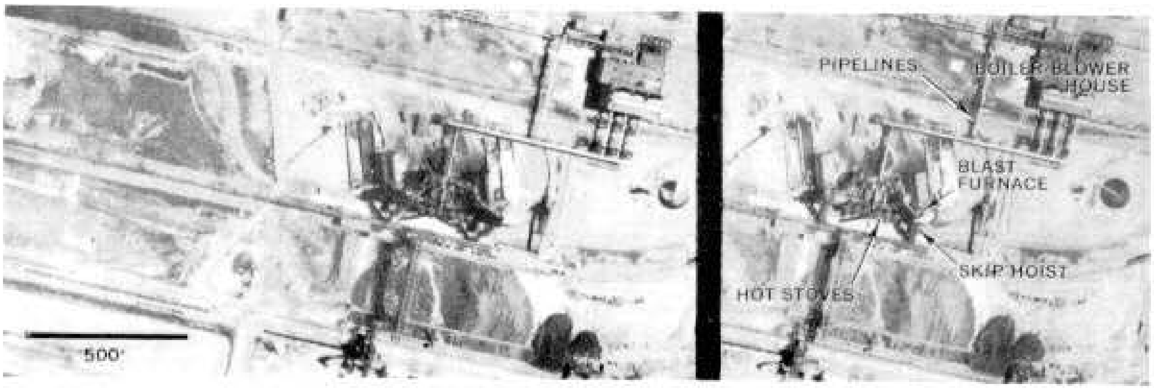


Figure A-59. Blast Furnaces.

NOTE: Iron ore, coke and limestone are charged into these brick-lined furnaces by a skip hoist. Air heated in the hot stoves is supplied to the furnaces to smelt the charge.

DAMS.

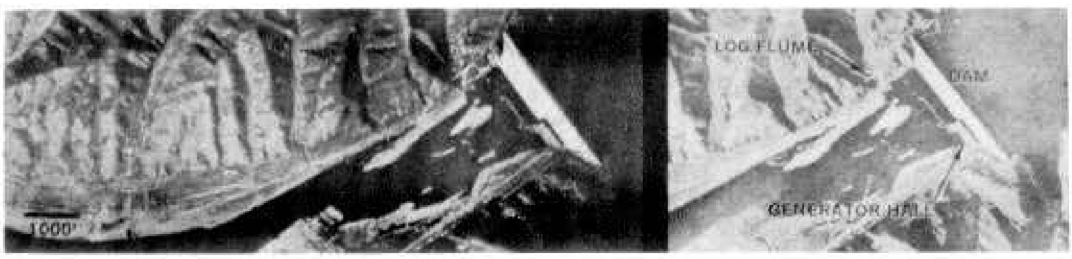


Figure A-60. High Head, Reinforced Concrete Dam.

NOTE: Such large tall structures are frequently used in rugged terrain. The high head to water creates the high pressure used to generate electric power for the processing industry involved. The dam also impounds a reserve of water to ensure continuous operation.

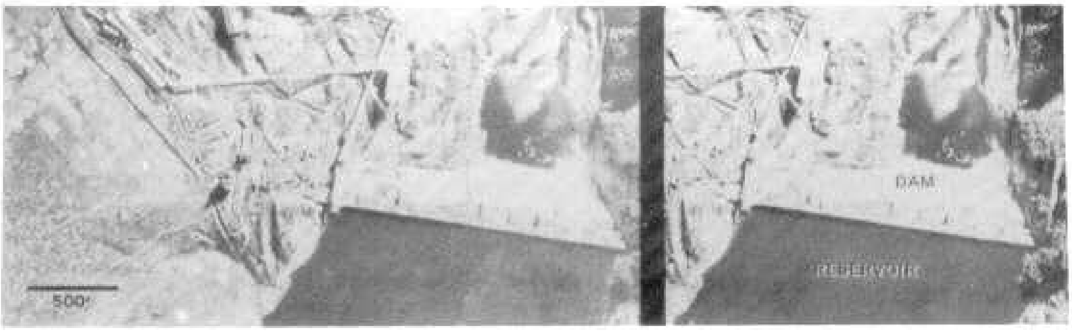


Figure A-61. High Head, Reinforced Concrete Dam Under Construction.

NOTE: The solid, massive structure is required to withstand the pressure to such a deep reservoir. A generator hall will be erected downstream, which generates the electric power for the processing industry.

