Appendix 3

PLANT DESCRIPTION

LOCATION

Place

The Northern Chemical Industry plant is situated in central coastal Maine, three miles north of the small town of Searsport, in Knox County, and one mile east of U.S. Highway 1. The plant is situated on Kidder Point, Stockton Harbor, in the upper Penobscot Bay area (see Figure 1).

Community

The town of Searsport has a population of 800, and Knox County has a population of 29,000. Bangor with a population of 39,000 is the largest nearby city, located 30 miles north of the plant. Belfast with a population of 7,000 is five miles south on U.S. Highway 1.

The area is serviced by several good motels and restaurants. Generally, housing in the Searsport township is difficult to find as well as being very old and somewhat expensive. The nearest hospital is in Bangor, 30 miles from the plant site, and there are approximately 10 doctors in the Searsport and Belfast townships. Most of the employees of NCI live in Searsport and Belfast townships, which have one theatre, two small libraries, a Maine museum and essentially no other cultural facilities.

The education facilities leave something to be desired, inasmuch as the secondary school systems are not accredited and there are no Technical schools in the immediate area. College facilities are available at the University of Maine at Orono, Maine, approximately 35 miles from the plant. In general, the recreation consists of hunting, fishing, boating, curling and skiing. Local governments are town meeting type governments, with Northern Chemical Industries having a fair political climate.

There are no garbage disposal or street cleaning services offered by the government. However, police protection and street lights and road paving are supported by the local government. Fire protection is by volunteer fire department, with the equipment furnished by the local government. The industry in the township of Searsport consists only of Northern Chemical Industries and two deep water shipping terminals. Neighboring townships have, as the major industries, paper mills. There are no research facilities, major machine shops or other major supplying facilities within reach of the Searsport plant. Shopping is somewhat limited and major purchases must be made in Bangor (population 39,000) or Portland (population 71,000), the latter of which is 115 miles away.

<u>Communications</u>

The plant is served by the Bangor-Aroostock Railroad and numerous trucking companies.

Northwest airlines serve Bangor. Adequate airport facilities are available at Belfast for private air travel.

The area has adequate telephone and telegraph service and supports two television channels with a third channel planned for 1966.

Water transportation is not currently available at the plant. However, raw materials are delivered by ocean going vessels to Searsport, then unloaded and transported to the plant by rail or truck.

Climate

The plant area experiences a fairly even rainfall of about 40-50 inches each year. Snowfall generally occurs from December to the end of April and rarely exceeds 50-60 inches. Fog is prevalent along the coast. The area averages about 150 days per year without a killing frost. Average midsummer temperatures range between 50 and 85°F. Average midwinter temperatures range between 12 and 25°F. Tides are approximately ten feet.

Topography

Central coastal Maine is rocky rolling terrain covered with forests of pine, maple, elm, and birch trees. The waters of the bay and inlets are quiet and clean. Hunting and fishing are ideal sports for the area due to the abundance of woods and water. A few miles inland the land becomes less hilly, more suitable for farming.

PLANT SITE

Boundaries

The plant property includes 149.5 acres, bounded by the highway on the west, property lines to the North and South, and the Stockton Harbor water line to the East.

Map

Figure 2 is a map of the plant property showing fence line, water line, and access road.

Plot Plan

A plot plan of the plant area, indicating fences, roads, buildings, and structures is shown on Figure 3.

PRODUCTS & RAW MATERIALS

History

The original plant facilities were built during the 1930's by Summers Fertilizer Company. In the mid 1940's the site was aquired by Northern Chemical Industries for production of superphosphate ammonium sulfate, and alum. An additional section was constructed during 1955 for the manufacture of ammonia and related products in a joint venture of NCI and Chemetron Corp.

Products

Products currently produced at the plant are as follows:

Product	Type	Specification
Ammonia (Ind.)	Anhyd.	$>0.4\% H_2O, >10$ ppm oil
Ammonia (Refrig.)	Anhyd.	99.999% NH_3, 3 ppm oil
Ammonia	Aqua	29% NH_3
Sulfuric Acid	Conc.	66° Be'
Nitrogen Solution	45% N	450 (25-69-0)
Nitrogen Solution	44% N	440 (22-66-6)
Ammonia Sulfate	Cryst.	20.5%N
Alum	Liquid	36.15° Be', 48.6% ~~Alum~~. DRY HYDRATE
Superphosphate	Bulk	16-21% P_2O_5

Raw Materials

All products currently in production are manufactured from the following basic raw materials:

Raw Mat'l	Type or Grade
Sulfur	Molten, light color
Oil	Bunker "C"
Urea	Uncoated prills
Bauxite	Granular, 50% Al_2O_3
Phosphate rock	Ground, 74-76 BPL

Block Flow Diagram

The NCI plant is a complex of operating units. The process scheme of raw materials, intermediates, and products is shown on the block diagram on Figure 4.

Performance

~~The production capacity of each operating unit is greater than the actual output of the plant.~~ Based on demonstrated operating periods, the capacity of each unit is shown on Figure 4. The on-stream time shown on Figure 4 is the ratio of actual production, to ~~theoretical~~ full time production at [redacted] capacity rate during the past year.

Plant production for the past three seasons (August through July) is shown on Table I.

The plant has not operated at sustained full capacity during the past three years, ~~This is~~ as evidenced by the ~~rather~~ extensive downtime. Poor ammonia productivity has limited the output of nitric acid, ammonium sulfate and solutions.

Sulfuric acid production is reasonably high. However, sulfuric acid must be balanced between ammonium sulfate, alum, superphosphate and direct sales with the result that both alum and superphosphate production lags the respective plant capabilities.

TABLE I

NCI ANNUAL PRODUCTION

	Fertilizer Year, August through July, Tons		
	1962-1963	1963-1964	1964-1965
Ammonia, 100%	31,520	31,052	31,406
Sulfuric Acid, 100%	46,834	66,270	67,132
Nitric Acid, 100%	20,144	21,013	16,046
Ammonium Nitrate, 100%	25,102	26,185	19,996
Solutions, Total	39,057	38,218	29,198
Type 450 N	29,016	32,064	24,184
Type 440 N	10,041	6,150	5,014
Ammonium Sulfate, Total	7,935	10,518	13,952
Bulk	5,608	7,386	9,869
Bagged	2,327	3,132	4,083
Alum, [redacted] Dry HYDRATE Basis	14,678	15,070	15,865
Superphosphate Normal	62,545	106,842	95,548

MANUFACTURING FACILITIES

Normal Superphosphate Plant

The manufacturing facilities for normal superphosphate are housed in a group interconnected buildings originally constructed around 1935. With the exception of a few minor pieces of auxiliary equipment, the superphosphate plant is indoors.

The superphosphate plant covers a total of 55,100 sq. ft. under roof, of which 7,800 sq. ft. is for storage of phosphate rock and 4,800 sq. ft. is for processing. The remaining 42,500 sq. ft. is used for curing and storage of bulk superphosphate.

The buildings are wooden, with heavy timber supporting structure. The floor is both dirt and concrete. Although worn and aged, the buildings are sound and useable.

The manufacturing section is of classic design for a superphosphate fertilizer plant. The processing unit was built in 1944. Although the plant is dirty and fairly unkempt, it is turning out a good product at a reasonable rate. Prodution capacity exceeds the demand.

The bulk storage sections are adequate, although mechanical conveyors and related equipment need attention.

Sulfuric Acid Plant

The sulfuric acid plant consists of two production units of the Leonard-Monsanto Design. The older plant was constructed in 1944 with a design capacity of 60 T/D. The newer plant was constructed in 1956 with a design capacity of 100 T/D.

Most of the processing equipment is housed in a 5,000 sq. ft. building of steel, brick, and transite construction. The building is in fair shape.

The condition of the process equipment ranges from bad to good. Some fumes (leaks) are noticeable and catwalks should be replaced. Unused equipment lies scattered around and the structural steel needs paint.

The absorbing Tower in the older plant has a bottom leak. Repairing this tower is mandatory on the next shutdown, and this is a sizable job.

Ammonium Sulfate Plant

The ammonium sulfate plant is completely housed in a small 1,600 sq. ft. three-story building. The plant was built in 1944 and was patterned after the French Kuhlman process. The building is a combination of wood, transite, tar paper, and asphalt siding. The building is rather unkempt. Although unsightly, it is sound and useable.

The process equipment is essentially worn out. The centrifuge needs an overhaul or replacement. Process revisions could effect a c onsiderable improvement in the product.

Plant capacity is at least three times the current output.

<u>Alum Plant</u>

The alum plant building is a nice two story concrete block building covering 17,000 sq. ft., of which about two-thirds is used for raw material storage.

The plant was designed by an engineer employee of NCI and patterned after a similar unit operated by Monsanto. The process equipment is entirely indoors. The equipment area is crowded but manageable. The catwalks, stairs, and ramps are wood. The plant is quite dirty and should be ~~housed down~~ washed down more frequently.

The track scale foundation at the railroad loading dock has collapsed. The scale was recently unapproved by a state weights and measures inspector.

<u>Ammonia Plant</u>

The ammonia plant was built in 1955 by Girdler using the oil fired Texaco process and designed to produce 125 T/D. The plant covers a 100,000 square feet area outdoors plus a 6,000 square foot transite compressor building. Offices, control room, and laboratory are located in the compressor building.

The process equipment is neatly arranged. However, the layout has suffered due to ten years of modification from breakdowns, process changes and general deterioration.

A 1,000 sq. ft. three story transite carbon removal building is unused. The area is unpaved and consists mainly of rock and dirt.

The compressors and control room appear in excellent condition. The plant needs painting and the insulation needs repair. Unused process equipment has been left standing unattended.

The storage spheres are ajacent to the railroad track and loading dock. The insulation on one sphere is in poor condition. The storage area is well laid out and serviceable.

<u>Nitric Acid Plant</u>

The nitric acid plant was built by Girdler in 1955 and designed to produce 60 T/D. The air compressors are indoors. The processing equipment is outdoors. The compressor room is between the power house and E & I maintenance shop.

The plant is in good condition, and shows visible signs of good management and attention.

<u>Ammonium Nitrate and Solutions Plant</u>

Both the ammonium nitrate and solutions plants are located outdoors and are in fair condition. Some maintenance is needed on the insulation and some painting of structural steel is required.

The area is not crowded, but poorly arranged for expansion purposes.

UTILITY FACILITIES

Power Generation

The power house was constructed in 1955 by Girdler. The building is a 4,400 sq. ft. concrete and steel structure, with adequate space and ventilation. The turbogenerator and auxiliary facilities are indoors; the boiler is outdoors.

The power house and boiler are in good condition and reflect good care during the ten year life of the facility.

City Water

Water is delivered to the plant through mains belonging to the Searsport Water District. This water originates from a nearby fresh water lake and is untreated. The quality is generally excellent, although organic content varies with seasons.

The water is distributed throughout the plant in a network of piping, some of which needs painting, winterizing and replacement.

Salt Water

The sea water inlet is at the east end of the plant extending into the bay about sixty feet on piling. A channel has been dredged around the inlet. A screen traps sediment, fish, etc., from entering the system.

The plant cooling water exchangers are located on-shore and are in fair condition, considering the corrosive nature of sea water. Sea water is distributed through piping to the various services in the plant and returns to the bay in open ditches.

A small separate salt water intake and effluent ditch is located at the superphosphate plant.

Purchased Power

A 750 KVA transformer station is located in the Power House to step-down power bought from the Central Maine Power Company.

Natural Gas

No natural gas is available at the plant. There are plans to run a pipeline into this section of Maine within the next three to five years. Bottled propane is used to pilot the plant flares.

Fuel Oil

An oil tank is located about 200 feet from the Power House. A tank car oil unloading station is abandoned, and trucks currently deliver oil to the plant. Oil is piped 450 feet from the truck unloading station to storage.

OFF-SITE FACILITIES

Offices

Administrative offices are in a 4,000 sq. ft. brick one-story building.

Production supervision, personnel and safety departments occupy a 1,600 sq. ft. wood frame one-story building. The building is crowded.

Shift foreman and some maintenance foremen in the sulfuric acid and superphosphate area occupy a 450 sq. ft. wood frame building located near the respective plants.

Maintenance engineers occupy adequate office space set aside in the new maintenance shop.

Production supervision and foremen in the ammonia and nitric acid plants occupy adequate office space in the ammonia plant compressor building.

Fences

Chain link fencing surrounds the plant section built in 1955. The older sections, including the administration building and parking lot, are not fenced. The fence is in need of repair.

Gates are rarely used. There is no guard house or guard stationed at the plant entrance.

Roads

A black asphalt two lane access road leads into the plant Administration Building from U.S. Highway No. 1.

Plant roadbeds are rough gravel. Drainage is both good and bad in spots.

Dock

The plant has no useable dock. The remains of a small old dock is near the superphosphate plant. A sailing vessel sunk in 1913 lies partly submerged about thirty feet off-shore at this point.

Laboratories

The main laboratory is a 1,400 sq. ft. building of wood frame construction.

A 400 sq. ft. gas analysis laboratory is located in the ammonia plant compressor house.

Numerous small testing stands are scattered throughout the plant for use by the operators.

Railroad Spurs & Rolling Stock

The plant has nine spurs off the Bangor-Aroostock Railroad main line for a total of 8,300 feet of track. Car pullers are available but no longer used. Two trackmobiles are used to handle car movements. One is worn out and should be replaced. The other is still serviceable. The railroad is very cooperative in providing switches.

The tank car fleet under lease is as follows:

29	Low pressure solution tank cars.
36	High pressure solution tank cars.
25	Ammonia tank cars.
6	Sulfuric acid tank cars.
5	Alum tank cars.
3	Aqua ammonia tank cars.
104	Total

Employee Change House

A very old 600 sq. ft. locker room is located behind the sulfuric acid plant. This building is unsuited for employee accomodations.

No other change room, showers, or lunch room facilities are provided the employee.

Parking Area

The parking lot consists of approximately 3,000 sq.ft. of graded, unpaved area, part of which is seldom used.

Yard Lighting

Lighting of some areas is inadequate. The newer processing sections are well lighted. The road lighting is fair. There is no stand-by generator system for emergency lighting. Some battery operated emergency lights are placed in the operating areas.

Safety and Fire Equipment

All warehouses are equipped with sprinklers.

A salt water and fresh water fire water loop is available and several hose houses are strategically located.

No fresh air line gas masks are used. Cartrige types are available in the operating areas. The personnel office maintains a supply of protective clothing, compressed air (30 minute) breathing apparatus, and first aid equipment.

Safety showers and eye wash fountains are found indoors only, and are not plainly accessible. The severe winters limit the practical use of outdoor showers and fountains.

Stores

Plant stores are maintained in three new Butler type buildings. The main storeroom adjoins a new maintenance shop and covers 4,000 sq. ft.

The other two buildings are used for spare and useable parts and are located across the road from the main store room. These buildings cover 3,600 and 2,400 sq. ft., respectively.

A 200 sq. ft. shack behind the sulfuric acid plant is used to store chemicals and catalysts.

Maintenance Shops

Maintenance shop facilities are scattered through the plant.

A new 4,000 sq. ft. shop adjoins the main store room. An old 3,600 sq. ft. shop is located near the superphosphate plant. The Electrical and Instrument shop covers 800 sq. ft. in the nitric acid compressor building.

Small work benches and tool racks are positioned in the operating areas for use by the operators.

Warehouse

Warehouse space is used for storage of bulk and bag ammonium sulfate, triple superphosphate which is bought and sold, and bulk normal superphosphate. Trucks and payloaders are parked in the warehouse when not in use.

A total of 87,000 sq. ft. of warehouse space is available. There are two main buildings connected by a covered roadway. The buildings were described above in the superphosphate plant description. Both buildings are about equal in size.

