CONCEPTUALIZED FLY-ASH AND SULFUR DIOXIDE SCRUBBING SYSTEM WITH BY-PRODUCT RECOVERY

THE BABCOCK & WILCOX COMPANY
POWER GENERATION DIVISION

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by

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January 29, 1971

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General

Based on the experimental data gathered during this contract, a conceptualized air pollution system was established. The system was designed to remove 99% of the fly-ash and 97 1/2% of the sulfur dioxide contained in an assumed but typical flue gas. A venturi-type scrubber was chosen to remove the fly-ash, and a tray-type absorber was chosen for sulfur dioxide absorption. A slurry of magnesium oxide and magnesium sulfite is the active absorbent. The conceptualized system is shown schematically on Drawing No. 390407B-0. Drawings Nos. P17-96-1X0 and P17-96-2X0 show the side and plan views of scrubbing venturis and sulfur dioxide absorbers as integrated into an 800 MW boiler system. The outline and location of the major pieces of equipment are shown on Drawing No. P17-96-3X0.

The above drawings were utilized to develop the cost of the conceptualized system. Whenever possible, commercially available equipment was utilized in the design and cost estimate. When commercial equipment was not available, suitable conceptual equipment designs were developed, and the cost of the equipment established.

System Description

The system, as conceptualized here, starts at the plenum which collects the flue gas leaving the primary and secondary air heaters. The flue gas passes through the following equipment which is arranged in parallel: four venturi scrubbers, four sulfur dioxide absorbers, four induced fans, and two steam coil gas reheaters. The gas is then discharged through a stack. The entrances to the stack are considered terminal points. The cost of the stack has not been included in the estimate.

The gas entering the venturis is mixed with water which contacts and removes the entrained fly-ash. The resulting fly-ash slurry is transferred to a thickener for separation. The clarified overflow is returned to the venturis for reuse while the underflow is pumped to filters. Here, the fly-ash is washed with fresh water to minimize the amount of soluble sulfur and magnesium compounds that leave the system with the fly-ash. Pumps have been included to sluice the fly-ash to a pond. The discharge of these pumps is the terminal point of the ash system.

The particulate-free flue gas passes to the absorbers where sulfur dioxide is removed by reacting with magnesium sulfite. The resulting magnesium-sulfur compounds are dewatered by thickening and centrifuging. The liquor which is separated from the slurry in the thickener and centrifuges is returned to the absorbers. Magnesium oxide, which results from the regeneration of the magnesium-sulfur compounds, is added to the absorbers to replace the magnesium which reacts with sulfur dioxide and is removed to the thickener as a sulfide. The solid materials leaving the centrifuge are dried and then decomposed to yield magnesium

System Description (Continued)

oxide and a gas stream containing 17.7% sulfur dioxide by weight. The product gas leaving the reactor is cooled and filtered and leaves the system. This gas is suitable for making concentrated sulfuric acid. The cost of the acid plant is not included in this study.

The flow quantities at the terminals described above are listed below:

Gas at Entrance to Fly-Ash Scrubber

Temperature - 300 F

Lb/Hr	SO_2	43,500
Lb/Hr	CO_2	1,386,000
Lb/Hr	O_2	243,000
Lb/Hr	N_2	4,790,000
Lb/Hr	H_2O	392,000
Lb/Hr	Ash	67,200
Total		6,921,700 Lb/Hr

Stack Gas

Temperature - 180 F

Lb/Hr	SO_2	1,090
Lb/Hr	CO_2	1,386,000
Lb/Hr	O_2	243,000
Lb/Hr	N_2	4,790,000
Lb/Hr	H_2O	729,000
Lb/Hr	Ash	670
Total		7,149,760 Lb/Hr

Product Gas

Temperature - 400 F

Lb/Hr	SO_2	40,200
Lb/Hr	CO_2	23,300
Lb/Hr	O_2	20,100
Lb/Hr	N_2	132,500
Lb/Hr	H_2O	11,700
Total		227,800 Lb/Hr

System Description (Continued)

Waste to Ash Pond

Temperature - 128 F

Solids	Lb/Hr	69,720
Water	Lb/Hr	104,580
Total		174,300 Lb/Hr

Equipment Cost Estimates

For estimating purposes, the air pollution control system has been divided into three sections. These sections, the equipment associated with each, and the costs are listed below. Also shown is the cost of erecting the equipment.

