GENERAL OFFICE: 155 East 21st Street / P.O. Box 4667 / Jacksonville, Florida 32201 / (904) 355-1781
FLORIDA ROCK INDUSTRIES INC Mining, Ready Mix Concrete, and Construction Products

May 8, 1997

Via Hand Delivered
Mr. A. A. Linero, P.E.
Bureau of Air Regulation
FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Re: Air Permit AC01-26311/PSD-FL-288
Florida Rock Industries, Inc.

Dear Mr. Linero:

The purpose of this letter is to update your files with Florida Rock Industries, Inc.'s commencement of construction under the above-referenced permit. We previously notified you of the ground-breaking ceremony for the cement plant held on March 26, 1997.

Florida Rock Industries, Inc. has entered into binding contractual agreements with two contractors to undertake a program to construct the Portland Cement plant which is subject to the above-referenced permit. One contract was entered into between Florida Rock Industries, Inc. and Polysius Corporation on April 1, 1996, for process engineering and equipment supply, and another contract was entered into between Florida Rock Industries, Inc. and The Hardaway Company/Stone & Webster Engineering Corporation, J.V. on December 9, 1996, for engineering and construction services.

Both contractual agreements were activated by amendments to the original agreements on April 7, 1997. Non-refundable down-payments to both Polysius Corporation and The Hardaway Company/Stone & Webster Engineering Corporation, J.V. pursuant to the contractual agreements with Florida Rock Industries, Inc. were made on April 4, 1997.

In addition, we hereby provide to FDEP, pursuant to Specific Condition 27 of the above-referenced permit, the final construction schedule for the construction of the cement plant. The terms of the contracts with both major suppliers of goods and services for the construction of the cement plant (Polysius Corporation and The Hardaway Company/Stone & Webster Engineering Corporation, J.V.) Call for twenty-four (24) month's construction time. We anticipate

plant start-up to occur in May or June of 1999, provided certain delivery items will arrive on the job site as promised by the suppliers. With the activation of the contracts on April 7, 1997, this is consistent with the 24-month schedule previously discussed with you.

We also hereby provide FDEP with the design and manufacturer's guarantee for Electrostatic Precipitators (ESP's) for the cement plant pursuant to Specific Condition 26 of the above-referenced permit. See enclosed documents from Environmental Elements Corporation of Baltimore, Maryland. These documents were previously submitted to FDEP on March 11, 1996, in a letter from Florida Rock Industries, Inc.'s consultant, John B. Koogler, Ph.D., P.E., to Mr. Howard Rhodes, Director, FDEP, Division of Air Resources Management. Any as-built variations will be consistent and equivalent to these, and will be provided to you as we receive them.

I apologize for the delay in formally providing the attached documents for your files post-permit issuance. I have assumed all along that our previous submittal would have sufficed for Specific Condition 26, but submit these again in an overabundance of caution. If you need any further information, or have any questions concerning this letter of the attached documents, please contact me at 800/874-8382/Ext. 307.

Sincerely,

Fred W. Cohrs

Fred W. Cohrs
Vice President

FWC:bvk

Enclosures/

ENVIRONMENTAL ELEMENTS CORPORATION
ELECTROSTATIC PRECIPITATOR

FOR

POLYSIUS CORPORATION

ATLANTA, GEORGIA

FOR

FLORIDA ROCK

NEWBERRY, FLORIDA

Environmental Elements Corporation
Proposal Number ACS-95-04-15290-R2110E-F-A&B
May 5, 1995

TABLE OF CONTENTS

SECTION 1

PROPOSAL SUMMARY

SECTION 1

1. PROPOSAL SUMMARY

A. DESIGNATION

Throughout this proposal, Polysius Corporation, Atlanta, Georgia 30339 and Environmental Elements Corporation, Baltimore, Maryland 21203, shall be referred to as "Buyer" and "Seller", respectively.

B. TRADEMARKS

Trademarks of Environmental Elements Corporation, Baltimore, Maryland 21203.

ENELCO®
RIGITRODE™
DIGICON®
OPTI-CON II®
MODULOK®
OPTIPULSE™

C. SCOPE – GENERAL

Seller will design, fabricate and deliver F.O.B. jobsite, two single chamber electrostatic precipitator one to clean the flue gases from the cement preheater kiln with roller mill circuit and one to clean the flue gas from the clinker cooler.

D. SCOPE – SELLER

Included in the scope of this proposal as part of Seller's supply are:

1. Two single chamber electrostatic precipitators of the floating bottom design with trough hoppers.

2. A pressurized penthouse covering the entire precipitator hot roof for the housing of the high voltage insulators and bus bars, complete with pressurizing blower and insulator heaters.

3. Electric rapping system for the collecting plates, discharge electrodes and gas distribution plates, complete with solid state microprocessor rapper panel.

4. Transformer-rectifiers with digital microprocessor controllers.

5. Inlet and outlet nozzles.

6. Shop paint as described in the proposal.

7. Structural steel to support the precipitator from grade.

8. Access facilities to scope shown on the drawing.

9. Hopper conveyor and dust valve.

10. High dust level alarm system for the precipitator hoppers.

11. Hopper heaters including thermostats and controls.

12. Motor control center/Power distribution panel.

13. Main breaker.

14. Insulation specifications.

15. A resident Construction Advisor/Superintendent.(Monthly rate)

16. Engineering personnel for mechanical and electrical inspections, precipitator start-up, and training of plant personnel.

17. Six (6) copies of operations and maintenance manuals.

E. SCOPE – BUYER

Under this proposal, it shall be the responsibility of the Buyer to provide and/or complete the following:

1. Required foundations and anchor bolts.

2. All ductwork to and from precipitator, except inlet and outlet nozzles.

3. Inlet test ports with access thereto.

4. Stack with test ports and access thereto.

5. Dust removal system from the screw conveyor dust valve exit.

6. Performance tests.

7. Ventilated control room for rectifier controls.

8. Annunciator panel as required.

9. All interconnecting low voltage wiring.

10. Permanent area lighting.

11. Grounding of all precipitator equipment to mill grounding system.

12. Precipitator and nozzle insulation, insulation supports and lagging.

13. Erection of all materials furnished by Seller.

F. GENERAL ARRANGEMENT

1. Kiln/Mill Precipitator - Proposal Drawing 15290-21110-D-1

ENELCO ESP Model SC 23-16-4x9x36T will be single chamber with 23 gas passages on 16 inch centers. The precipitator will have four mechanical and electrical fields in direction of gas flow. Each mechanical field will contain 24 collecting surfaces, 36 feet high by 9.125 feet long. This provides a total field length of 36.5 feet. Each of the four fields is independently powered.

2. Clinker Cooler - Proposal Drawing 15290-2110-D-2

ENELCO ESP Model SC-19-16-4x9x36T will be single chamber with 19 gas passages on 16 inch centers. The precipitator will have four mechanical and electrical fields in direction of gas flow. Each mechanical field will contain 20 collecting surfaces, 36 feet high by 9.125 feet long. This provides a total field length of 36.5 feet. Each of the four fields is independently powered.

G. DESIGN FEATURES

1. The ENELCO electrostatic precipitator utilizes the RIGITRODE discharge electrode. This is a virtually indestructible rigid mast electrode system.

2. Patented MODULOK collecting surfaces are included providing a factory assembled, rigid, baffled, one piece collecting electrode. Field assembly of collecting electrodes is not required.

3. DIGICON OPTIPULSE microprocessor automatic power controllers provide the latest state-of-the-art precipitator control. These user-friendly controllers are among the most intelligent and responsive voltage controllers available today, and include programmable intermittent energization. In-house construction and testing before shipment insures trouble-free field installations.

4. Top mounted electronic impulse rappers, complete with microprocessor controllers, provides an adjustable, essentially maintenance free, rapper system mounted outside of the gas stream.

5. Rigid frame casing construction with no internal struts or bracing to support dust build-ups or disrupt uniform gas flow. Minimal number of support points to grade for ease of site maintenance.

6. Nozzle and hopper designs incorporate minimum 55° sloped sides and no ledges to impede the flow of collected materials.

H. SCHEDULE

1. Delivery of materials may begin seven to eight months from issuance of purchase order.

2. Erection period will normally extend over a three to four month period dependent on scope of work, weather and labor conditions.

3. For the purposes of this project, delivery of materials will begin on or about April 1996 based on an award of contract or notice to proceed by September 1995.

SECTION 2

DESCRIPTION OF EQUIPMENT

SECTION 2

2. DESCRIPTION OF EQUIPMENT

A. CASING

The precipitator casing is fabricated from 3/16 inch ASTM A-36 steel plate with external columns and stiffeners. The design utilizes rigid frame construction with no internal struts or bracing thus avoiding ledges for dust buildup and disturbance to uniform gas flow. The roof and all internal loads are supported by fabricated plate girders. The design utilizes a "floating bottom" system where the precipitator is anchored at only one point on the support steel. Lubrite sliding plates are provided for the other support points to allow for thermal expansion in all directions.

Seller's shell design allows 4'-5" head room above the top of the dust plates for interior access to perform maintenance or inspection.

Interlocked single wall doors are provided for penthouse roof access. Access to the area above the collecting plates is gained through non-interlocked double wall doors in the precipitator hot roof.

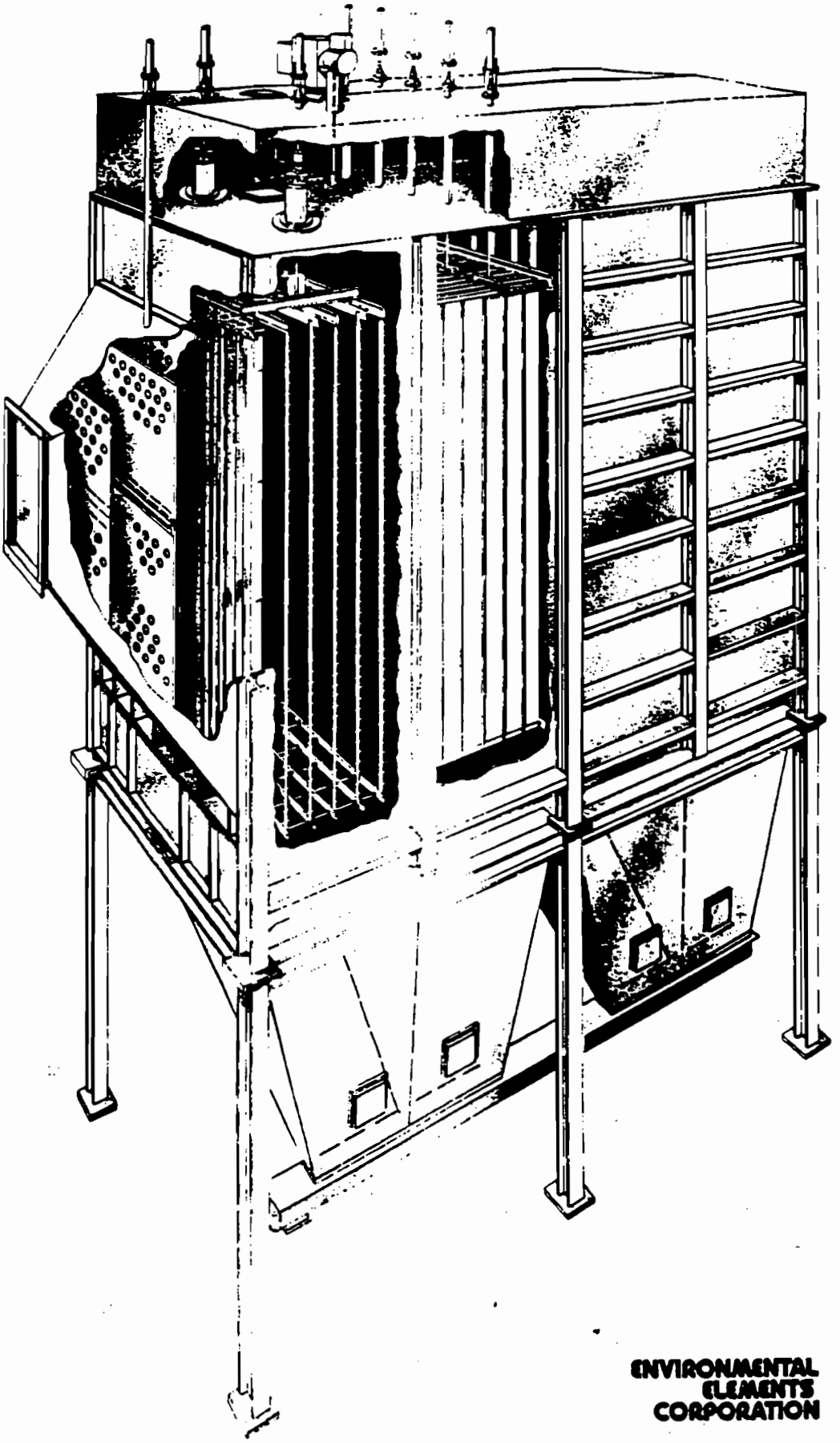
B. NOZZLES

Inlet and outlet nozzles are fabricated from 3/16 inch ASTM A-36 steel with external structural stiffeners of uniform depth to provide full support for insulation and siding. The bottom of the nozzles are sloped 55° with no horizontal ledges to impede free flow of dust fallout inherent with reduction in gas velocity.

The inlet nozzle is complete with three perforated plates to distribute the gas across the face of the treatment zone. The lower 4 inches of the perforated plates are open to allow any dust that falls out in the nozzle to be carried into the inlet field hopper. A double wall, quick-opening, interlocked door is provided in each nozzle for internal inspection and maintenance. Bolted panels are incorporated into the perforated plates for through access.

C. HOPPERS

Trough type hoppers are provided fabricated from 3/16 inch ASTM A-36 steel with external stiffeners of uniform depth to provide support for thermal insulation and siding. The hoppers are designed to support a full dust load. The sides and ends are sloped 60° and 75°, respectively, from the horizontal. The valley angle resulting from this design is 57-1/2°. The between field baffles are extended to the hopper outlet to eliminate gas bypassing in the hoppers. A double wall interlocked door is provided as shown to permit access into each baffled section of each hopper. Each hopper is provided with high level alarms, strike plates for manual hopper rapping, and dust removal system. Hoppers should not be used for storage.



ENVIRONMENTAL
ELEMENTS
CORPORATION

Form 7782

D. HOPPER LEVEL DETECTORS

A Bindicator or equal high level switch is provided for each section of each hopper. This system operates by radio frequency oscillation, which is dampened by a high ash level, producing a proportionate A/C signal. The detector operates a DPDT relay for alarm actuation. The probe is mounted in the side wall of the hopper with the electronics mounted in the hopper area away from high temperatures.

E. DUST REMOVAL SYSTEM

The dust removal system consists of hopper screw conveyor sized to operate at 28 rpm maximum to reduce wear. The hopper conveyor is designed to operate at 30% loading at rated conditions and powered for flooded operation in the event of hopper dust buildup. The conveyor is equipped with a motion detector to initiate a conveyor failure alarm.

To insure positive dust removal a Sprout Bauer, or equal, motor operated rotary dust valve with Type 2 rotor with ni-hard adjustable tips is furnished at the outlet of the hopper conveyor. The dust valve is equipped with a motion detector to initiate a valve failure alarm.

F. PRECIPITATOR SUPPORTING STEEL

Structural steel is provided to support the precipitator as shown on the proposal drawings. All columns, beams, wind bracing and other structural members supplied by Seller for support of the precipitator will be rolled or fabricated from ASTM A-36 steel. Connections will be bolted and the overall structural design will be in accordance with the latest applicable AISC Standard except as noted under Design Conditions. The support steel and bracing is arranged to provide maximum access for maintenance and cleanup.

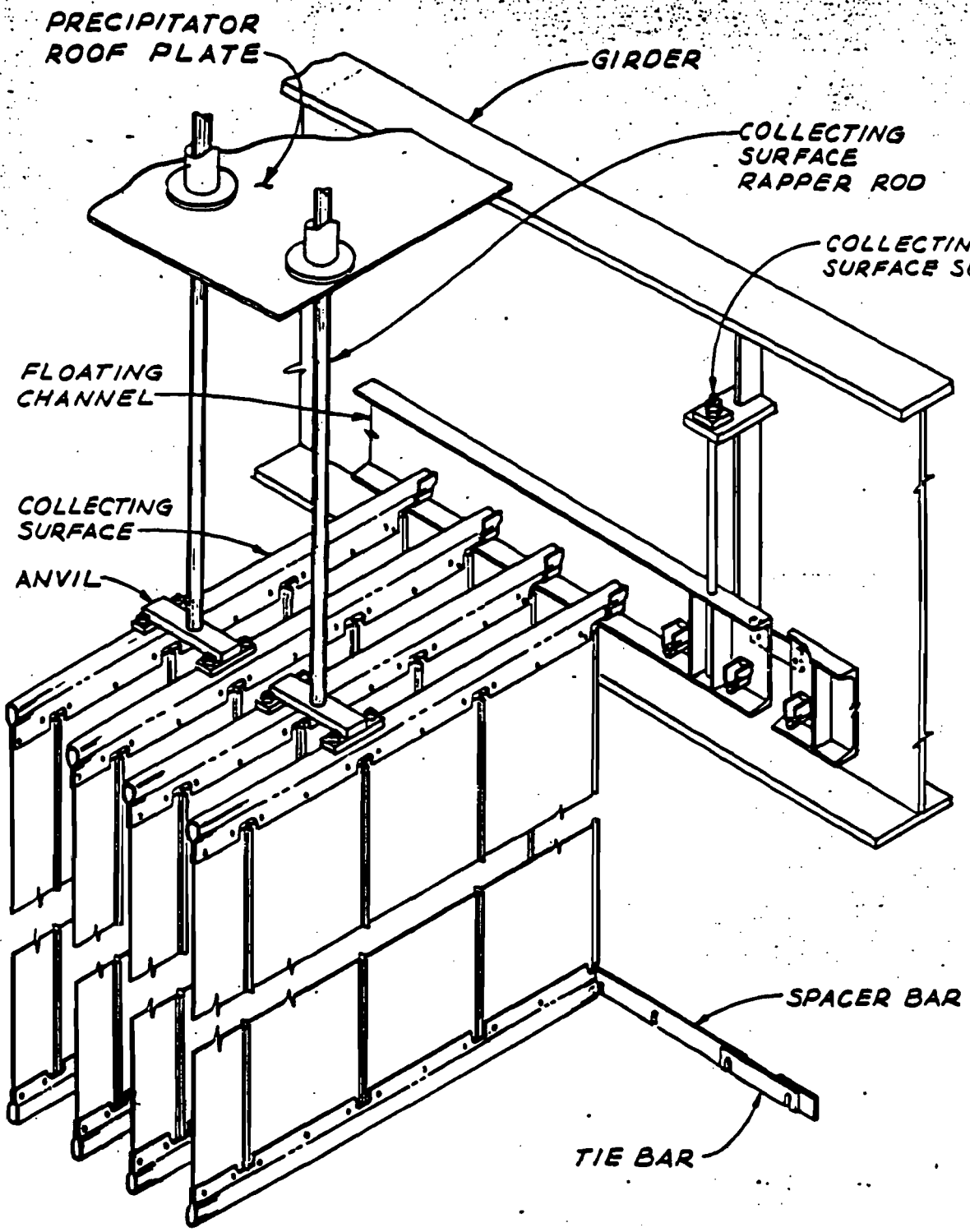
G. ACCESS FACILITIES

Access facilities are provided to the scope as shown on the proposal drawings. Structural steel is ASTM A-36 designed for 100 psf loading. Stairtreads and grating are galvanized. The handrail will be dual rail using 1-1/4 standard pipe rail and post. Platforms will be provided with 4 inch x 1/4 inch toe plates. Walkways are 36 inch minimum width. Stairways are 30" width.

H. COLLECTING ELECTRODE SYSTEM – Drawing No. 1120

Seller's C1010 steel MODULOK collecting surfaces (U.S. Patent # 3,418,792) are roll formed into 18 inch modules having tightly interlocked edges which when factory assembled form a rigid one piece baffled structure, which provides maximum stiffness, optimum gas exposure and minimum field assembly.

The top and bottom edges of each collecting surface are reinforced and stiffened by 7 gauge and 11 gauge respectively tubular structural members which are factory welded to the roll formed collecting surfaces. These members prevent edge effect arc-over where the discharge electrodes enter and leave the collecting field. This horizontal welding at the top and bottom is the only heat applied to the plate during manufacture. This procedure



ENVIRONMENTAL ELEMENTS CORPORATION

COLLECTING SURFACE RAPPER ARRANGEMENT

OWG. No 1120

ELK 2-21-78

prevents the deformation and "oil-canning" which can easily result when individual modules are welded together. The collecting surfaces are rapped by electric impact type rappers located on the penthouse roof. Full provision is made in the collecting system suspension for uniform thermal movement up to the maximum design temperature without disturbance to internal alignment.

These collecting surfaces are shipped and lifted into the precipitator shell in nested, upright packages thereby affording maximum protection against handling damage for optimum straightness and uniformity in operation.