Portable Tools and Vehicles

Gasoline power tools and vehicles used for plant service are as follows:

1	1963 Ford Station Wagon
1	1945 Chevrolet Truck
2	1952 Dodge Trucks
1	1963 International Truck
1	1962 Mercury Winch Truck
2	Lawn Mowers
1	Power Dredge

1	Leroy Compressor
1	Gas Welding Machine
1	Heliac Machine
1	Fire Pump
2	Diaphram Pumps
1	Centrifugal Pump
2	Trackmobiles

SECTION V C

PROCESS DESCRIPTION

SULFURIC ACID

Flow Diagram

Figure 5 is a simplified process flow sheet for both the old and new sulfuric acid units, including combined raw material handling and storage facilities.

Process Description

Molten sulfur is delivered to the plant in 20 ton tank trucks from the Texas Gulf Sulfur terminal in Searsport. The hot liquid sulfur is unloaded into below ground steam heated storage tanks. Approximately 2,300 tons of raw sulfur is stored in bulk for use in the event the molten sulfur supply is delayed or discontinued.

Raw sulfur is dumped via payloaders into below ground sulfur melting pots which are adjacent to the molten sulfur storage. Molten sulfur is pumped to Sulfur Burners in both the old and new acid plants via submerged pumps from the molten sulfur storage tanks.

Air is taken directly from the atmosphere through a blower and dried in the Air Drying Tower against a counter current stream of concentrated (66° Be') acid at from 90 to 120°F. Air leaves the Drying Tower at slightly above one atmosphere pressure, with under 30 ppm moisture and enters the Sulfur Burner.

In the Sulfur Burner, molten sulfur is burned to form sulfur dioxide. The resulting gases contain approximately 9% SO_2, 12% O_2, and 79% N_2. Considerable heat energy is liberated during combustion of sulfur and the burner product gases are generally about 1650°F.

The burner gas is then cooled to 775°F in a Waste Heat Boiler which produces 60 psig steam. For temperature control, a by-pass around the Waste Heat Boiler is provided.

The hot gases then pass through the Hot Gas Filter where ash is removed, and on to the Converter.

The Converter consists of four layers of vanadium pentoxide catalyst which facilitates the oxidation of sulfur dioxide to sulfur trioxide. The reaction is exothermic and the gas leaves the first catalyst bed at about 1100°F. and is passed through a second Waste Heat Boiler where additional steam is produced.

Between the second and third catalyst bed of the converter additional reaction heat is removed by passing the gases over steam superheater coils which super heat the 60 psig steam well above saturation. The gases leave the Converter at about 800°F.

In the old acid plant, the converter exit gases are further cooled against ambient air by passing the gases through a large duct which runs completely around the outside of the acid plant building. In the newer plant, the gases are cooled in an Economizer against incoming boiler feed water, followed by an air cooled Gas Cooler.

The gases then pass into the Absorber where the SO_3 combines with dilute sulfuric acid to form concentrated (98-99%) sulfuric acid. Weak acid enters the top of the packed Absorber and the concentrated acid leaves the bottom and joins the Air Drying Tower concentrated effluent acid. Stack gases, essentially O_2, N_2 and some sulfur oxides, are vented out the Absorber.

The acid from the Absorber and Air Drying Tower is recirculated through coolers and back into the columns. As the concentration increases due to burner gas absorption, a product acid stream is purged from the recirculating acid. This product stream (98-99% H_2SO_4) is then diluted to 66° Be' (93.19% H_2SO_4) and sent to storage.

<u>Raw Material & Supplies Requirements</u>

	per ton 100% H_2SO_4
Sulfur	0.338 tons
Supplies, including Boiler water chemicals	5.8¢

Utilities Requirements

	per ton 100% H_2SO_4
Power	9.2 KWH
Net Steam produced	~~2500~~ 1220 lbs.
City Water	356 gal.

Storage & Distrubution

Product sulfuric acid is stored in two tanks having a total capacity of 4,000 tons acid, 100% basis. This is equivalent to approximately twenty days of full production. One tank (1500 ton capacity) is adjacent to the plant; the other (2500 ton capacity) is located about 700 feet away. From either tank, acid can be delivered to the superphosphate plant, the ammonium sulfate plant, the alum plant, or to a tank car loading station.

Operation

Both plants are operating satisfactorily, showing a 97% conversion of sulfur to sulfuric acid. The older unit produces continuously at a rate 50% above design; the newer unit produces continuously at a rate 20% above design. Purity, concentration and color of the acid is good.

NORMAL SUPERPHOSPHATE

Flow Diagram

A schematic flow sheet for production of superphosphate is shown on Figure 6.

Process Description

Normal superphosphate is produced by the acidification of phosphate rock in a batch operated one ton Mixer and a 40 ton Gunite lined Den.

Florida rock (74-76 BPL) is delivered to the plant in rail hopper cars from the Searsport terminal where ships are unloaded. The rock is stored in bulk in several locations at the plant. Normally, 2000 to 3000 tons of rock are stored at the plant.

Rock is transported via payloaders to a Bucket Elevator which feeds two Raymond Roller Mills. The mills are used alternately to grind the rock (66% + 200 mesh, 90% + 100 mesh) and convey the rock pneumatically to two 112 ton Ground Rock Silos (225 total tons).

Rock is then conveyed via Bucket Elevator into a Weigh Hopper. Sulfuric acid is delivered from the acid storage tanks to the Acid Surge Tank and diluted in a lead lined Acid Dilution Tank to 56^{O}Be'. Heat of dilution is removed by circulating water through lead coils in the Dilution Tank.

Dilute sulfuric acid at 130^{O}F is pumped to the Acid Feed Tank and then dropped by gravity into the Mixer along with the ground rock in a predetermined weight ratio.

The Mixer is a pan type, equipped with paddles for continued slow agitation of the mix. During acidulation noxious fumes of water vapor, hydrogen flouride, carbon dioxide and silica dust are removed from the Mixer by an induced draft blower and scrubbed in a two stage wooden Scrubber against cascading sea water. The sea water flows back into the bay.

When the acidulation is complete, the batch is dropped from the Mixer into the Den by gravity flow where the mixture cures and hardens. Subsequent batches are mixed and dumped into the Den until the Den has been filled.

After the Den has been filled and the mixture is allowed to solidify, the Den doors are opened. The Den is moved along a track in such a manner that the superphosphate is pushed out and chopped off by large Excavator blades. The superphosphate breaks easily and falls into a chute leading to a Bucket Elevator. From the Elevator, the superphosphate travels via overhead Belt Conveyor to bulk storage for final curing.

Raw Material & Supplies Requirements

	per ton Superphosphate
Sulfuric Acid	0.357 tons
Phosphate Rock	0.586 tons
Sterox	0.12 lbs.

Utilities Requirements

	per ton Superphosphate
Power	20.3 kwh
City Water	30.3 gal.
Steam	40 #

Storage & Distribution

A total of 15,000 tons of bulk storage space is available. This must be split between phosphate rock and normal superphosphate, and occasionally triple superphosphate which is purchased, stored and shipped through the plant. The usual peak inventory of normal superphosphate is about 9,000 tons.

When warehouse space becomes a limiting factor, the normal superphosphate is reworked through a Tailing Mill and Screen. This serves to increase the bulk density, blend the product and increase the available P_2O_5 content about 0.5% by releasing moisture which was trapped during curing in the bulk pile. Although this procedure improves the product and permits greater tonnage to be stored, the added handling cost discourages full time use of this technique.

Normal superphosphate is shipped only as bulk. Rail cars are loaded at a spot alongside the bulk warehouse.

Operation

The normal superphosphate plant produces a reasonably typical product. Specifications are easily met, although some problems were recently encountered when low grade rock was used.

Phosphate rock is tested in the laboratory in order to select a formulation for the mix. The formulation varies from rock differences and must be altered with each new rock shipment. A typical formulation is as follows:

	Per Mix Batch
Ground rock	840 lbs.
Acid, 56° Be'	688 lbs.
Total mix	1528 lbs.
Fume loss shrinkage, 8%	122 lbs.
Batch weight	1406 lbs.

Normally, sixty Mixer batches will fill the Den. The plant is capable of producing 600 Mixer batches each day, which is equal to 10 Dens per day. A Den contains about 42 tons of product. An eight hour shutdown is needed every week to clean the Den, Excavator and Conveyors.

The Mixing operation is controlled by operator experience. By noting the consistency of the mix, the operator judges when to drop the mixture into the Den. Occasionally, a particular rock or formulation will cause abnormal thickening of the mixture. In such cases Sterox, a lubricating agent, is added in small quantities.

AMMONIUM SULFATE

Flow Diagram

A schematic flow sheet for the ammonium sulfate process is shown on Figure 7.

Process Description

Ammonium sulfate is produced in crystal form in a continuous single train atmospheric Neutralizer-Crystallizer.

Sulfuric acid (66^{o} Be') is pumped directly from acid storage into the Neutralizer-Crystallizer. Ammonia is pumped from Sphere storage directly into the Neutralizer-Crystallizer. The resulting exothermic heat of reaction is removed by allowing the liquor to boil and steam is vented out the top of the Neutralizer-Crystallizer. At one atmosphere pressure, the saturated liquor boils around 230^{o} F.

Circulation is maintained by continuous overflow of the liquor into the Overflow Tank and then pumped back to the top of the Neutralizer-Crystallizer.

Crystals of ammonium sulfate collect in the conical lower section of the Neutralizer-Crystallizer and are drawn off as a slurry by gravity into the Sharples C-28 Centrifuge. Mother liquor from the Centrifuge is collected in the Mother Liquor Tank and then pumped to the Overflow Tank for recycling back to the Neutralizer-Crystallizer.

Wet crystals at about 230°F. are ejected from the Centrifuge into the rotary type Dryer. Air is drawn through the Dryer by an induced draft Blower, which discharges into the Mother Liquor Tank. Fines are thus collected in the Mother Liquor Tank while the air escapes through a vent stack.

Leaving the Dryer, the crystals (145°F.) are conveyed via Bucket Elevator to a vibrating Screen. Oversize crystals are rarely encountered, and are easily dumped by hand into the Overflow Tank.

Product crystals travel by gravity through chutes to waiting plant trucks or to a small St. Regis Bagging unit. The trucks carry the crystals to bulk storage. The bags are palletized and carried to the warehouse on fork lift trucks.

<u>Raw Materials & Supplies Requirements</u>

	Per Ton Sulfate, 100%
Ammonia	0.265 tons
Sulfuric Acid	0.74 tons

Utilities Requirements

	Per Ton Sulfate, 100%
Power	23.3 kwh
City Water	174 gal.
Steam	150 lbs.

Storage & Distribution

Crystals are stored in bulk and bags in the old warehouse. Bulk sulfate is loaded by the shipping crews in the superphosphate plant. Bags bear no label except contents and analysis. Manufacturers name is omitted. Multi-Ply Kraft Bags are normally used. Occasionally, Polyethylene bags are used. When necessary, the plant can bag crystals at a rate of 30 tons per eight hours.

Operation

Neutralizer pH is controlled manually. A new automatic pH controller is installed but has never worked properly.

The appearance of the product is poor. The product crystals are hot and very fine and tend to cake almost immediately into a solid fused mass. An effort to reduce this caking by spraying a "Petro Aq" additive ~~sprayed~~ onto the crystal is being tried.

The purity of the crystal is acceptable. Iron contamination ranges from 15 to 20 ppm.

The demonstrated plant efficiencies for ammonia and sulfuric acid are 97.2% and 100%, respectively.

ALUM

Flow Diagram

A schematic flow sheet of the Alum process is shown on Figure 8.

Process Description

Alum (aluminum sulfate hydrate) is produced batchwise by the digestion of bauxite ore with sulfuric acid.

Granular bauxite is delivered in bulk to the plant via trucks from Searsport. The bauxite is stored in the building in a bulk pile and handled by bulldozers. Inventory space is available for approximately 6,000 tons of bauxite.

Bauxite is fed to an Elevator which conveys the material to an overhead Crude Bauxite Hopper. The bauxite then drops onto a Belt Conveyor and is conveyed to the processing area.

Bauxite is then dumped into a second Bucket Elevator and carried to a Feed Hopper which discharges into a Raymond Mill where the bauxite is finely ground and pneumatically conveyed to a Cyclone Separator. Leaving the cyclone Separator, a Redler conveyor drags the bauxite to a large 45 ton Ground Bauxite Storage Bin. The same

Redler conveyor drags the bauxite into one of two Dissolver Tanks.

Sulfuric acid (66° Be') is pumped from acid storage into the Dissolver Tank. The Volume of acid is measured by level from the top of the Dissolver. Bauxite is then allowed to enter the Dissolver while agitating the mix. The quantity of Bauxite is measured by running time of the Redler conveyor. Some heat is supplied with steam coils to start the digestion. Once started, the reaction progresses freely and fumes are vented through a natural draft stack. The Dissolvers are constructed of carbon steel, lined with lead and brick.

During digestion the formation of sediment from clays, calcium, silica, etc. precipitate into a sludge or "mud". Iron is removed by the addition of sodium bisulfite, which forms a precipitate iron complex, liberating sulfur oxide fumes out the stack. Following digestion the sediment is allowed to settle and alum liquor (38° Be') is decanted off, filtered and pumped into one of two Alum Storage Tanks.

The Filters are Adams cartridge type, precoated with Johns Manville Celite 545 filter aid. Two Filters are available and alternately switched from service to backwash.

Washing consists of a four step cycle during which the mud is progressively mixed with liquor from previous washes.

Mud is pumped from the Dissolver into one of four Mud Tanks and washed with 15° Be', 10° Be', and 7° Be' liquor, and finally with incoming water. The mud is then pumped to a collecting pond for disposal. Liquid is decanted from the pond for reuse when it reaches about 10° Be'.

Liquor from the first wash (15° Be') is pumped to the Storage Tanks to adjust the Alum concentration from 38° Be' to 36° Be'.

<u>Raw Material & Supplies Requirements</u>

	Per Ton 100% dry alum
Bauxite	0.340 ton
Sulfuric Acid	0.516 ton
Sodium Bisulfite	6 lbs.
Supplies	[redacted]14¢

<u>Utilities Requirements</u>

	Per Ton 100% dry alum
Power	16 kwh
City Water	546 gal.
Steam	1430 lbs.

<u>Storage & Distribution</u>

Alum is stored in two tanks holding approximately 100 tons of dry alum as a 50% concentrate. Alum is pumped directly into rubber lined railroad tank cars at a loading station and track scale at the plant.

Operation

Each batch made in the Dissolver Tank produces 30 tons of dry alum. About 45 batches per month are produced. A limiting factor is the time required to convey bauxite into a Dissolver. While the Redler conveyor is being used for this service, the Raymond mill cannot be used to grind bauxite.

Digestion is controlled by titrating a grab sample for free acid. This is done by the operators. Sodium bisulfite consumption will vary with the quality of bauxite. A normal charge for each batch ranges from 100 to 175 lbs., depending on the iron content of previous alum batches. Iron should not exceed 0.01% in the product alum.

Settling time of the mud is facilitated by adding about four pounds of American Cyanamid "Superfloc" to a batch. This is a floculating agent and is used only for stubborn batches.

Occasionally, the Redler conveyor will breakdown during digestion. If the delay for repairs is extended over five or six hours, the batch in progress tends to become passive. The reaction will not continue upon addition of more bauxite and the batch must be sewered.

AMMONIA

Flow Diagram

Process flow sheets for syn gas preparation, purification, and the synthesis and storage sections are shown on Figures 9, 10, and 11, respectively.

Process Description

Ammonia is produced continuously in accordance with the following basic process steps:

- Air Separation
- Partial Oxidation
- Shift Conversion
- Carbon Dioxide Removal
- Nitrogen Wash Purification
- Compression
- Synthesis

Oxygen is provided for the partial oxidation of oil from a 108 T/D O_2 (100% basis) medium pressure Air Products air separation plant. Air is compressed in four stages to about 600 psi and passed through the Ammonia Aqua Wash Tower where CO_2 is absorbed in a counter current stream of weak aqua ammonia. The air then passes through a Caustic Wash Tower where remaining traces of CO_2 are removed. The air is then cooled to about 40^{o}F in the Prechiller and passed through a Dryer to remove moisture.

