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PLAINTIFF'S EXHIBIT

UC-3565

GENERAL ENGINEERING STUDY

UCNC PIPE PROJECT

UCN 74

PART III
ASBESTOS-CEMENT PIPE

BY

K. W. LENTZ

JANUARY 12, 1962

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UNION CARBIDE NUCLEAR COMPANY
TUCKAHOE, N. Y.

Engineering Department
Union Carbide Nuclear Company
Division of Union Carbide Corporation
New York, New York

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dry and add water later. The prepared slurry flows to cylinder vats which have paddle agitators to prevent settling of the slurry. The horizontal cylinders are covered with fine mesh wire screen and are operated at a speed which deposits a film of stock .02 to .10 inches thick on its surface. This film of stock is transferred to a continuous felt belt which carries it to the accumulator roll.

The ratio of asbestos and cement in the stock slurry for pipe is approximately 15-20% asbestos and 85-80% cement and silica. A No. 5 grade crysotile fiber is used. A recent trend is to add some blue asbestos fiber to the mix to achieve greater pipe strength. Silica flour is also being added to the mix in plants utilizing the steam autoclave for rapid curing. A reaction between the silica and the calcium oxide in the cement forms "Tobermorite," a long filament-like crystal which adds strength to the pipe.

Mazza Process

The Mazza Process is the most important commercial process. The basic difference between the Mazza machine and other wet processing machinery is its width and a mandrel which replaces the accumulator roll. Mandrels vary in diameter from 5 to 250 inches. The large mandrels are mounted in pairs, one on each side of the machine so that while wrapping on one mandrel, the previously wrapped pipe may be withdrawn from the other mandrel. Because of the stock loading method of this machine, a higher density asbestos-cement product is obtained.

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Magnani Process

This process requires the lowest capital investment and utilizes a pasty mix of stock rather than a slurry. The mix flows by gravity to the mandrel which is an evacuated hollow steel tube. A backer roller maintains pressure on the stock as it is layered on the mandrel to the desired thickness. The mandrel and asbestos-cement pipe is then removed for further dewatering and pressure roll treatment before the pipe is finally withdrawn from the mandrel.

Dalmine Process

This process utilizes a narrow wet mechanical machine having a width of approximately 50 inches. An evacuated hollow tube mandrel is substituted for the accumulator roll and angled to the axis of the wet machine so the stock can be wrapped on the mandrel in spiral form. Thus, by moving any size mandrel back and forth before the wet machine, a pipe much longer than the machine width may be formed.

Hiamanit Process

This process can be used for the manufacture of concrete and reinforced concrete pipe, as well as asbestos-cement pipes. Its distinctive characteristic is the use of a roller process consisting of a system of rollers over which a cloth belt is run. The pipe mandrel is perforated and covered with fabric to prevent the cement mixtures from entering the perforations when vacuum is applied to the mandrel. A quantity of thick stock sufficient for the required length and thickness

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of the pipe is spread on the cloth belt as a flat sheet. The pipe is formed immediately by the rolling operation. It is compressed by a pressure roller as the water is removed through the mandrel and from the outside surface through the cloth belt. When rolling is completed, the core is replaced with an auxiliary core which remains in the pipe until it sets.

In the United States, Johns-Manville Corporation has been a growing producer of asbestos-cement products, especially pressure pipe which is sold under their trade name "Transite." To examine in detail the economics of an asbestos-cement pipe plant, information was collected on their newest plant.

II. JOHNS-MANVILLE ASBESTOS-CEMENT PIPE PLANT

Plant Description

The most recent plant built in the United States for asbestos-cement pipe manufacture is owned and operated by Johns-Manville at Dennison, Texas. It was constructed by the Austin Company of Cleveland, Ohio at a reported cost of $10 million.* The plant is situated on a 469-acre site on the banks of the Red River, which separates Texas from Oklahoma. It adjoins the 1,300 mile man-made Lake Texoma, the ninth largest water reservoir in the world.

