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Definition of Scale Model Slurry Mixing/Distribution Facility

May 1978

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Prepared For
U.S. Department of Energy
Assistant Secretary For Energy Technology
Division of Power Systems

Under Contract No. EX-77-C-01-2637

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Washington, D.C. 20545

Prepared By
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DEFINITION OF SCALE MODEL
SLURRY MIXING/DISTRIBUTION FACILITY

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I. INTRODUCTION

The United States Department of Energy (DOE), formerly the Energy Research and Development Administration (ERDA), desires to develop a coal-in-oil slurry combustion concept for demonstration in the industrial and utility sectors. Commensurate with this objective, this document is intended to present a definition of a scale model representing a slurry mixing/distribution facility.

Motivation for the DOE Coal-Oil Slurry Program resulted from: dwindling domestic oil and natural gas supplies, an abundant national reserve of coal, advanced coal conversion systems not being available in the near future, and the potential for utilization of coal-oil slurry fuel systems in the near future. Thus, coal-oil slurry systems can extend the nation's fuel supplies and possibly provide emergency preparedness in the event of an embargo.

The 1/8" = 1'-0" scale model described herein depicts a mock commercial coal-in-oil slurry mixing and distribution type plant. The model represents a suggested facility for the optimization and marketing of a stable coal-oil slurry to multiple users under a single specification. The raw materials are assumed to be coal, fuel oil and a stabilizer additive to keep the slurry in suspension during transit and storage. The model reflects a method for handling coal using railroad cars which are bottom dumped to a below grade track hopper, weighed and transported to a stockpile by belt conveyors. Stockpile reclaim is accomplished by a front-end loader and the coal is conveyed to the fuel preparation building. There it is pulverized and mixed with fuel oil and a stabilizer. The slurry produced is then tank stored to await shipment to the user by railroad tank car or truck.

The plant sizing and model construction was conceived to provide a portable model unit with carrying case and all necessary hardware for one to two man cartage. The primary intent of the scale model was to provide a "showcase sales tool," representing one possible scheme for a coal-oil mixture manufacturing and distribution facility.

II. PLANT AND MODEL DESIGN BASIS

A. Scope of Engineering Effort

The conceptual design drawings, attached under Section V, were developed using the following basic guidelines:

1. The selection and sizing of the process equipment was made for a mock commercial facility capable of supplying 64,000 gallons/day of a coal-oilmixture of a 50 percent by weight coal concentration.
2. The flow sheet and general arrangement drawings were developed sufficiently to ensure a proper material flow and balance and a workable and practical plant layout with adequate plant equipment detail to allow modeling.
3. In general, only major material handling equipment, process equipment and major structures were developed.
4. The mock commercial plant includes facilities for:
 - a. Receipt of the Raw Materials - coal, fuel oil and a stabilizer received via railroad and/or truck.
 - b. Raw Material Storage - exposed coal stockpile; fuel oil vertical tank storage; stabilizer horizontal tank storage.
 - c. Raw Material Reclaiming Systems - coal reclaimed by front-end loader, fuel oil by pumping and stabilizer by pumping.
 - d. Coal Grinding and Slurry Mixing
 - e. Product Storage - vertical tanks prior to shipment to the user.

- f. COM Loadout - station was provided for railroad tank car or truck loading along with associated pumping systems.

B. Model Guidelines

Due to the model scale size (1/8" = 1'-0"), plant design and modeling efforts were restricted to basic material handling and process flow. The model reflects all major process equipment, main transport piping with pumps, as well as major support structures and buildings. Some landscaping was also included. The model was designed and supplied with carrying case and all necessary hardware for one to two man handling.

Auxiliary and support systems such as dust collection, dust suppression fire protection, compressed air system, underground, etc. were disregarded. However, facilities such as an office, control room, locker room and a motor control center are shown on the model.