The Air Plant utilizes Regenerators to cool the imcoming air and remove the last trace of water vapor and CO_2 in the air. The Regenerators are switched every eight hours. Leaving the Air Separation Plant are 95% oxygen and 99.9% N_2 streams, plus an impure nitrogen stream which is vented. Oxygen is preheated with steam in the Oxygen Preheater and sent to the partial oxidation Texaco Generators.

Oil is delivered in tank trucks and pumped in the main Oil Storage Tank which serves the boiler house as well as the ammonia plant. From the Oil Storage Tank, Bunker "C" grade oil is pumped through a Heater and into the Oil Flash Tank. Oil for fuel service is also pumped directly to the burners on the Vaporizers and Preheaters.

The partial oxidation section consists of three separate trains. Condensate is pumped through the oil fired Vaporizers where high pressure steam is produced. The steam is further heated in the No. 1 and No. 2 Preheaters and joins the process oil stream passing through the Preheaters. The No. 3 Preheater has been taken out of service recently as a process modification. The effect of this modification is being studied on the No. 3 partial oxidation train.

Leaving the Preheaters, the oil-stream mixture enters the Texaco Generator where the oil is combined with 95% oxygen to produce a stream of essentially CO, CO_2, and

H_2, plus minor amounts of H_2S, COS, and N_2. The gases leave the combustion chamber at about 2500°F. and are rapidly quenched with water. The quench water is cooled and passed through a large sand filter bed where soot is removed, followed by a two stage pond decantation clarifying step.

The exit gases from the quench section are passed through a series of Peabody and Pease-Anthony type scrubbers and into the Carbon Scrubbing Tower where carbon is removed from the gases with a counter current stream of water. Sooty water is purged from the system and serves as quench water for the Texaco Generators.

Leaving the Carbon Scrubber, the gases are heated against First Stage Shift Converter exit gases, mixed with steam, and passed into the First Stage Shift Converters. The First Stage Shift Converters are two parallel vessels containing three beds each of Girdler catalyst which promotes the conversion of carbon monoxide into carbon dioxide and hydrogen.

Following heat exchange with the incoming gas, the gas stream is then cooled first in the MEA Reboiler, then in the Contact Gas Cooler by saturating the gas with water.

The gases leave the Contact Gas Cooler and pass directly into the First Stage CO_2 Absorber where carbon dioxide is absorbed in a counter current stream of 15% MEA. The gases are then heated in a second Shift Exchanger and flow into the Second Stage Shift Converter where the remaining carbon monoxide is converted to hydrogen and carbon dioxide.

Following exchange with incoming gases, the gases are further cooled in the second MEA Reboiler and then enter the Second Stage CO_2 Absorber where remaining carbon dioxide absorbed in a counter current stream of 15% MEA.

The carbon dioxide rich MEA is recovered in a Regenerator where heat supplied by the hot gases and steam in the Reboilers is used to separate the carbon dioxide from the MEA. Carbon dioxide and water vapor exit the Regenerator and pass through the Acid Gas Condenser where reflux condensate is recovered and returned to the Regenerator. The acid gas, which is essentially carbon dioxide plus some sulfides, is sent to the main plant boilers where the objectional odorous sulfides are burned and vented out the boiler stack.

From the Second Stage Absorber the gas, essentially H_2, passes through the Carbon Scrubber where any remaining carbon dioxide is removed in a counter current stream of weak caustic. The hydrogen is then cooled against flashing ammonia in the Hydrogen Chiller.

Leaving the Hydrogen Chiller, the hydrogen gas enters the Nitrogen Wash Unit where the hydrogen is scrubbed in a stream of cold liquidified nitrogen to absorb and remove any remaining last tract of contaminant carbon dioxide and carbon monoxide. Refrigeration for the Nitrogen Wash is supplied by the Air Plant.

From the Nitrogen Wash, the pure hydrogen stream enters the Methanator, which serves as a guard to any remaining traces of oxygen to water or carbon monoxide to methane in order to insure against synthesis catalyst poisoning.

Pure nitrogen from the air plant then joins the purified hydrogen stream in a 3:1 ratio of hydrogen to nitrogen and is cooled in the Syn Gas Cooler.

The Syn gas mixture is then compressed to 4500 psi in three stages of the main compressor and sent to the synthesis loop. The ammonia synthesis loop consists of a circulating stream of H_2, N_2, and NH_3 which pass through the Ammonia Converter where H_2 and N_2 are combined to form ammonia in the presence of 24,000 lbs. of Topsoe KM-1 and KM-2 catalyst. The synthesis gases leave the Converter and pass through an air cooled condenser where ammonia is condensed. The vapors are recycled to the synthesis loop via the Compressor, the ammonia is collected in a series of pressure let-down vessels.

Raw Materials & Supplies Requirements

	Per ton ammonia
Oil, Bunker "C"	6.23 bbl
Oil, #2 fuel	0.13 bbl
Caustic (liquid NaOH)	0.605 lbs.
Shift Catalyst	55.4¢
MEA	0.442 gal.
Ammonia	0.003 ton

Utility Requirements

	Per ton ammonia
Power	1300 kwh
Steam	12,860 lb.
Salt Water	15,000 gal.
City Water	400 gal.
Cooling Water	25,000 gal.

Storage and Distribution

Ammonia is stored in a 30 ton pressure bullet for delivery to the nitric acid, ammonium nitrate and solution plants. The main ammonia inventory is stored in two 2000 ton Hortonspheres, which are refrigerated with three small compressors totaling only 97 HP. This is inadequate compression during warm weather.

Refrigeration grade ammonia is filtered and stored in a 50 ton pressure bullet.

Aqua ammonia is made and stored in a 25,000 gallon pressure bullet (30 tons NH_3).

All ammonia shipments are by rail. Tank car loading facilities (scale and dock) are available to fill one car at a time.

Operation

Although designed to produce 125 T/D the ammonia plant has never met this rate, in spite of a raft of changes made in the plant. In the past ten years, the process scheme has been altered substantially in such units as carbon scrubbing, CO_2 removal, and partial oxidation, with only moderate rewards.

Partial oxidation thermal efficiency is in the range of 82%, which is reasonable for the oil fired Texaco Process.

Corrosion of the MEA system continues to plague the operation.

NITRIC ACID

Flow Diagram

A simplified process flow sheet is shown on Figure 12.

Process Description

Nitric acid is produced in a high pressure unit designed to make 59% HNO_3 on a continuous basis from the oxidation of ammonia.

Air is passed through a screen and water scrubber and compressed to 25 psig in the First Stage Compressor.

The hot (280°F) compressed gas then passes through the Intercooler where moisture is condensed and removed in the Separator. The air then enters the Second Stage Centrifugal Compressor at 80° F. and discharges at 110 psig, 470°F.

The compressed air stream is then split, and 85% of the flow enters the Air Preheater where heat is exchanged with hot burner gases. For temperature control, a by-pass around the Air Preheater is provided. The air exits the Air Preheater at about 580° F. and enters the ammonia-air Mixer.

Anhydrous liquid ammonia from the ammonia plant pressure bullet storage enters the steam heated Ammonia Vaporizer followed by the Ammonia Superheater. Leaving the Superheater at 210° F the ammonia gas is filtered and joins the air stream in the Mixer. Ammonia and air are blended in the Mixer to a composition of 9.5% NH_3 by volume.

The NH_3-Air gas mixture passes into the catalyst zone of the Converter where ammonia and oxygen combine catalytically to form nitrogen oxides. The catalyst consists of 135 troy ounces of platinum-rhodium alloy gauze. From the Converter the burner gas is cooled first in the Converter Gas Precooler against tail gas, followed by the Tail Gas Heater, and finally to about 750° F in the previously noted Air Preheater.

Leaving the Air Preheater, the burner gases pass through the Catalyst Filter to remove catalyst dust and are then cooled to 280°F in the air cooled Acid Gas Cooler, followed by the Acid Condenser. From the Condenser, the acid gas mixture at 100°F flows into a Separator where 50% acid is collected and fed to the Absorber on the eighth tray. Gases from the Separator are fed to the second tray of the Absorber.

The Absorber consists of a tower packed with 38 trays. The upper trays have serpentine cooling coils. Heat is generated by the reaction of nitrogen oxides and water to form nitric acid. This heat is removed by circulating cooling water through the tray coils. Condensate is fed to the top tray of the Absorber.

The remaining 15% of the compressed air flow is cooled in the Bleach Air cooler to 170°F. and fed to the bottom of the Absorber.

Product acid at from 58% to 59% HNO_3 is withdrawn from the bottom of the Absorber. Tail gas which is essentially nitrogen and oxygen leaves the top of the Absorber, passes through a Demister, and is heated in the Convertor Gas Precooler to 640°F and then in the Tail Gas Heater. A portion of the hot tail gas is used to drive the First

Stage Air Compressor via the Tail Gas Turbine. The tail gases leave the plant through the acid plant stack.

Raw Materials and Supplies Requirements

	Per ton 100% acid
Ammonia	0.290 tons
Catalyst	0.0097 troy ounces
Supplies	9.5¢

Utility Requirements

	Per ton 100% acid
Power	11 kwh
Steam	4066 lbs.
City Water	87 gal.
Cooling Water	44,000 gal.
Salt Water	24,000 gal.

Storage & Distribution

The nitric acid storage tank has a capacity of 500 tons acid, 100% basis, which is equal to about one week of production. Acid is used solely for the manufacture of ammonium nitrate.

Operation

Burner efficiency is very good, averaging 95 + %. Absorber efficiency is also very good as evidenced by tail gas losses of only 0.1% nitrogen oxides. Overall, plant efficiency of ammonia to acid averages 93%. The stack color is comparable to more expensive plants utilizing catalytic disposal of the oxides in tail gases.

A spare supply of catalyst equal to two replacement charges plus some new catalyst is maintained at all times. The Catalyst Filter is changed every three months.

The plant is plagued by a very delicate air compression system. The first stage operates extremely close to surge conditions. Any minor upset or dip in the second stage will cause a drastic surge in the first stage axial compressor. This can cause severe damage and, on one occasion in the past, blew a turbine through the compressor room roof.

The air compression system limits production. The absorption and heat exchange hardware was designed to handle 120 T/D, while the air compressors were sized to provide air for 60 T/D.

AMMONIUM NITRATE

Flow Diagram

Figure 13 is a schematic flow diagram of the ammonium nitrate process.

Process Description

Nitric acid is pumped from storage directly into the Neutralizer. Ammonia flow from the ammonia storage pressure bullet, plus ammonia from the Stripper in the Ammonia Plant, is controlled by pH of the Neutralizer stack.

The Neutralizer operates at atmospheric pressure and heat of reaction is released through steam in the Neutralizer stack. Ammonium nitrate liquor of 84% concentration is produced in the Neutralizer.

The 85% liquor is pumped to the Evaporator which operates at 21 inches of mercury vacuum. Overhead vapors are condensed. The Evaporator product concentration is 94% ammonium nitrate.

Raw Materials & Supply Requirements

	Per ton 100% AN
Ammonia	0.217
Nitric Acid, 100%	0.803
Supplies	1¢

Utility Requirements

	Per ton 100% AN
Power	17 kwh
Steam	148 lbs
Salt Water	2160 gal.

Storage & Distribution

Ammonium nitrate is stored as 84% liquor in an 1800 ton (100% basis) tank equipped with circulation heaters. The tank is heavily insulated. Only a small surge capacity of 94% ammonium nitrate is stored. All ammonium nitrate is consumed in solutions manufacture.

Operation

The ammonium nitrate plant is relatively simple to operate. The plant efficiency is 97.5% on ammonia, and 98.1% on acid.

The Neutralizer capacity is considerable larger than the demand, psssible by an additional 100 T/D. However, the Evaporator is currently being run at its maximun capacity for 94% concentration.

SOLUTIONS

Flow Diagram

A schematic process flow sheet of the solutions plant is shown on Figure 14.

Process Description

Nitrogen solutions can be produced containing any combination of ammonia, ammonium nitrate and urea, although a variety of nitrogen solution grades are generally not produced. The principle types made are:

Type	Vap. Press. @ 104° F	Salting Temp.
440(22-66-6)	17 psig	14°F
450(25-69-0)	22 psig	1°F

Both types are sold as fertilizer manufacturing solutions. Very little, if any, direct application nitrogen solutions are produced. The processing equipment consists of a single train batch operated mixing system for all NH_3 and AN bearing solutions and a single train system for mixing urea and water. The urea containing solutions are produced in two steps.

To produce a solution containing only NH_3 and AN, water is first loaded into the Mixing Tank and weighed. The Mixing Tank is a 13,000 gal. stainless steel pressure vessel set on a scale. Circulation is started around the Mixing Tank through a Mixer and Cooler. Ammonia and AN are fed to the Mixer and heat of reaction is removed as the solution circulates through the cooler. Ammonia is weighed and fed to the Mixer from the Ammonia Weight Tank, a 20 ton pressure vessel set on a scale. Concentrated 94% AN is pumped from the surge tank to the Mixer. The amount of AN used is determined by difference between the final solution weight and the water and ammonia weights. The solution is then circulated, analyzed, inhibited with ammonium thiocyanate and pumped to storage.

Urea bearing solutions are blended from a stock ammonia and ammonium nitrate solution, and urea syrup. Urea is delivered to the plant both in bags and as bulk, although bagged urea is preferred. The urea is conveyed on a Belt Conveyor from the storage building into the Urea Syrup Tank where a 35% urea-water solution is prepared. Heat of solution is added through coils inserted in the Urea Syrup Tank. The urea syrup is then added to the stock solution in the Urea Solution Mix Tank. The solution in the Urea Solution Mix

Tank is then circulated, analyzed and pumped directly into tank cars.

Raw Material & Supplies Requirements

	Per ton 450 N	Per ton 440 N
Ammonia	0.254 tons	0.223 tons
Ammonium Nitrate	0.708 tons	0.677 tons
Urea	-	0.062 tons
Ammonium Thiocyanate	3 lbs.	-
Supplies	1.6¢	1.6¢

Utilities Requirements

	Per ton solution
Power	6.8 kwh
City Water	7.4 gal.
Cooling Water	1980 gal.
Salt Water	1080 gal.
Steam	24 lbs.

Storage and Distribution

Urea bearing solutions (440 N) are loaded directly from production into tank cars. No storage is available for this solution type.

The 450 N type is is stored in two 450,000 gallon steel tanks lined with Lithcote. The tanks are held at one atmosphere pressure, have no insulation, and breath through a small water scrubbing column to remove ammonia vapors. A total of 4000 tons of solution can be stored. To avoid salting out in Winter, the tanks are equipped with a circulating line and a steam Heater. However, the Heater is rarely needed. The tank lining is in need of repair.

Operation

No difficulty is encountered meeting solution specifications. Data on raw material consumption is fairly inaccurate, however, the yield of nitrogen from urea, ammonia and ammonium nitrate appears to range from 95 to 100%.

Advantage is taken of the cold weather in Maine by storing pressure solutions in non-pressure tanks. In late Summer, a solution containing about 21% NH_3 and 71% AN is prepared and loaded into storage. This solution is compatable with warm weather, having a fairly low vapor pressure (7 psig @ 100^{o}F) and a high salting temperature (62^{o}F). As cooler weather develops, the solution concentration in the tanks is gradually adjusted to one having a lower salting temperature and higher vapor pressure. This is done by preparing solutions of higher ammonia content. The higher vapor pressure is not a significant factor because the solution is stored quite cold during the Winter. By the end of the inventory season, the stored solution has reached the 450 N type concentration and is ready for shipment.