PROCESSING BUILDINGS.

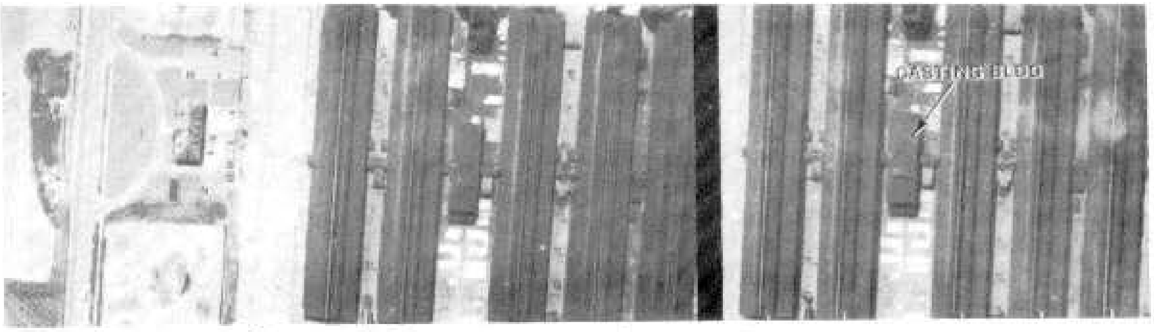


Figure A-62. Aluminum Casting Building.

NOTE: Molten aluminum is brought from the pot rooms through covered passageways and cast into shapes here. Vents on the roof allow heat to escape.

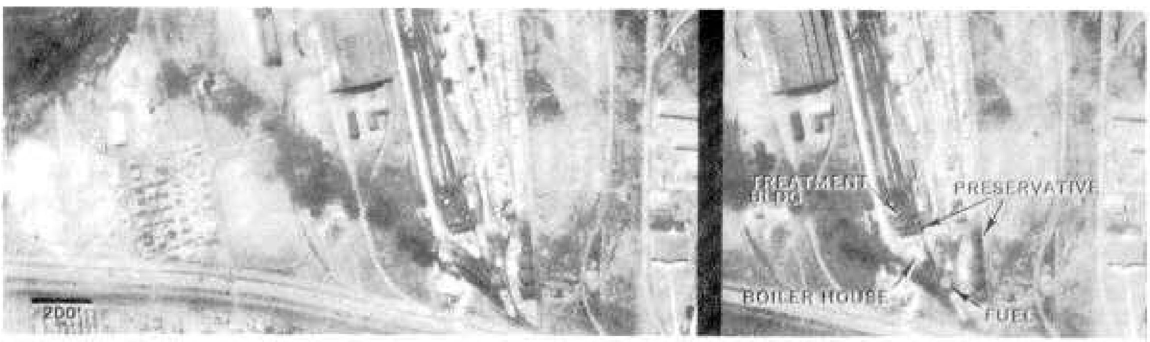


Figure A-63. Boiler House.

NOTE: The steam is necessary to heat liquid preservative in the tanks next to the wood treatment building. A boiler house may be a small detached building or a section attached to a larger building. In either case there is usually a conspicuous stack and an obvious fuel supply.

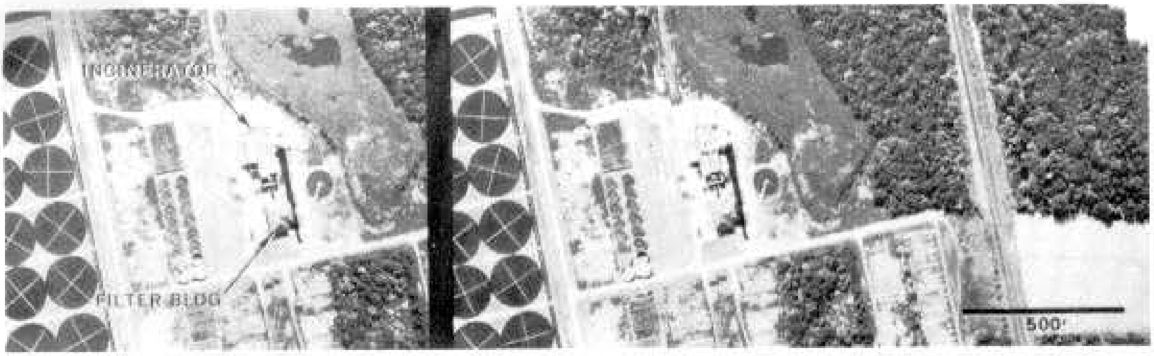


Figure A-64. Sewage Incinerator and Filter Buildings.