The plant consists of five one-story steel, concrete, and corrugated Transite buildings on a 469-acre tract. All the production equipment and process layouts were designed by the Johns-Manville general engineering department to performance specifications of the pipe division. The new plant utilizes the latest

*Note: This information was acquired by the UCC Purchasing Dept.

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production techniques based on manufacturing experience dating back to 1904 when Johns-Manville first introduced asbestos-cement Transite in flat sheet form and from 1929 when Transite was first fabricated in tubular shape.

The main plant building covers four acres. It provides more than 186,000 sq. ft. of manufacturing and warehousing floor space. (See Figure 1). The structure is of peak-roof, single-story design with reinforced concrete foundations and floor slab. The frame is of structural steel.

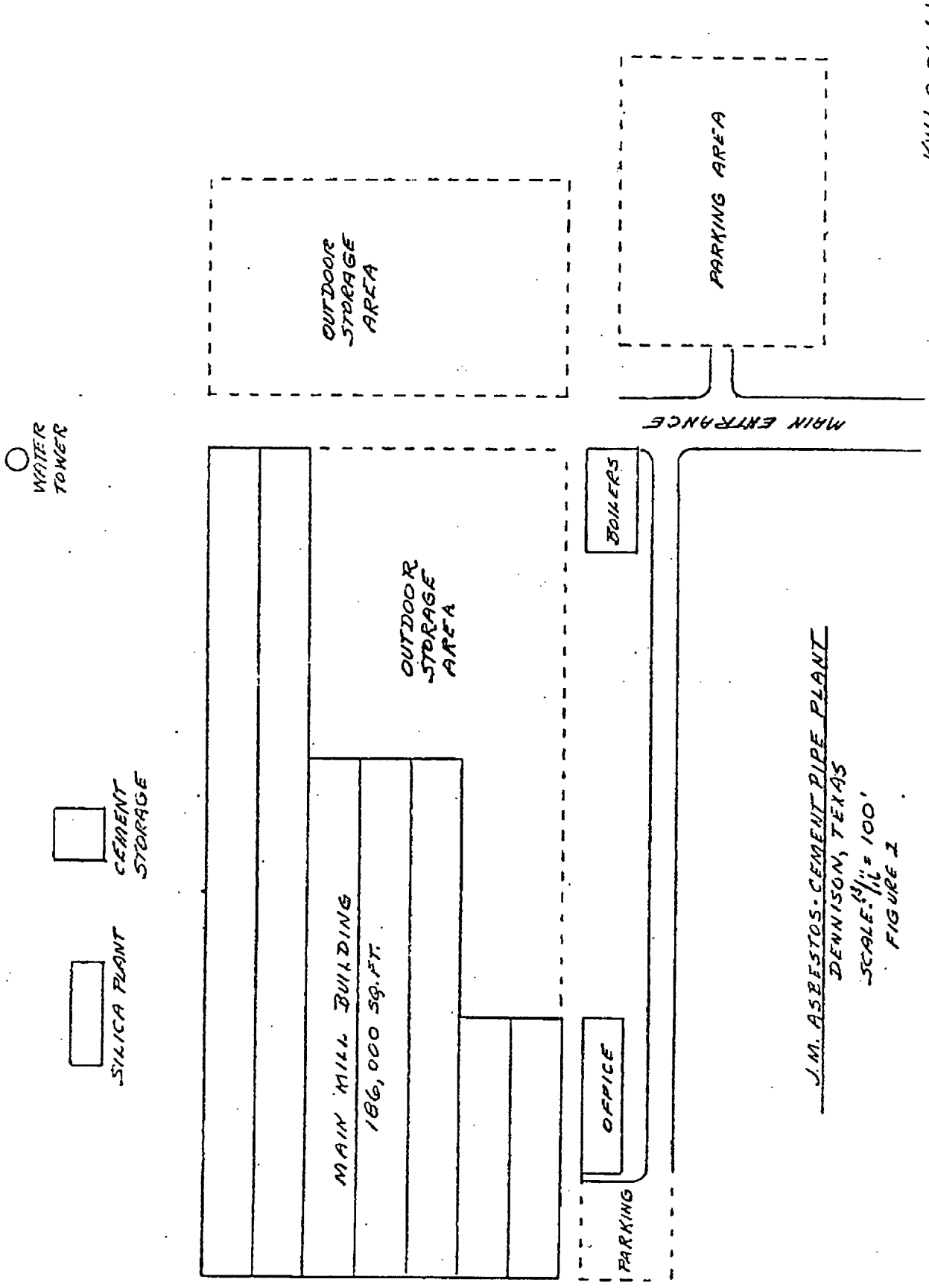
The roof is of J-M corrugated Transite with built-in translucent corrugated sections permitting direct outdoor lighting. The feature is carried into the wall construction which contains wide translucent sheets that make daylight operations possible inside the plant.