Boiler Associated Equipment

- Flue Platework
- Expansion Joints and Dampers
- Venturis (4)
- Sumps (4)
- SO_2 Absorbers (4)
- Ash and Sulfite Collection Tanks (2)
- Foundations
- Structural Steel
- Brickwork, Refractories, Insulation, and Lagging
- Controls
- Electricals
- Valves
- Pumps and Drives (28)
- Mixer
- Steam Coil Gas Reheaters (2)
- Absorber Packing
- Demisters (4)
- I.D. Fans (4)
- I.D. Fan Drives (4)
- Piping and Fittings
- Rubber Lining for Tanks
- Engineering and Drawings

Total Cost for Boiler Associated Equipment $5,835,000

Equipment Cost Estimates (Continued)

Dewatering Equipment

Filtrate Tanks (2)
Foundations
Structural Steel
Brickwork, Refractories, Insulation, and Lagging
Controls
Electricals
Valves
Pumps and Drives (24)
Mixer
Thickeners and Filters (7)
Rubber Lining for Tanks
Piping and Fittings
Engineering and Drawings

Total Cost for Dewatering Equipment	$1,205,000

Regeneration Equipment

Flue Platework
Expansion Joints and Dampers
Heat Exchangers (2)
Reactors (2)
Combustors (2)
Dryers (2)
Holding, Wash, and Storage Tanks (4)
Coal Bunker
Foundations
Building Steel
Structural Steel
Brickwork, Refractories, Insulation, and Lagging
Controls
Electricals
Valves
Pumps and Drives (8)
Mixer
Fans and Blowers (12)
Fan Drives (12)
Conveyors (4)
Cyclones (5)
Centrifuges (4)
Bag Filter Houses
Pug Mills (2)
Rotary Feeders (14)
Engineering and Drawings

Total Cost for Regeneration Equipment	$3,225,000

Equipment Cost Estimates (Continued)

Total Equipment Costs	$10,265,000
Erection Cost	$ 3,398,500
Total Delivered and Erected Cost	$13,663,500

Operating Requirements

The following list of operating utilities has been prepared and is based on the terminal flow quantities listed above and an 800 MW steam generator operating at a levelized load factor of 70% or 6,132 hours per year.

Electrical Power	$\frac{86.1 \times 10^6 \text{ kwhr}}{\text{yr}}$	
Fuel	$\frac{1,281,000 \text{ MkB}}{\text{yr}}$	57.9% coal 42.1% oil
Water	$\frac{303.3 \times 10^6 \text{ gal}}{\text{yr}}$	
Steam	$\frac{131,500 \text{ MkB}}{\text{yr}}$	(added fuel input)
Dolomite	$\frac{5,940,000 \text{ lb}}{\text{yr}}$	