III. PROCESS DESCRIPTION

A. Material Flow (refer to Flow Diagram SK92177-1)

1. Incoming Raw Material Handling

Run-of-mine coal is received in 100 ton bottom dump railroad cars #100. Nine cars per week would be required to supply the 24 hr/day operating plant. The cars are dumped, one at a time, over the underground track hopper #103. The car unloading is assisted by the use of the overhead car shaker and car spotting is accomplished by the use of the capstan type car puller. The track hopper will also accommodate truck unloading. The coal is removed from the track hopper by two vibrating pan feeders, each at a rate of 75 tph, which discharge to the 24" wide belt conveyor #105. The coal is weighed in transit to the stockpile by the belt scale #106 mounted on conveyor #105. The 24" rail mounted radial stacker conveyor #107 delivers the coal at a rate of 150 tph to the stockpile. At full capacity, the stockpile is 15 ft high and has sufficient storage for 14 days of plant operation. As an alternate, the radial stacker may be positioned to by-pass the stockpile and deliver incoming coal directly for processing by way of the reclaim hopper #109.

No. 6 fuel oil is received by railroad tank car or tank truck and pumped to the two fuel oil storage tanks #134, which together contain a one week operational supply. Pumping to the tanks is accomplished at the rate of 120 gpm.

The stabilizer additive required for the process is delivered by truck and is pumped to storage tank #124, which has a capacity of about 2200 gallons. This capacity is sufficient to supply the plant operations for about one week.

2. Fuel Preparation System

Slurry production is initiated by reclaiming coal using the 6 cubic yard front-end loader #108, which discharges to the reclaim hopper #109. Vibrating feeder #110, under the reclaim hopper, discharges onto the inclined 36" flexible sidewall conveyor #112. The metal detector #111, mounted over the flexible sidewall conveyor, is intended to stop the conveyor in the event of tramp metal contaminants, to allow manual removal. Conveyor #112 was selected to load the raw coal storage bin #114 at a rate of 150 tph. The coal is weighed as it is metered out of the bin at a controlled rate of 5 tph, utilizing the 18" belt weigh feeder #116. The weigh feeder conveys the coal to one of two coal pulverizers (bowl mills), accomplished through a diverter type chute with a "flop" gate. As designed, only one pulverizer is to be on-line, while the other is on stand-by. This will allow plant operation while one mill is shutdown for maintenance. The function of the mills is to pulverize the coal to about 80 percent less than 200 mesh.

Each coal pulverizer has a rated capacity of 13,600 lbs/hr. The pressure through the mill is generated by the mill fan #119. This air flow carries the coal upwards through the mill to the air separator #120. As the coal particles are transported upwards by the air stream, the larger and heavier particles fall back into the mill to be further reduced in size. The coal particles transported to the air separator will drop into the hopper portion of the air separator. Some very fine airborne coal particles will be transported back to the pulverizer along with the recycled air, by way of the mill fan.

The rotary valve #121 feeds pulverized coal from the air separator to the weigh auger #122, which delivers 5 tph to the mix tank #126, for mixing with the other raw process materials.

The #6 fuel oil is pumped from either of the oil storage tanks #134 to the mix tank at a rate of 45 gpm using either of the fuel oil pumps #135. Simultaneously, the additive is pumped from the additive storage tank #124 to the mix tank at a rate of 60 gpm (0.5% of total mix assumed) using pump #125. The mixing is then accomplished by using an agitator, powered by a variable speed drive. As mixing is completed, the stable slurry is pumped from the mix tank to either of the two slurry storage tanks #128.

Slurry pumping to storage tanks is provided at a rate of 45 gpm using either one of the slurry pumps #127. The slurry product storage capacity is about 64,500 gallons per tank or a storage of one day's plant production each. Both of the slurry storage tanks are equipped with an agitator.

3. Product Loadout

The coal oil mixture is loaded into railroad tank cars or trucks. An operator's platform has been appropriately provided for pumping slurry product using pump #130 at a rate of 120 gpm from the slurry tanks #128.