UTILITIES

Flow Diagrams

Power distribution is shown on block diagram Figure 15.

Steam distribution is shown on block diagram Figure 16 .

Water distribution is shown on block diagram Figure 17 .

Process Description

Steam is supplied from three sources as follows:

Main Boilers
Stand-by Boiler
Sulfuric Acid Waste Heat Boilers

A 140,000 lbs/hr Erie City main steam boiler produces 420 psig steam superheated to 750°F. Boiler feed water is demineralized to zero ppm. The steam purity is less than one ppm solids. Betz chemicals are used for treatment. The boiler is started up on No.2 grade fuel oil and then operates continuously on Bunker "C" fuel oil. Boiler feed water make-up ranges from 25 - 30%, while blowdown is less than 3%. The make-up is fairly high because condensate is exported to the solutions and nitric acid plants for process use.

The stand-by boiler is a small 5000 lb/hr. oil fired unit, and is used sparingly.

The Sulfuric acid boilers were described above. Steam from the acid Waste Heat Boilers is distributed among the older plants, ie., ammonium sulfate, alum and superphosphate. This distribution is not metered or charged into the production cost of these plants.

Electrical power for all plant sections is generated in a 7500 kw turbogenerator. The turbine drive operates from superheated steam from the main boilers in 14 stages. The steam discharges at 28" Hg, 100° F. Some 60 psig, 450° F steam is bled from the third stage for process distribution, and occasionally low pressure surplus steam is fed to the sixth stage. The design generator power factor is 0.8. The actual generator power factor is 0.96 to 1.00. Condensate from the acid plant turbine joins the turbogenerator discharge at the surface condenser. The surface condenser is cooled with circulating slat water.

It is proposed that by the Fall of 1967, the ammonia plant will be shut down. This will eliminate the need for power generating facilities, including both the 7500 kw turbogenerator and 140,000 pph high pressure steam boiler.

However, since a small portion of the steam and power is also distributed to other operating units not retired, it will be necessary to provide utility services equal to sustaining the operating units. This will involve uprating the power transformer station, and incorporating a small (40,000 pph) auxiliary steam boiler into the existing steam distribution system.

There are three water systems in the plant. City water from a nearby lake is used for sanitary purposes, some cooling requirements, and for process make-up water.

A chromate inhibited closed circuit cooling water system serves the newer plants. The circulating cooling water is cooled with salt water pumped from the bay.

Salt water is also used for cooling service in the power plant, ammonia plant, nitric acid plant, and ammonium nitrate plant. The salt water temperature ranges from 30° F to 64° F from Winter to Summer. All salt water used is on a once-through basis, and returns to the bay in surface ditches.

AMMONIA STORAGE

Flow Diagram

Figure 18 is a simplified process flow sheet for the [redacted] ammonia terminal to be located at the NCI plant.

Process Description

It is proposed that by the Fall of 1966, ammonia raw material will be supplied the NCI plant from a 10,000 ton low temperature atmospheric storage terminal. The ammonia will be brought to the plant in Grace ships from Trinidad. The existing ammonia manufacturing facilities will be retired.

Anhydrous ammonia is delivered to the terminal in 9000 ton cargos from W. R. Grace & Company atmospheric ammonia tankers. Ammonia is then delivered from the terminal to the Hortonsphere storage of the Northern Chemical Industries plant. The ammonia tanker is unloaded in sixteen hours. The terminal is capable of delivering ammonia to the plant at a rate of 410 tons per day.

Refrigeration for the terminal is integrated with the plant sphere refrigeration in such a manner that normal vapor boil-off from the terminal is delivered to the spheres. During tanker unloading, the short term high vapor boil-off is vented and burned. When unloading, about 26 tons of ammonia vapor are lost, accounting for only 0.3% of the cargo. During normal holding of the terminal, about 4½ tons per day of vapor are sent to the spheres.

Liquid anhydrous ammonia, saturated at one atmosphere, is pumped via a by-pass line from the pumps into the filling line at the dock to precool the piping. Ammonia from the tanker is then pumped into the storage tank via the ship pumps. As the liquid enters the tank, all of the energy which it has picked up in the unloading operation results in evaporation of a part of the liquid.

During filling, the excess vapors formed by the flashing liquid, plus the vapor displaced by the liquid are allowed to escape through a pressure relief system to a vent stack equipped with a flare to destroy the vapors. Ignition is maintained by bleeding propane into the vent gas stream.

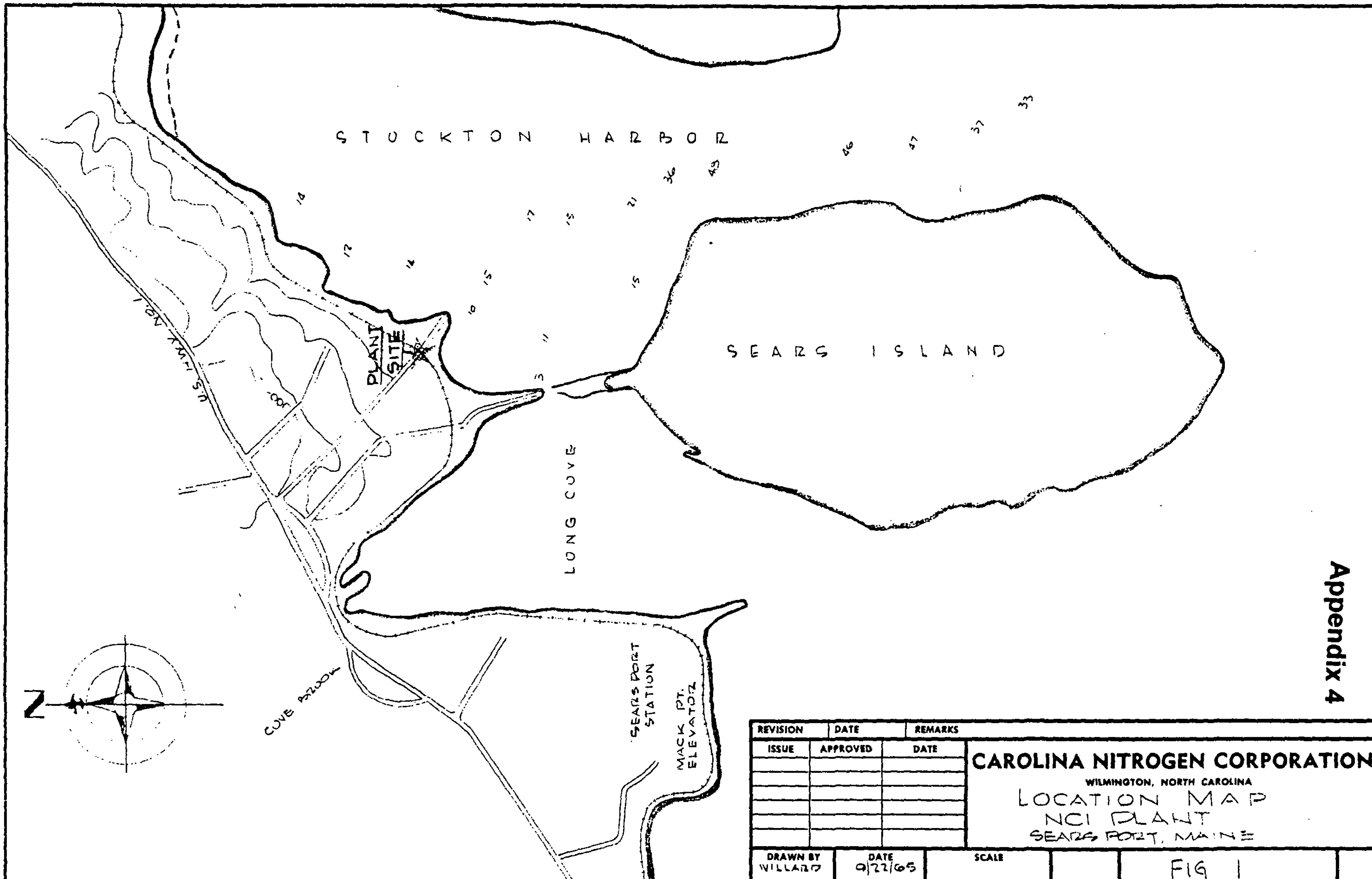
During holding, all of the energy picked up from external sources results in evaporation of a part of the liquid ammonia stored in the tank. The ammonia vapor formed is withdrawn from the tank by the small holding compressor.

Ammonia vapors ~~are~~ At one atmosphere are compressed by the holding compressor to 56 psig. The compressor automatically loads and unloads to maintain the tank at 0.5 psig. Leaving the compressors, the hot ammonia vapors are cooled to saturation by contact with liquid ammonia in the flash tank. The flash tank is located adjacent to the NCI plant storage spheres, and the pressure of the flash tank is equalized with the operating sphere pressure of 56 psig.

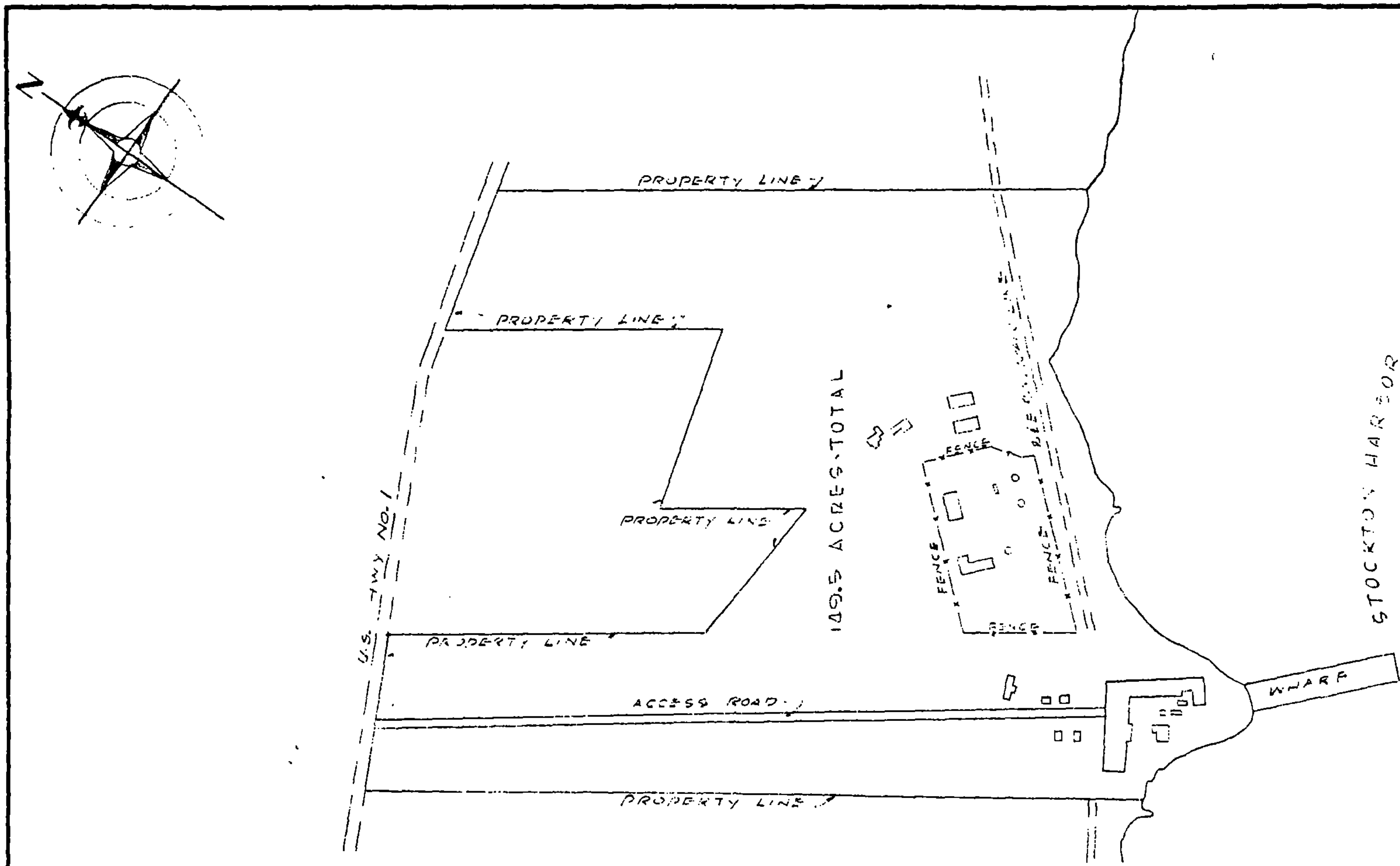
Liquid ammonia for cooling flows by gravity from the spheres to the flash tank on level control. The hot superheated ammonia gas enters the flash tank through a dip pipe beneath the liquid level. The resulting saturated vapors flow into the sphere vapor space to join the existing sphere refrigeration system, or to pass directly into the plant for processing.

Liquid anhydrous ammonia is pumped from the storage terminal to the heater. The heater provides the energy necessary to raise the liquid ammonia temperature up to that of the NCI storage spheres. Steam is provided to the heater from NCI at 150 psig, saturated. Leaving the heater, the liquid ammonia flows into the spheres. Ammonia is delivered from the NCI spheres to all sections of the plant via existing hardware.

Appendix 4



STUCKTON HARBOR
SEARS ISLAND
LONG COVE
PLANT SITE
U.S. HWY No 1
COVE BROOK
SEARS PORT STATION
MACK PT. ELEVATOR
REVISION
DATE
REMARKS
ISSUE
APPROVED
DATE
CAROLINA NITROGEN CORPORATION
WILMINGTON, NORTH CAROLINA
LOCATION MAP
NCI PLANT
SEARS PORT, MAINE
DRAWN BY
WILLARD
DATE
9/22/65
SCALE
FIG 1