I. DISCHARGE ELECTRODE SYSTEM – Drawing No. 1121

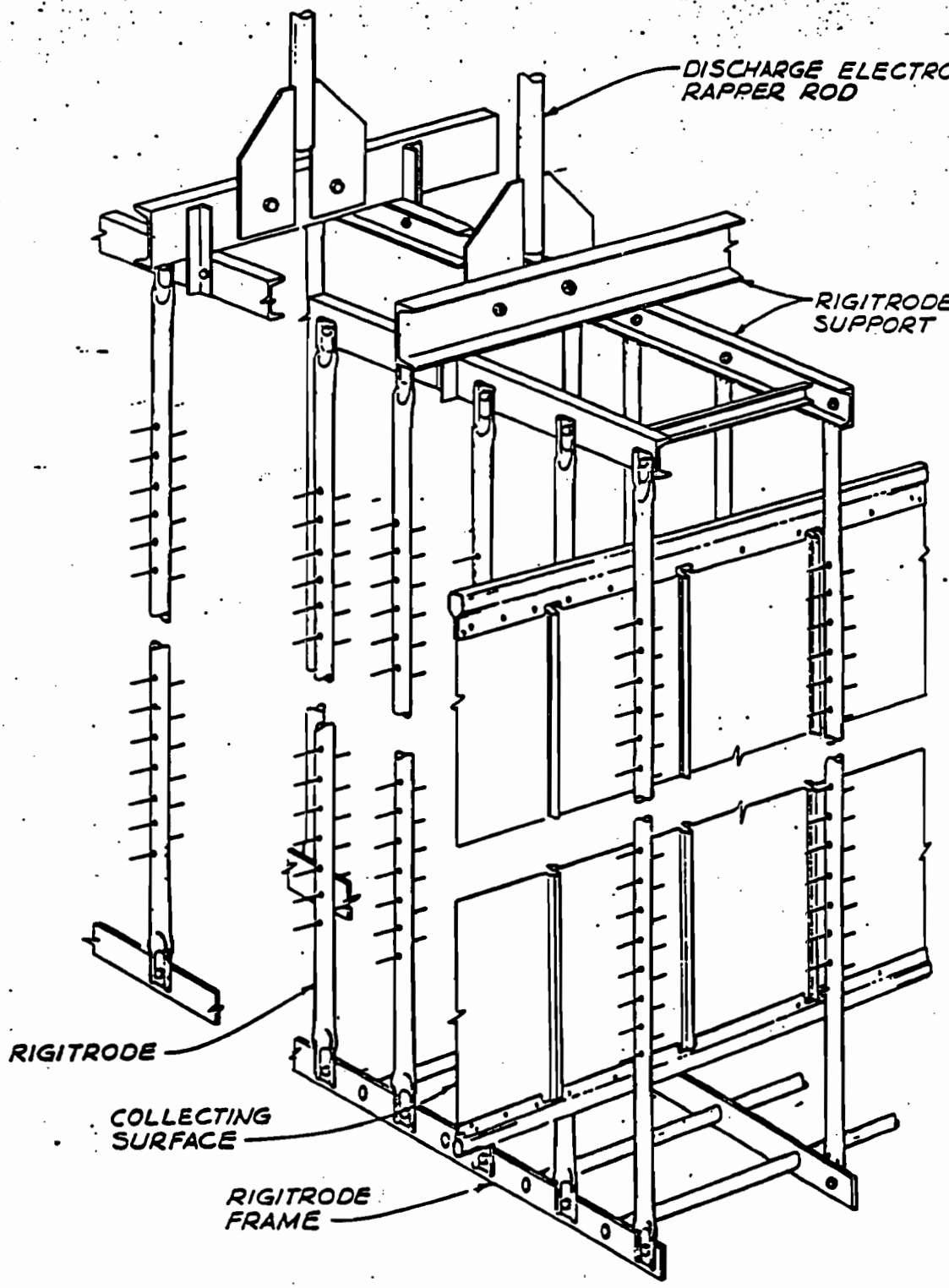
Seller's RIGITRODE electrode is a true unbreakable rigid discharge electrode. The RIGITRODE electrode is a 1-1/2 inch diameter 16 gauge mild steel tube with corona-generating studs welded to it. The studs are 12 gauge and are fully annealed to eliminate fatigue cracking. The RIGITRODE electrode exhibits a low corona onset voltage typical of a pointed discharge electrode. This feature makes it appropriate in inlet fields where dust loadings are high. As voltage is increased, the V-I relationship approaches that of a smooth electrode. This feature allows the same RIGITRODE electrode to be used effectively in outlet fields. Laboratory tests and commercial operation has shown this design to have a unique combination of several characteristics: high sparkover voltage, high field strength and an even current distribution from discrete emission points.

The restoring forces of this system are substantial; therefore, an overfull hopper will not cause permanent misalignment. The system will return to correct alignment when the hopper is emptied, thus avoiding unscheduled outages. Further, the computerized power control (discussed in detail later in this proposal) will protect the power supply and prevent the formation of fused ash in a full hopper.

J. HIGH VOLTAGE SUPPORT – PENTHOUSE DESIGN – Drawing No. 1217

Each bus section is supported by two (2) suspension insulators located on the precipitator roof. An epoxy filled glass filament rod connects an externally located rapper to the high voltage support rod to transmit energy while at the same time providing the necessary electrical insulation.

The insulators are housed in a gas-tight 6 foot high penthouse covering the entire roof area. The sides are fabricated from 10 gauge steel. The roof is fabricated from 1/4 inch checker plate to provide a firm walk surface. All rappers, transformer-rectifiers and rapper panels are located on the penthouse roof allowing inspection and maintenance with the precipitator in operation. The penthouse construction reduces the radiator effect of the many projections through the precipitator and eliminates the roof corrosion inherent with the use of individual insulator compartments. The insulators are totally accessible for cleaning and inspection. The penthouse roof is sloped 1/4 inch in 12 inches for drainage. The penthouse is pressurized by a forced air system, sized to supply 100 cfm per insulator, to prevent the entrance of dust into the penthouse and to keep the inside surface of the support insulators clean.



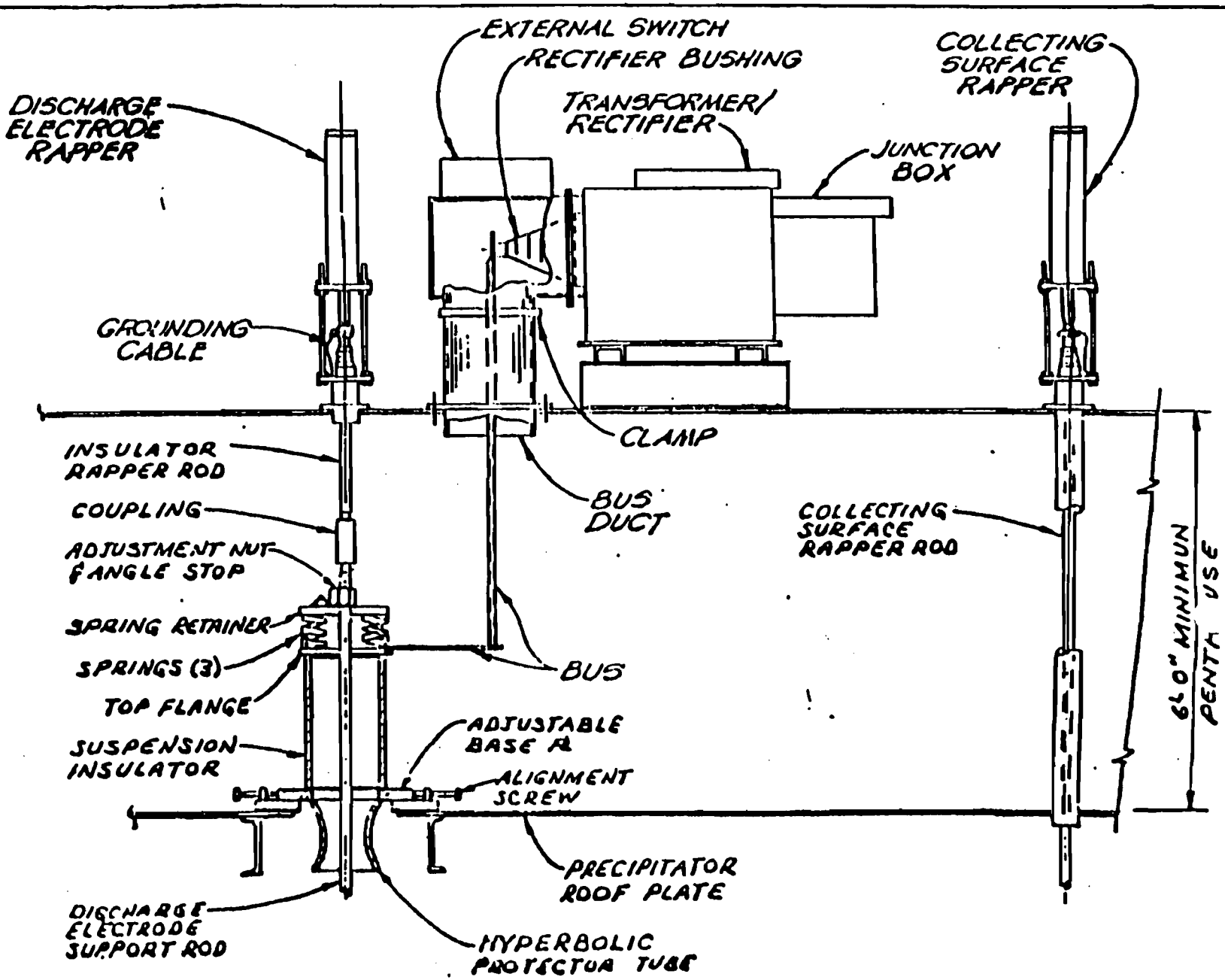
ENVIRONMENTAL ELEMENTS CORPORATION

RIGITRODE DISCHARGE ELECTRODE ARRANGEMENT

DWG. NO. 1121

REV. ELK 10-28-80

M.J.W 2-84



ENVIRONMENTAL ELEMENTS CORPORATION

HIGH VOLTAGE SYSTEM PENTHOUSE ARRGT

DWG. NO. 1217

K. INSULATOR HEATERS

A 0.4 KW contact heater is provided around each support insulator. Insulator heaters are not essential to operation of the precipitator since the precipitator is normally heated prior to energization. The insulator heaters are included, however, as insurance in the event that the precipitator is energized cold.

L. ELECTRIC IMPULSE RAPPER MODEL ESI-I – Drawing No. 1076

The electric impulse rapper has been specifically designed for rapping the collecting surfaces, discharge electrodes and perforated distribution plates of electrostatic precipitators. The ESI-I is a single impulse gravity impact type rapper consisting of an integral DC coil and steel housing assembly, a 20 pound piston and mounting hardware. Its features include:

Accurate Control. Rapper impact is precisely repeatable. Intensity of impact and frequency of operation are controlled by a microprocessor based controller. With the optional Data Management System, the operating characteristics can be controlled from a remote control room through the CRT.

One Piece Construction. The coil is permanently bonded to the inside of the housing and is totally encapsulated in epoxy to seal out the environment. Long life is assured with this uncomplicated construction.

Lubrication. None is required.

Maintenance Free. The ESI-I requires absolutely no periodic adjustment or maintenance over its entire service life.

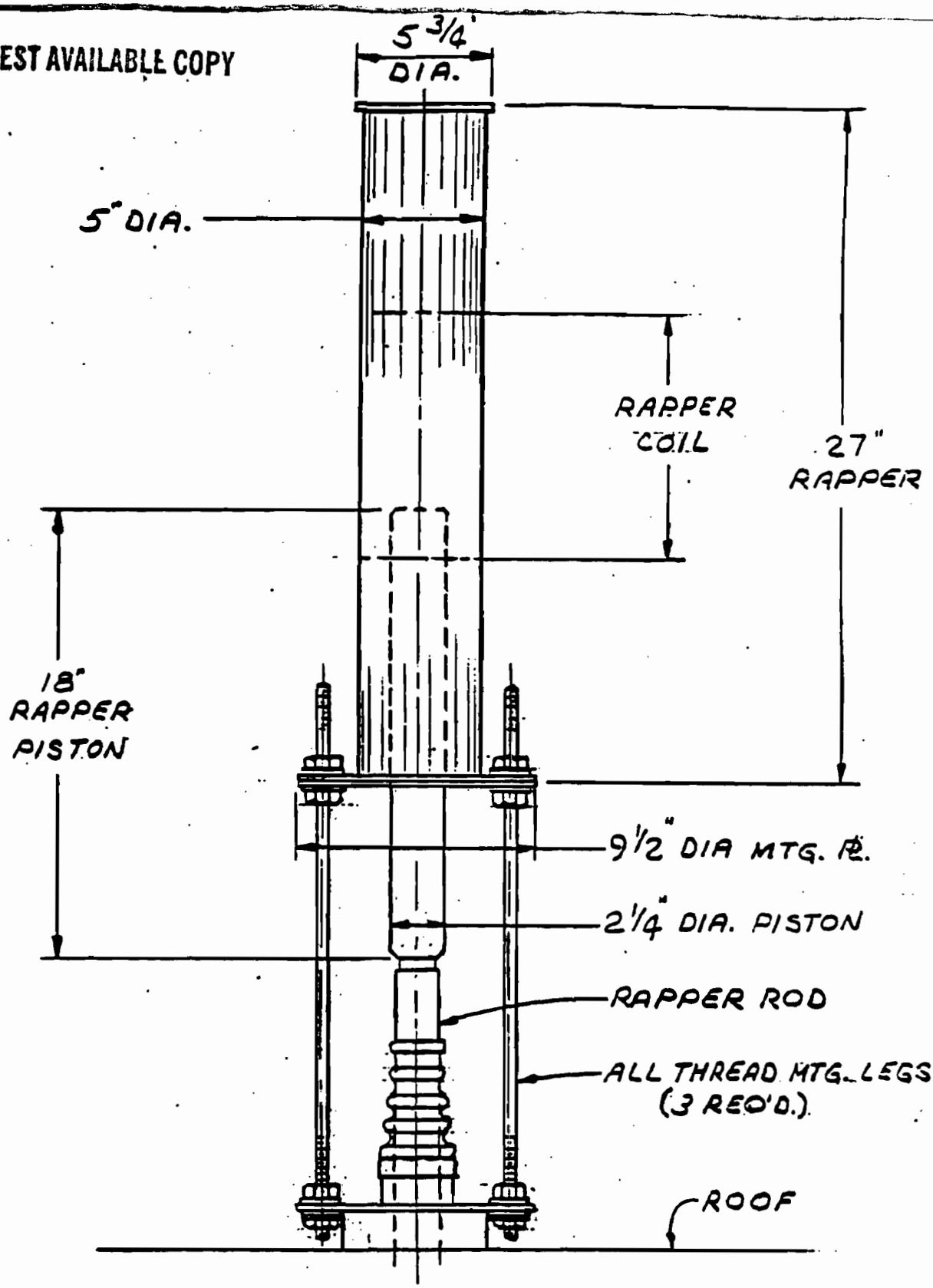
Roof Mounting. The rapper is mounted on the roof by means of three (3) support rods. The piston moves freely in and out of the rapper body when striking the rapper rod. The impact does not impart a shock to the housing which eliminates any chance of material fatigue. The rapper is weatherproof for outdoor operation.

Power Supply. The rapper operates from a 240 volt supply and draws an instantaneous current of 22 amperes maximum. The three (3) wire conductor cable supplied with the rapper is used to make the electrical connections. An additional grounding strap is provided for connecting the housing to the precipitator roof.

Energy Output. Microprocessor controlled output levels are provided.

M. RAPPER CONTROLS

The microprocessor based rapper controls are housed in a NEMA 4 weathertight enclosure. The rapper control system is designed to operate within ambient temperature limitations of -25°C to 85°C. The rappers for the discharge electrodes and each collecting surface field are individually controlled to permit adjustment of rapper impact intensity and cycle time for each section. Impact is variable up to 10 foot pounds. On time is 1 to 8 half line cycles



ENVIRONMENTAL ELEMENTS CORPORATION

ESI RAPPER

DWG. Nº 1076

R.W.E 8-81 REV'D. 9-90

and off time is variable from 1 to 999 seconds. Control, rapper status indication and fault detection can be transferred to a remote location by multiplex signals from the optional Data Management System. For further details, see Attachments.

N. TRANSFORMER-RECTIFIER – Drawing No. 1221, 1222

Each field is energized by a high voltage, coolant filled, silicon diode transformer-rectifier. Power is conducted to the precipitator through 3/4 inch A-36 steel bus bar enclosed in a 16 inch round 10 gauge A-36 steel water-tight housing.

The transformer is single phase, liquid cooled with the silicon diode rectifiers immersed in the same tank. Line voltage is regulated by a full range thyristor controller (SCR) which provides automatic power control. The current linear reactor is located in the junction box.

The transformer-rectifiers are furnished with a magnetic liquid level gauge, dial thermometer, drain, low voltage junction box and liquid filled bushings. The units are designed for a 55°C rise, at rated load, based on operation in an average ambient temperature of 40°C providing the maximum daily ambient shall not exceed 50°C. An alarm contact is provided on the temperature gauge.

The high voltage ground switch is integrated into the key interlock system to insure that the transformer-rectifier bushing is grounded before entry can be gained to the precipitator.

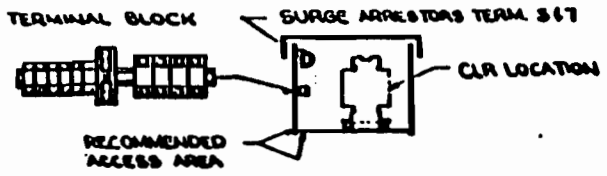
O. AUTOMATIC GROUNDING SYSTEM

The automatic grounding switch is located in the bus duct between the transformer-rectifier and penthouse insulator compartment. The automatic grounding of the high voltage system is solenoid activated when the transformer-rectifiers are deenergized on CO gas detection signal.

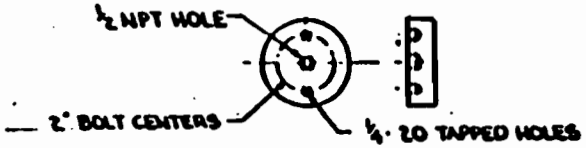
P. RECTIFIER CONTROL CABINETS – Drawing No. 1224, 1225

Environmental Elements rectifier control cabinets are fabricated as attractive two section (2-PAC) dead front, NEMA 12 enclosures. The cabinets are independent of one another, each containing separate assemblies to apply voltage to the primary of an associated transformer-rectifier at levels determined by a dedicated automatic power controller. Access to all equipment is through the front door allowing easy access for maintenance. Components include the circuit breaker, contactor, control transformer, monitoring circuits, relays, firing circuit and Silicon Controlled Rectifiers (SCR's). The SCR assembly utilizes two (2) SCR's fitted to electrically isolated heat sinks of an appropriate size. The electronic components of the firing circuit are mounted on a printed circuit board attached to the heat sink. The firing circuitry determines the conduction angle (0° to 180°) of the SCR's as a function of the signal from the automatic power control or manual control.

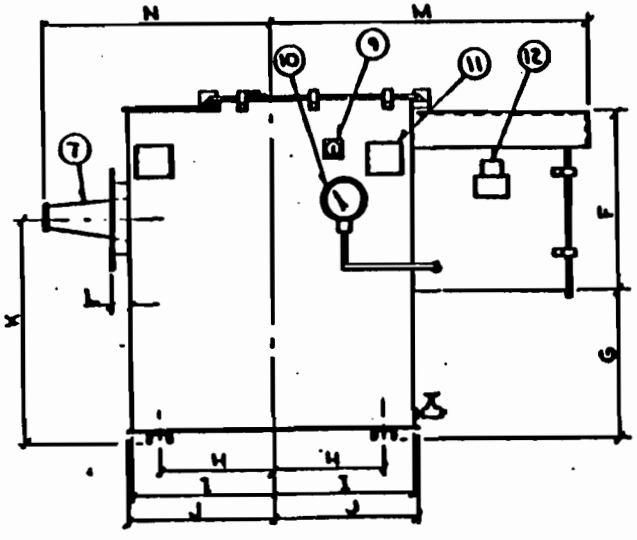
A separately enclosed high impedance linear reactor (CLR) with an iron core and air chimneys in the windings is connected in series with the SCR's to limit primary current surges during sparking.

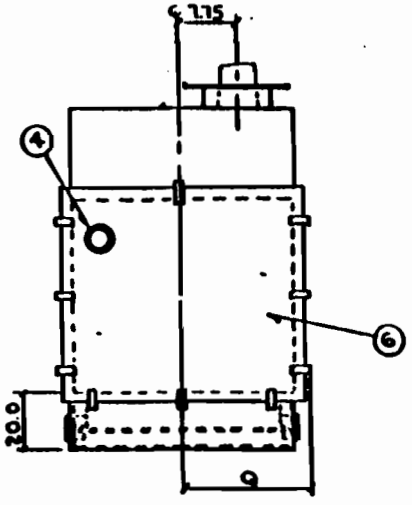


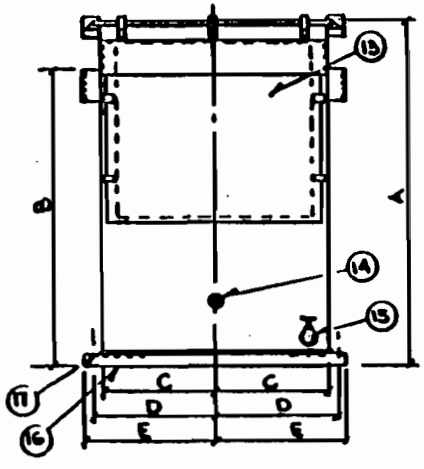
JUNCTION BOX LAYOUT



DETAIL "A"







REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APP'D

(4) 0.5" FILL CPLG & PLUG WITH PRESSURE RELIEF VALVE INSTALLED
(6) HANDHOLE FOR INTERNAL ACCESS WITH REMOVABLE COVER
(7) HIGH VOLTAGE SEMI OUTDOOR BUSHING. SEE DETAIL "A" FOR CORONA RING.
(9) MAGNETIC LIQUID LEVEL INDICATOR
(10) TEMP. IND. MOUNTED IN WELL TO FACILITATE REMOVAL WITH OVERTEMP CONTACTS
(11) LIFTING CHANNEL 4"x4"x2" 4 PROVIDED
(12) NAMEPLATE LOCATION
(13) LOW VOLTAGE JUNCTION BOX WITH REMOVABLE COVER
(14) 0.5"-13 GND BOSS WITH THD PROTECTIVE PLUG.
(15) 0.5" GATE VALVE & PLUG FOR SAMPLING
(16) 0.25" FLAT PLATE BOTTOM WITH (2) 3"-3" STEEL CHANNELS
(17) 0.687" DIA MTG. HOLES 4-REQ'D

DIM.	100-500MA	750MA
A	31.88	31.88
B	26.25	26.25
C	12.75	12.75
D	14.25	14.25
E	15.75	15.75
F	20.00	20.00
G	9.5	9.5
H	12.0	12.0
I	14.5	14.5
J	14.75	14.75
K	18.75	18.75
L	3.25	3.25
M	24.5	24.5
N	30.0	32.0
P	23.0	23.0
Q	18.25	18.25
R	24.75	24.75

SPECIFICATIONS		
K.V.D.C.	M.A.D.C.	APPROX. WEIGHT
55	100	1700
55	250	1800
55	500	1900
55	750	2200

SHIPPING NUMBER	FIND OR MARK NO.	DRAWING NUMBER	TO SHIP	PER ASSY	TOTAL REQ'D	CODE IDENT.	DESCRIPTION	MAT'L/REMARKS	PAGE	LINE
			QUANTITY REQ'D						SOURCE	

PARTS LIST

ACCUMULATION OF TOLERANCES NOT ALLOWED

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONS ±
ANGLES ±
3 PLACE DECIMALS ±
2 PLACE DECIMALS ±

DO NOT SCALE DRAWING

MATERIAL SPECIFICATIONS, UNLESS OTHERWISE INDICATED:
SHAPES: ASTM-A36
BAR: MERCHANT QUALITY AISI-M1020 (CD-S-633)
PLATE: ASTM-A36
SHEET OR STRIP:

M.R. NO.
CONTRACT NO.