4. Process Design Summary

a. Raw Material Requirements

Coal - 5 tons/hr, 120 tons/day

#6 fuel oil - 1177 gal/hr, 28,250 gal/day, 673 barrels/day*

Additive - 30 gal/hr, 720 gal/day, 17 barrels/day*

b. Product Yield

COM - 2700 gal/hr, 64,000 gal/day, 1524 barrels/day*

* 42 gallons = 1 barrel

B. Operational Requirements

It is estimated that the plant process and material flow would require the following operating schedule and manpower:

1. Incoming Raw Material Handling

The incoming coal and additive materials would require two operators on a single 8-hour shift per week. The #6 fuel oil receiving would be accomplished on a three 8-hour shift per week basis. The men required in this area could also serve in the product loadout area, as required.

2. Fuel Preparation

Coal grinding and mixing activities would be on a continuous basis, three shifts per day, handled by one operator each shift.

3. Product Loadout

It is judged that the operating function in this area could be accomplished during one 8-hour shift per day, 5 days per week, by the same two operators handling incoming raw materials.

IV. MAJOR EQUIPMENT LIST

PROJECT: DEFINITION OF MODEL - SLURRY MIXING/DISTRIBUTION FACILITY

ITEM NO.	NO. REQ'D.	DESCRIPTION	EQUIPMENT DATA
100	9/wk	Railroad cars	100 ton; bottom dump
101	1	Car puller	10,000 lb pull capstan type; 10 hp
102	1	Car shaker	5 hp shaker with 7 1/2 hp motorized lift of 10,000 lb capacity
103	1	Track hopper	125 ton capacity
104	2	Vibrating feeder	Size 18" x 5'-0"; 3/4 hp each; 75 tph each
105	1	Belt conveyor	24" belt; 15 hp; 150 tph
106	1	Belt scale	In transit weighing of incoming coal
107	1	Radial stacker conveyor	24" belt; rail mounted; power travel; belt speed = 250 fpm; conveyor hp = 7 1/2
108	1	Front-end loader	6 cubic yard capacity
109	1	Reclaim hopper	About 9 cubic yard capacity (6 tons)
110	1	Vibrating feeder	Size 24" x 5'-0"; 1 hp; 150 tph
111	1	Metal detector	To stop conveyor to allow tramp metal removal
112	1	Conveyor	36" wide belt with flexible sidewalls and cleats to allow steep incline; speed = 200 fpm; 15 hp
113	1	Baghouse dust collector	Bags discharge to bin (collector not selected)
114	1	Raw coal storage bin	18 ft diameter; cone bottom; 120 ton capacity
115	1	Slide gate	Mechanical gear type; used for feeder maintenance
116	1	Weigh feeder	18" belt; 3 hp; - 1 1/2% accuracy by weight
117	1	Diverter chute	Allows feed to either coal pulverizer - gate manually operated
118	2	Coal pulverizer (1 operating and 1 standby)	Capacity = 13,600 lb/hr bowl mill; 150 hp
119	1	Mill fan	75,000 scfm; 75 hp
120	1	Air separator	Cyclone type