NOTE: The sewage solids from the digestors are hauled here to be dried and burned. Incinerators have tall stacks and so look somewhat like boiler houses, but they are not associated with many other buildings.

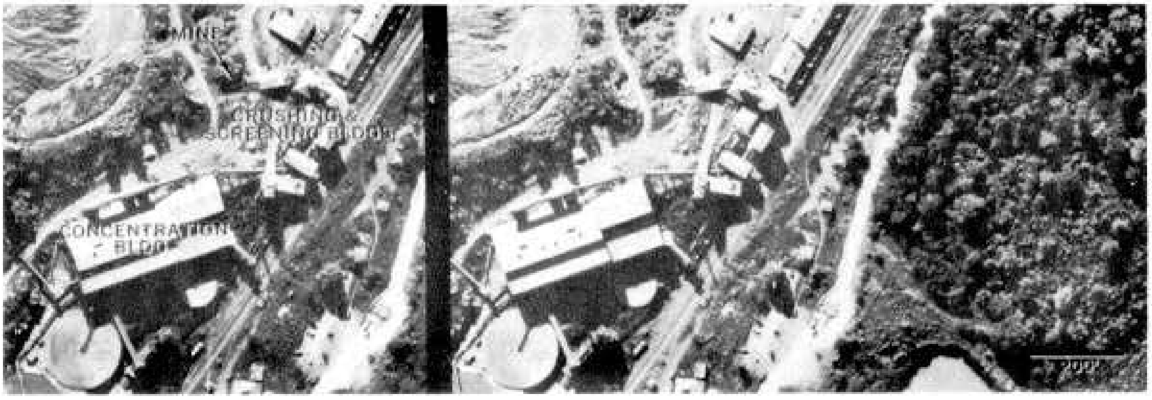


Figure A-65. Ore Crushing and Screening Buildings.

NOTE: Ore from the mine is crushed and screened in these small buildings connected by conveyors. The crushed ore is then conveyed to the adjacent concentration building.

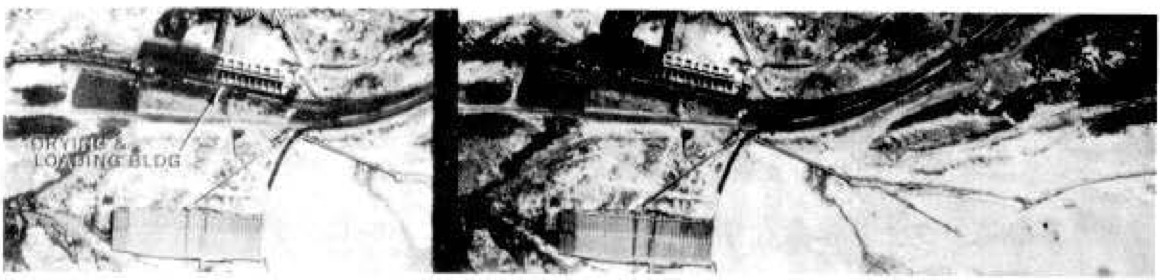


Figure A-66. Building for Drying and Loading Copper Ore Concentrate.

NOTE: Ore concentrate from the thickening tanks is filtered, dried in the gable roof building and stored until it is shipped. Rail cars pass beneath with small extension to be loaded. The building is being enlarged.

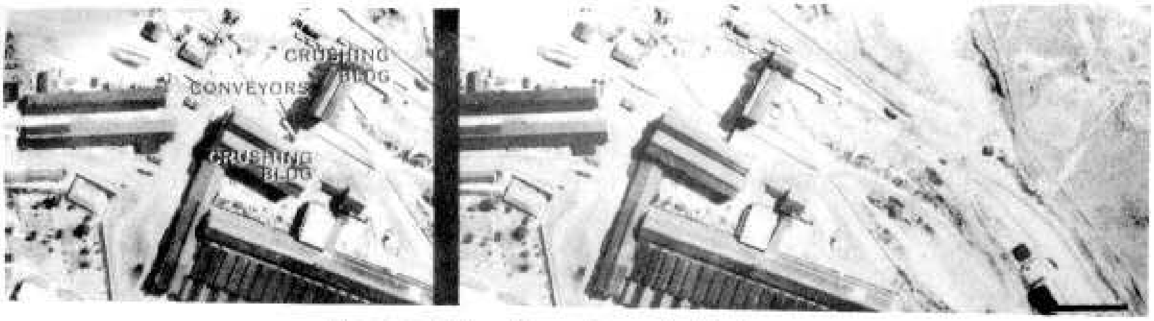


Figure 67. Crushing Buildings.