	BY	DATE
DRAWN		
CHECKED		
APPROVED		
APPROVED		
APPROVAL		
APPROVAL		

ENVIRONMENTAL ELEMENTS CORPORATION
P.O. Box 1318
Baltimore, Md 21203 USA

TRANSFORMER RECTIFIER GENERAL ARRANGEMENT

SIZE	FSCM NO.	DRAWING NO.	REV
C		1221	

SCALE ~ SHEET —

NEXT ASSY	USED ON
APPLICATION	

9-24-84

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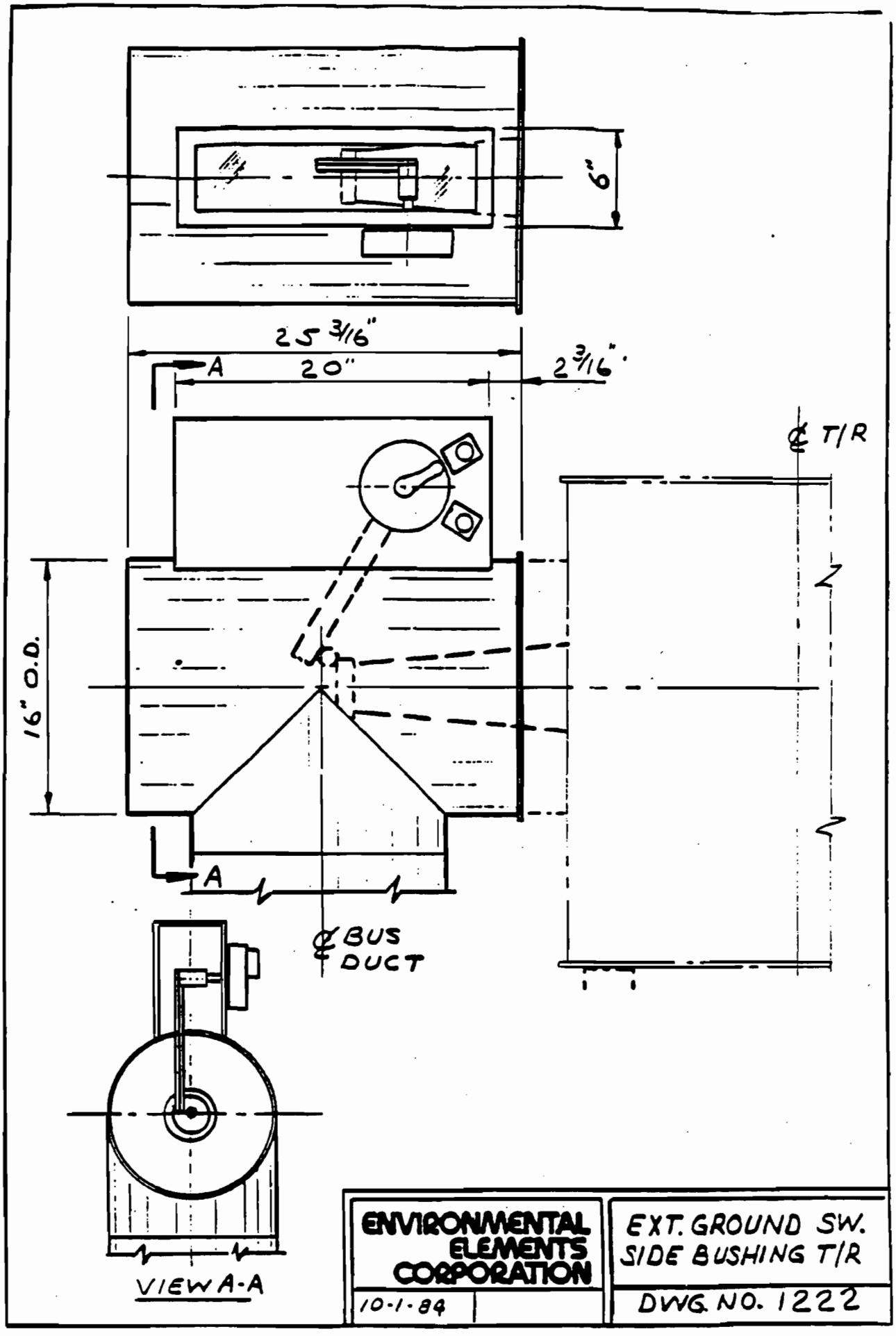
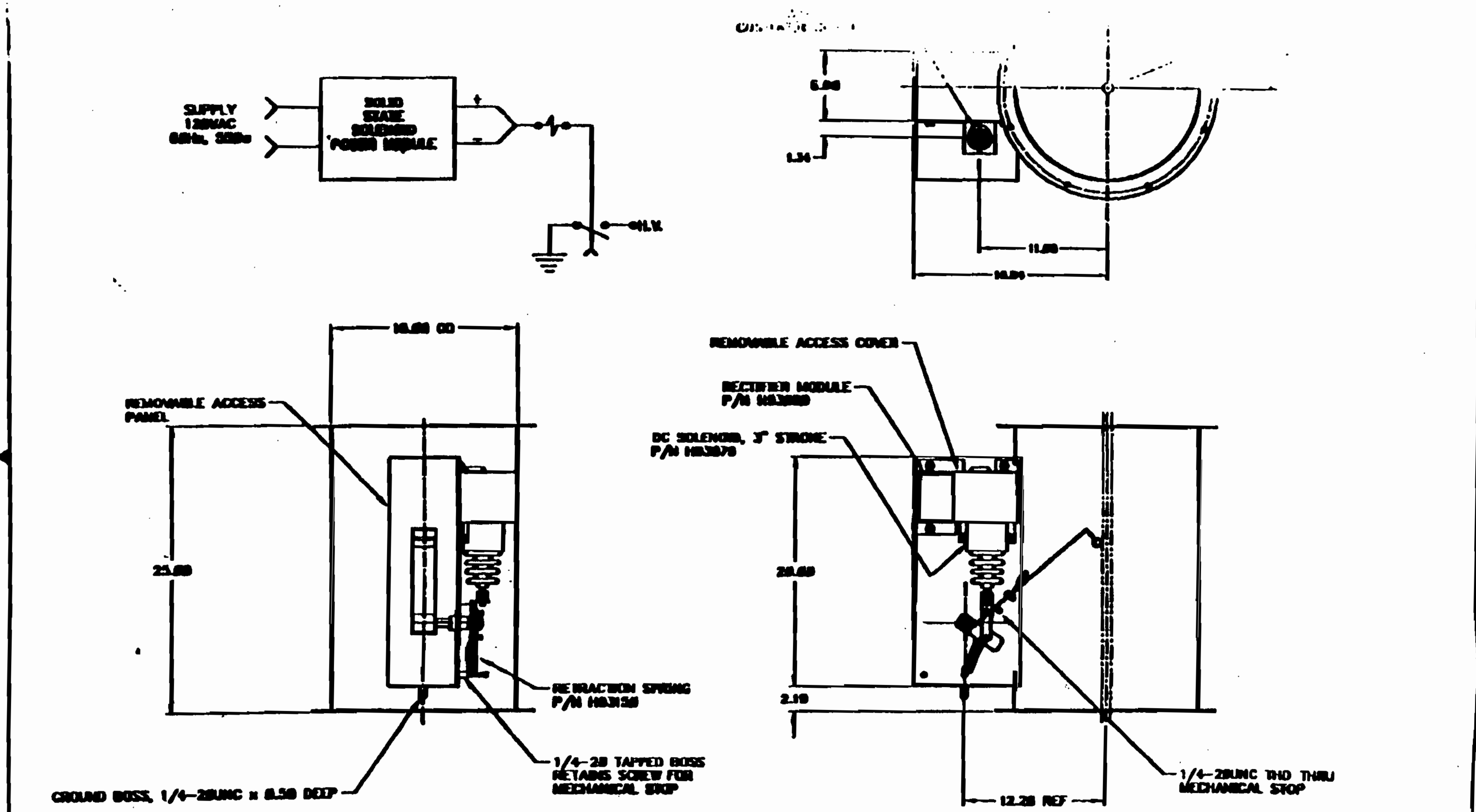


ENVIRONMENTAL ELEMENTS CORPORATION	EXT. GROUND SW. SIDE BUSHING T/R
10-1-84	DWG. NO. 1222

APR 24 '95 11:06AM BORDENTOWN NJ



NOTES:

1. BUS DUCT IS TO BE SELF SUPPORTING.

REV	DATE	BY	DESCRIPTION
D	[illegible]	[illegible]	[illegible]
C	[illegible]	[illegible]	MECHANISM UPDATED PROFILE REDUCED
B	[illegible]	RK	MECHANISM REDESIGN
A	[illegible]	RK	ADDED SUPPLY SCHEMATIC

NWL TRANSFORMERS

PHYSICAL OUTLINE
NWL # 37136

1=6	[signature]	02/15/93
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The control cabinets also contains a number of features that protect the precipitator and other components. Associated fuses and surge arresters protect the SCR's and metering circuits against external circuit failure and transient current sparks. An electronic overcurrent relay provides additional protection.

To eliminate the manual monitoring of the units, each cabinet contains a DIGICON OPTIPULSE automatic power controller to maintain optimum power input to the precipitator.

Each controller has a two line 32 character alphanumeric Liquid Crystal Display (LCD) located on the front panel which presents a user-friendly interface to the plant operator. Controller faults, operating status and other information are presented in plain English.

Six standard alarms are annunciated through the controller:

Overcurrent
Undervoltage
Overspark
SCR Phase Imbalance
High Ambient Temperature
T-R High Temperature

In the event that power is interrupted due to one of the above mentioned faults, the fault is indicated on the LCD display. An additional three (3) alarm points are available for customized alarming (e.g. SCR high temperature, T-R low liquid level, ...etc.). Process related alarms may also be incorporated into the controller to trip the precipitator field due to such conditions as incomplete combustion in the boiler.

The DIGICON OPTIPULSE controller is described in more detail on the following pages.

Each cabinet is provided with the following meters:

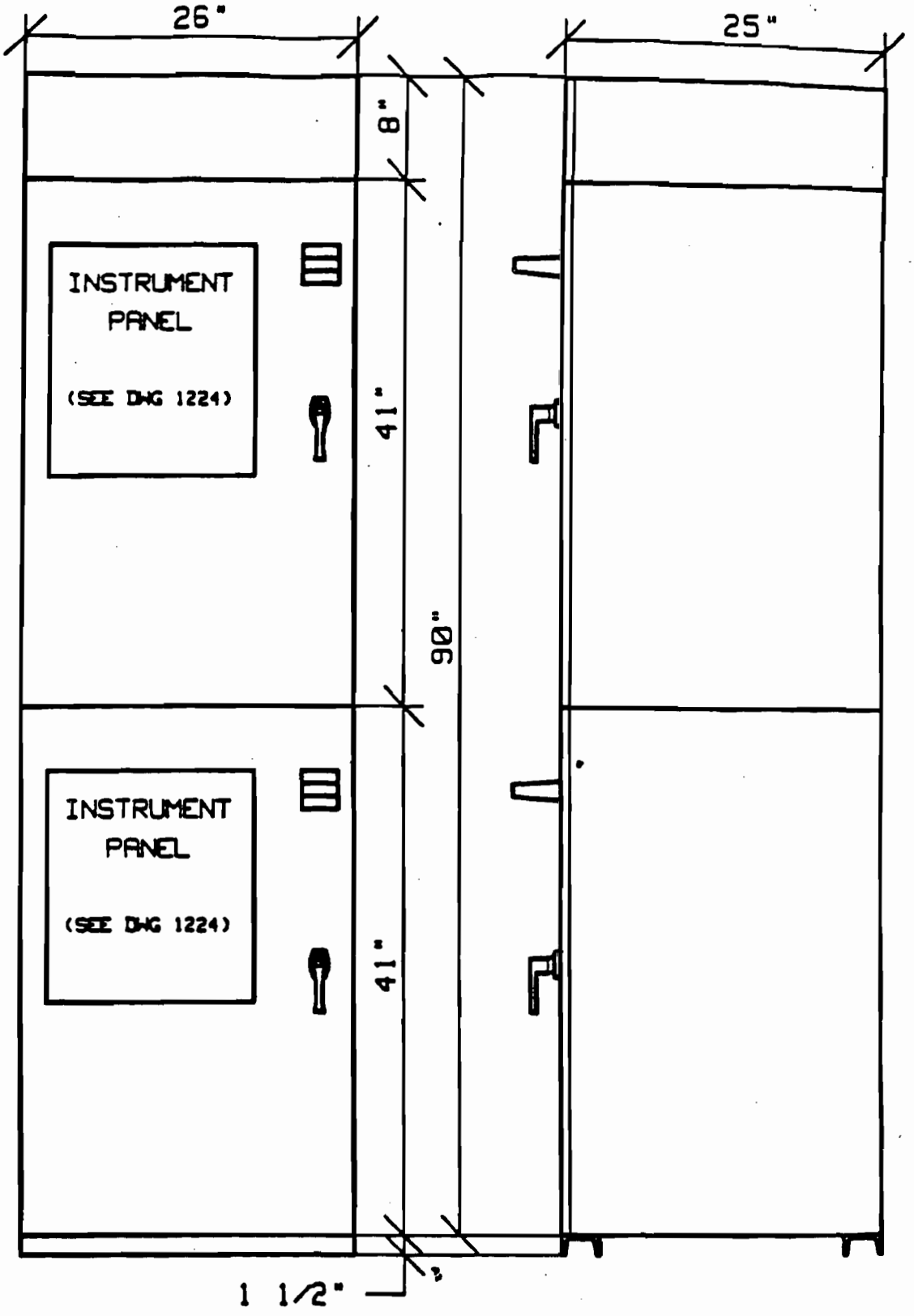
Primary Current
Primary Voltage
Secondary Current
Secondary Voltage
Spark Rate (Digital)

The control cabinets are equipped with face mounted breakers. The circuit breaker interrupting capacity is greater than or equal to 50,000 amperes symmetrical. As a safety feature, each cabinet is integrated into the key interlock system.

Where space is limited, the 2-PAC arrangement offers an attractive alternative to conventional rectifier control cabinets which house the automatic power controller, power components and current limiting reactor all in one enclosure.

Q. DIGICON OPTIPULSE AUTOMATIC POWER CONTROLLER

The DIGICON OPTIPULSE Automatic Power Controller is a microprocessor based controller using the latest state-of-the-art components. The controller is equipped with dual



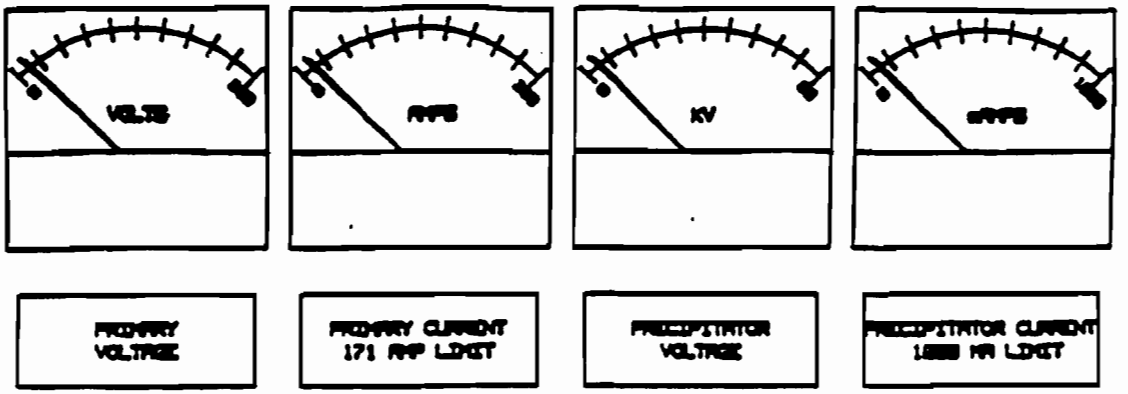
REV.

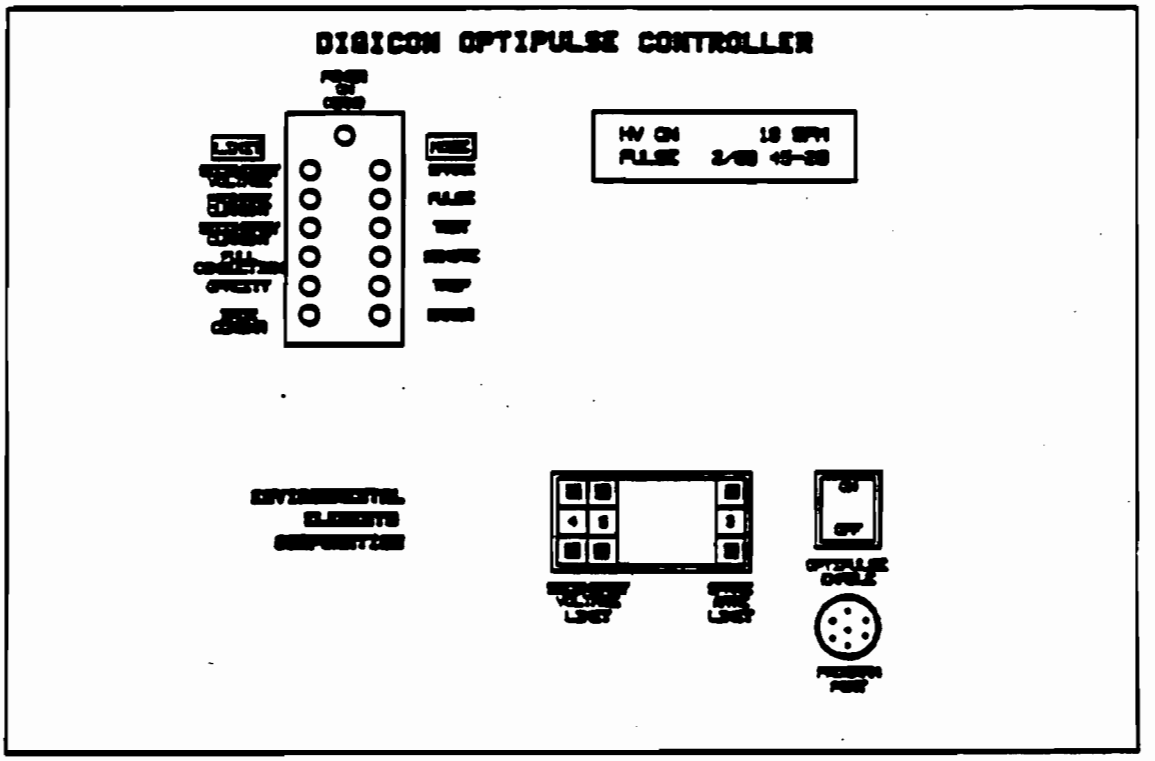
DWG. NO.

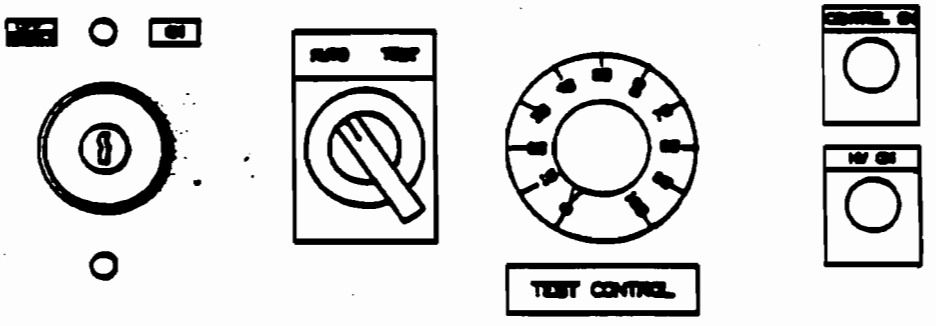
ENVIRONMENTAL ELEMENTS CORPORATION	M.O. NO.	DUAL CONTROL CONSOLE WITH CIRCUIT BREAKER	
DRAWN AJD 2-8-67	SIZE A	DRAWING NO. 1225	REV
DATE	SCALE		SHEET

A B E INC - BALT.