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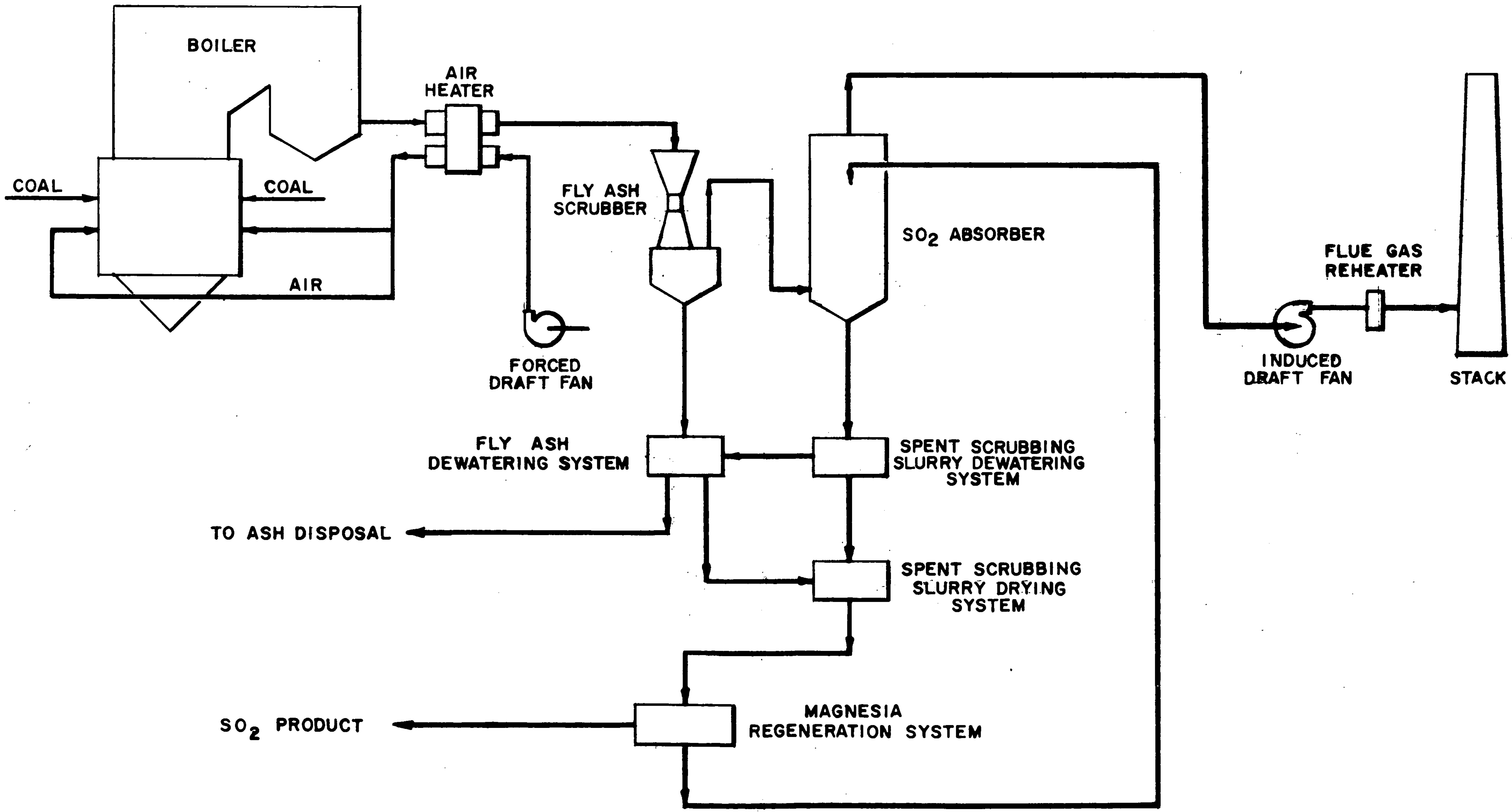