NOTE: The copper ore is delivered by rail cars to the upper level of the primary crusher. The primary and secondary crushing buildings are both tall structures so that gravity flow moves ore to the crushers. A conveyor connects the bottom of the primary crushing building with the top of the other.

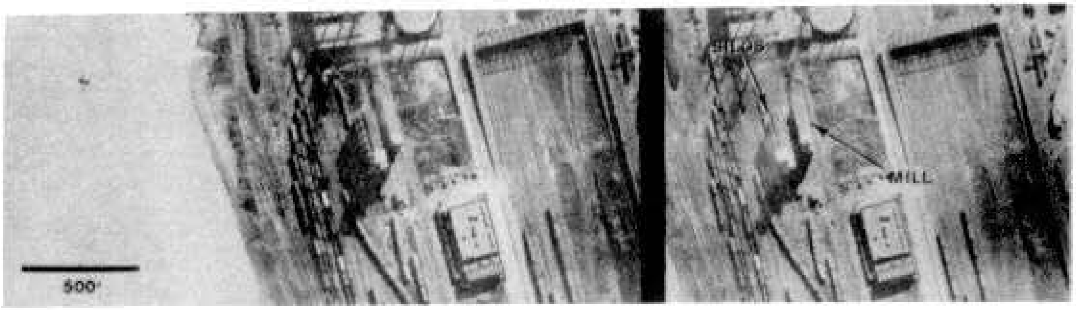


Figure A-68. Grain Mill.

NOTE: The flat roof building is tall so that gravity flow can be used in the milling processes. The mill is connected with the silos by conveyor. The taller section of each structure houses elevators for lifting grain.

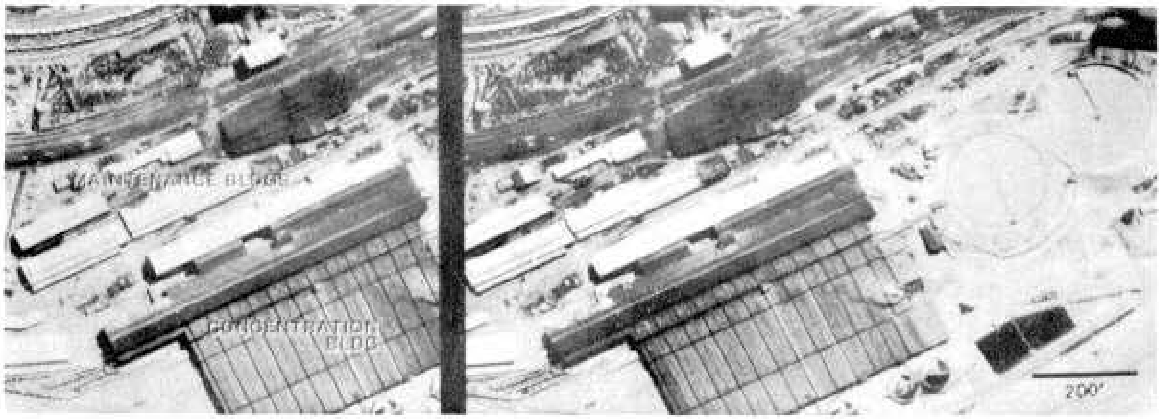


Figure A-69. Maintenance Buildings.

NOTE: These monitor roof buildings are served by rail and are workshops for the maintenance of railroad rolling stock and other equipment used in the copper concentration plant.