FORM 7304-A







A153

ENVIRONMENTAL ELEMENTS CORPORATION	M.O. NO. INSTRUMENT PANEL		
	SIZE	FSCM NO.	DRAWING NO. 1224 REV X
DRAWN J. HAMLIN			
DATE 2-16-87	SCALE		SHEET

specialized microprocessors for extremely fast processing of operational functions, and a 16K EEPROM for storage of all program parameters. The controller enclosure is NEMA 12, dust tight, and mounted inside the transformer-rectifier control cabinet. The ambient conditions can range from -10°C to +50°C and 0% to 95% humidity. On the front of the controller are two (2) digital selector switches: secondary voltage and spark rate. The controller uses this information to regulate the power level supplied to the precipitator. An additional selector switch is provided to enable the intermittent energization mode of operation. For further details regarding other features including host computer interfacing, user friendly displays and on line program modification capabilities, see Attachments.

R. UNDERVOLTAGE RELAY PROTECTION

Dust build-up into the electrostatic field is a possibility with failure of the dust removal system. The result is high heat generated due to the resistive ground formed by the dust bridging the space between the discharge and collecting electrodes. This leads to distortion of the discharge and collecting systems. To guard against this, undervoltage protection is built into the controllers to trip the power and sound an alarm in the event of a dead short or ground.

S. ALARM SYSTEM

Alarm contacts are provided in the following circuits for incorporation into Buyer's annunciator system. These contacts may also be integrated into Seller's optional Data Management System.

1. Transformer-rectifier control cabinet trip.
2. Penthouse blower failure.
3. Rapper failure.
4. High dust level in hoppers.
5. Dust conveying system failure.
6. Dust valve failure.
7. Hopper low temperature.

T. GROUNDING DEVICES

Grounding devices, permanently located within the penthouse, are provided for attachment to the high voltage frame whenever work is being performed on the system.

U. ELECTRICAL – GENERAL

All electrical equipment furnished is in accordance with current accepted engineering practices including the National Electrical Code, NEMA standards and the AIEE standards, wherever they apply. Controls for the high voltage are assembled into self-contained units of standard dead-front switchboard construction.

All control circuits will operate on 120V unless otherwise specified. All pushbutton and indicating lights will be combination type. Terminal boards are furnished in each control panel to which customer's signal circuit or safety circuits may be connected.

V. POWER DISTRIBUTION CENTER/MOTOR CONTROL CENTER

A power distribution center of NEMA 1 construction will be provided for installation in the precipitator electrical equipment room. The panel will contain a main breaker and branch breakers for all electrical equipment supplied. Since the control cabinets have circuit breakers mounted on the front, branch breakers are not required.

The motor control center is of dead-front construction incorporating vertical buses connected to the horizontal bus. The horizontal bus is located at the center of each vertical section. The motor starters are plug-in type with molded case circuit breakers. The control center will consist of one or more vertical sections bolted together to form a rigid, free-standing assembly designed to permit future additions by Buyer.

W. INTERLOCK SYSTEM

Seller's offering is complete with key-interlock system for the portions of the precipitator where high voltage may be a hazard. Access may not be gained to these danger zones without first turning off the power and grounding the appropriate high voltage elements.

Interlocks are provided for the following:

1. Transformer-rectifier control cabinets.
2. Transformer-rectifier grounding switches.
3. Penthouse roof access doors.
4. Hopper access doors.
5. Inlet and outlet nozzle doors.

X. ACCESS DOORS

Seller's standard quick-opening 22 inch x 28 inch access doors are provided. Each opening through thermal insulation will be of double-door construction consisting of a hinged, dogged outer door of ductile iron and a clamped steel inner doorplate, fabricated of 11 gauge carbon steel. Dogs and lugs on the outer door are made of stainless steel to assure free operation in all environments. This dual construction reduces or eliminates the need for insulation at the door area, and the inner plate provides an additional safety feature not found in competitive designs. The hopper inner door plate is provided with a 1-1/2 inch diameter inspection port which allows the operator to determine if the ash level is above the door level. A Viton coated aramid blend fiber gasket with a stainless steel mesh core is provided on the outer door to maintain a gas-tight seal, and positive interlocking is provided to prevent accidental entry. Each door bears a highly visible "Warning" sign made of enameled aluminum.

Y. SHOP PAINT

External uninsulated surfaces will be cleaned per Specification SSPC-SP-6 and given one (1) coat of zinc rich primer.

Z. THERMAL INSULATION

Seller will provide thermal insulation specifications for the electrostatic precipitator system. Three inch thick, 8 pcf, 1000°F mineral wool and 0.032 inch ribbed unpainted aluminum lagging (exterior surfaces) is recommended to insulate the hoppers, inlet nozzle, outlet nozzle precipitator casing and penthouse sides. The penthouse floor should be covered with 3 inches of calcium silicate block insulation. The transformer-rectifier bus duct and the penthouse blower system need not be insulated.

AA. VENDOR'S LIST

The items not manufactured in fabrication shops are furnished by the following suppliers or equal.

Transformer-rectifiers:	NWL
Control Cabinets:	Electronic Power and Control
Rapper Panels:	Forry Incorporated
Hopper Alarms:	Drexelbrook, Bindicator,
Penthouse Blowers:	ACME
Screw Conveyors:	Jervis B. Webb Co., Summelot or Equal
Dust Valves:	Sprout Bauer or equal

AB. GAS DISTRIBUTION MEDIA AND BAFFLING (WITHOUT MODEL STUDY)

Uniform gas distribution to the precipitator is essential if performance guarantees are to be achieved for the specified service. Included in this proposal are the perforated distribution plates as shown on the proposal drawing. Other vanes, splitters, turning devices and grids as required for uniform gas distribution are to be included in the ductwork contract.

Seller has extensive experience with ductwork configurations and will provide an aerodynamic (not structural) design without additional charge or a model study.

AC. FIRE PROTECTION

The potential for fires exists in all equipment cleaning the exhaust gases from a pyro process where a combustible gas mixture or burning char carryover can occur through improper firing or loss of process control. Risk of fire is minimal where process monitors are installed and maintained to alarm and control a developing hazardous condition. In the rare instance where the process cannot be controlled, the precipitator must be de-energized until conditions are safe for restart.

AD. QUALITY ASSURANCE PLAN

Our Corporate Quality Assurance Section is staffed, trained and equipped to maintain effective quality management of a contract from the time it is awarded until final customer acceptance has been made.

This group routinely provides the following for all contracts:

1. Review of the customer's procurement and technical documents to determine that the requisite requirements have been defined and documented as well as to assure that Seller's resources and capabilities are adequate to meet the requirements.

2. Assist Seller's Purchasing Section in the selection and development of quality fabricators including judgments relative to potential fabricator's abilities to conform to those requisite requirements.

3. Review and assess, for approval, designated fabricator's quality systems including their organizational structure, responsibilities, procedures, processes and resources for implementing quality management to conform to contractual requirements.

4. Schedule source inspection visits by Seller's Quality Assurance Representatives (QAR's) to monitor in-process activities and/or to provide shipping releases.

5. Assure qualifications of all welders to AWS D1.1 for arc welding and AWS C1.1 for spot welding or equivalent as required.

6. Perform system, product and process audits as required to assure conformance and implementation to contractual requirements including the pertinent documentation.

SECTION 3

TECHNICAL TABULATION

SECTION 3

3. TECHNICAL TABULATION

A. KILN MILL PRECIPITATOR

1. Structural Design Parameters

a.	Structural Design	AISC Code throughout
b.	Wind Load	90 mph
c.	Live Load	50 psf on precipitator roof 100 psf on all access
d.	Seismic Zone	1
e.	Dust Bulk Density - Structural Volumetric	 85 pcf 35 pcf
f.	Snow Load	Nil
g.	Temperature	750°F
h.	Pressure	±25 inches H_2O

2. Mechanical Design Data

a.	Number of Precipitators	1
b.	Number of Chambers	1
c.	Fields	4
d.	Bus Sections Per Field	1
e.	Total Number Bus Sections	4
f.	Gas Passages	23
g.	Spacing of Gas Passages	16 inches
h.	Precipitator Casing Dimensions	See Drawing 15290-2110-D-1
i.	Number & Type Hoppers	2 trough
j.	Hopper Material	3/16 inch A-36 steel

k.	Casing Material	3/16 inch A-36 steel
l.	Distribution Plates	12 gauge mild steel

3. Collection Surface Systems

a.	Type of Material	Modular Roll Form 18 gauge Mild Steel
b.	Baffle Stiffeners	Integrally formed on 18 inch centerlines
c.	Number and Size of Surfaces	96@9.125'x36'
d.	Total Active Collecting Surface	60,444 sq. ft.
e.	Floating Channel Support System	Leading and trailing edges of each mechanical field

4. Discharge Electrode System

a.	Type	1.5 inch diameter Rigid Tube with emitting studs
b.	Effective Length Per Electrode	36 feet
c.	Number of Electrodes Per Gas Passage	24
d.	Total Number Electrodes	552
e.	Total Effective Length	19,872 feet
f.	Suspension Insulators	
(1)	Number and Material	8 Alumina
(2)	Manufacturer	Coors
(3)	Dry Arc-Over K.V. RMS	99.1 KV, 60 Cycle
(4)	Wet Arc-Over K.V. RMS	97.0 KV, 60 Cycle
(5)	Leakage Distance	19 3/4 inch

5. Rapping System

a.	Quantity and Type of Rappers	Electrical impulse

(1)	Collecting Surfaces	48 Model ESI-I
(2)	Discharge Electrodes	8 Model ESI-I
(3)	Perforated Distribution Plates	1 Model ESI-I

b. Weather-Proof Rapper Panels

(1)	Material	Steel - NEMA 4
(2)	Quantity	1
(3)	Type	Solid State
(4)	Power Transformer	15 KVA 480/240 volt

6. Electrical

a. Transformer-Rectifiers

(1)	Type	Silicon
(2)	Voltage Rating	70kv (DC Avg.) 83kv (AC) RMS 118 kv (DC) Peak
(3)	Output Wave Form	Full Wave

	Quantity	KVA	MA
1st Field	1	75.1	750
2nd Field	1	75.1	750
3rd Field	1	75.1	750
4th Field	1	75.1	750

b. T-R Insulation Fluid — Mineral Oil

c. High Voltage Switch Type — One per T-R unit, interlocked grounding switch with observation window

d. T-R Control Cabinet — One per pair of T-R's
NEMA 12 Construction

e. Type of Control — Thyristor (SCR)

f. Maximum Ambient Temperature for Electrical Supply and Control Equipment — 40°C

g. Electrical Supply — 480 Volt, 60 Hertz, 3 Phase

h. Maximum Expected Power Consumption

(1)	Precipitator (T-R's)	153.2 KW

(2)	Rappers	2.0 KW
(3)	Insulator Heaters	3.2 KW
(4)	Penthouse Blowers	1 1/2 HP
(5)	Conveyor	25 HP
(6)	Dust Valve	3 HP

i. Total Connected Load (Transformer-Rectifier Units) — 300.4 KVA

j. Type of High Voltage Conductor — 3/4 inch pipe in 16 inch round or square duct

7. Access Doors

Penthouse Roof	2, single door, interlocked
Precipitator Roof	4, double door, non-interlocked
Nozzles	2, double door, interlocked
Hoppers	4, double door, interlocked

8. Thermal Insulation - By Erector

Precipitator Roof	3 inch calcium-silicate block AREA = 1361 sq. ft.
Nozzles, Precipitator Sides Penthouse Sides and Hoppers	3 inch 8 PCF mineral wool AREA = 1614 sq. ft.

All lagging will be 0.032 inch ribbed aluminum on exterior surfaces.

9. Dust Removal

a. Hopper Conveyors

(1)	Quantity and Size	One 18"
(2)	Type - Trough	1/4" A-36 Box
	Screw	Full Flight
(3)	Speed	25 rpm
(4)	Capacity @ 36% load	1225 cfh
	@ 100% load	3,408 cfh
(5)	Dust Density Volumetric	35 pcf
	Compacted	85 pcf
(6)	Drive	25 Hp end mounted reducer
(7)	Motion Sensor	Shaft mounted

b. Dust Valves

(1)	Type	Sprout Bauer Rotary Valve w/Type 2 Rotar and Ni-Hard Adjustable Tips

(2)	Quantity and Size	One Size 2422
(3)	Capacity @ 20% Load	4,250 cfh
(4)	Speed	18 rpm
(5)	Drive	3 Hp
(6)	Motion Sensor	Shaft mounted

B. CLINKER COOLER PRECIPITATOR

1. Structural Design Parameters

a.	Structural Design	AISC Code throughout
b.	Wind Load	90 mph
c.	Live Load	50 psf on precipitator roof 100 psf on all access
d.	Seismic Zone	1
e.	Dust Bulk Density - Structural Volumetric	 85 pcf 35 pcf
f.	Snow Load	Nil
g.	Temperature	750°F
h.	Pressure	±20 inches H_2O

2. Mechanical Design Data

a.	Number of Precipitators	1
b.	Number of Chambers	1
c.	Fields	4
d.	Bus Sections Per Field	1
e.	Total Number Bus Sections	4
f.	Gas Passages	19
g.	Spacing of Gas Passages	16 inches

h.	Precipitator Casing Dimensions	See Drawing 15290-2110-D-2
i.	Number & Type Hoppers	2 trough
j.	Hopper Material	3/16 inch A-36 steel
k.	Casing Material	3/16 inch A-36 steel
l.	Distribution Plates	12 gauge mild steel

3. Collection Surface Systems

a.	Type of Material	Modular Roll Form 18 gauge Mild Steel
b.	Baffle Stiffeners	Integrally formed on 18 inch centerlines
c.	Number and Size of Surfaces	80 @ 9.125'x 36'
d.	Total Active Collecting Surface	49,932 sq. ft.
e.	Floating Channel Support System	Leading and trailing edges of each mechanical field

4. Discharge Electrode System

a.	Type	1.5 inch diameter Rigid Tube with emitting studs
b.	Effective Length Per Electrode	36 feet
c.	Number of Electrodes Per Gas Passage	24
d.	Total Number Electrodes	456
e.	Total Effective Length	16,416 feet
f.	Suspension Insulators	
	(1) Number and Material	8 Alumina
	(2) Manufacturer	Coors

(3)	Dry Arc-Over K.V. RMS	99.1 KV, 60 Cycle
(4)	Wet Arc-Over K.V. RMS	97.0 KV, 60 Cycle
(5)	Leakage Distance	19 3/4 inch

5. Rapping System

a. Quantity and Type of Rappers — Electrical impulse

(1)	Collecting Surfaces	40 Model ESI-I
(2)	Discharge Electrodes	8 Model ESI-I
(3)	Perforated Distribution Plates	1 Model ESI-I

b. Weather-Proof Rapper Panels

(1)	Material	Steel - NEMA 4
(2)	Quantity	1
(3)	Type	Solid State
(4)	Power Transformer	15 KVA 480/240 volt

6. Electrical

a. Transformer-Rectifiers

(1)	Type	Silicon
(2)	Voltage Rating	70kv (DC Avg.) 83kv (AC) RMS 118 kv (DC) Peak
(3)	Output Wave Form	Full Wave

	Quantity	KVA	MA
1st Field	1	75.1	750
2nd Field	1	75.1	750
3rd Field	1	75.1	750
4th Field	1	75.1	750

b. T-R Insulation Fluid — Mineral Oil

c. High Voltage Switch Type — One per T-R unit, interlocked grounding switch with observation window

d. T-R Control Cabinet — One per pair of T-R's
NEMA 12 Construction

e. Type of Control — Thyristor (SCR)

f. Maximum Ambient Temperature for Electrical Supply and Control Equipment — 40°C

g. Electrical Supply — 480 Volt, 60 Hertz, 3 Phase

h. Maximum Expected Power Consumption

(1)	Precipitator (T-R's)	128.1 KW
(2)	Rappers	2.0 KW
(3)	Insulator Heaters	3.2 KW
(4)	Penthouse Blowers	1 1/2 HP
(5)	Conveyor	20 HP
(6)	Dust Valve	2 HP

i. Total Connected Load (Transformer-Rectifier Units) — 300.4 KVA

j. Type of High Voltage Conductor — 3/4 inch pipe in 16 inch round or square duct

7. Access Doors

Penthouse Roof	2, single door, interlocked
Precipitator Roof	4, double door, non-interlocked
Nozzles	2, double door, interlocked
Hoppers	4, double door, interlocked

8. Thermal Insulation - By Erector

Precipitator Roof	3 inch calcium-silicate block AREA = 1,140 sq. ft.
Precipitator Sides, Nozzles, Penthouse Sides, Underside Penthouse Roof and Hoppers	3 inch 8 PCF mineral wool AREA = 10,321 sq. ft.

All lagging will be 0.032 inch ribbed aluminum on exterior surfaces.

9. Dust Removal

a. Hopper Conveyors

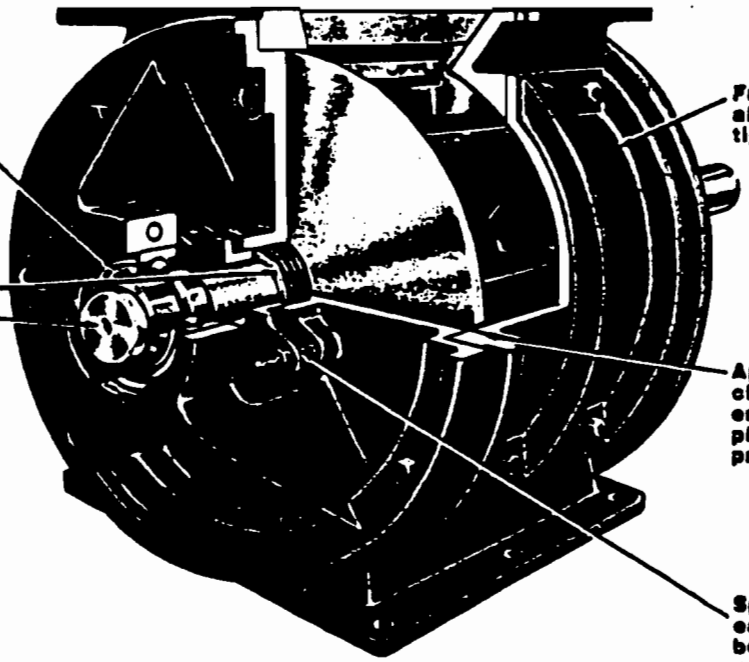
(1)	Quantity and Size	One 14"
(2)	Type - Trough	1/4" A-36 Box
	Screw	Full Flight
(3)	Speed	25 rpm
(4)	Capacity @ 30% load	500 cfh

		@ 100% load	1593 cfh
(5)	Dust Density	Volumetric	85 pcf
		Compacted	35 pcf
(6)	Drive		20 Hp end mounted reducer
(7)	Motion Sensor		Shaft mounted

b. Dust Valves

(1)	Type	Sprout Bauer Rotary Valve w/Type 2 Rotar and Ni-Hard Adjustable Tips
(2)	Quantity and Size	One Size 2018
(3)	Capacity @ 80% Load	2,500 cfh
(4)	Speed	18 rpm
(5)	Drive	2 Hp
(6)	Motion Sensor	Shaft mounted

Andritz Sprout-Bauer MST Modular Rotary Valve



Andritz Sprout-Bauer's modular rotary valves offer a wide range of sizes, models and materials of construction for versatile use in most pneumatic conveying and feeding systems. Andritz Sprout-Bauer valves provide rugged, trouble-free performance as feeders and air locks in both vacuum and low-pressure positive systems.

Andritz Sprout-Bauer's modular concept lets you stock fewer parts, reducing inventory costs. And Andritz Sprout-Bauer backs its valves with experienced service technicians and fast, dependable delivery of valves, systems and replacement parts.

Abrasive and Corrosive Systems

For abrasive applications, the rotor shrouds and the bore of the housing can be hard-surfaced with a variety of abrasive resistant coatings and inlays, including an ⅛-inch stellite-lined housing for extremely abrasive conditions. Highly corrosive-resistant alloys are also available.