An area of 26,400 sq. ft. has been set aside in the main plant building for storage of raw materials - asbestos fibre, cement, and silica. A concrete slab and asphalt paved storage area of 185,000 sq. ft. is assigned outside the plant building for the storage of finished pipe products. Heating and ventilation is provided by unit heaters and roof vents placed strategically throughout the plant to equalize heating in the winter and air-cooling in the summer. Outside temperatures average 43° in January and 84° in July, with a mean annual temperature of 65°.

The main fuel source of the plant is natural gas supplied by a Texas Power and Light Company pipeline. Natural gas is used to fire the plant boilers and the sand-drying unit in the silica grinding operations. Oil stored on the plant property in a 10,000 gallon tank provides an emergency fuel supply.

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Compressed air is supplied by two 100-hp Worthington reciprocating air-compressors, delivering 650 cu. ft. at 100 lb./sq. in. with distribution through a 4-in. pipeline. The air is used to operate the Fuller-Kinyon conveying system and the pneumatic units of the production equipment, as a booster to the gas flame in the plant boilers, and in the silica grinding unit.

Steam at the new plant is generated by two Union Iron Works MH-type package boilers delivering 30,000 lb. per hour at 150 p.s.i. Steam is used in the pipe-curing facilities and heating units.

Process water required for the plant is supplied from the Red River through a pumping station. Most process water is pumped directly into the manufacturing system. In addition, a small amount of water is drawn to a 50,000-gallon watersphere where it can be served into the manufacturing process or sprinkler system by gravity flow. Domestic water is supplied by an artesian well drilled on the plant property.

Raw Material Preparation

In the design of the plant, special consideration was given to the problems of handling and processing large amounts of bulk materials. The extent of mechanization of these functions is such that virtually no manual handling is involved. Instead, ingredients are transported by a system of belts, chutes, and pneumatic conveyors from receiving points, through intermediate processes, to automatic weighing and mixing equipment where final batches are prepared.

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One of the ingredients, silica, is prepared from sand in a special griding building at the plant. There, sand from incoming trucks and railroad cars is dumped into a receiving bin. From the bin, the sand is fed to a bucket elevator supplying a surge tank. Discharge from the surge tank is to a gas-heated dryer which automatically deposits dry sand in a 200-ton storage hopper.

From dry storage, the sand feeds out to a ball mill where it is ground into "silex," a finely divided silica. Finished "silex" is then conveyed pneumatically to a classifier screen where the proper production size is accepted and fed to a 200-ton storage bin. From this bin, the "silex" is conveyed pneumatically to two 80-ton process storage bins to await movement into production.

Cement arriving either by hopper truck or railway hopper car is unloaded by gravity into bins. From these temporary storage areas, the cement is conveyed pneumatically into four 80-ton process storage tanks.

Asbestos fiber in various grades obtained from Canada, Africa, and Australia arrives at the plant in freight cars and is moved to storage by fork lift trucks. When required, the fiber is moved to a processing area where it is weighed, blended, and willowed. In willowing, the blended asbestos fiber is fluffed and mixed thoroughly. From the willow, the fiber is transported pneumatically to production storage bins.