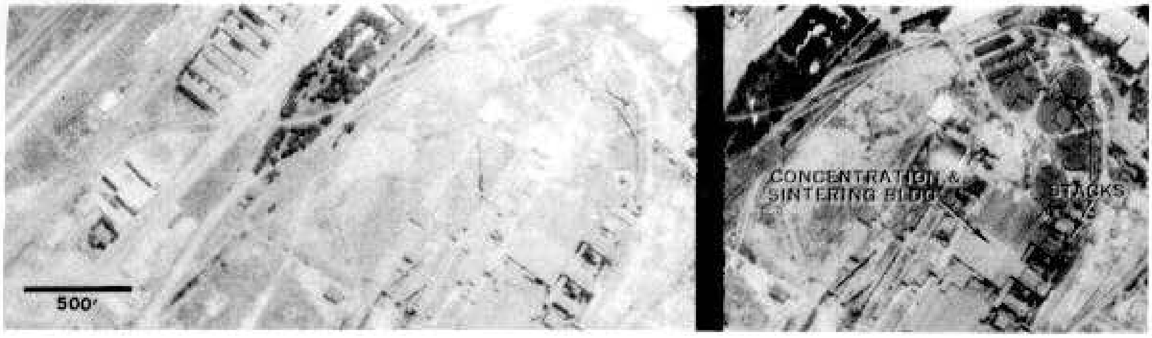


Figure A-70. Ore Concentration and Sintering Building.

NOTE: The stepped-down appearance of this building and its construction on a hillside is common to ore concentration buildings. After grinding, the iron ore passes through magnetic separation equipment, is washed, and finally sintered. The tall sintering section has heavy stacks.

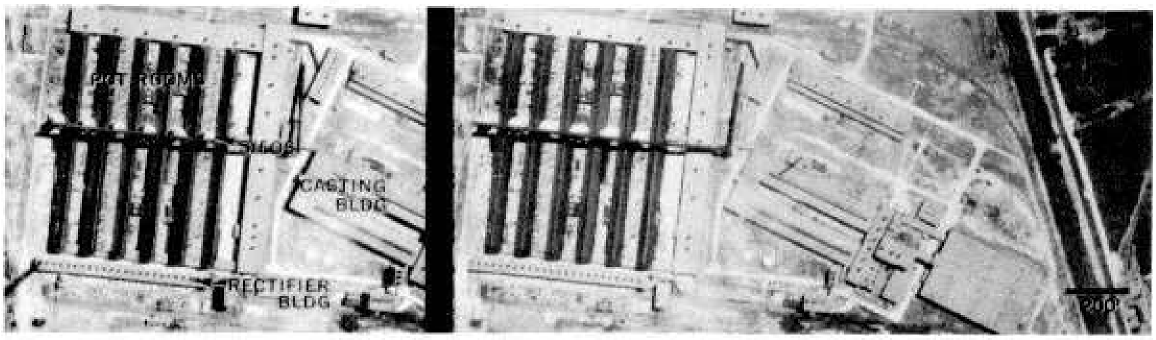
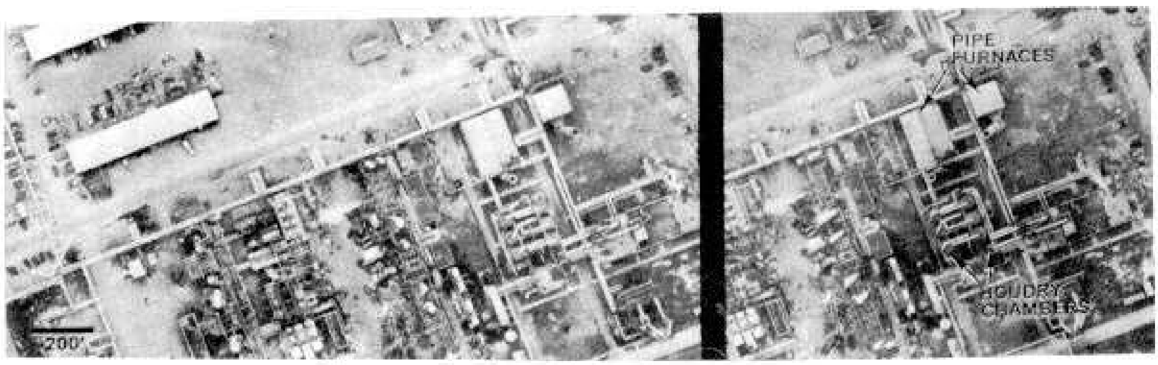


Figure A-71. Pot Rooms.