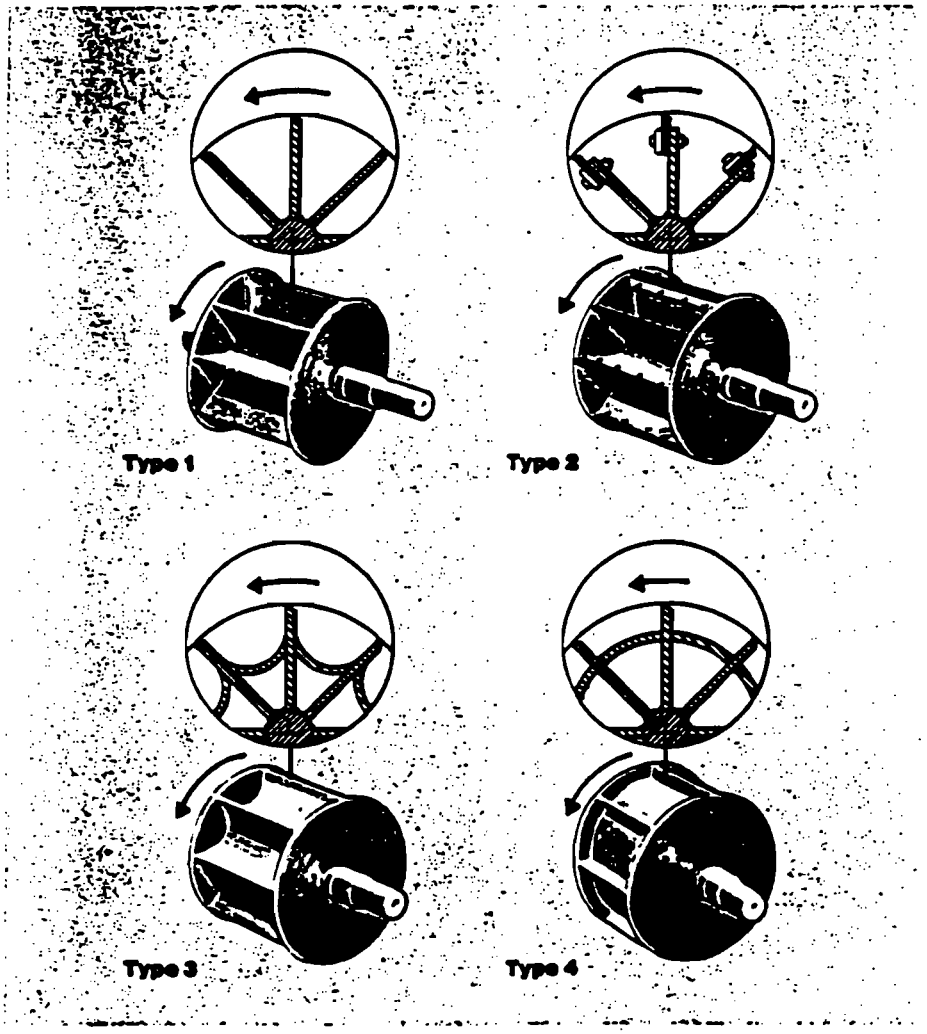
The split packing gland allows easy access to the stuffing boxes, where a minimum of three to four rings of packing maintains a proper seal. When the product is abrasive or difficult to seal, a lantern ring is available. Compressed air is piped into the lantern ring at a pressure one to two pounds above the valve's internal pressure.

Options

Modular rotary valves are usually equipped with enclosed roller chain drives, parallel shaft motor and reducer or gear-motor drive packages. Other options include:

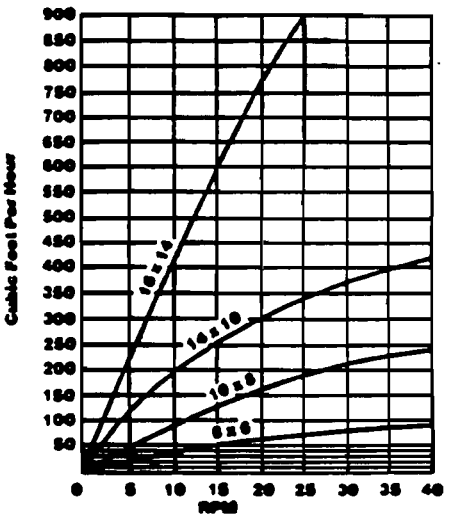
- right-angle gear motors
- variable speed drives
- weather-tight or oil-tight drives
- motion switches
- shearpin sprockets
- lantern rings

Andritz Sprout-Bauer Rotors



- Eight pockets per rotor
- Type 2 features adjustable tips for close rotor-to-housing clearances, peak valve efficiency and maximum life. Tips are manufactured in abrasion-resistant steel, stainless steel and Ni-hard. Tips are also available in brass, neoprene, teflon and polyurethane.
- Shroud (end plate) periphery, vane edges and adjustable tips may be hard-surfaced to minimize the effects of abrasive materials on the rotor.

Side Inlet Valve Curve



Rotor Displacement (dimensions in inches)									
ROTOR SIZE (DIA. X LENGTH IN INCHES)	Rotor displacement in cu. ft./rev.				NORMAL AIRLOCK RPM*	MAXIMUM RECOMMENDED FEEDER RPM*	NORMAL REQUIRED HP*	APPROXIMATE WEIGHTS (lbs.)	
	Type 1	Type 2	Type 3	Type 4				VALVES	DRIVES
0806	.122	.116	.063	.032	45	25	½	173	100
1008	.29	.27	.130	.070	45	25	¾	245	125
1410	.70	.65	.310	.155	45	25	1	443	185
1614	1.3	1.225	.650	.325	45	25	1½	640	250
2018	3.02	2.9	1.150	.575	35	25	2	1205	280
2422	4.95	4.92	2.30	1.15	31	25	3	2285	300

*Dependent upon characteristics of material handled.

SECTION 4

OPERATING CONDITIONS AND GUARANTEES

SECTION 4

4. OPERATING CONDITIONS AND GUARANTEES

A. OPERATING CONDITIONS - KILN/MILL PRECIPITATOR

Process - Type	Preheater Cement Kiln with Roller Mill Circuit	
Mode of Operation	Direct	Compound
Gas Volume ACFM	173,000	200,000
Gas Temperature °F	350	220
Inlet Particulate Loading gr/ACF	18	25
Dew Point°F	138	115
Collection Efficiency (percent removal)	99.96	99.97
Outlet Particulate Residual gr/ACF	0.007	0.007
Precipitator Gas Velocity (f.p.s.)	2.6	3.0
Time of Treatment (Sec.)	14.0	12.2
SCA (Ft^2 collecting surface per 1,000 ACFM)	349.4	302.2
Aspect Ratio	1.0	1.0
Pressure Loss (in. H_2O)	1.0	1.0

B. PERFORMANCE GUARANTEE

1. Direct Operation

With all electrical fields energized under normal conditions of operation with kiln only, as stipulated under "Operating Conditions", when passing 173,000 ACFM of gas through the precipitator, with an inlet loading of 18 gr/ACF or more, the efficiency is guaranteed to 99.96% removal.

Under identical conditions of operation, with an inlet particulate loading of 18 gr/ACF or less, the outlet particulate residual is guaranteed not to exceed 0.007 gr/ACF.

2. Compound Operation

With all electrical fields energized under normal conditions of operation with kiln only, as stipulated under "Operating Conditions", when passing 200,000 ACFM of gas through the precipitator, with an inlet loading of 25 gr/ACF or more, the efficiency is guaranteed to 99.97% removal.

Under identical conditions of operation, with an inlet particulate loading of 25 gr/ACF or less, the outlet particulate residual is guaranteed not to exceed 0.007 gr/ACF.

C. OPERATING CONDITIONS - Clinker Cooler

Process - Type	Clinker Cooler Exhaust	
Mode of Operation	Upset	Normal
Gas Volume ACFM	148,000	123,500
Gas Temperature °F	500	330
Inlet Particulate Loading gr/ACF	13	13
Moisture Content (% by volume)*	2 to 3	2 to 3
Collection Efficiency (percent removal)	99.95	99.95
Outlet Particulate Residual gr/ACF	0.007	0.007
Precipitator Gas Velocity (f.p.s.)	2.7	2.0
Time of Treatment (Sec.)	13.5	18.2
SCA (Ft^2 collecting surface per 1,000 ACFM)	337.4	404.3
Aspect Ratio	1.0	1.0
Pressure Loss (in. H_2O)	1.0	1.0

*Note: Additional moisture may be required.

D. PERFORMANCE GUARANTEE

With all electrical fields energized under normal conditions of operation with kiln only, as stipulated under "Operating Conditions", when passing 148,000 ACFM of gas through the precipitator, with an inlet loading of 13 gr/ACF or more, the efficiency is guaranteed to 99.95% removal.

Under identical conditions of operation, with an inlet particulate loading of 13 gr/ACF or less, the outlet particulate residual is guaranteed not to exceed 0.007 gr/ACF.

Attention is drawn to the fact that the material, workmanship and performance guarantee clauses are contingent upon the Buyer's assuring that the equipment is erected according to plans and specifications.

E. PERFORMANCE TEST

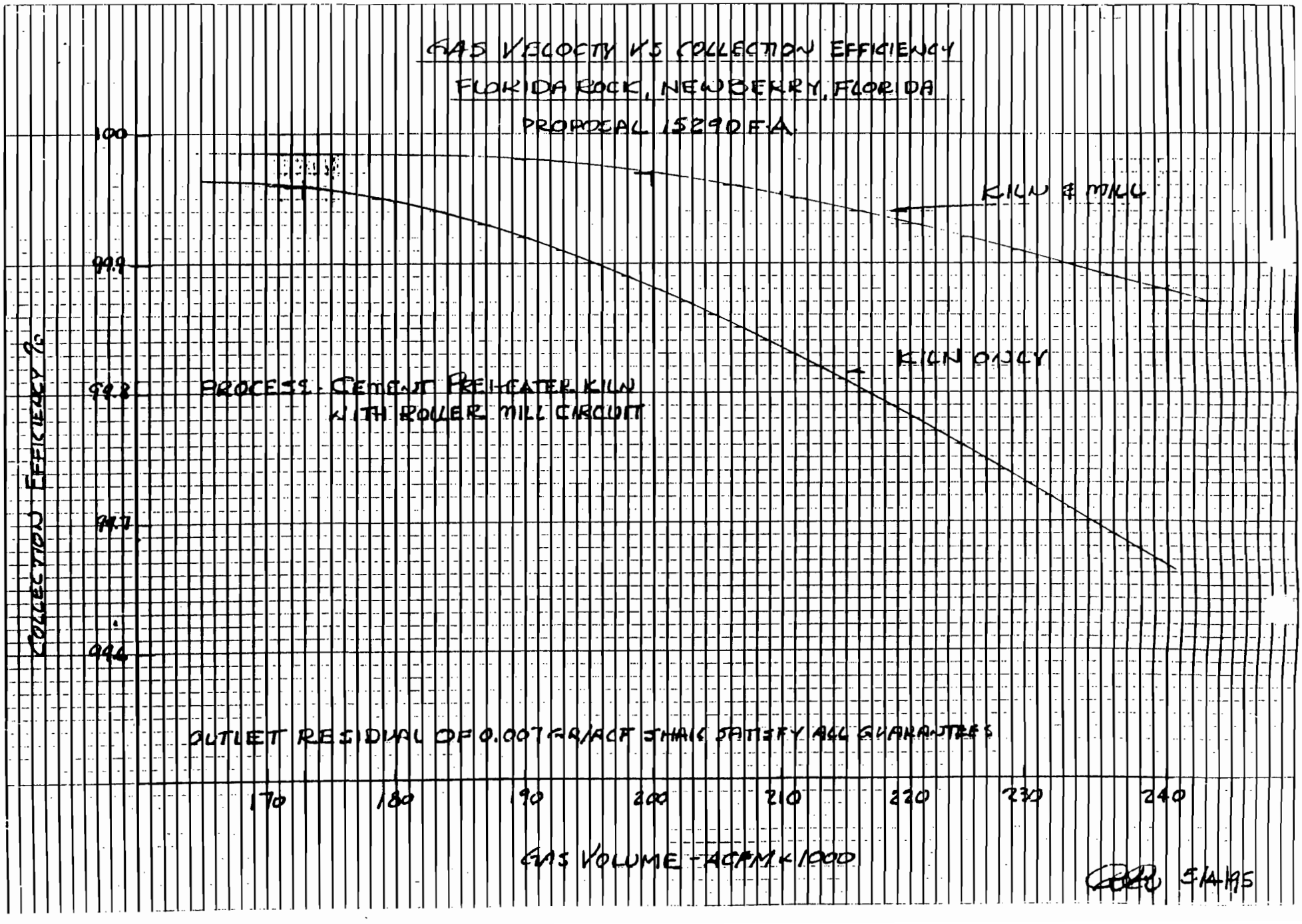
All particulate emission tests will be conducted in accordance with the methods set down by the Environmental Protection Agency in 40 CFR Part 60, Appendix A (Reference Methods), and any subsequent revision to these methods in effect on the date of this proposal. The EPA Method 17 will be used for inlet sampling and the dry, front half of the EPA Method 5 will be used for outlet sampling. Test ports with suitable access are to be furnished with inlet duct and outlet duct or stack to meet EPA and OSHA standards.

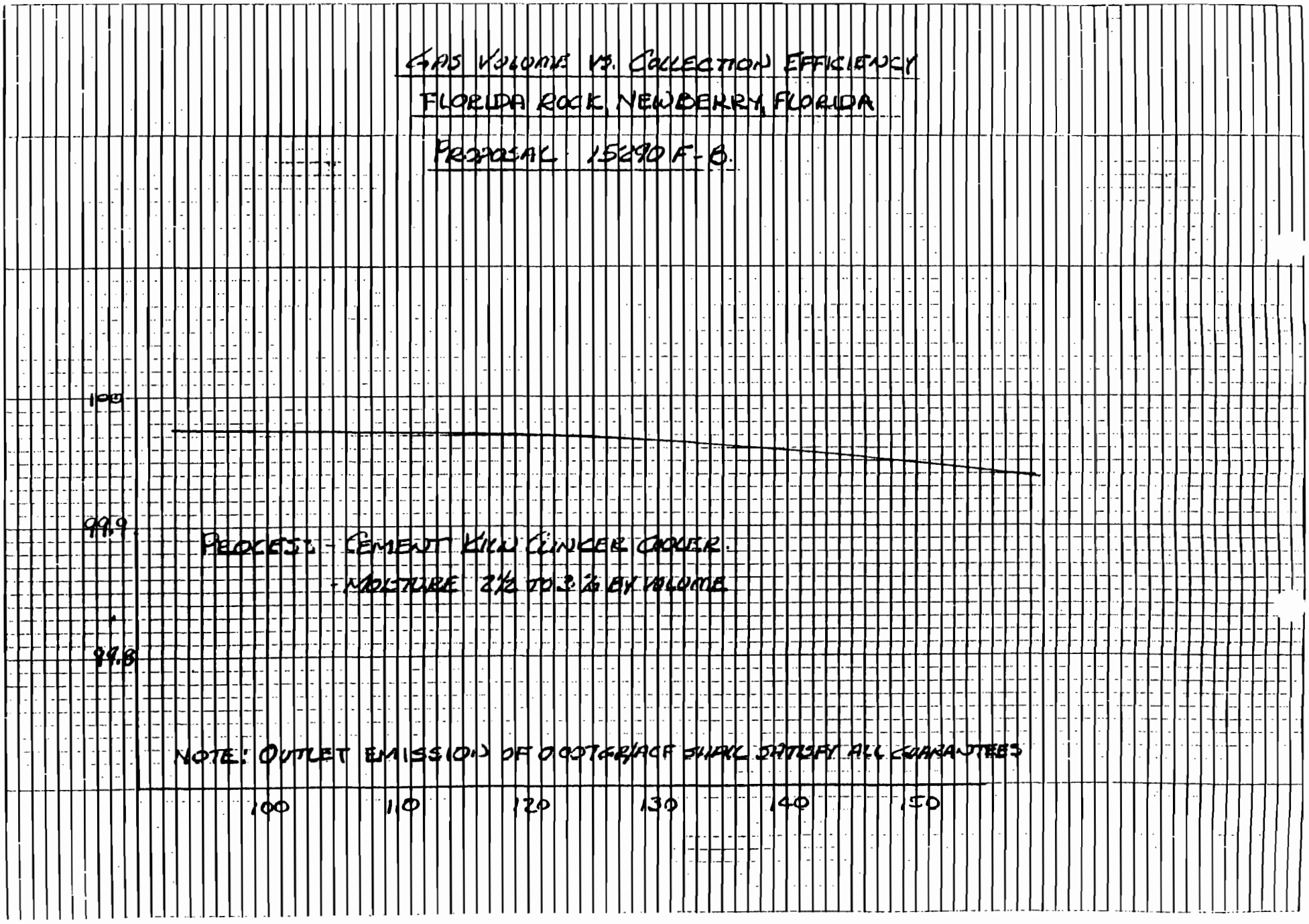
Performance tests will be conducted within ninety (90) days after the equipment is first commercially operated, but no later than (Later). Performance testing will be done by an independent testing company mutually acceptable to both Buyer and Seller. The cost of testing will be borne by Buyer. If, through no fault of Seller, performance test cannot be run within the time periods given above, the equipment will be treated as though the performance tests were run and the performance guarantees met.

The performance test shall be deemed "passed" when the Buyer and Seller have analyzed the test results and determined that equipment guarantee has been met. The test results will be available to the Buyer and Seller for said analysis within three (3) weeks after completion of testing. Whatever security Buyer has retained to secure compliance with the performance guarantee shall be due and payable to Seller immediately upon the determination that the performance test has been "passed".

Seller shall have the right to witness testing and to have access to all information acquired by said third party which is relevant to determining whether the equipment has passed the performance test. Seller does not assume the risk that the performance test will be improperly performed, or that tests results will be improperly computed. If, as a result of the fault of either Buyer and/or the third party responsible for conducting the performance test, the determination that the equipment has passed the performance test is delayed, the amount outstanding on the contract price, if any, shall be subject to a per diem interest charge at the maximum rate allowed by law, chargeable from the time the equipment would have passed the performance test but for said fault.

Compliance with the performance criteria on a majority of the tests performed shall constitute fulfillment of the performance guarantee. Seller shall have the right to make, at its own expense, any adjustments, changes, or additions to the equipment in an endeavor to obtain performance in accordance with the guarantee. If Seller in good faith determines that compliance with the performance guarantee is unobtainable, Seller shall forfeit its right to the funds or security retained by Buyer to secure equipment compliance with the guarantee, unless Buyer has not suffered actual damages which are recoverable hereunder.





SECTION 6

GENERAL CONDITIONS OF SALE FOR MATERIAL AND EQUIPMENT

SECTION 6

T&C Rev. 3/94

ENVIRONMENTAL ELEMENTS CORPORATION

COMMERCIAL REQUIREMENTS

1. Seller's Proposal

Seller is willing to negotiate with Buyer mutually acceptable terms. In the absence of such negotiations prior to issuance of a purchase order however, neither Seller's proposal nor Seller's commencement of performance hereunder is or shall be construed to be an acceptance in whole or in part of any terms proposed by Buyer. Seller's proposal is an offer conditioned upon acceptance by Buyer of all, and only, those commercial terms set forth in Seller's proposal and the technical specifications set forth in Buyer's request for proposal as modified by Seller's proposal. Seller objects to any different or additional terms.

2. Mutuality

Whenever any provision of this contract provides that Buyer or a delegate of Buyer may unilaterally interpret the contract, resolve contractual disputes, or modify the scope of supply or time of delivery, the contract interpretation, dispute resolution, or modification can only be accomplished by written agreement between Buyer and Seller. Seller shall be entitled to all costs, both direct and indirect, incurred in performing any modification to the scope of supply or time of delivery together with reasonable allowances for overhead and profit.

Buyer and Seller promise to act in good faith and with reasonable care in performing their respective obligations under this contract including the obligations set forth above, to mitigate any damages which may be incurred, and to not unreasonably withhold any consent or approval which must be obtained by the other. Acting in bad faith or unreasonably shall constitute a material breach of this contract.

3. **Termination and Suspension**

Neither party may terminate this contract for cause on grounds less substantial than the other's material breach of this contract. Nor may either party terminate unless and until the other party has failed and refused to cure or commence curing said breach within a reasonable time of receipt of written notice specifying said breach.

If this contract permits the suspension of Seller's work by Buyer, Seller shall be entitled to all reasonable costs, direct and indirect, incurred as a result of the suspension, in addition to whatever compensation Seller would otherwise be entitled to, plus the reasonable cost associated with Seller's remobilization at the end of a suspension period.

4. ***Indemnification***

All of Seller's indemnification obligations are contingent upon Seller's receipt of prompt written notice of any suit to which Buyer asserts a right to indemnification under this contract, Buyer's relinquishment of control of said suit, including the settlement thereof, to Seller, and Buyer's assistance in preparing Seller's defense thereto.

Seller's obligation to indemnify for personal injury or property damage, and for costs of suit and attorney's fees is conditioned upon its negligence being the cause of the injury which forms the basis of the Buyer's liability and only then to the extent of such causation. Buyer shall indemnify Seller for all costs and attorneys' fees incurred by Seller if Seller is brought into any action by Buyer and it is determined that Seller's negligence was not the cause of the injury which forms the basis of the Buyer's liability.

5. **Warranty and Guarantees**

Seller warrants that the equipment shall be free from defects in materials and workmanship. Seller's warranty obligations are conditioned upon payment for the work; receipt of prompt written notice within the warranty period specifying the breach; maintenance and operation of the equipment in strict accordance with Seller's written advice and instructions, generally accepted industry practices, and specified operating conditions. ANY WARRANTY WHICH OTHERWISE MIGHT BE IMPLIED, INCLUDING MERCHANTABILITY OR FITNESS FOR INTENDED OR PARTICULAR PURPOSE, IS DISCLAIMED. Any statement by Seller, including any statement in Seller's proposal, with respect to estimated equipment life is for informational purposes only and is not to be relied upon or construed by Buyer as a warranty. Seller's equipment is not warranted against the consequences of abrasion, corrosion, or erosion and is not warranted to comply with any air pollution control code, regulation, ordinance, or order of court. Replacement parts shall be warranted for the unexpired portion of the original warranty period. In the event of a breach of warranty, Seller's sole obligation shall be to repair or replace, at its option, (F.O.B. destination point if installation is by others, in place if installation is by Seller) the nonconforming equipment or work. Seller's warranties shall expire not later than twelve months from installation. In the event that Seller's scope hereunder is limited to the provision of engineering services, Seller's sole obligation in the event of defect in its engineering service shall be to provide corrected engineering drawings.