Pipe Forming

Two pipe forming lines; one for production of pipes 10 feet long, and the other for sections 13 feet long, are installed in

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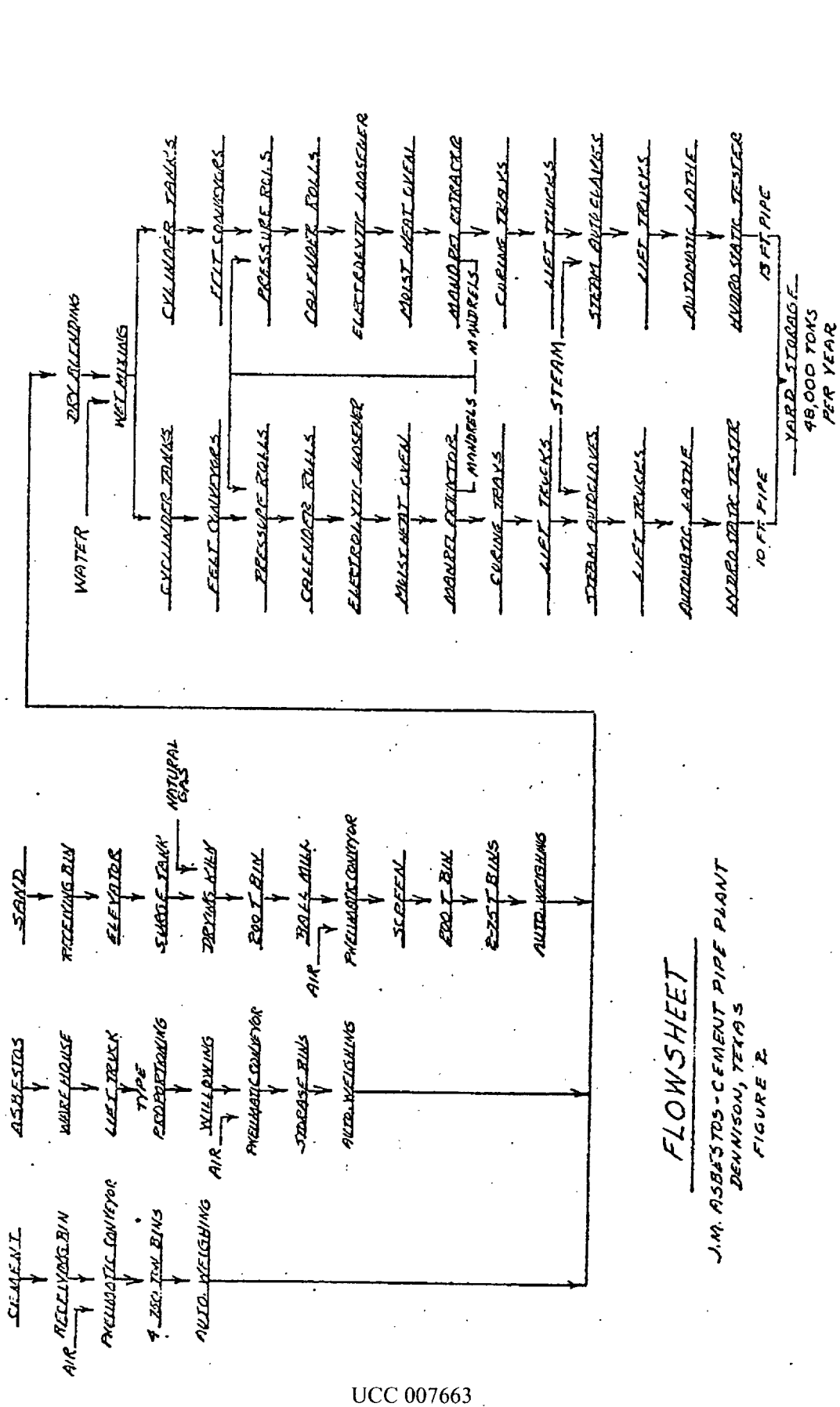
the plant. Each line includes facilities such as those illustrated in the flow diagram, Figure 2. In operation, prepared raw materials are drawn from the storage tanks, weighed, and mixed to form a wet asbestos-cement-silex mixture. The mixture is then fed to a tank at the input end of a pipe forming machine.