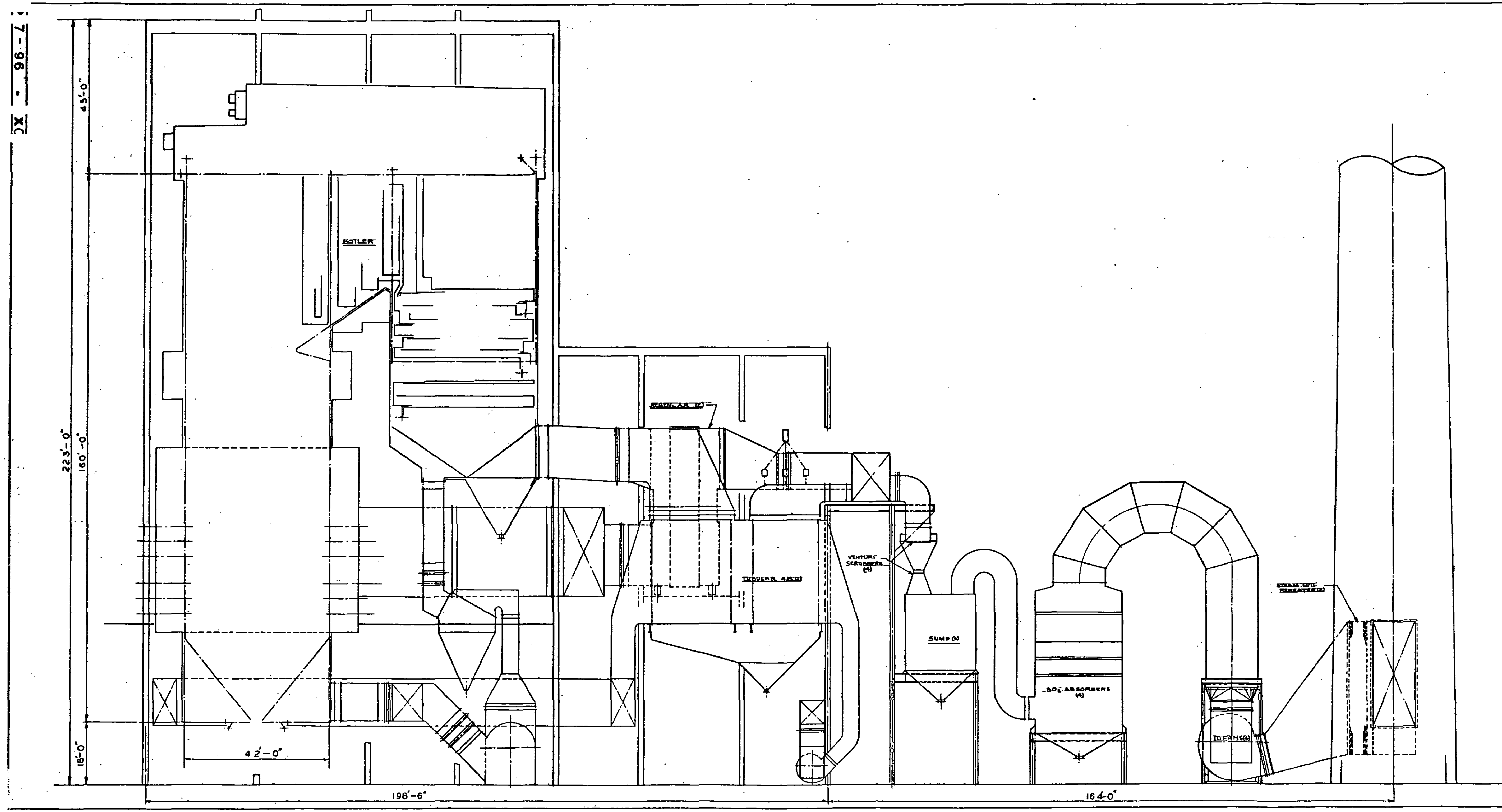
POWER GENERATION DIV.