Seller guarantees that the equipment, when tested at the times and as specified in Seller's proposal, will meet or exceed the performance criteria set forth in the technical portion of this contract. This guarantee is expressly conditioned upon: proper fabrication, storage and installation of the equipment to the extent that fabrication of any component or installation is by others, which includes compliance with all advice given by Seller's construction representative; provision to Seller and its construction representative of a reasonable opportunity to inspect the equipment throughout its delivery, storage, installation, maintenance and operation; maintenance and operation of the equipment, at all times prior to and during testing and during the warranty period, in strict accordance with Seller's written advice and instructions, Seller's operation and maintenance manual, conditions set forth by Seller in its proposal, generally accepted industry practices, and Buyer's specified operating parameters; and good and satisfactory operating condition of existing structures and, if Seller's contract is for repair or replacement, of existing components not replaced hereunder by Seller. The failure of any condition stated above or elsewhere in this contract to the performance guarantee shall cause the rights and duties of both parties to enure to each under this contract as if Seller has demonstrated compliance with the guarantee; and the purchase price including retention shall be immediately due and payable.

Buyer shall schedule performance tests as soon as possible after the equipment is installed, whether or not the equipment is to be put into immediate service. Testing of the equipment shall be done simultaneously and in conjunction with any process equipment tests if possible. Conducting the performance test within ninety (90) days after the equipment is installed shall be a condition to the guarantee. Seller and Buyer shall mutually select a qualified third party to conduct the performance tests. The performance test shall be conducted in compliance with the test methods set forth in Seller's proposal and shall be deemed "passed" when the third party responsible for conducting the test has issued a statement to the Buyer indicating the fact that the equipment has met guarantee, but no later than five (5) calendar days after said third party is in possession of information, indicating the fact that the equipment has met guarantee. Whatever security Buyer has retained to secure compliance with the performance guarantee shall be due and payable to Seller immediately upon the determination that the performance test has been "passed". Seller shall have the right to witness testing and to have access to all information acquired by said third party which is relevant to determining whether the equipment has passed the performance test. Seller shall have the right to make, at its own expense, any adjustments, changes, or additions to the equipment in an endeavor to obtain performance in accordance with the guarantee. If Seller in good faith determines that compliance with the performance guarantee is unobtainable, Seller may, at its option, forfeit its right to the funds or security retained by Buyer to secure equipment compliance with the guarantee, and Seller shall have no further liability or obligation hereunder with regard to warranty or performance guarantee.

6. **Limitation and Liquidation of Damages**

Under no circumstances shall Seller's liability in the aggregate to Buyer on any grounds including breach of contract, or warranty, or commission of any tort, including negligence and strict liability, or repair, replacement, or other corrective work, exceed fifty percent (50%) of the price of this contract.

Seller will not be liable for liquidated damages unless the amount is specifically stated on the face of any Purchase Order, and will furthermore not be liable for special, consequential, indirect or incidental damages, and Buyer hereby assumes the risk thereof, regardless of whether said damages

are based upon Seller's breach of contract, or warranty, or commission of any tort including negligence or strict liability. Seller's liability shall be reduced to the extent of any insurance proceeds Buyer has received on account of Seller's breach of contract or warranty, or commission of any tort.

In the event that this contract requires that liquidated damages be paid by Seller for late delivery, such liquidated damages shall be Buyer's sole and exclusive remedy for Seller's failure to timely deliver and such liquidated damages shall not be due and payable unless Buyer has incurred actual damages, in excess of nominal damages, solely as a result of Seller's delay.

7. **Schedule and Changes**

All prices are predicated on the assumption that Seller may conduct work on any schedule that will result in drawings submitted, equipment deliveries, and installation if applicable, as given in Seller's specification. Seller shall conduct the work on any other feasible schedule which the Buyer desires, provided Buyer reimburses Seller for all extra costs resulting from such schedule. Seller's contract schedule is conditioned upon Buyer timely meeting its obligations under the Contract Documents and upon the conditions, if any, set forth by Seller in its proposal.

Buyer shall have responsibility to properly coordinate the work of Seller with that of other subcontractors and shall be responsible to Seller for delays and damages occasioned by its failure to so properly coordinate the work.

Seller is excused from performing this contract for the period of time required to overcome the effects of any Act of God, war, riot, fire, explosion, flood, strike, lock-out, injunction, delay or unavailability of a common carrier, inability to obtain raw material, delay or breach by any entity to which any part of Seller's performance has been delegated (provided that such occurs without the fault of and despite the due diligence of Seller), or any cause reasonably beyond the control of Seller. Seller shall be entitled to reimbursement for its costs associated with overcoming the effects of any said cause to the extent that said costs are allocable to this contract.

Seller shall be entitled to an equitable adjustment in the contract price and time occasioned by any change order; by any act, omission, or delay by Buyer, Owner, Engineer, or any representative thereof in, among other things, providing site access, reviewing and approving submittals, providing any power, water, equipment or other materials or services required to be provided, or ordering that work stop for any cause not the fault of the Seller, in issuing interpretations of the contract, or in failure to make payments; or occasioned by any changed site conditions, or by any site conditions not discoverable by the exercise of Seller's reasonable engineering diligence at the time of submission of its proposal. The Seller shall be under no obligation to carry out any change order unless and until any equitable adjustment to the contract price and time has been agreed upon between the parties.

8. **Backcharges**

Buyer may withhold from any payment then due Seller an amount reasonably necessary to correct any of Seller's defective work, provided that it is a condition to said right to withhold payment that Buyer gives Seller prompt notice of the defect and reasonable opportunity to cure the defect.

Buyer shall thereafter make prompt payment of the amount withheld to Seller immediately upon Seller's correction of the defect.

In the event extra field work is being performed by Buyer or by others with the consent of Seller or as set forth above, Seller shall reimburse Buyer's reasonable and necessary costs as follows: (i) actual cost of hourly paid field labor, plus ten percent, for labor hours for which time sheets have been signed by Seller, together with applicable insurance and taxes only, with no reimbursement for salaried personnel; (ii) actual cost of materials or supplies, plus ten percent, for material charges supported by a material receipt or invoice; (iii) seventy percent of the unit rates published in the A.E.D. publication or local equivalent for welding machines and similar equipment, two percent of labor cost for small tools, with no reimbursement for crane or crane operator charges.

9. **Compliance with Laws**

Seller agrees to furnish the goods and services purchased under this contract in accordance with applicable federal and with contract-specified state and local law as it exists at the time of this contract's formation. To the extent that Seller incurs costs in furnishing the goods and services hereunder as a result of complying with laws, regulations, or ordinances enacted subsequent to the formation of this contract, and such costs would not otherwise have been incurred, Buyer agrees to reimburse such costs to Seller.

10. **Confidential Information**

Buyer shall treat as confidential all information which may be furnished to it, either directly or indirectly, by Seller and may use such information only for the purpose of enabling Buyer to determine whether it is desirous of purchasing the equipment from Seller and enabling Buyer to operate and maintain the equipment. Buyer shall not disclose such confidential information to any third party, including any affiliate of Buyer, except to those of its employees who require knowledge of the same and who have agreed with Buyer and, if required by Seller, with Seller to safeguard the confidential nature of such information to the same extent as Buyer is obligated hereunder. Buyer shall employ restrictive legends on all documentation and further take all other reasonable measures to avoid wrongful disclosure by its employees. Buyer shall use the same degree of care with respect to such documentation and confidential information as it would normally use in protection of its own confidential and proprietary information.

11. **Site Conditions**

Buyer acknowledges that Seller is relying upon the accuracy of Buyer's specifications and design information, and that Seller has not endeavored to independently verify the accuracy of either.

Seller does not assume the risk of any latent site conditions which were undiscoverable prior to this contract's formation by Seller's exercise of reasonable diligence.

12. **Price and Payment**

Buyer shall make payments to Seller promptly per Seller's payment terms set forth in its proposal. If no payment terms are set forth in Seller's proposal, Buyer shall make payments to Seller

monthly, commencing with the date of receipt of order or notice to proceed, within thirty (30) days after receipt of Seller's invoice reflecting estimated value of the work performed to date.

If for any reason not the fault of Seller, Seller does not receive a progress payment from Buyer within seven (7) days after the date such payment is due, then Seller, upon giving an additional seven (7) days' written notice to Buyer, and without prejudice to and in addition to any of his other legal remedies, may stop work. The Contract Price shall be increased by the amount of the Seller's reasonable costs of shut-down, delay, and start-up, which shall be effected by appropriate change order. If Seller's work has been stopped for thirty (30) days because Seller has not received progress payments as required hereunder, the Seller may terminate this Contract upon seven (7) days' written notice to Buyer, and recover from Buyer payment for all costs to date of termination, plus reasonable overhead, profit, damages, and attorneys fees.

The portion of any payment due to Seller not paid when required to be paid shall be deemed delinquent, and shall bear interest from the date payment should have been made until paid at the rate of 1.2 percent per month or portion thereof. In the event that acceptance is delayed for any reason not the fault of Seller, the retain shall accrue interest at the rate of 1.2 percent per month or portion thereof for the time acceptance would have occurred but for such delay until paid.

13. **Inspections**

Seller shall afford Buyer, at all reasonable places and times, and upon seven (7) days written notice, opportunity to inspect all equipment and work manufactured, fabricated, or procured hereunder. After such inspection, whether prior to or upon tender, Buyer's failure to advise of any nonconformity which would have been discoverable by a reasonable inspection shall constitute a waiver of such nonconformity for all purposes. Otherwise, Buyer's acceptance of or right to reject the equipment, and the rights and obligations of Buyer and Seller upon acceptance or rejection, shall be determined by application of the Uniform Commercial Code.

14. **Miscellaneous**

The Seller may subcontract portions of the work covered under this contract, provided that Seller shall remain liable to Buyer for any work so subcontracted.

In the event Seller should employ an attorney to enforce any of the provisions hereof, to protect its interest in any matter arising under this contract, or to collect damages for the breach by Buyer of this contract, Buyer shall reimburse Seller for all attorneys' fees, expert fees, and other litigation or arbitration costs paid or incurred by the Seller, to the extent that Seller prevails in whole or in part.

Seller shall not be required to commence or to proceed with work, or the affected area of the work, if there is present asbestos, polychlorinated biphenyls (PCB's), or other hazardous material, or any material containing any of them ("Hazardous Material"), and Buyer shall indemnify and hold harmless Seller from and against any loss, damage, liability or expense arising out of or in connection with the presence of Hazardous Materials, or in connection with any testing, or requirement of testing to determine the presence or absence of Hazardous Materials.

The contract between the parties shall consist of the following documents, listed in order of priority, and in the event of inconsistency among any of them the terms of the first listed document shall prevail: (i) Seller's proposal, including these commercial exceptions; (ii) Seller's drawings prepared pursuant to this contract, to the extent such drawings are not more stringent than Buyer's request for proposal; and (iii) Buyer's request for proposal (collectively, the "Contract"). The Contract constitutes the entire agreement between the parties and there are no representations, warranties, covenants or obligations except as set forth therein.

SECTION 7

BUYER'S SPECIFICATION EXCEPTIONS AND CLARIFICATIONS

SECTION 7

7. BUYER'S SPECIFICATION EXCEPTIONS AND CLARIFICATIONS

This equipment is being offered in compliance with Specification Inquiry No. 6823-0G-004 dated April 13, 1995 which hereby is made a part of this proposal subject to the exceptions and clarifications listed below.

Item 3.3 Specification allows conveyor speed up to 50 rpm which provides a very high wear rate and excessive precipitator outage for repair. Seller has restricted conveyor speed to 25 rpm to provide reasonable service life since the precipitator must be taken out of service for conveyor repairs.

SECTION 8

INSTALLATION LIST

AIR CLEANING SYSTEMS

Recent Rock Product Precipitator Installations Dry and Wet Process Rotary Cement Kilns and Mills

INSTALLATION LIST

Air Cleaning Systems Group
P.O. Box 1318; 3700 Koppers Street
Baltimore, Maryland 21203
Telephone: 301-368-7222

COMPANY	PROCESS/PLANT	EQUIPMENT
Ash Grove Cement Company Kansas City, Missouri	Dry, Louisville, Nebraska	1 Precipitator on Grate-Preheater Kiln (1975)
Climent Quebec, Inc. St. Basil Cte Portneuf Province of Quebec, Canada	Dry St. Basil Cte Portneuf Province of Quebec, Canada	4 Precipitators on 4 stage Suspension Preheater in Circuit with Roller Mill (1981)
Dundee Cement Company Dundee, Michigan	Wet Dundee, Michigan	2 Precipitators on Kilns #1 and #2 (1972)
Empresa Industrias Guapan, S.A.Ecuador	Dry Azogues, Ecuador	1 Precipitator on 4 stage Suspension Preheater in Circuit with Roller Mill (1980)
General Portland, Inc. Dallas, Texas	Wet Paulding, Ohio	2 Precipitators on Kilns #1 and #2 (1967)
	Wet Fredonia, Kansas	2 Precipitators on Kilns #1 and #2 (1974)
	Dry New Braunfels, Texas	1 Precipitator on 4 stage Suspension Preheater with Flash calciner, in Circuit with Roller Mill (1980)
	Alkali Bypass New Braunfels, Texas	1 Precipitator (1980)

ENVIRONMENTAL ELEMENTS CORPORATION

COMPANY	PROCESS/PLANT	EQUIPMENT
Lehigh Portland Cement Co. Allentown, Pennsylvania	Dry Mason City, Iowa	2 Precipitators on kiln #7 (1957)
	Dry Union Bridge, Maryland	2 Precipitators each on Kilns #1, #2, and #3 (1956) 1 Precipitator following above 6 units (1974)
	Dry Mitchell, Indiana	1 Precipitator on #3 single stage Suspension Preheater Kiln (1976)
Lehigh Portland Cement Co. Allentown, Pennsylvania	Dry Leeds, Alabama	1Precipitator on 4 stage Suspension Preheater in circuit with Roller Mill, high suction (1975)
	Calcium Aluminate Buffington, Indiana	1 Precipitator on Rotary Kiln (1970)
Lone Star Industries Greenwich, Connecticut	Wet Bonner Springs, Kansas	1 Precipitator on Kiln #4 (1969) 2 Precipitators on Kilns #1, #2, and #3 (1970)
	Dry Roanoke, Virginia	1 Precipitator each on Kilns #1 and #2 (1951) 1 Precipitator each on Kilns #3 and #4 (1953 & 1956) 1 Precipitator on Grate-Preheater Kiln #5 (1975)
	Raw Mills Roanoke, Virginia	2 Precipitators on 2 Roller mills, high suction (1975)
	Wet Pennsuco, Florida	1 Precipitator each on Kilns #1 and #2 (1969) 1 Precipitator each on kilns #3 and #4 (1975)
	Clinker Cooler Pennsuco, Florida	1 Precipitator each on Kilns #1 and #2 (1969)

COMPANY	PROCESS/PLANE	EQUIPMENT
Lone Star Industries Greenwich, Connecticut	Dry Davenport, California	1 Precipitator on 4 stage Suspension Preheater with Flash Calciner, in circuit with Roller Mill high suction (1980)
	Alkali Bypass Davenport, California	1 Precipitator (1980)
	Wet Neville Island, Pennsylvania	1 Precipitator on Kiln #1 (1963)
Louisville Cement Company Louisville, Kentucky	Dry Speed, Indianna	1 Precipitator on 4 stage Suspension Preheater in circuit with Roller Mill Circuit, high suction (1977)
Louisville Cement Company Louisville, Kentucky	Alkali Bypass Speed, Indianna	1 Precipitator (1977)
Medusa Cement Cleveland, Ohio	Dry Wampum, Pennsylvania	2 Precipitators on Kilns #1 and #2 (1979) Follows existing precipitators
National Cement Company Birmingham, Alabama	Dry Ragland, Alabama	1 Precipitator on Kiln #1 4 stage Suspension Preheater with flash Calciner, in circuit with Roller Mill (1977)
	Alkali Bypass Ragland, Alabama	1 Precipitator (1977)
River Cement Company St. Louis, Missouri	Dry Festus, Missouri	1 Precipitator on Kiln #2 (1968)
	Dry Festus, Missouri	2 Precipitators on Kilns #1 and #2 (1981) Follows existing precipitators

COMPANY	PROCESS/PLANE	EQUIPMENT
Signal Mountain Cement Co. Chattanooga, Tennessee	Wet Chattanooga, Tennessee	1 Precipitator on Kiln #5 (1964) 1 Precipitator on Kiln #3 (1971)
SME Cement Inc. Middle Branch, Ohio	Dry Middle Branch, Ohio	1 Precipitator on Grate-Preheater Kiln
SME Cement Inc. Bessemer, Pennsylvania	Wet Bessemer, Pennsylvannia	1 Precipitator each on #4 (1968) and #5 (1966) kilns.
South Dakota Cement Rapid City, South Dakota	Wet Rapid City, South Dakota	3 Precipitators on Kilns #1 #2, and #3 (1968)
Southern Province Cement Company Gizan, Saudi Arabia	Dry Gizsan, Saudi Arabia	2 Precipitators on 2-4 stage Suspension Preheaters with Flash Calciners, in circuit with Roller Mill (1980)
Southern Province Cement Company Gizan, Saudi Arabia	Alkali Bypass Gizan, Saudi Arabia	2 Precipitators on 2 Kilns (1980)
State Cement Corp. Pakistan	Dry Javedan, Pakistan	1 Precipitator on 4 stage Suspension preheater in circuit with Raw Mill (1977)
	Alkali Bypass Javedan, Pakistan	1 Precipitator (1977)
	Cement Finish Mill Javedan, Pakistan	1 Precipitator (1977)

SECTION 9

ATTACHMENTS

ESI RAPPERS – IMPACT TYPE

The collecting surfaces and the discharge electrodes are both subject to dust buildup during normal precipitator operation. When such buildups occur, reduced electrical clearances develop inside the precipitation zone and decreased precipitator performance could result. Seller's ESI-I electric impulse rapper is provided to rap and dislodge the collected particulate from the collecting and discharge electrodes, as well as all perforated distribution plates. The ESI-I is a single impulse, gravity impact type rapper. It consists of an integral DC coil and housing assembly, a 20 pound piston and the associated mounting hardware. The rapper is mounted on 3 lengths of all-thread and is designed as a completely weatherproof unit. The rapper, as installed, weighs 37 pounds (20# piston and 17# barrel and coil).

Rapping impact occurs when the piston falls and strikes a steel rapper rod. The rapper rod rest on an anvil which transmits the rapping energy directly into the dust plates. The discharge electrodes are rapped in the same way. Rapping energy is transferred from the falling piston to the discharge electrodes through epoxy filled glass filament insulator rods. The entire discharge electrode matrix need only be rapped at the support points, typically two per field. These rappers are automatically set to operate together as a pair. The intensity of impact is dependent on two (2) factors: (1) The rest position of the piston with respect to the rapper coil, and (2) the number of half line cycles applied to the rapper. The amount of piston insertion in the coil is simply adjusted by varying the height of the rapper on the all-thread. This is an adjustment that is made once for the particular precipitator application. Once the height adjustment is set the intensity of the impact can then be set on the rapper controller. The controller has programmable selections for each field that can be adjusted to apply the appropriate number of half line cycles to the rappers in that field. This adjustment is the only adjustment that would normally be required and can be duplicated and varied quite easily. Maximum output is limited to prevent excessive impacts.

RAPPER CONTROL SYSTEM

Introduction

The rapper control system is very important for efficient operation of an electrostatic precipitator. Since all electro-mechanical timers have inherent weaknesses, Seller offers a microprocessor based solid state rapper control system to control and monitor accurately the ESI-I rappers.

The solid state rapper control system is designed for maximum service life, minimum size and easy maintenance. It is ruggedly built to provide years of trouble-free service under the most severe conditions.

Control Cabinet

The rapper control system is contained in a single, pre-wired NEMA 4 weather-tight enclosure. The dimensions of the enclosure are 48 inches long by 36 inches wide by 16 inches deep.

The control system is a microprocessor-based programmable controller using plug-in industrial grade cards. All inputs and outputs are optically isolated, all connectors are pin and socket, and all IC's are socketed. The cards insert into a 19 inch card rack mounted in the control cabinet. Input system wiring to the circuit boards is done on the back plane of the card rack. Output wiring from the printed circuit boards is done through 20 amp, 500 volt DIN standard connectors. Control power for the programmable controller is through a 200 VA control transformer, and supply power for the rappers is through a 2 KVA step down transformer.

The card rack consists of the following plug-in printed circuit boards:

A. CPU Board: Contains the central processing unit, the logic power supply and the programmable memory chips. Each CPU board has a user selective unit address switch ant operating mode switch.

B. Auxiliary Board: Contains the failed rapper detection, remote program selection, alarm output and a real time of day clock.

C. DC Output Board: Contains sixteen (16) solid state outputs that convert 208 VAC line voltage into pulsed DC output for operating magnetic impulse rappers or magnetic vibrating rappers.

D. CCU Board - (Optional): Contains the ROM program that allows two (2) CPU cards to share a common fiber optic data link. Each CCU board has a user selective switch that permits switching between RS-232 and RS-422 interface.

E. RS Board - (Optional): Is a communications interface between the rapper panel and Data Management System/distributed control system.

Crystals are provided for independent, custom baud rates for RS-232 and RS-422 interfaces.

F. Terminal with Keyboard and Flat Display: (Note: The terminal is a stand alone unit connected to the CPU card.) There may be more than one (1) local terminal per system.

Control System Location and Reliability

The control panel may be mounted in any convenient location. For most installations it is located on top of the precipitator to minimize the wiring between the panel and the rappers. It is recommended that dusty or extremely humid areas be avoided. The rapper control system is designed to operate with operating temperatures between -25°C (-13°F) to 85°C (185°F). High reliability is achieved by the following:

A. 100% solid state components.

B. Microprocessor speed of one megahertz.

C. All parts are commercially available.

D. All IC's use sockets that are tin plated.

E. All printed circuit boards connectors are gold on gold, pin sockets.

Control System Operation

Separate timers are employed for the perforated plates, collecting surfaces and discharge electrode rappers. This permits the rapping on collecting surfaces and discharge electrode fields to be adjusted independently. Independent adjustment is absolutely essential since the rate of dust deposition on the collecting surfaces varies greatly from the inlet to outlet, and the rapping required to clean the discharge electrodes is significantly different from that required to clean the collecting surfaces.