IV. MAJOR EQUIPMENT LIST (CONT'D.)

PROJECT: DEFINITION OF MODEL - SLURRY MIXING/DISTRIBUTION FACILITY

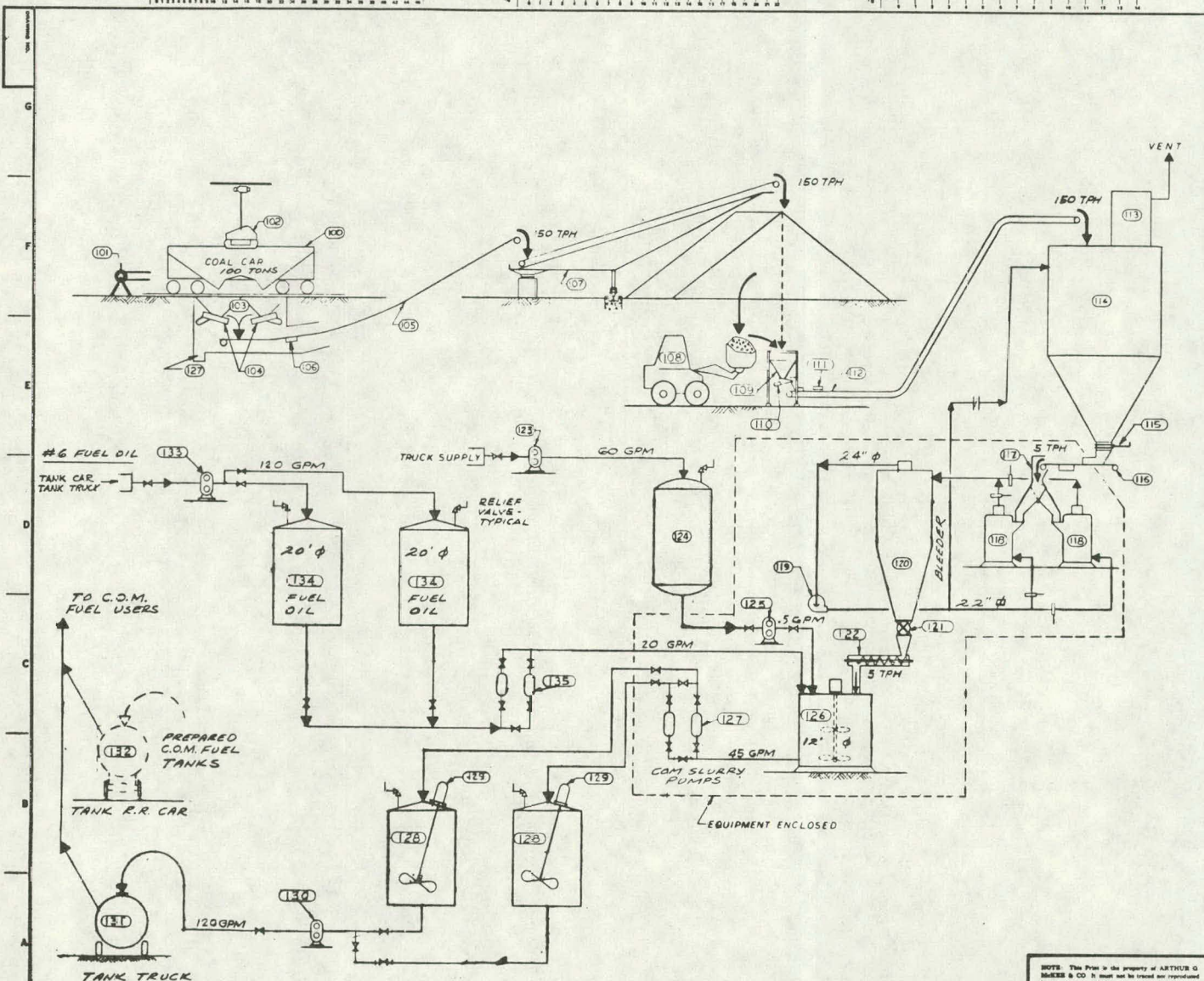
ITEM NO.	NO. REQ'D.	DESCRIPTION	EQUIPMENT DATA
121	1	Rotary valve	1 hp, 8" diameter
122	1	Weigh auger	5 tph; prefeeder hp = 3/4; conveyor hp = 1/4; + 1/2% accuracy
123	1	Additive unloading pump	60 gpm
124	1	Additive storage tank	10 ft diameter x 20 ft long; about 2200 gallons capacity; about one week's supply at 0.5% by weight of total mix
125	1	Additive feed pump	0.5 gpm
126	1	Mix tank	12 ft diameter x 11 ft high with 3 hp agitator for mixing pulverized coal, #6 fuel oil and additive; 9200 gallon capacity
127	2	COM slurry pump (1 operating and 1 standby)	45 gpm
128	2	COM slurry storage tank	64,500 gallons each; one day's plant production each; 20 ft diameter x 30 ft high
129	2	COM agitator	50 hp each
130	1	COM pump	120 gpm
131		Tank truck	
132		Railroad tank car	
133	1	Fuel oil storage pump	120 gpm
134	2	Fuel oil tanks	100,000 gallons each; two tanks = approximately one week of plant needs
135	2	Fuel oil feed pumps (1 operating and 1 standby)	20 gpm