CONTRACT NO. CPA 22-69-129

FOR NATIONAL AIR POLLUTION CONTROL ADMINISTRATION

DWN. / DATE 5/15/70	CHK'D / APP'D	SCHEMATIC PROCESS DIAGRAM FOR MAGNESIA SLURRY ABSORPTION OF SO2, MAGNESIA REGENERATION AND BY-PRODUCT RECOVERY	SCALE INCHES = 1 FOOT 390407 B-



NOTE: FOR PLAN VIEW SEE DWG. P17-96-2X

FOR

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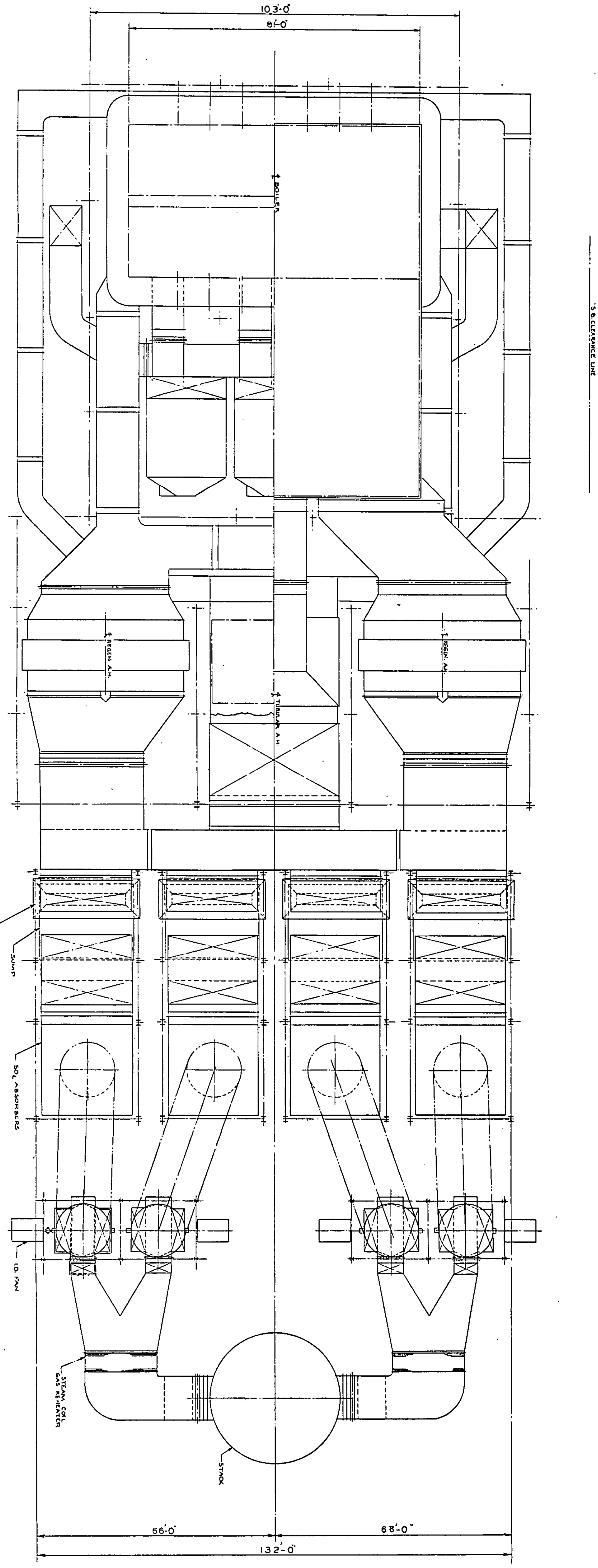
FLY ASH SCRUBBING AND
SO_2 ABSORPTION SYSTEM