The rappers for each collecting surface field are evenly spaced along the field perpendicular to the direction of gas flow. They are activated in sequence, one (1) collecting plate group at a time from one end of the field to the other. The sequence is a continuous cycle; as soon as a rapping sweep of a field is completed, the control returns to the first rapper and sweeps the field again. The discharge electrode rappers are activated in sequence from the inlet to the outlet fields. The collecting surfaces and discharge electrodes on the inlet portions of the precipitator are rapped more often than those on the outlet portion.

Other features of the microprocessor based rapper control system are:

A. The installation and operating programs are stored in static RAM while the main operating program is stored in ROM. This feature eliminates the need for an auxiliary D.C. power supply.

B. Selection of interweave: This feature prevents the simultaneous energizing of rappers that are marked for interweave regardless of rapping group or anti-coincidence group.

C. Fault Detection: This feature is a tremendous aid in troubleshooting the rapper system. It will detect the following:

1. Rapper ground faults which draw 100% or more of normal full-load current (short).

2. Rapper coil open circuit.

3. Intermittent faults which are neither open or shorted.

4. Disconnected wires.

5. SCR not turning on.

When any of the above faults occurs, the display will show "failed rapper", the failed rapper will be added to the failed rapper list and listed as open or shorted, and the fault relay will be energized. The fault relay has contacts which may be wired to a distributed control system and/or a remote annunciator panel.

Program

The rapper control has 100% memory retention of the field set variables without battery backup. The installer sets the installation parameters that customizes the control to each customer's specific system requirements. This password protected program can be modified at any time using the standard keyboard/display terminal. Typical installation program parameters are:

A. Address of auxiliary card.

B. Four digit operator access password.

C. Enable/disable failed rapper detection.

D. Specify failed rapper threshold.

E. Name of each field or group of rappers.

F. Number of rappers in each field.

G. First number of display in each field.

H. Type of rapper in each field.

I. Maximum lift or "on" time of the rapper.

J. Output wiring address for each field.

K. Enable/disable power off rapping.

L. Output wiring of power off rapping.

M. Interweaving rappers in different anti-coincidence groups.

N. Individual adjustment of each magnetic impact rapper lift.

The operating variables that are regulated by the rapper control system are:

A. Option to copy programs.

B. Program starting method (restart/blend/continue).

C. Rest time.

D. Name of each field or group of rappers.

E. Repeat or cycle time for each rapper field.

F. Power off rapping lead time (if applicable).

G. Rapper lift/on time for each field.

H. Rapper intensity (if applicable).

I. Number of impacts (if applicable).

J. Impact frequency (if applicable).

K. Rapper sequence ascending/descending.

L. Number of first rapper in each field.

M. Rest mode (min/max: rap field together or spread out over repeat time).

N. Rapper anti-coincidence with other rapper fields.

O. View field/anti-coincidence group duty.

The operator may also use the maintenance program. Typical parameters used are:

A. List of all the failed rappers and whether they are open, shorted or intermittent.

B. List of all rappers deliberately removed from the rapping sequence (bypass).

C. Manually test an individual rapper.

D. Manually or continuously cycle a rapper field.

These variables are easily adjustable using standard keyboard/display terminal. The terminal is readily accessible when the control cabinet door is opened. The rapper control system is adjusted for optimum performance by the Seller's field engineer during precipitator start-up. Any further adjustments will only require selecting an appropriate program.

Fiber Optic Link

Two (2) or more rapper controls may be linked together via fiber optic cable and connectors (CPU board to CPU board to CCU board). Each connected CPU is assigned an identifying number. When the controls are linked, they function together as one system. All the units terminal screens show the some information, and a key pressed at any terminal is relayed to the other units. In the "run" mode, anti-coincidence groups which include fields from more than one unit will operate normally (rappers will not be energized simultaneously).

DIGICON
AUTOMATIC POWER CONTROL FOR ELECTROSTATIC PRECIPITATORS

Introduction

Thyristors (SCR's) have superseded saturable core reactors as control elements for the electrical energization of modern electrostatic precipitators. This change was a result of the inherent advantages of the SCR.

Basically, a saturable core reactor is an electromagnetic or transformer-like device wherein the voltage available for precipitation is controlled by change in the reactor impedance, achieved by a change in reactor core saturation responding to a feedback signal from the precipitator. By its very nature, a saturable core reactor is of considerable size and weight, has measurable power (heat) loss and, most important, has considerable electrical inertia (i.e., impedance change as a result of control signal change is slow).

The SCR is a semiconductor or transistor-like device, and is basically a very fast off-on switch operating sixty (60) times a second in response to firing or gate pulses controlled from precipitator feedback signals. The SCR is inherently small in size and weight, consumes little power and most important, has little electrical inertia (i.e., change of state from off to on is almost instantaneous).

It is a basic tenet of precipitation that the highest collection efficiency results when the precipitator is energized at the highest usable voltage. Even on steady state industrial processes, conditions inside the precipitator are constantly changing as dust is precipitated and then rapped off into the hoppers for disposal. Therefore, the fast reacting SCR controller has the potential to produce improved collection efficiency over that attainable through the use of the slower saturable core reactor.

The ability of the SCR to fulfill its potential and actually raise collection efficiency, or conversely allow the use of smaller precipitators for a given efficiency, is totally dependent upon the quality and ingenuity of the design of the "brain" or sensor-controller system which provides the operating instructions or gate pulses to the SCR slave. Thus, an important conclusion: ALL SILICON CONTROLLED RECTIFIER AUTOMATIC POWER CONTROLS ARE NOT ALIKE. The mere substitution of an SCR controller for a saturable core reactor offers only the potential for improved performance if it is properly driven. This driver, or brain, of the system is usually a proprietary, and sometimes patented, package which will differ considerably in function and sophistication among the different equipment manufacturers. The fact that this difference exists is an important concept to be remembered by the potential Buyer when evaluating competitive equipment offerings.

DIGICON® OPTIPULSE™ AUTOMATIC POWER CONTROL SYSTEM

The DIGICON OPTIPULSE controller is a microcomputer based control used to regulate the power applied to a single T-R set. The control function integrates precipitator operating parameters (primary and secondary voltage and current) and precipitator sparking to operate the T-R set in the most efficient manner. The principal output of the controller is a selectable current or voltage signal. This signal feeds the firing circuit, which in turn gates the SCR's with a corresponding conduction angle and ultimately determines the level of secondary voltage inside the precipitator.

In the absence of precipitator sparking, the DIGICON OPTIPULSE controller will attempt to increase precipitator power until one of the following limits is reached:

Primary Current Rating of T-R
Secondary Current Rating of T-R
Full Conduction of SCR's
Secondary Voltage Limit

The secondary voltage limit is operator selectable using one of the two manual thumbwheel switches. Upon reaching any of the above limits, an LED indicator light on the front panel of the controller will illuminate.

In addition to the front panel LED indicators, the controller has a two (2) line 32 character alphanumeric Liquid Crystal Display (LCD) which presents a user-friendly interface to the plant operator. Controller faults, operating status and other information are presented in plain English.

In the presence of precipitator sparking, the DIGICON OPTIPULSE controller responds by quickly quenching the spark, then ramping the power back to automatically maintain the most efficient level of operation coincident with a selected spark rate limit. A thumbwheel setting on the front of the panel allows the operator to select the desired spark rate limit. The switch setting selected is a sparks per minute rate at which the controller will attempt to limit precipitator sparking. When a spark occurs, the controller will record the spark-over voltage and calculate the return slope and kickdown values required to achieve a spark rate as selected on the spark rate limit thumbwheel. Selecting a high spark rate limit will result in a correspondingly steeper slope and smaller kickdown after a spark occurs. High and low limits are programmed into the controller to prevent unrealistic response parameters.

The controller incorporates a number of features that protect the precipitator and transformer-rectifier. An undervoltage algorithm monitors the transformer-rectifier primary voltage. When the primary voltage drops below a predetermined setpoint, accompanied by primary or secondary current above a predetermined value for longer than 30 seconds, the T-R will be tripped off and the fault annunciated on the alphanumeric display. Trip points and set times are changeable within the program.

A spark counter, which updates every 6 seconds, displays an actual count of sparks per minute as opposed to an average spark rate. Should the T-R trip due to a high spark count, an overspark condition will be displayed along with the spark count that caused the trip.

To prevent possible damage to the T-R, the controller will also interrupt power and annunciate fault in the event an SCR phase imbalance is detected. Up to six (6) other alarms can also be annunciated through the controller.

The DIGICON OPTIPULSE controller has a supervised test or manual mode, allowing an operator to run the power up manually, while monitoring for overcurrent (exclusive of the Overcurrent relay), undervoltage, overvoltage and overspark. The controller will trip the cabinet if one (1) of these conditions occurs in the manual or test mode.

Some of the other important standard features of the DIGICON OPTIPULSE controller can be summarized as follows:

1. Secondary Voltage Control: With its advanced program, the DIGICON OPTIPULSE controller senses and adjusts secondary voltage, which is the most accurate indicator of precipitator operation.

2. Rugged Construction: The controller is housed in a dust-tight, NEMA 12 enclosure and is specifically designed for rigorous, industrial duty at electrostatic precipitator installations.

3. Custom Design: The DIGICON OPTIPULSE controller, including software and specialized input/output circuitry, are proprietary developments of Environmental Elements Corporation. It is a custom design, not an adaptation of an off the shelf item.

4. Non-Volatile Memory: The operating program is contained in EPROM and EEPROM type memory, as opposed to RAM type. The program in use is always retained on power loss, which eliminates the need for battery backups or auxiliary power sources.

5. Pre-Programmed: Complete programming is done prior to shipment at Seller's Technical Development and Services facility in Baltimore, Maryland. Should reprogramming be required in the event of a significant process or fuel change, it can be accomplished in the field by knowledgeable personnel.

   Although not required in normal application, a hand-held terminal is available to change any of the internal program parameters such as spark setback limits, power ramp rates and so forth. Access is through a hierarchal password system designed to give various levels of personnel different types of access. The inherent intelligence of the DIGICON OPTIPULSE controller will probably not require these parameters to be changed; however, the capability is still there. Any changes can be made on-line. A special command reloads the factory default parameters, if desired or required.

6. Self-Check: Upon energization, the controller automatically performs a self-check routine. Any problems found are annunciated on the alphanumeric display located on the front panel.

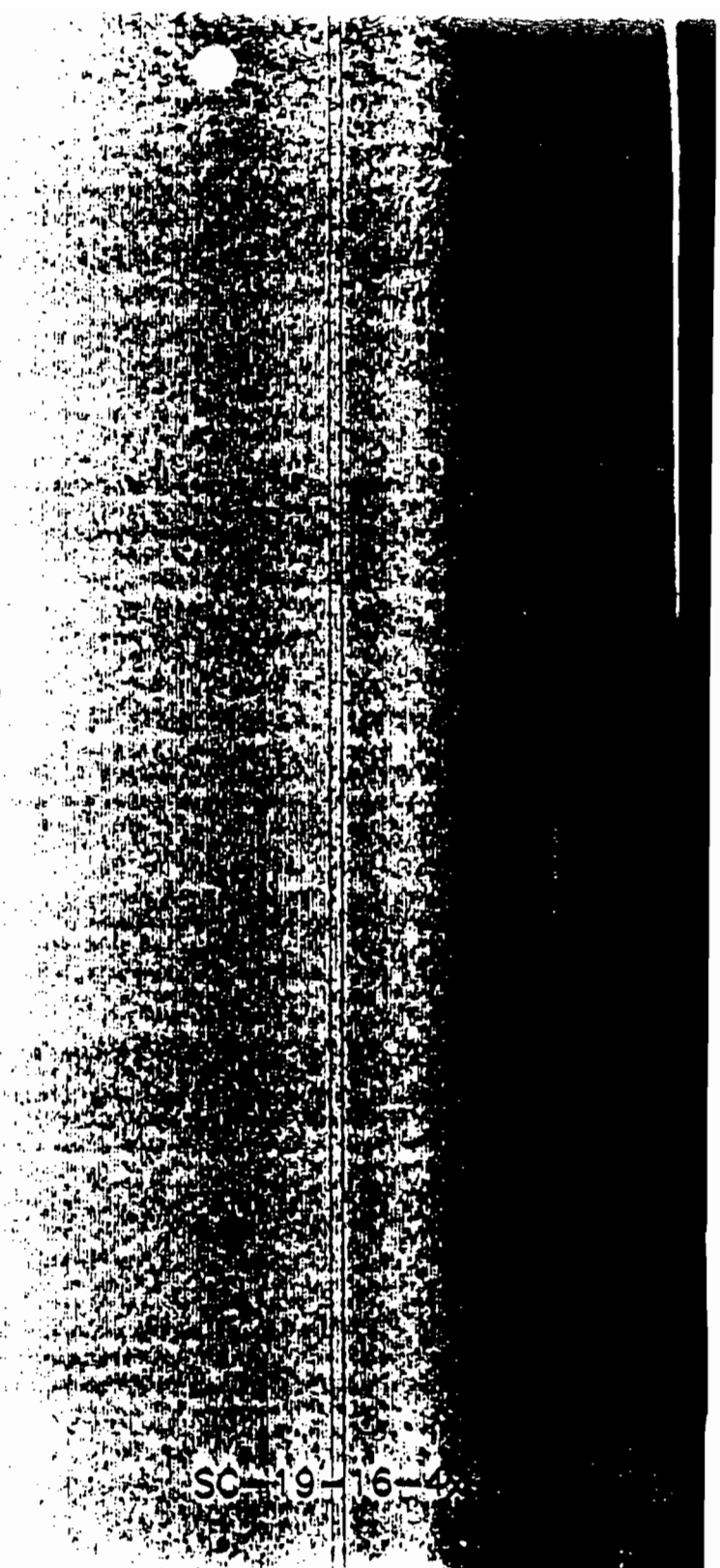
7. Ease of Maintenance: The controller utilizes plug-in circuit boards for ease of troubleshooting and repair. Neither Environmental Elements design philosophy nor the operation and maintenance manual assumes the requisite of computer expertise on the part

of plant maintenance personnel.

8. OPTIPULSE Intermittent Energization: For energy savings or for improved performance with high resistivity particulate, the *DIGICON OPTIPULSE* has an intermittent energization feature. This feature can be enabled by a front panel switch or remotely, if the proper software permissive is present. The number of cycles on and off can be varied via the hand held terminal. The amplitude of the pulses are automatically monitored and controlled by measuring the actual peak KV, the peak and average secondary current and the peak and RMS primary current. This is very important for T-R protection.

9. Expandable to the Data Management System: The controller is fully compatible with and becomes an integral part of Environmental Elements' modular Data Management System.

   In lieu of connecting to the Data Management System, the DIGICON OPTIPULSE controllers have a serial port which may be accessed directly by plant computers through a Buyer supplied gateway device thereby becoming part of a data highway.

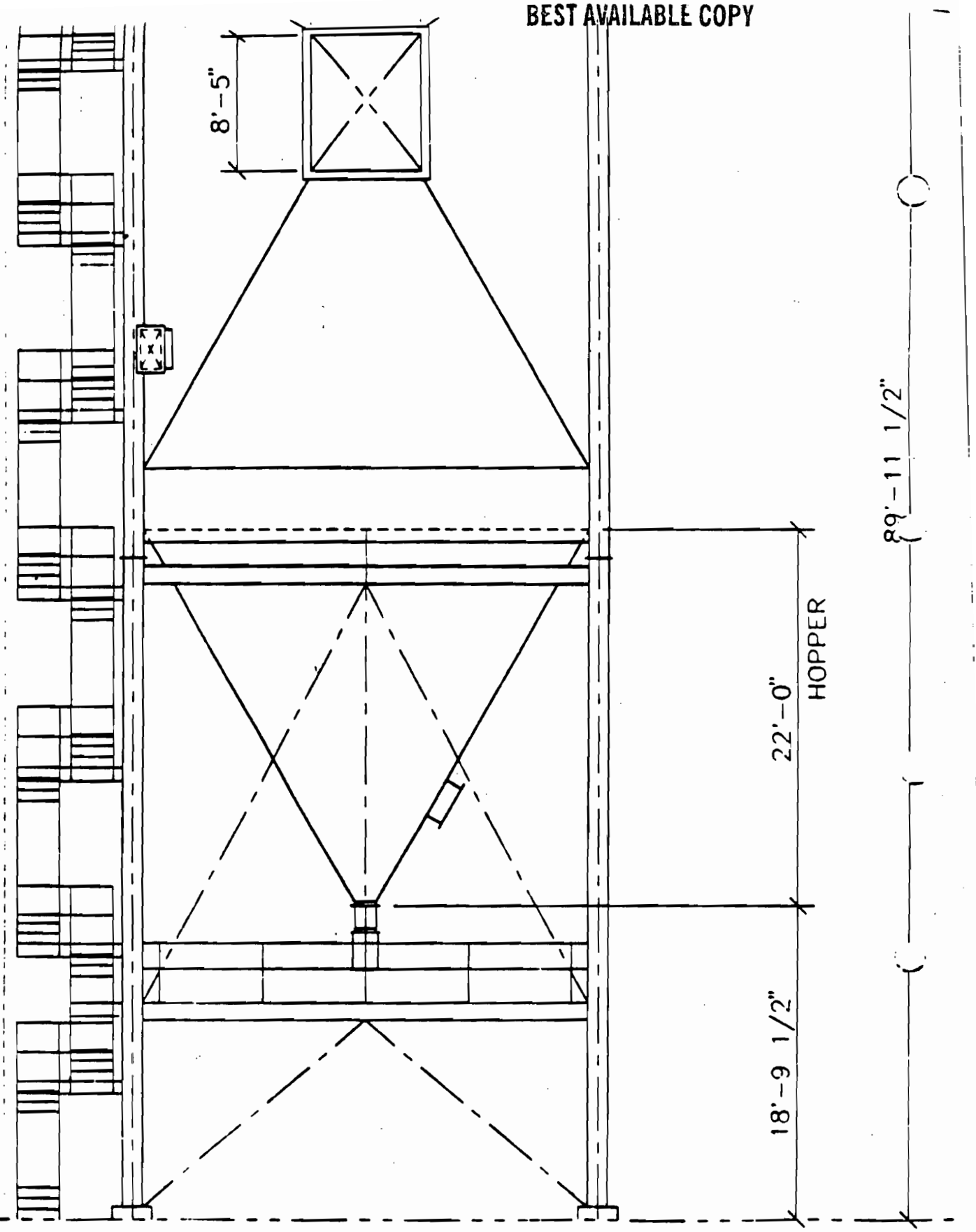


SC-19-16-4

NOTE: ALL DIMENSIONS ARE APPROXIMATE

ENVIRONMENTAL ELEMENTS CORPORATION	PRELIMINARY ARRANGEMENT POLYSIUS CORP. FOR FLORIDA ROCK NEWBERRY, FLORIDA	
DRAWN: TBT	SIZE D	DRAWING NUMBER: 15290-2110-D2
DATE: 04-25-95	SCALE: 1/8" = 1'-0"	SHEET: 1

LTR	DESCRIPTION	BY



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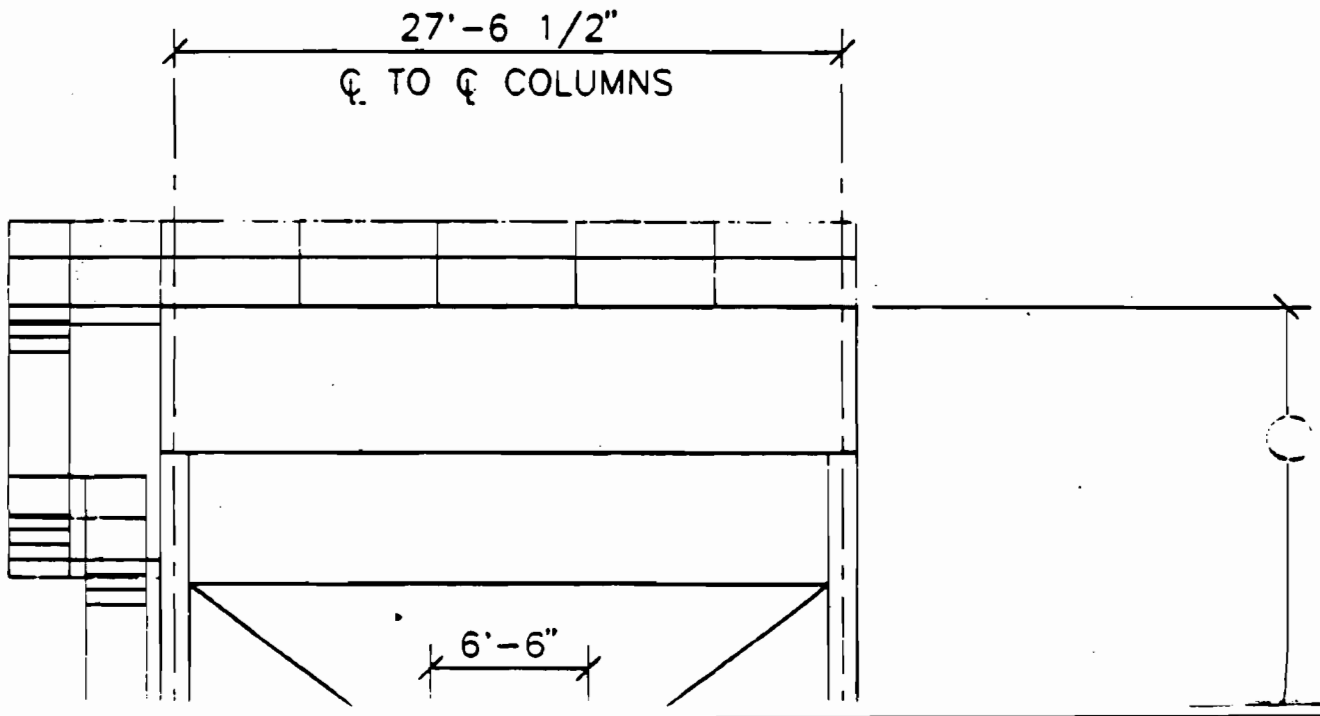