REVISION	DATE	REMARKS

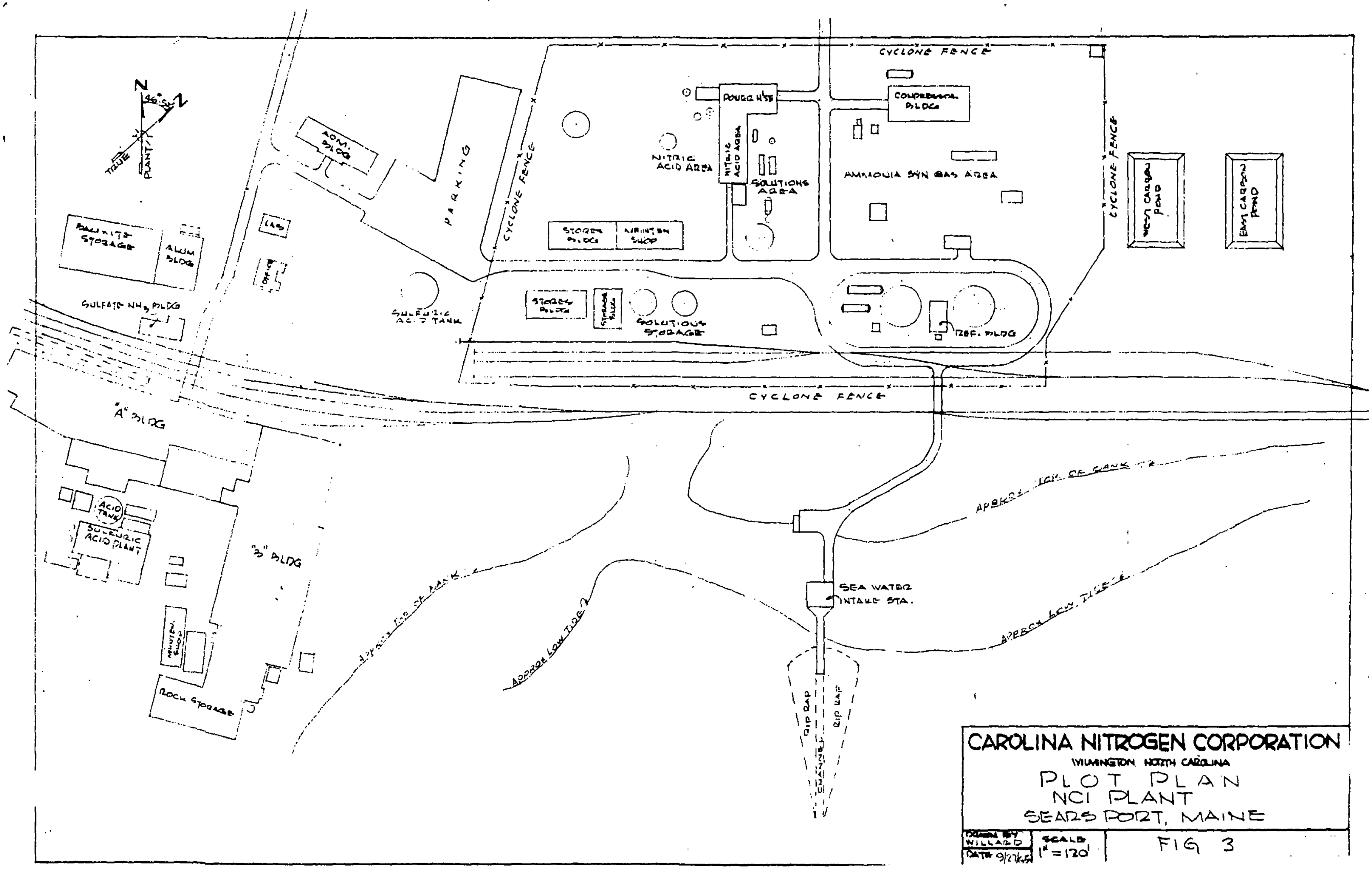
ISSUE	APPROVED	DATE

CAROLINA NITROGEN CORPORATION

WILMINGTON, NORTH CAROLINA

PROPERTY PLAN
NCI PLANT
SEARS PORT, MAINE

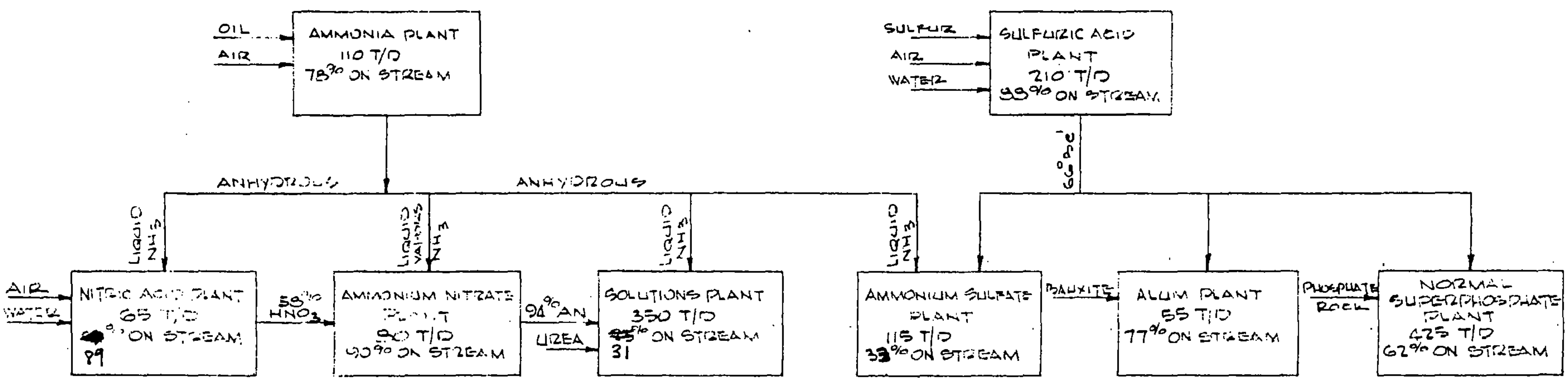
DRAWN BY	DATE	SCALE			
WILLARD	9/22/65	1" = 500'		FIG 2	



CAROLINA NITROGEN CORPORATION
WILMINGTON NORTH CAROLINA

PLOT PLAN
NCI PLANT
SEARS PORT, MAINE

DRAWN BY WILLARD / DATE 9/27/65	SCALE 1" = 120'	FIG 3



REVISION	DATE	REMARKS

ISSUE	APPROVED	DATE

CAROLINA NITROGEN CORPORATION

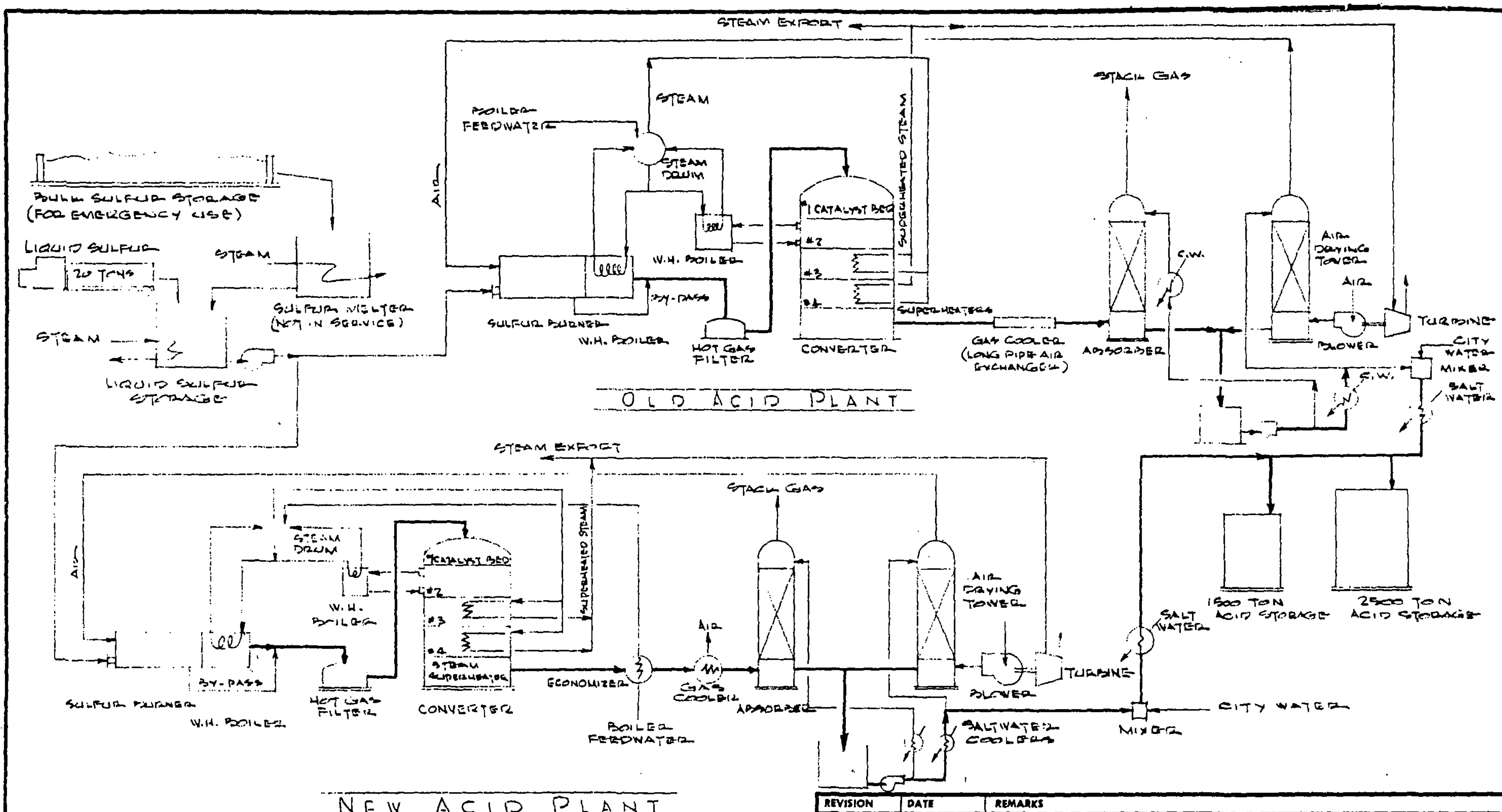
WILMINGTON, NORTH CAROLINA

BLOCK FLOW DIAGRAM

NCI PLANT

SEARSPORT, MAINE

DRAWN BY	DATE	SCALE		
WILLARD	9/28/65			FIG 4



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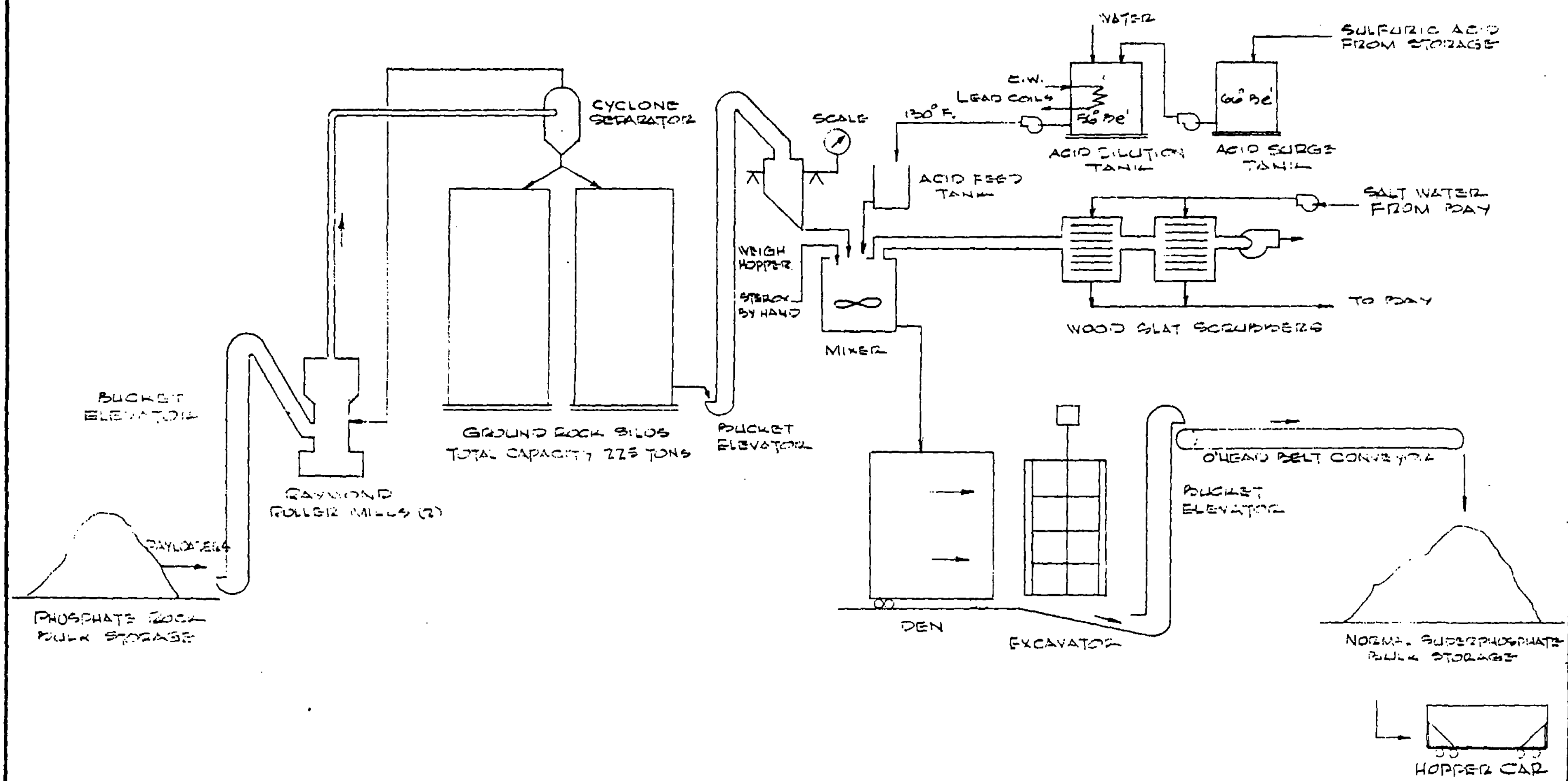
ISSUE	APPROVED	DATE