P 17 - 96 - 1XO



NOTE: FOR SIDE ELEVATION SEE DWG. P17-96-1X

FOR

P17-96 -2X0

FLY ASH SCRUBBING AND
SO_2 ABSORPTION SYSTEM

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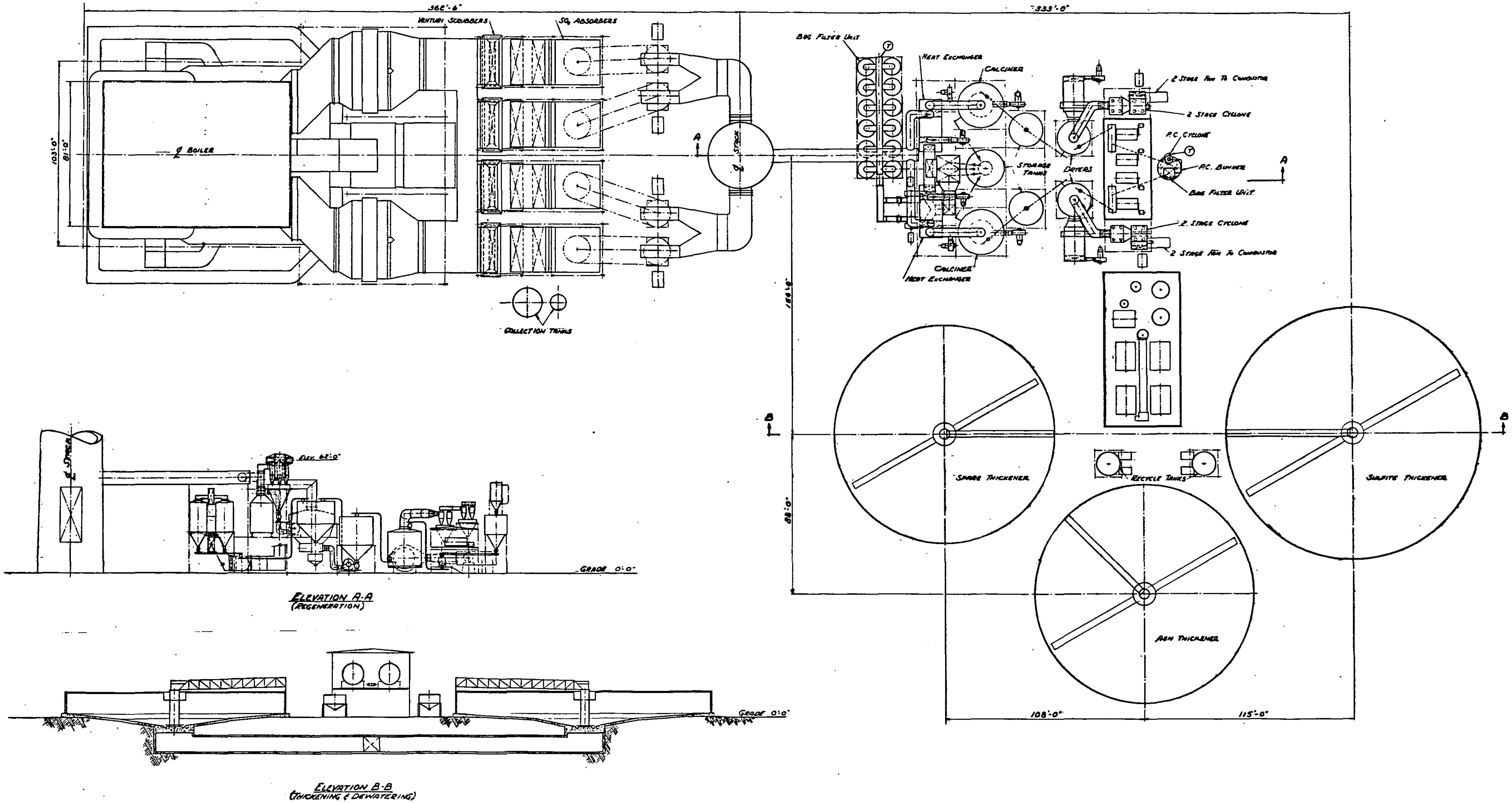

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PLOT PLAN AND ARRANGEMENT
FLY ASH SCRUBBING, SO_2 ABSORPTION,
DEWATERING AND REGENERATION SYSTEMS

CONTRACT NO. CPA 22-69-129
FOR NATIONAL AIR POLLUTION CONTROL ADMINISTRATION

P17-96 - 3X0