NOTE: These narrow buildings with longitudinal ventilators house electrolytic reduction cells. Alumina stored in silos is reduced in the pot rooms to metallic aluminum which is cast into desired shapes in the casting building.



Figures A-72. Pipe Furnaces.

NOTE: The charge stock for the Houdry catalytic cracking unit is heated in these small, gable roof buildings with tall stacks alongside. The roof may be flat, or the stack may be on the building. The inside walls of the heating chambers are lined with tiers of continuous horizontal pipes through which the charge stock flows. The chamber is heated by oil or gas. Pipe furnaces are also seen with fractionating towers and thermal cracking units.

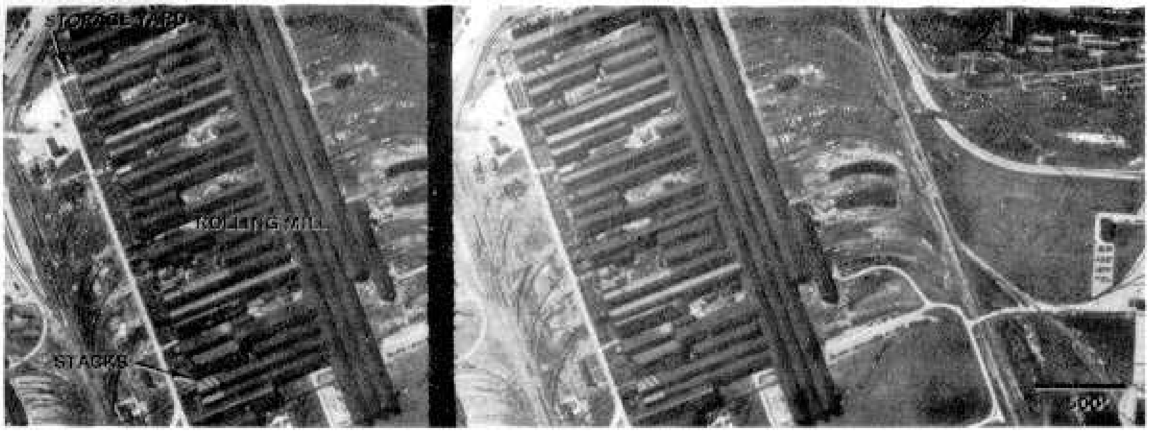


Figure A-73. Rolling Mill.

NOTE: Steel blooms or billets formed by a preliminary rolling are stored in a crane-served yard. These shapes are placed in reheat furnaces served by smalls tacks and further rolled in the large multisectional monitor roof building.

STORAGE BUILDINGS.

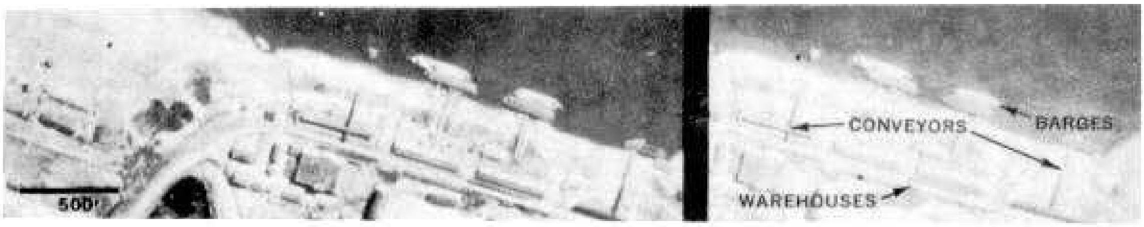


Figure A-74. Grain Warehouses.

NOTE: The gable roof buildings provide temporary storage for grain between land and water transportation. The warehouses are served by rail, and a conveyor or covered ramp extends to the river bank for loading and unloading barges.