CAROLINA NITROGEN CORPORATION

WILMINGTON, NORTH CAROLINA

SIMPLIFIED FLOW DIAGRAM
NCI SULFURIC ACID PLANTS
SEARS PORT, MAINE

DRAWN BY	DATE	SCALE		
WILLARD	9/21/65	#		FIG 5



REVISION	DATE	REMARKS

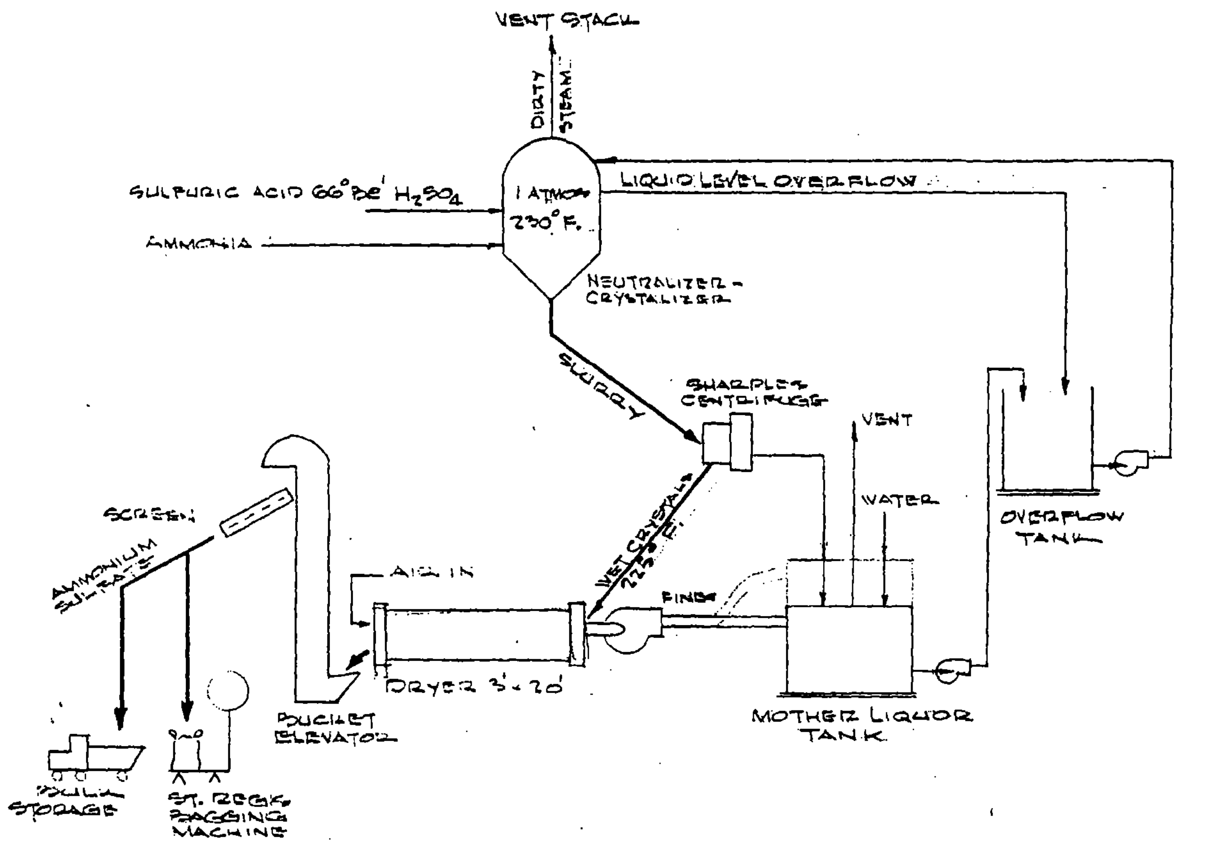
ISSUE	APPROVED	DATE

CAROLINA NITROGEN CORPORATION

WILMINGTON, NORTH CAROLINA

SIMPLIFIED FLOW DIAGRAM
NCI SUPERPHOSPHATE PLANT
SEARS PORT, MAINE

DRAWN BY	DATE	SCALE		FIG. 6
WILLARD	9/23/65	⁄		



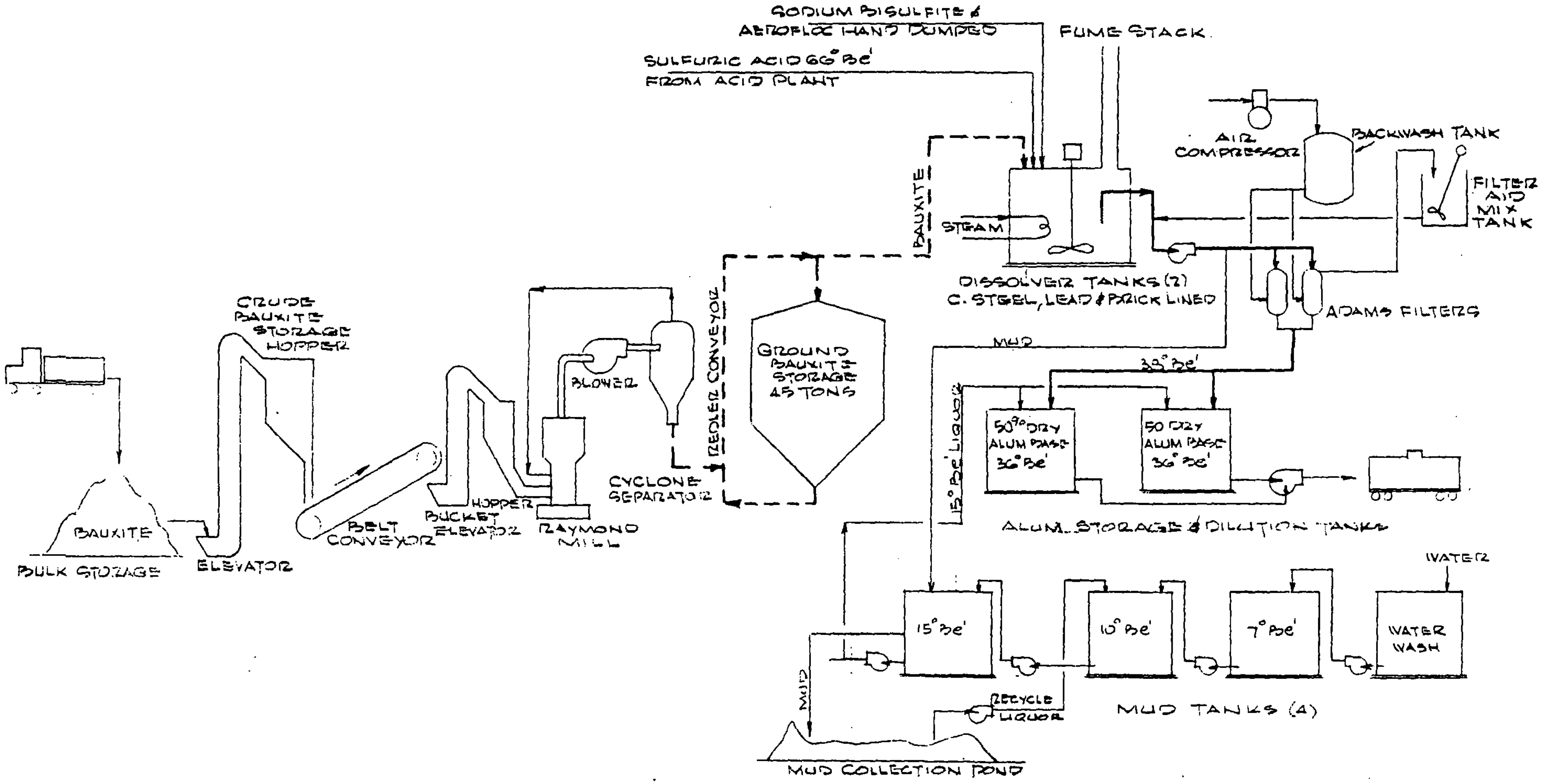
REVISION	DATE	REMARKS

ISSUE	APPROVED	DATE

CAROLINA NITROGEN CORPORATION
WILMINGTON, NORTH CAROLINA

SIMPLIFIED FLOW DIAGRAM
NCI AMMONIUM SULFATE PLANT
SEARS PORT, MAINE

DRAWN BY	DATE	SCALE		
WILLARD	9/21/65	✻		FIG. 7

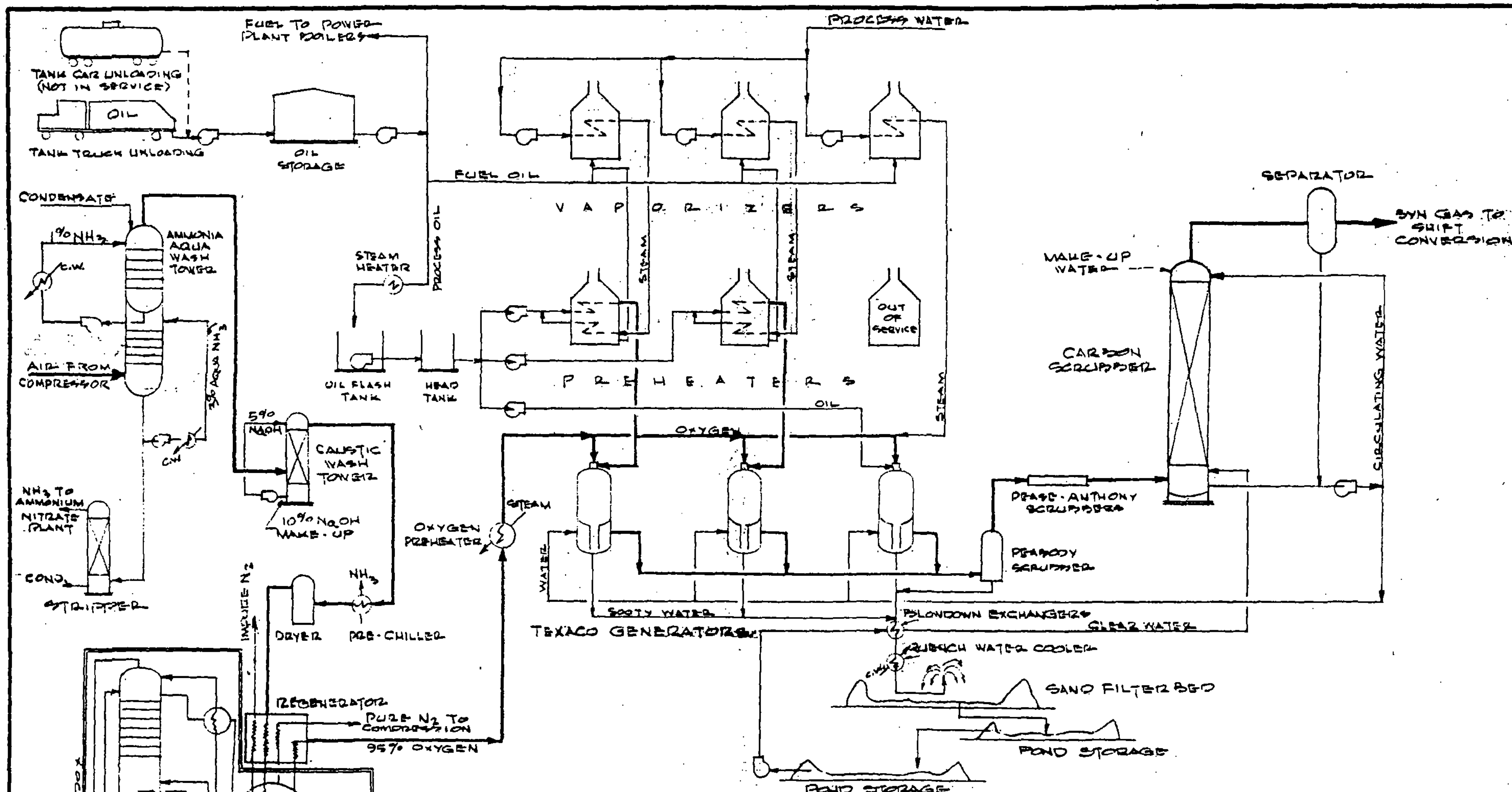


REVISION	DATE	REMARKS
ISSUE	APPROVED	DATE

CAROLINA NITROGEN CORPORATION
WILMINGTON, NORTH CAROLINA

SIMPLIFIED FLOW DIAGRAM
NCI ALUM PLANT
SEARS PORT, MAINE

DRAWN BY	DATE	SCALE	
WILLARD	9/21/65	#	FIG. 8



REVISION	DATE	REMARKS

ISSUE	APPROVED	DATE

CAROLINA NITROGEN CORPORATION

WILMINGTON, NORTH CAROLINA

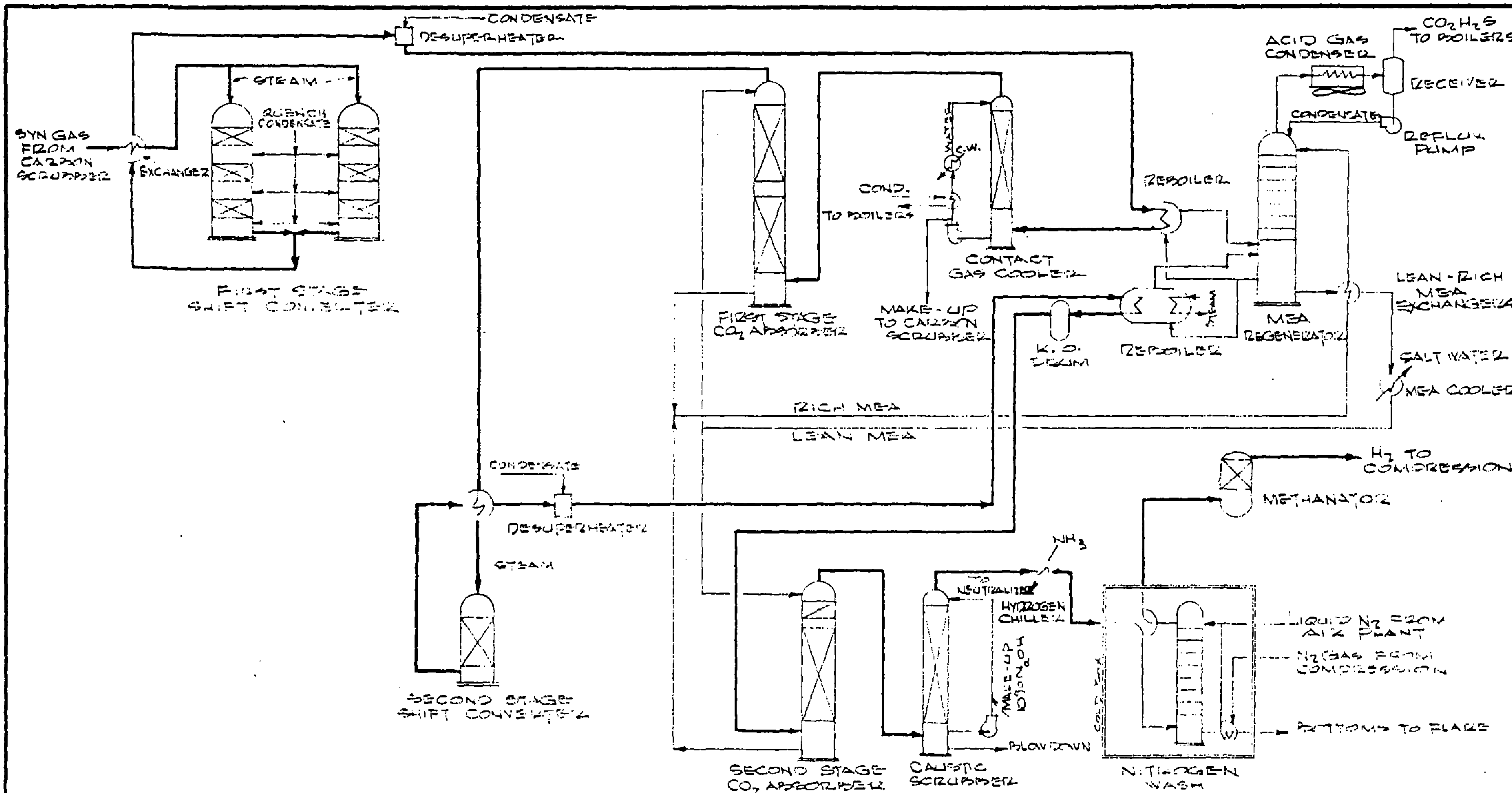
SIMPLIFIED FLOW DIAGRAM

SYN GAS PREPARATION

NCI AMMONIA PLANT

SEARS PORT, MAIN

DRAWN BY	DATE	SCALE	
WILLARD	9/22/65	✳	FIG. 9



REVISION	DATE	REMARKS

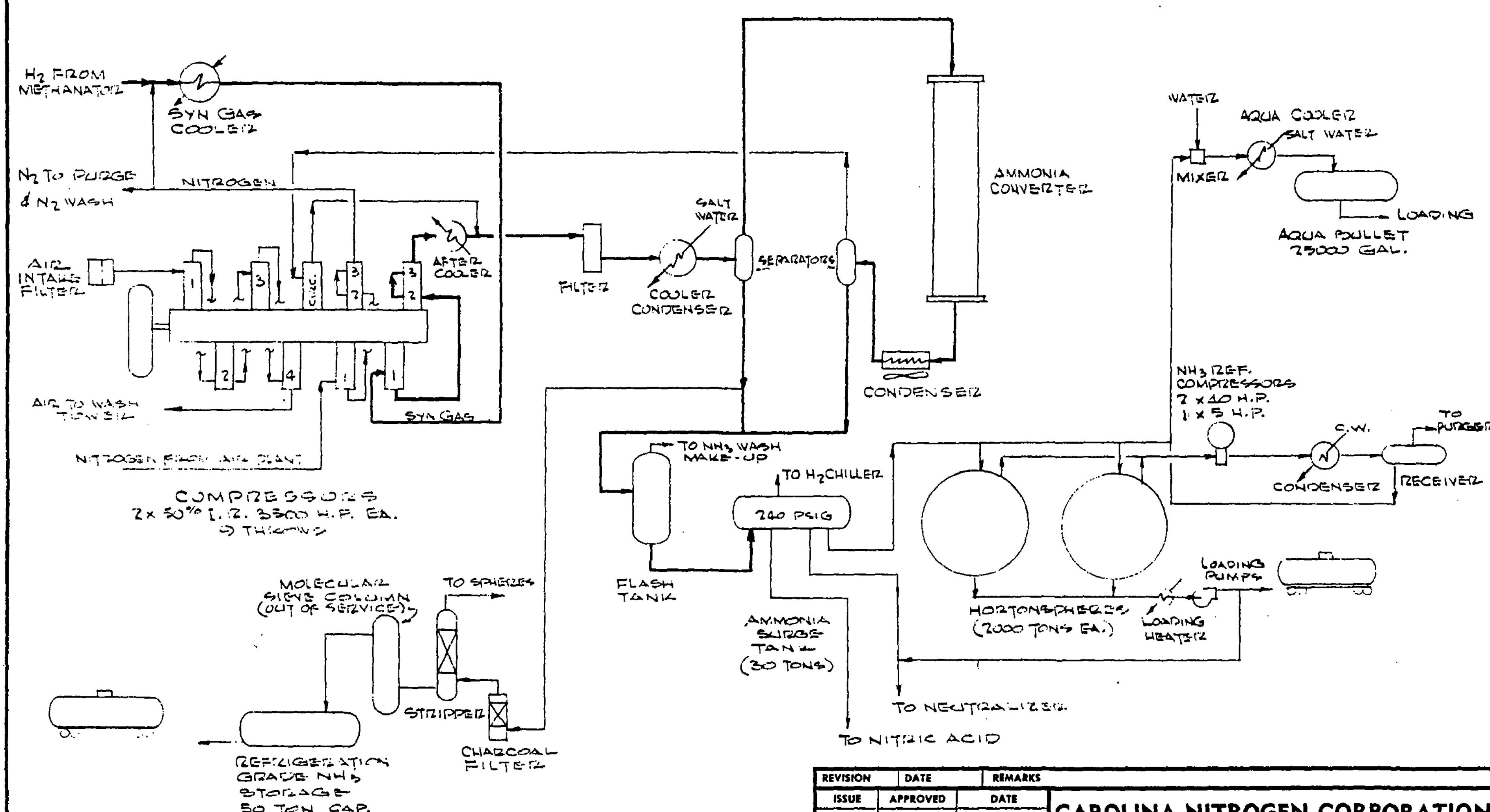