NOTE: All capacities shown above are process flow rates required and do not reflect equipment rated capacities.

V. CONCEPTUAL DRAWINGS

Listed below are the General Arrangement Drawings and Material Flow Diagram developed for the subject model facility and they are included in this section.

<u>Drawing No.</u>	<u>Title</u>
SK 92177-1	Material Flow
SK 92177-2	Plan of Plant
SK 92177-3	Sections
SK 92177-4	Sections



EQUIPMENT LIST		
ITEM NO.	QTY.	DESCRIPTION
100	2	100T CAP CARS
101	1	CAR PULLER
102	1	CAR SHAKER
103	1	TRACK HOPPER
104	2	VIBRATING FEEDER
105	1	24" BELT CONVEYOR
106	1	WEIGH SCALE
107	1	RADIAL STACKER
108	1	FRONT LOADER
109	1	RECLAIM HOPPER
110	1	VIBRATING FEEDER
111	1	METAL DETECTORS
112	1	FLEXOWALL CONV.
113	1	BAG HSE DUST COLL.
114	1	RAW COAL STORAGE
115	1	SLIDE GATE
116	1	WEIGH FEEDER
117	1	DIVERTER CHUTE
118	2	COAL PULVERIZER
119	1	MILL FAN
120	1	AIR SEPARATOR
121	1	ROTARY VALVE
122	1	WEIGH AUGER
123	1	ADDITIVE UNLOADING PUMP
124	1	ADDITIVE STORAGE TANK
125	1	ADDITIVE FEED PUMP
126	1	MIX TANK
127	2	C.O.M. SLURRY PUMP
128	2	C.O.M. SLURRY STORAGE
129	2	C.O.M. AGITATOR
130	1	C.O.M. PUMP
131	1	TANK TRUCK
132	1	TANK R.R. CAR
133	1	FUEL OIL STORAGE PUMP
134	2	FUEL OIL TANKS
135	2	FUEL OIL FEED PUMPS

NOTE -
THIS FLOW SHEET IS FOR THEORETIC 23.5 MILLION GALLON/YR C.O.M. PROCESS PLANT AND IS TO BE USED FOR MODELING PURPOSES ONLY.