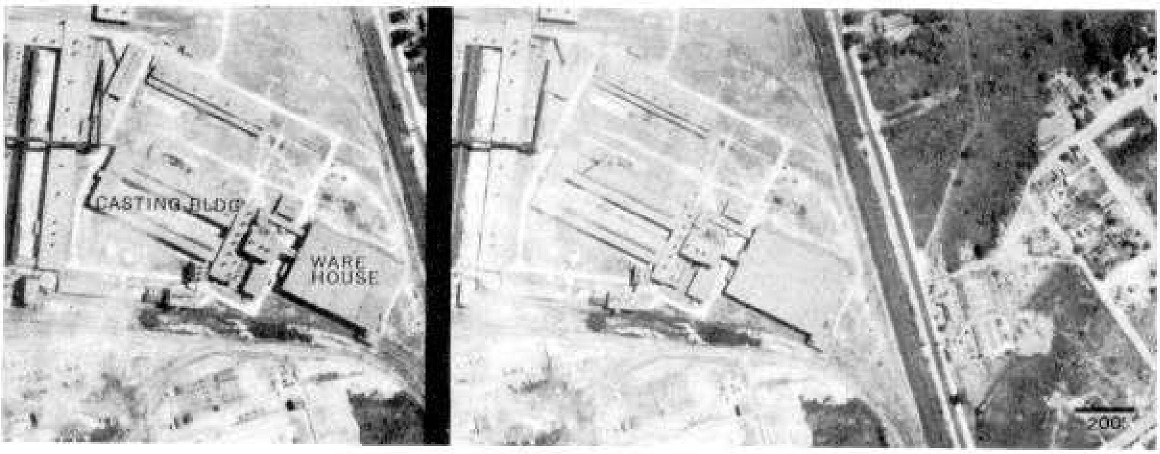


Figure A-75. Warehouse.

NOTE: Aluminum castings are stored in this large, near-flat roof building until shipped out by rail. It is connected to the casting building by two passage ways. Warehouses similar to this are common to many modern plants.

ADMINISTRATION BUILDINGS.

Figure A-76. Administration Buildings.

NOTE: The grounds around the three office buildings and the recreation building have been landscaped. The fence around the processing buildings also encloses this area and reveals its association with the industry.

Figure A-77. Office Building.

NOTE: This wood-frame, gable-roof building is smaller than the production buildings and is located to one side of the plant area beside one of the entrances to the plant. The area around the building is landscaped. All these features are common to office buildings.

OPEN STORAGE AND WASTE.

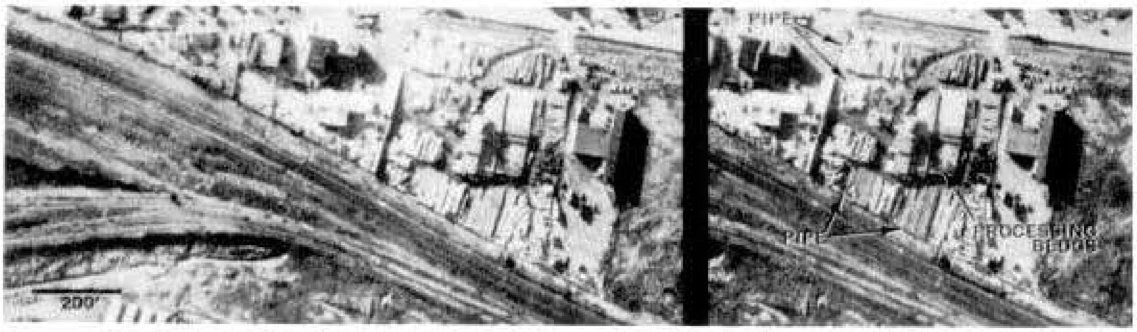


Figure A-78. Open Storage.

NOTE: After the concrete pipes have been cast and cured, they are strong enough to be stored in the open until shipment. The pipes appear as cylindrical objects, some stored on end and others on their sides.