ISSUE	APPROVED	DATE

CAROLINA NITROGEN CORPORATION

WILMINGTON, NORTH CAROLINA

SIMPLIFIED FLOW DIAGRAM
SYN GAS PURIFICATION
NCI AMMONIA PLANT
SEARS PORT, MAINE

DRAWN BY	DATE	SCALE			
WILLARD	9/23/65				FIG 10

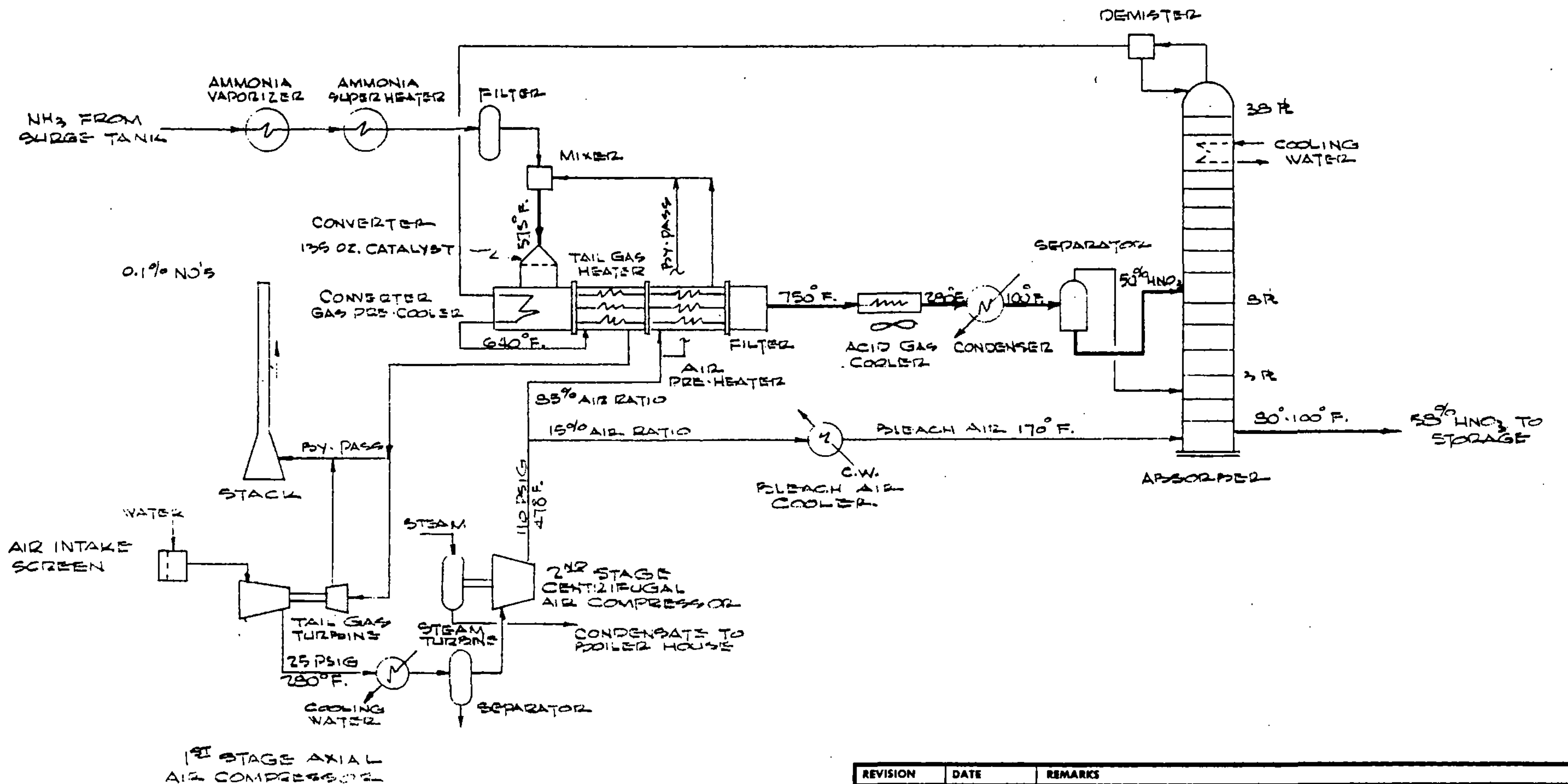


REVISION	DATE	REMARKS

ISSUE	APPROVED	DATE

CAROLINA NITROGEN CORPORATION
WILMINGTON, NORTH CAROLINA
SIMPLIFIED FLOW DIAGRAM
COMPRESSION · SYNTHESIS · STORAGE
NCI AMMONIA PLANT
BEARS PORT MAINE

DRAWN BY	DATE	SCALE		
WILLARD	9/23/65	#		FIG. 11



REVISION	DATE	REMARKS

ISSUE	APPROVED	DATE

CAROLINA NITROGEN CORPORATION

WILMINGTON, NORTH CAROLINA

SIMPLIFIED FLOW DIAGRAM
NCI NITRIC ACID PLANT
SEARSPORT, MAINE

DRAWN BY	DATE	SCALE		
WILLARD	9/23/65			FIG. 12

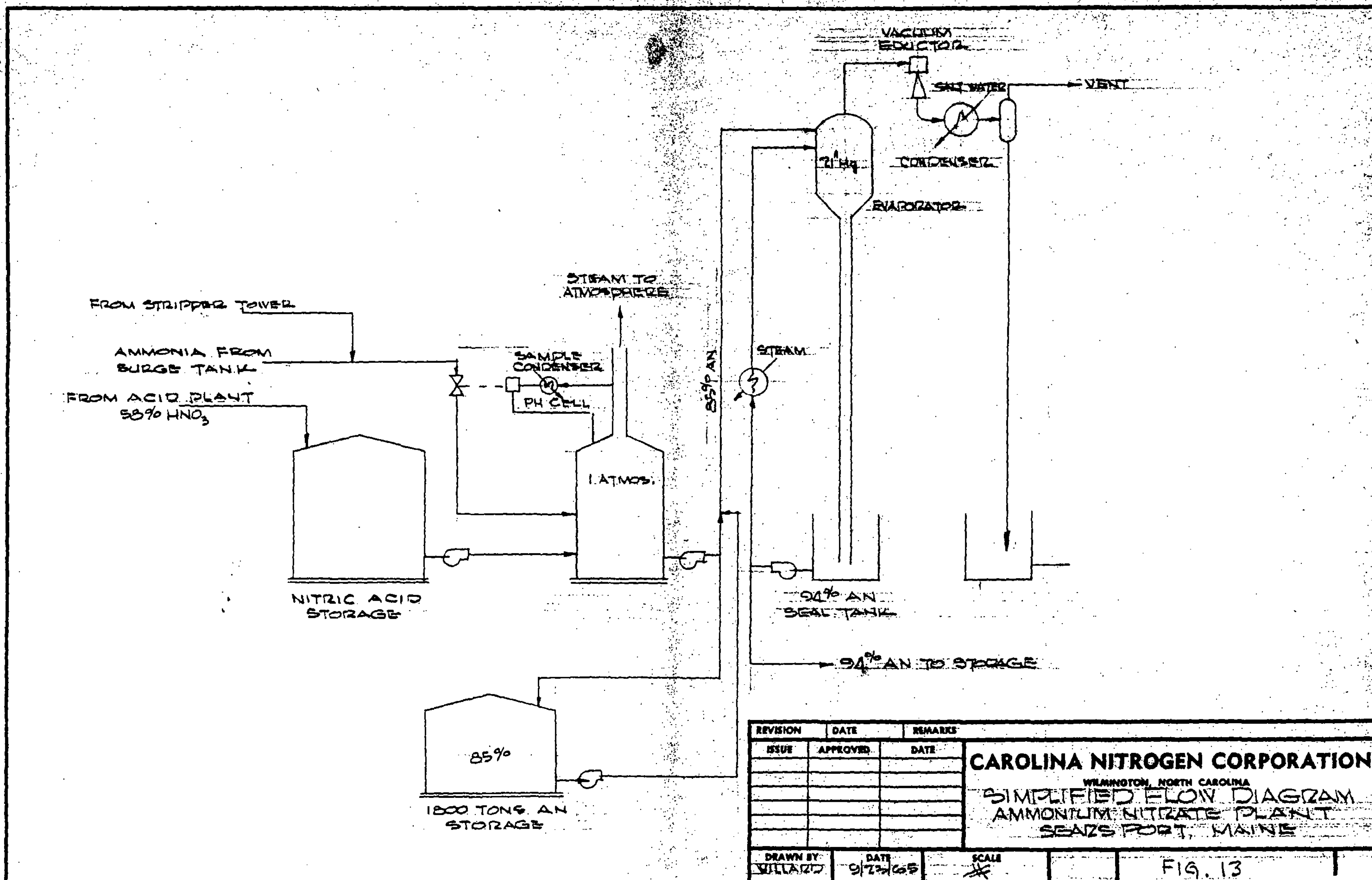
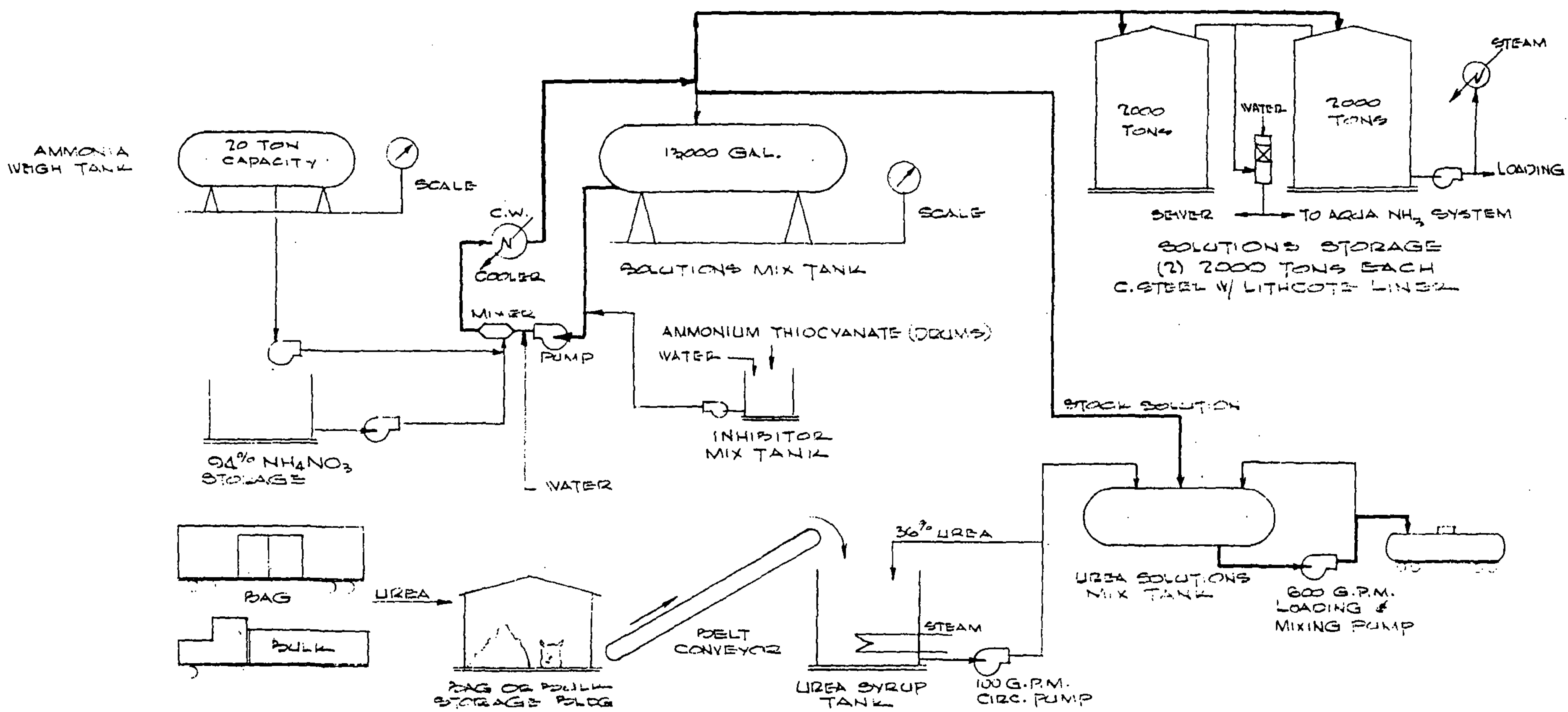

VACUUM EDUCTOR
SALT WATER
VENT
CONDENSER
21" Hg
EVAPORATOR
STEAM TO ATMOSPHERE
FROM STRIPPER TOWER
AMMONIA FROM SURGE TANK
SAMPLE CONDENSER
PH CELL
FROM ACID PLANT 58% HNO_3
85% AN
STEAM
1 ATMOS.
NITRIC ACID STORAGE
94% AN SEAL TANK
94% AN TO STORAGE
85%
1800 TONS AN STORAGE
REVISION
DATE
REMARKS
ISSUE
APPROVED
DATE
CAROLINA NITROGEN CORPORATION
WILMINGTON, NORTH CAROLINA
SIMPLIFIED FLOW DIAGRAM
AMMONIUM NITRATE PLANT
SEARS PORT, MAINE
DRAWN BY
WILLARD
DATE
9/23/65
SCALE