In the continuous pipe forming machine the wet mixture in the tank, in the form of a slurry, is transferred by a revolving drum onto an endless felt band. The material on the band is carried over vacuum chambers which remove excess moisture, and the resulting continuous sheet is carried beneath a pair of press sections. To form a pipe, one of the press sections is actuated. This places a steel mandrel in position over the sheet and lowers the press section onto the mandrel. As the mandrel rotates, the sheet builds up on the mandrel and a pipe is formed.

With two press sections to a machine, pipes can be formed rapidly. This is accomplished by forming successive pipes in alternate press sections. Each press section may be set up for a different size pipe, or pipes of the same size may be produced in both press sections.

Mandrels and pipes discharged from the pipe forming machine next move to a calendering station and then to an electrolytic loosener. In the loosener, a direct electrical current is passed between the outside of each pipe and its mandrel by means of a line of conducting rollers that contact the outside diameter of the pipe along its length. The mandrel is grounded during this operation. Resulting flow of high amperage current through the pipe wall loosens the pipe from its mandrel without causing excessive temperature rise or distortion of the pipe.

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FLOWSHEET

J.M. ASBESTOS-CEMENT PIPE PLANT
DENNISON, TEXAS
FIGURE 2

KWL 9-25-61

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Mandrels and loosened pipes pass, still assembled, through a moist heat oven and then to a mandrel extractor where the pipes and mandrels are separated. Mandrels are returned to the pipe forming machine on a conveyor, and the pipes are stacked in curing trays.

Curing and Finishing

After the pipes in the trays have undergone a short air curing period, the pipes and trays are placed in steam curing tanks. Under action of high pressure steam, the silica in the pipes unites chemically with the free lime in the cement and converts it into stable calcium silicates. This action improves the strength and corrosion resistance of the pipes.

From steam curing, the pipes are moved to a finishing area where the pipe ends are machined for fittings. In this operation, automatic lathes are used. Following machining, the pipes are moved to a hydrostatic test stand, where they are subjected to test pressures equal to three and one-half times their working pressures. After visual and dimensional inspection operations have been performed on them, the pipes are moved to an outdoor storage area for further air curing and shipping.

Capacity of the plant is 48,000 tons of asbestos-cement pipe per year. Pipes range in size from 2-inch diameter by 10-feet long, weighing about ten pounds, to 16-inch diameter by 13-feet long, weighing about 1,100 pounds each. With the production methods employed in the new plant, output is about 30 per cent higher than that attainable with previous methods. Product quality and uniformity have also been improved substantially, and ordering intervals shortened for customers in the southwestern states served by the plant.

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General

The following information was acquired verbally from Mr. M. V. Friedlander of the Consolidated Atlas Cement Division of the United States Steel Company. Mr. Friedlander has been working in the asbestos-cement field for twenty-three years, is Chairman of the A.S.T.M. Standards Committee for asbestos-cement pipe, and has an intimate knowledge of the Johns-Manville, Dennison, Texas plant.

Lengths of pipe which fail during the hydraulic testing are cut into shorter lengths and retested. This breakage during testing causes 20% of the total plant production to be random-length pipe. The plant also suffers a loss in each pipe failure which amounts to twice the diameter of the pipe which fails during testing. For this reason, they do not like to produce large diameter asbestos-cement pipe since the failure of a 36" section results in a complete loss.

Information indicates that the personnel required to run such a plant would be approximately 180 people, since it is known that a plant operating three machines had 250 employees and another plant operating one machine had 130 employees. A large number of employees are utilized in the quality control department.