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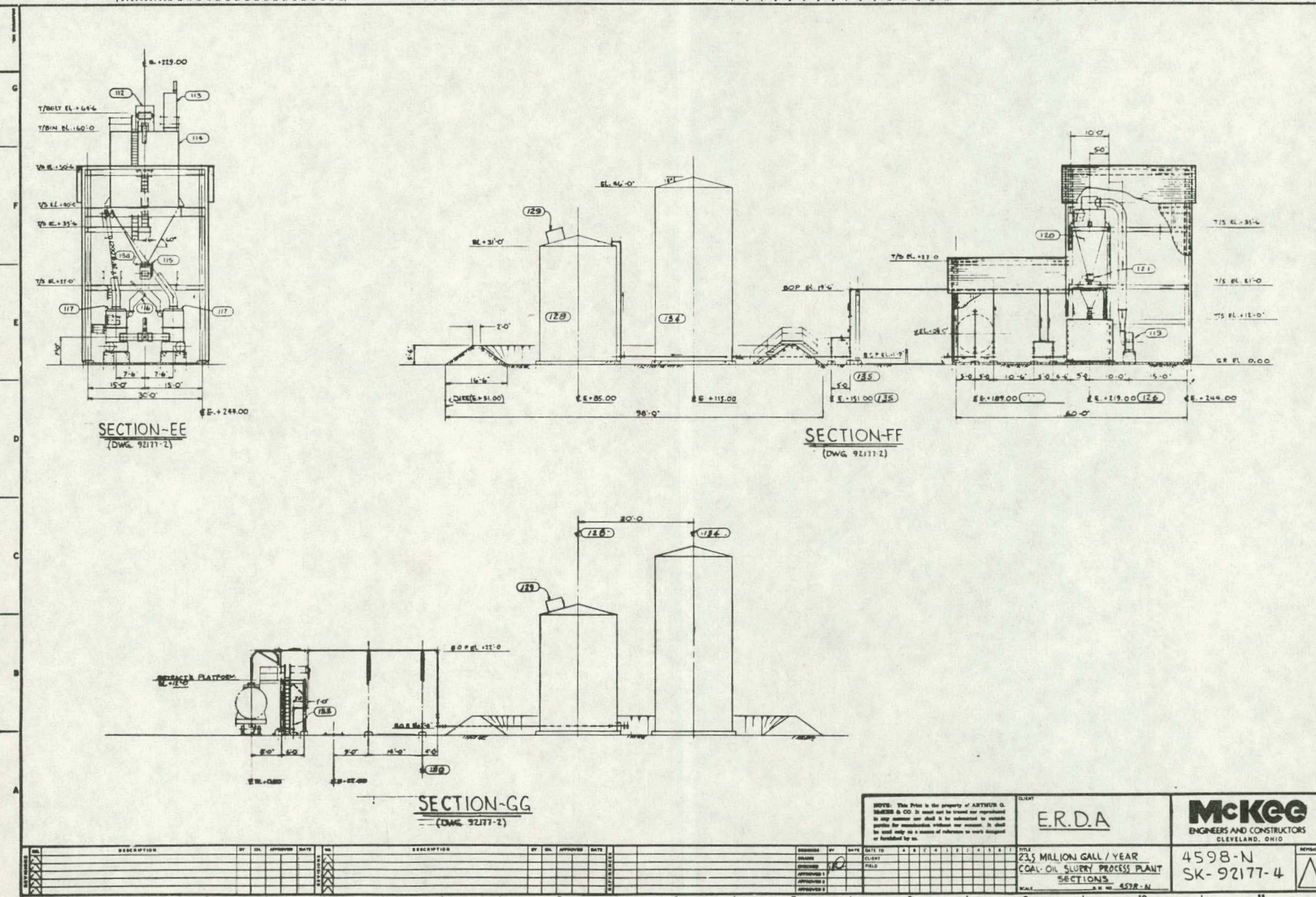
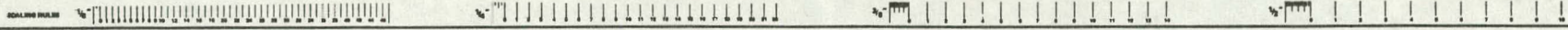
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CLEVELAND, OHIO

TITLE
23.5 MILLION GALLON/YR COAL-OR-SLURRY PROCESS PLANT MATERIAL FLOW

PROJECT NO.
4598-N SK 92177-1

NO.	DESCRIPTION	BY	CHK.	APPROVED	DATE	NO.	DESCRIPTION	BY	CHK.	APPROVED	DATE
1						1					
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23.5 MILLION GALL / YEAR
COAL-OIL SLURRY PROCESS PLANT
SECTIONS
A.R. NO. 4578-N

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SK-92177-4

NO.	DESCRIPTION	BY	CHK.	APPROVED	DATE	NO.	DESCRIPTION	BY	CHK.	APPROVED	DATE	ISSUED	BY	DATE	DATE TO	TITLE											
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