FIG. 13

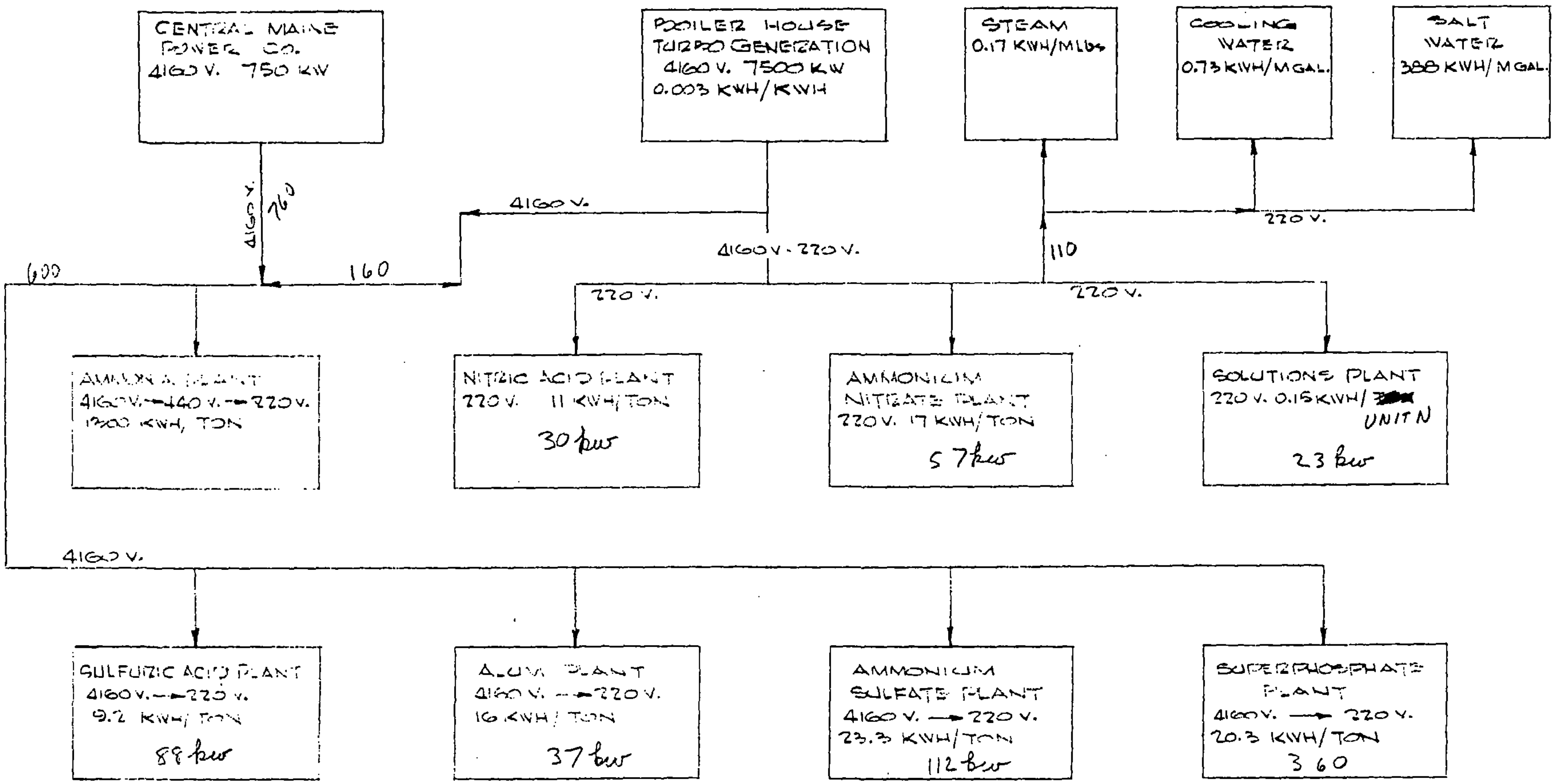


REVISION	DATE	REMARKS

ISSUE	APPROVED	DATE

CAROLINA NITROGEN CORPORATION
WILMINGTON, NORTH CAROLINA
SIMPLIFIED FLOW DIAGRAM
NCI SOLUTIONS PLANT
SEARS POINT, MAINE

DRAWN BY	DATE	SCALE	
WILLARD	9/22/65	#	FIG. 14



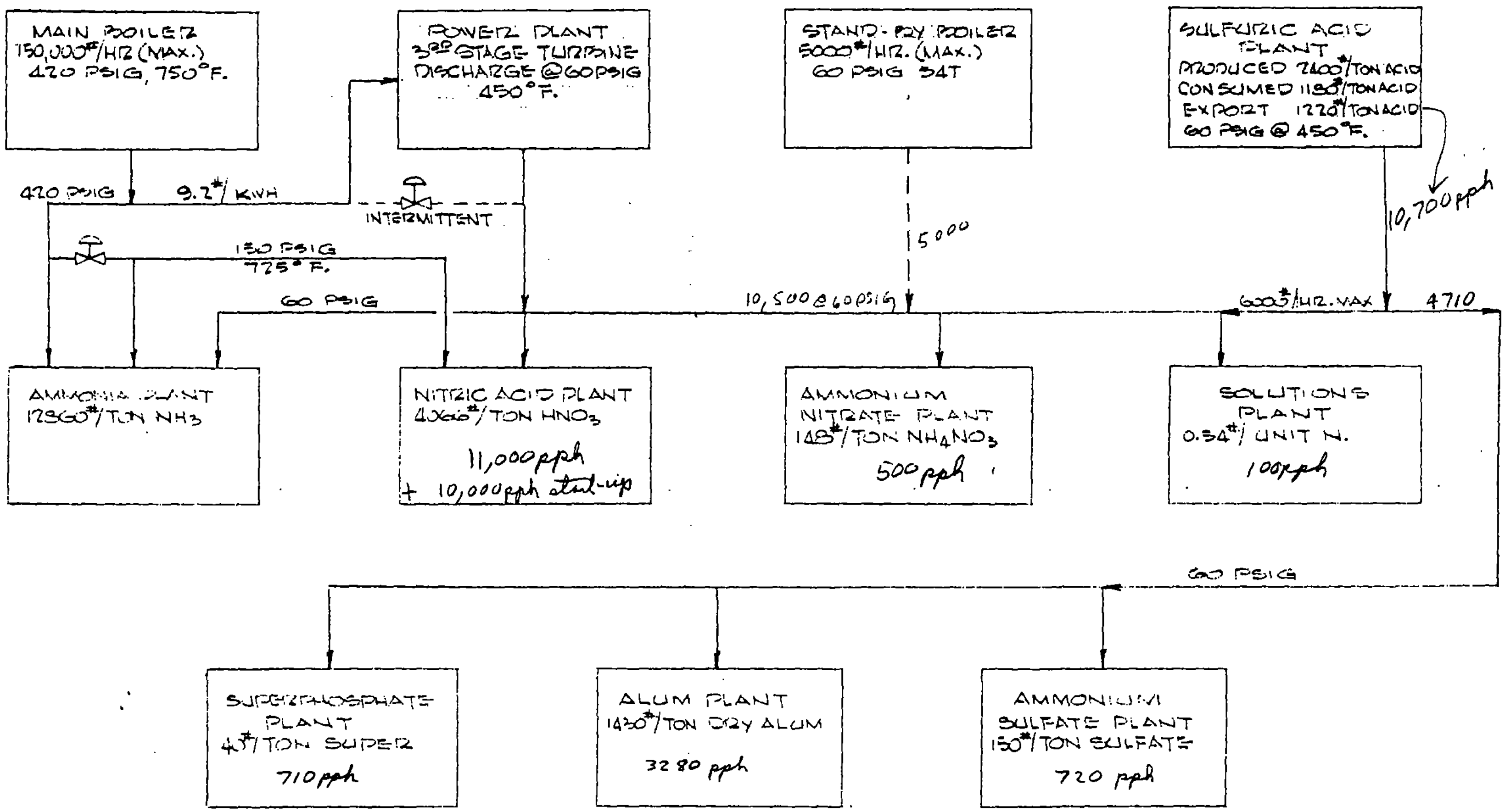
REVISION	DATE	REMARKS

ISSUE	APPROVED	DATE

CAROLINA NITROGEN CORPORATION
WILMINGTON, NORTH CAROLINA

POWER DISTRIBUTION
NCI PLANT
SEARS PORT, MAINE

DRAWN BY	DATE	SCALE		
WILLARD	9/28/65	✕		FIGURE 15



REVISION	DATE	REMARKS

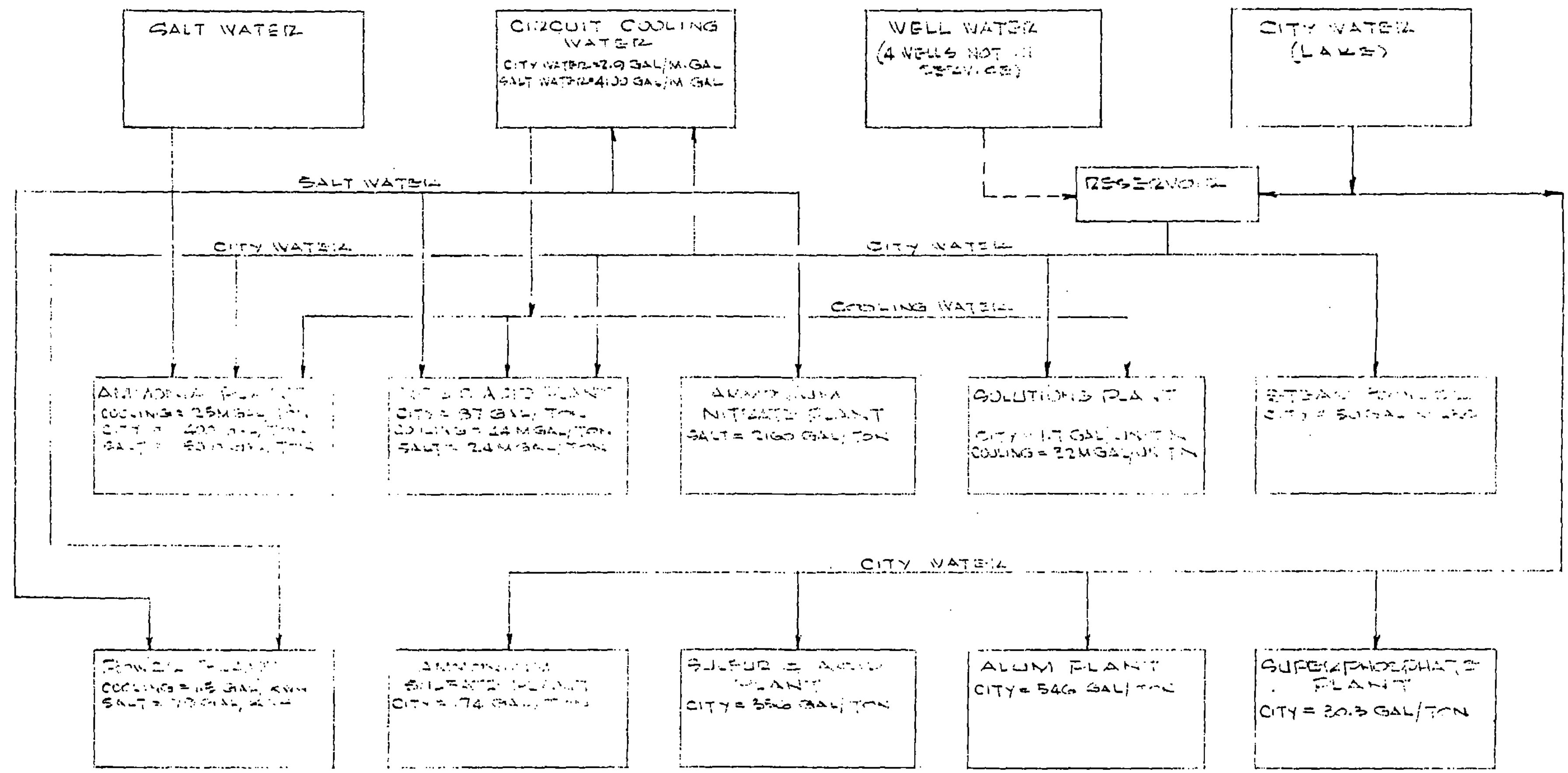
ISSUE	APPROVED	DATE

CAROLINA NITROGEN CORPORATION

WILMINGTON, NORTH CAROLINA

STEAM DISTRIBUTION
NCI PLANT
SEARS PORT, MAINE

DRAWN BY	DATE	SCALE	
WILLARD	9/28/65		FIG. 16



REVISION	DATE	REMARKS

ISSUE	APPROVED	DATE

CAROLINA NITROGEN CORPORATION

WILMINGTON, NORTH CAROLINA

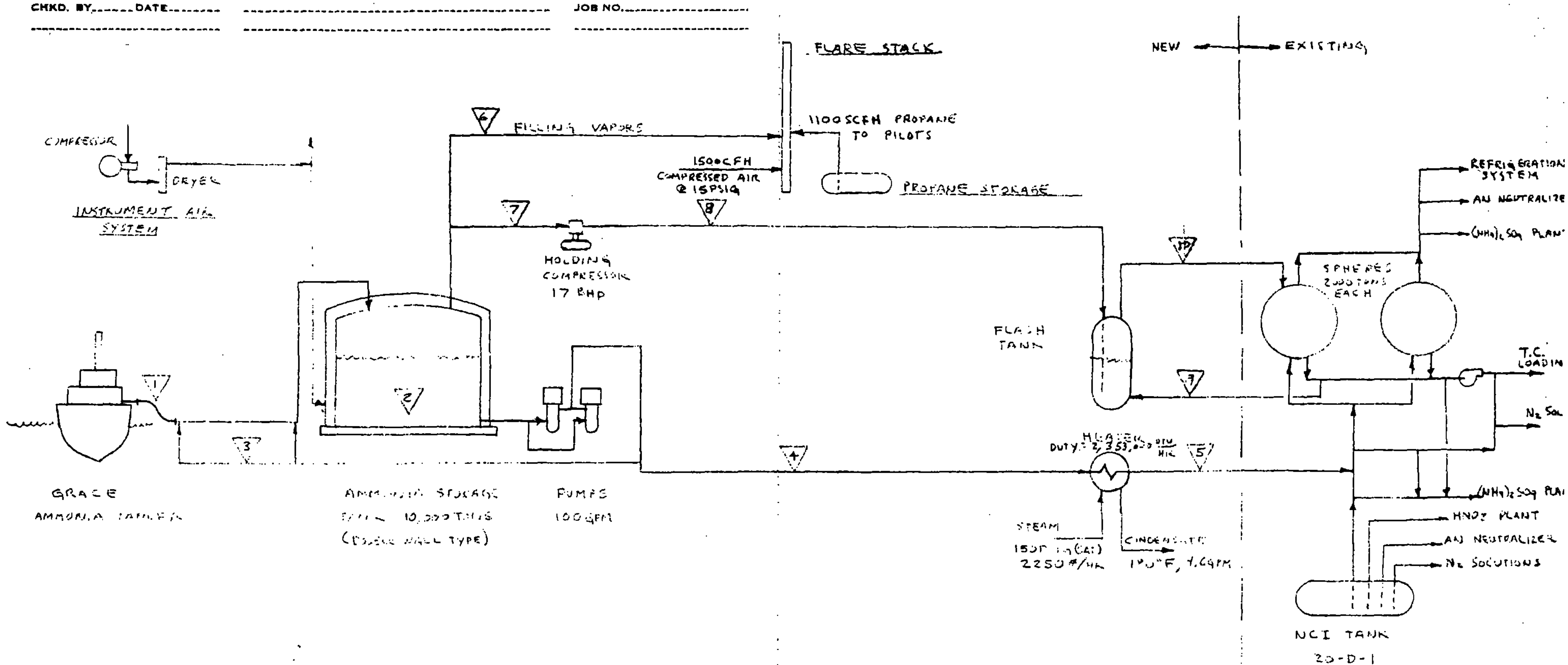
WATER DISTRIBUTION
NCI PLANT
SEARSPORT, MAINE

DRAWN BY	DATE	SCALE
WILLARD	9/29/65	#

FIG. 17

BY............ DATE........ SUBJECT.................................... SHEET NO........ OF......

CHKD. BY....... DATE........ JOB NO...........................



STREAM No.	1	2	3	4	5	6	7	8	9	10
NH_3, LBS/HR	1,125,000	1,125,000	50	34,200	34,200	3297	358	358	56	414
PSIA	120	15.2	120	150	140	15.2	15.2	70.7	70.4	70.4
°F	-26.5	-26.5	-26.5	-26.5	38	-26.5	-26.5	183	38	38

NEW ⟷ EXISTING

CAROLINA NITROGEN CORP.

10,000 TON AMMONIA TERMINAL

PROCESS FLOW DIAGRAM

SEARSPORT ME

FIGURE-18