The major operating difficulties apparently are due to each production shift feeling that they are better versed in the art of making good asbestos pipe than the preceding shift. As a result, machine settings and mix changes are apparently common from shift to shift resulting in variations in finished pipe.

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The major maintenance problems are involved in keeping all of the roller bearings of the pressure rolls in exact alignment.

The normal mix for the pipe material is:

50% Cement
20% Asbestos Fiber
30% Silica

The amount of blue African fiber mixed with Canadian fiber depends upon the product being produced. The high-pressure pipe contains a larger percentage of African fiber, whereas some of the thin-wall duct apparently contains none. Not all Canadian fiber is suitable for making pressure pipe. Johns-Manville uses fiber from their Munro mine in Canada.

Mr. Friedlander also indicated that the plant was highly automated and that most of the old manual labor handling of the pipe has been eliminated. The plant usually operates 24 hours a day, 7 days a week, but apparently is cut to two shifts when business is bad. All finished product is warehoused at the plant and orders filled directly from the plant warehouse. The large sales volume sizes of pressure pipe are six and eight inch diameter.

Processing Cost

Processing costs have been estimated on a monthly basis, producing 4,000 tons of asbestos-cement pipe.

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Direct Materials			
Power	1,255,000 KWH	@ .01	$ 12,550
Gas	60,600 MCF	@ 0.16	9,696
Cement	2,000 T	@ 18.40	36,800
Sand	1,200 T	@ 1.65	1,980
Asbestos	800 T	@ 150.00	120,000
SUB TOTAL			$181,026
Direct Labor			
93 Men @ $420/mo.			$ 39,000
Indirect Labor			
87 Men @ $460/mo.			$ 40,000
TOTAL LABOR			
180 Men @ $440/mo.			$ 79,000
Indirect Materials			
$40,000 (Ind. Lab.) x 2			$ 80,000
Expense			
40% of $159,000 (Lab. & Mat'ls.)			$ 64,000
TOTAL MONTHLY PLANT COST			$404,026
Distribution Costs			
5% of Gross Sales $0.095/# Asbestos-Cement Pipe x .05 x 4,000 Tons x 2,000 #/T =			$ 38,000
Home Office Overhead			
3% of Gross Sales $760,000 x .03 =			$ 22,800
Product Freight Cost			
3% of Gross Sales $760,000 x .03 =			$ 22,800

No account was taken for African blue asbestos in the Direct Materials estimate, since it is added in varying amounts to the pressure pipe and not added to ducts and tubes. The asbestos used

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was considered to be Canadian #5 at the lowest quoted price of $120.00 per ton, plus $30.00 per ton freight delivered to Texas. Cement and sand prices were taken from the August 10, 1961 issue of Engineer News-Record for the Texas area.

Johns-Manville quotes only delivered prices on transite pipe; therefore, a freight allowance of 3% of gross sales was included as a cost.

Plant Economics

These economics are based on a reported *$48,000 ton per year production of asbestos-cement pipe sold at an average price for all sizes of $0.095** per pound. All cost estimates are based on this production level.

	MM$	$/Lb.of Pipe	$/Ft. of 6" Pipe (130 P.I.S.Press. 15.3 Lbs./Ft.)
Fixed Investment	10.0		
Working Capital	2.3		
Total Investment	12.3		
Sales	9.12	0.095	1.45
Direct Mat'ls.	2.17	0.023	0.35
Labor	0.95	0.0099	0.15
Ind. Mat'ls.	0.96	0.01	0.15
Expense	0.77	0.008	0.12
Plant Cost Total	4.85	0.051	0.78
Distribution Cost	0.46	0.0048	0.07
Product Freight Cost	0.27	0.0028	0.04
Home Office Overhead	0.27	0.0028	0.04
Total Costs	5.85	0.061	0.93
Operating Income	3.27	0.034	0.52
Depreciation	0.67	.007	0.11
Net Before Tax	2.60	.027	0.41
R. O. I.	26%		
N. P. V. (15-Year)	8.418		

*Making Asbestos-Cement Pipe, Automation, October 1960.
**Average per pound sale price for asbestos-cement pipe disclosed by market analysis by J. A. Connors.