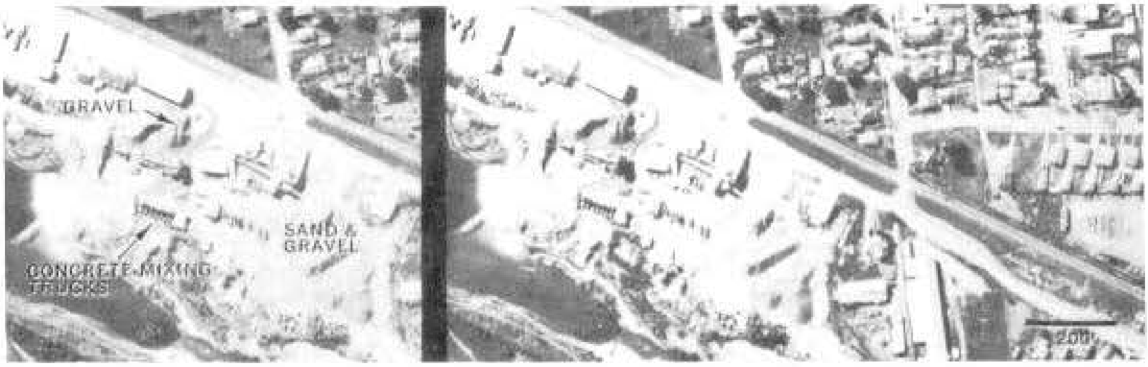
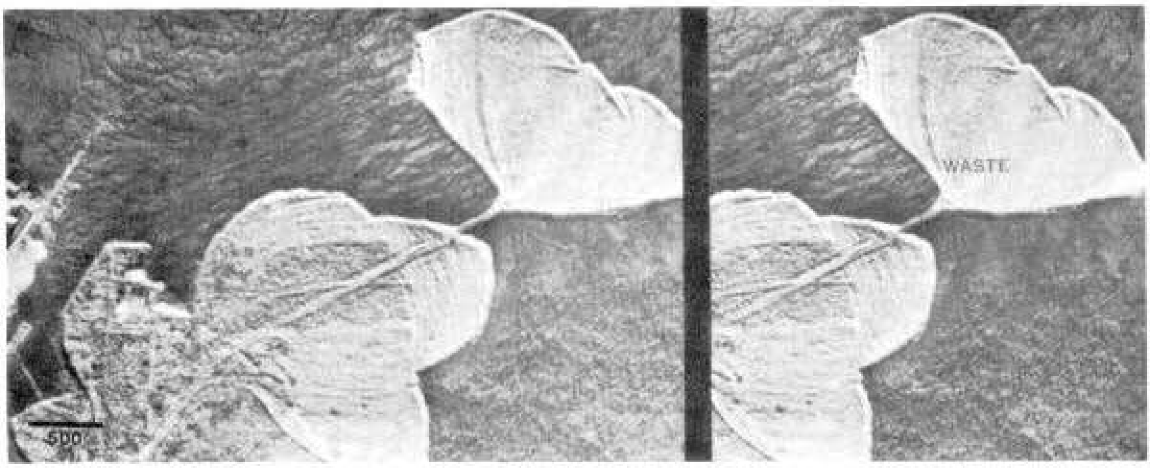


Figure A-79. Open Storage.

NOTE: Sand and gravel are hauled in by truck. Sand, gravel, cement and water are placed in concrete mixing trucks are hauled to the construction site. Here they are left in piles until needed.



Figures A-80. Sawdust and Wood Waste.

NOTE: The large, light-toned, fan-shaped dump is the waste from a nearby sawmill. Such waste also may be burned.

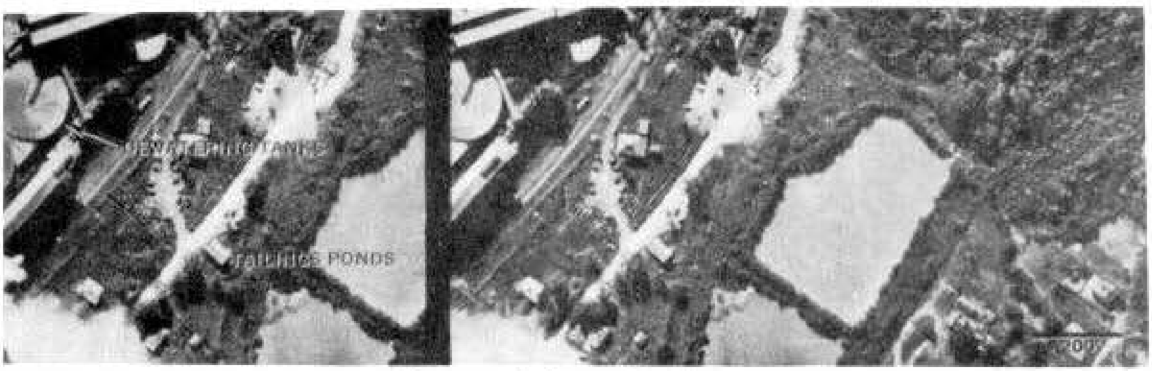


Figure A-81. Ponds.

NOTE: Waste from the dewatering tanks is piped to these ponds. The solids settle out, and the water is wasted.