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The above cost figures give an annual operating cost of $5,856,000 or $2,928,000 for one-half this production.

Mr. Friedlander quoted an annual operating cost of $2,980,000 for a one machine plant, from an actual engineering estimate. This provides a very close check and adds to the validity of the costs estimated above.

Capital Estimate
A One "Pipe Machine" Asbestos-Cement Pipe Plant

Land		$ 80,000 *
Buildings		700,000 *
Roads		20,000 *
R.R. Sidings		24,000 *
Storage Area		28,000 *
Power Sub Station		44,000 *
Fire Protection		22,000 *
Sewer and Treatment		22,000 *
Storm Sewer		12,000 *
Water Service		9,000 *
Process Sewers		10,000 *
Equipment		1,978,300 *
Equipment Installation		2,472,875
	Total	5,422,175
	Engineering 15%	813,325
	Total	6,235,500
	Contingency 15%	935,300
	Grand Total	7,170,800

Two "Machine" Plant - $7,000,000 x $(2)^{0.6}$ = $10,600,000
(Reported Cost of the Dennison, Texas Plant)

*Furnished by Mr. Friedlander from an actual engineering estimate.

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Equipment Estimate *

Quantity	Description	Cost
1	Fork Lift Truck 4,000 lbs.	$ 5,000
1	Fiber Mixer	19,000
1	Fiberizer	13,000
2	Fiber Bins	29,000
1	Dust Collector and Ductwork	25,200
1	Bulk Handling System - Silica and Cement	134,000
1	Elevator to Mixers	8,000
1	Double Mixer	19,000
1	Pipe Machine - 4" to 16" Dia. 13' length pipe and auxiliaries	218,000
400	Steel Mandrels 4" to 16" incl.	29,500
1	Mandrel Loosening Equipment	12,600
1	Mandrel Pulling and Return Equipment	39,400
1	Mandrel Sandblasting Machine	12,000
1	Fiber Recovery System from Scrap	51,500
3	Save-All Tanks	20,500
1	Shower Water Tank	6,600
2	Shower Water Pumps	9,200
1	White Water Pump	4,200
1	Dorr Thickener and Pumps	27,300
96	Pipe Autoclave Trucks	88,500
12	Coupling Autoclave Trucks	6,300
3	Autoclaves 7'6" x 150'0"	236,000
2	Platform Lift Trucks 20,000 lbs.	52,500
2	Pipe Lathes 4" to 16"	122,000
2	Flex Testing Machines	11,000
2	Hydrostatic Testing Machines	59,000
1	Random Length Saw	14,100
1	Finishing Lathe Overall Length	9,400
1	Coupling Cut Off Machine	14,700
1	Coupling Lathe 4" to 8"	21,000
1	Coupling Lathe 6" to 16"	22,000
1	Coupling Hydrostatic Testing Machine	17,000
1	Fork Lift Truck 4,000 lbs.	5,000
2	Overhead Cranes (5 Tons)	37,800
1	Dump Truck Scrap	8,400
1	Dust Collecting System Finishing Department	60,000
	Machine Shop Equipment	52,500
	Spare Parts	27,300
2	20,000 lbs. Boilers and Auxiliaries	189,000
	Quality Control Equipment	12,600
1	Air Compressor	10,000
	Process Piping	85,000
	Power Wiring	92,400
	Piping Steam	20,800
	Piping Air	10,400
	Piping Service Water	10,000
		$1,978,300

*Furnished by Mr. Friedlander from an actual engineering estimate.

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5. U. S. Patent No. 2,929,447, Method for the Continuous Manufacture of Asbestos-Cement Pipes, Robert Fourmanoit, Genoa, Italy, assigned to Johns-Manville Corporation.

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