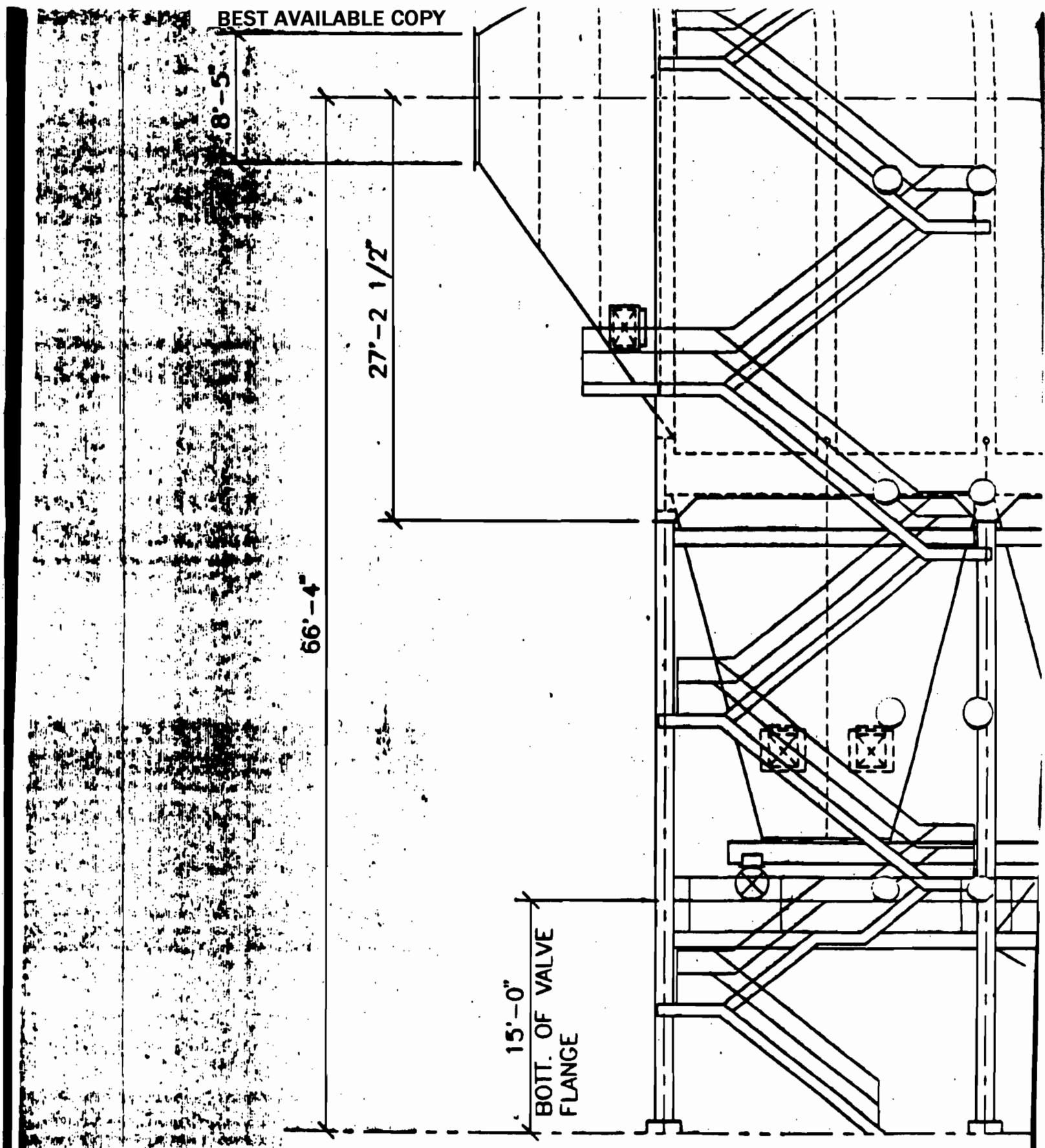

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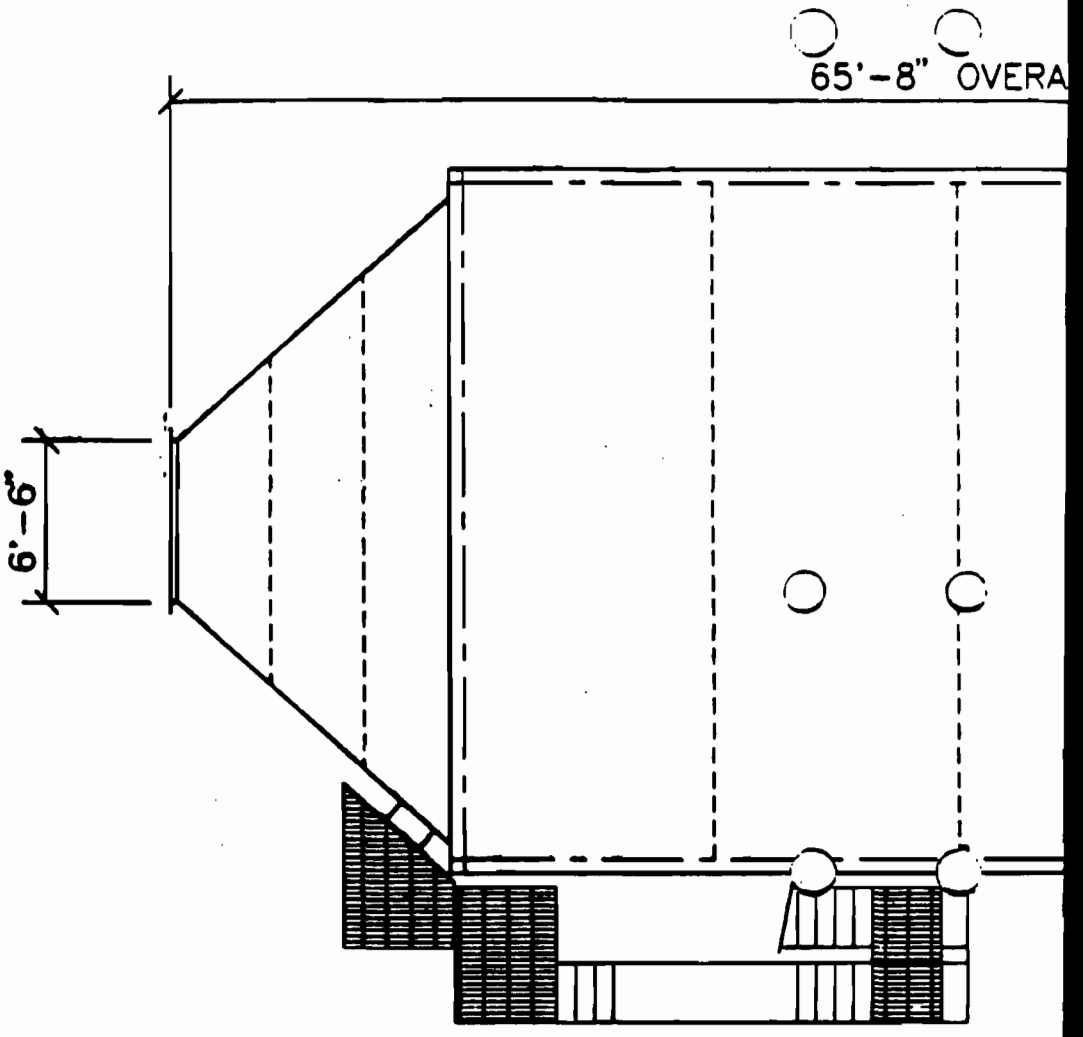
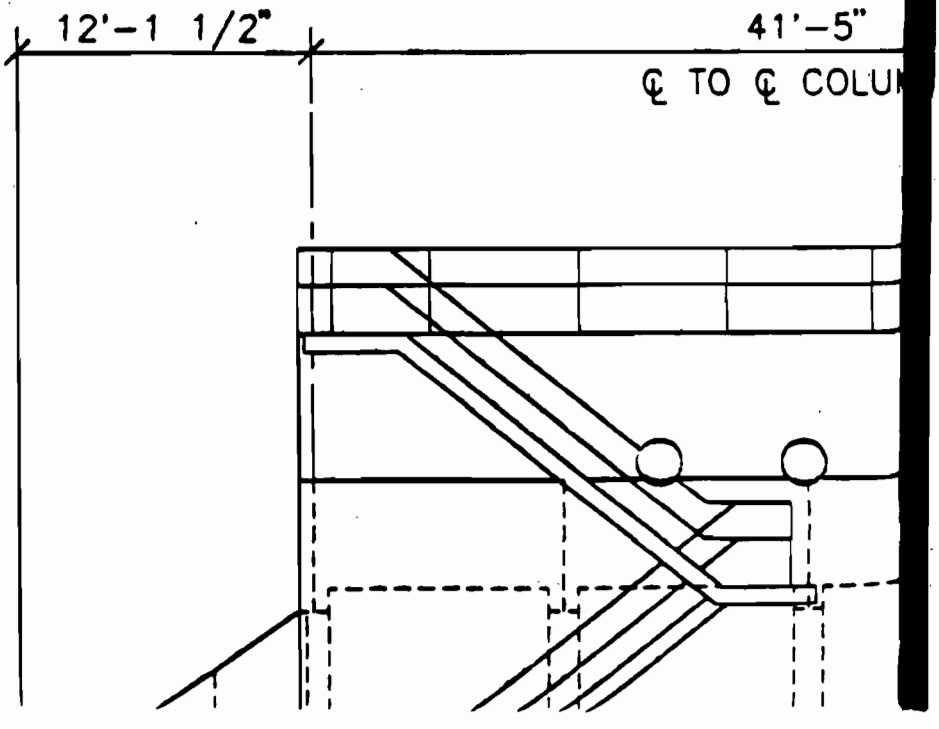
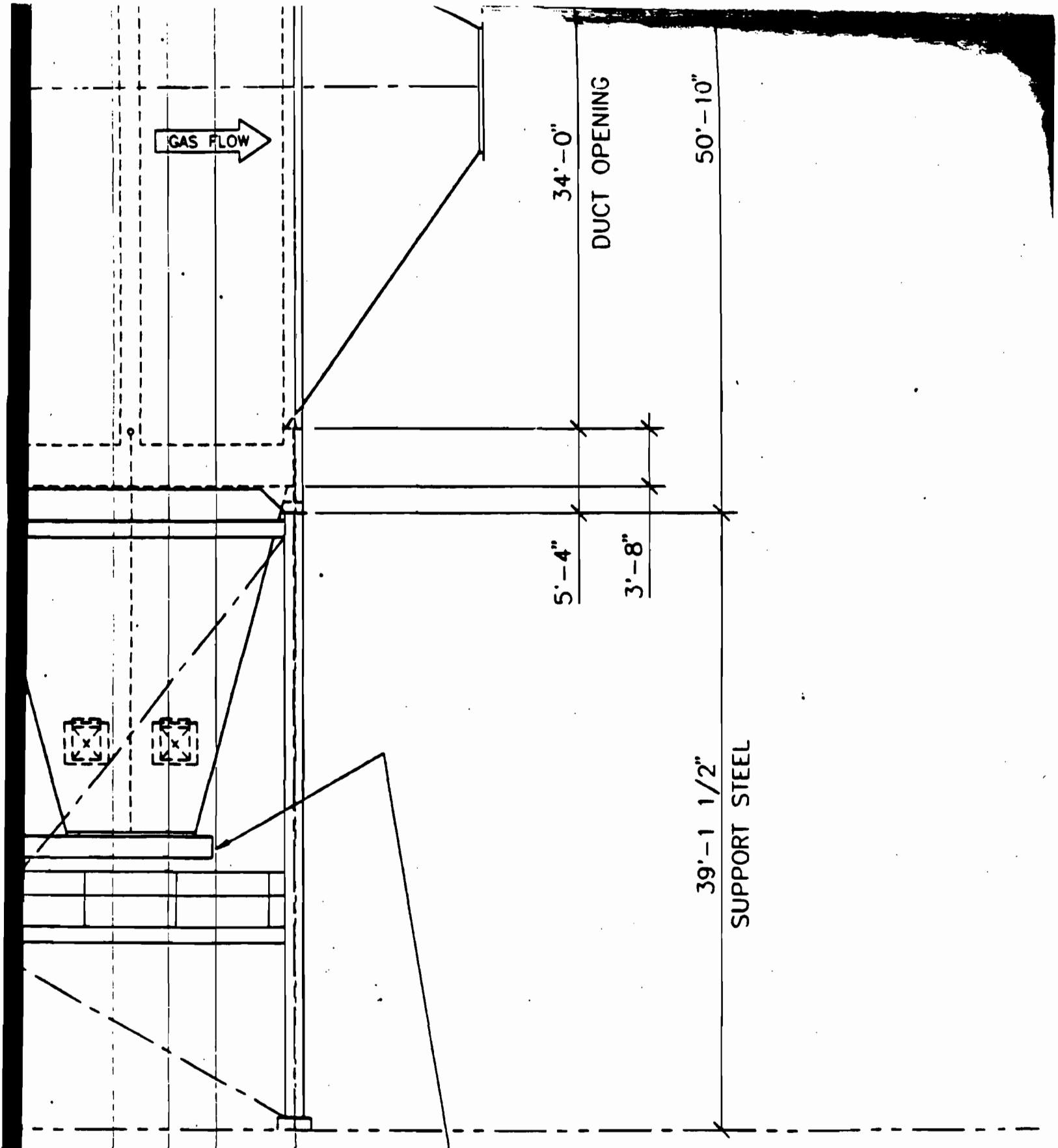


PLAN





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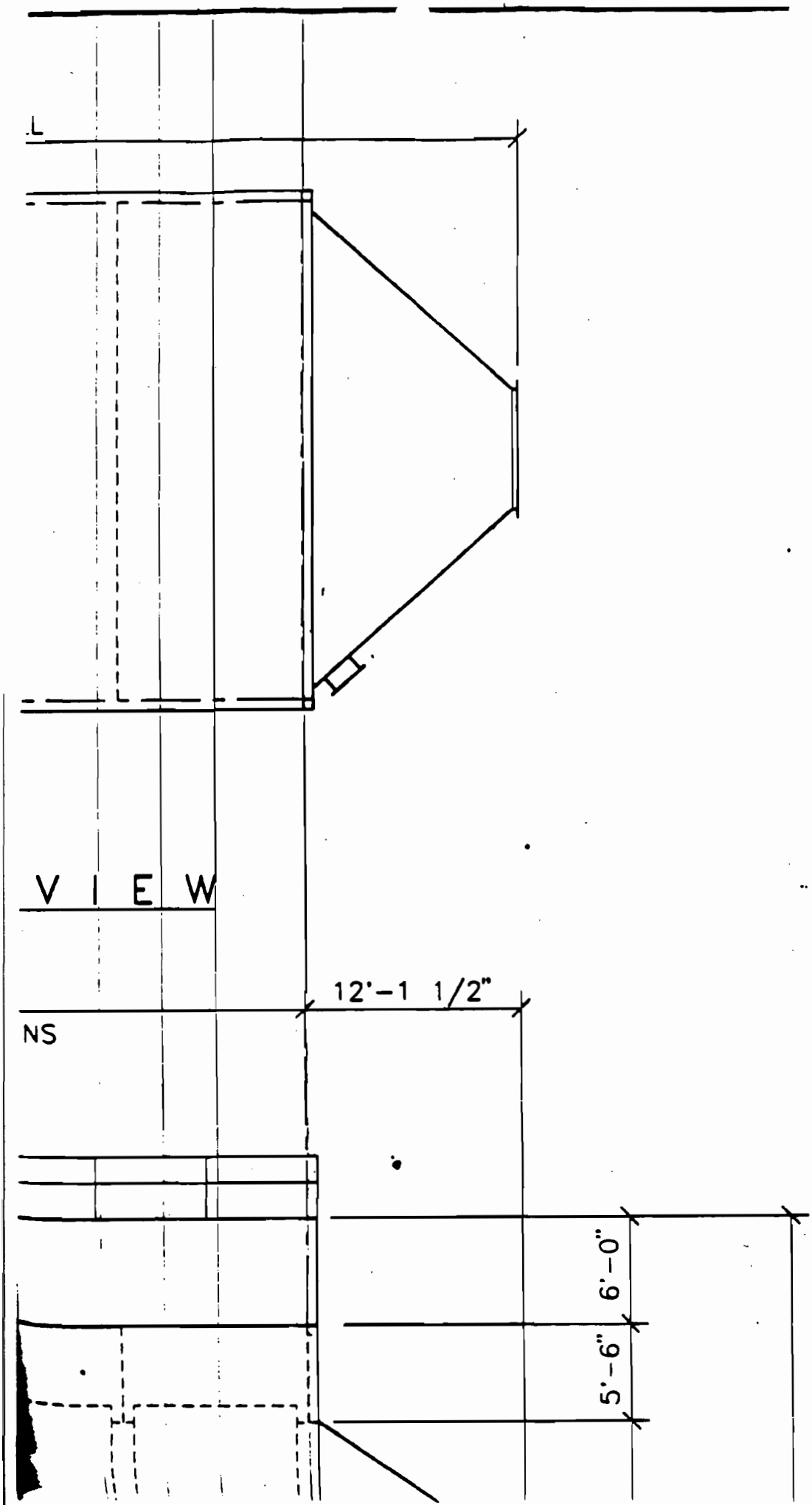

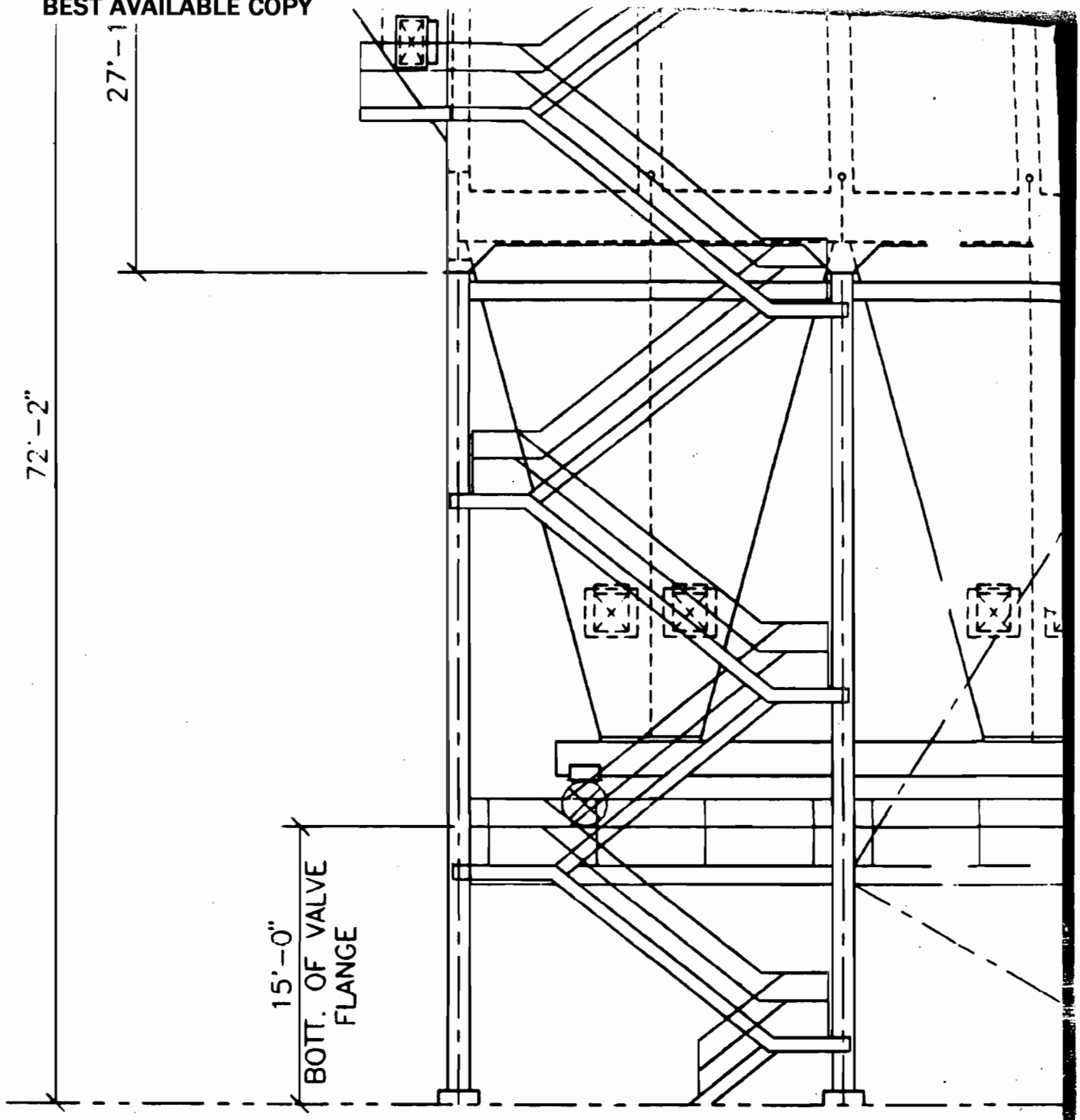

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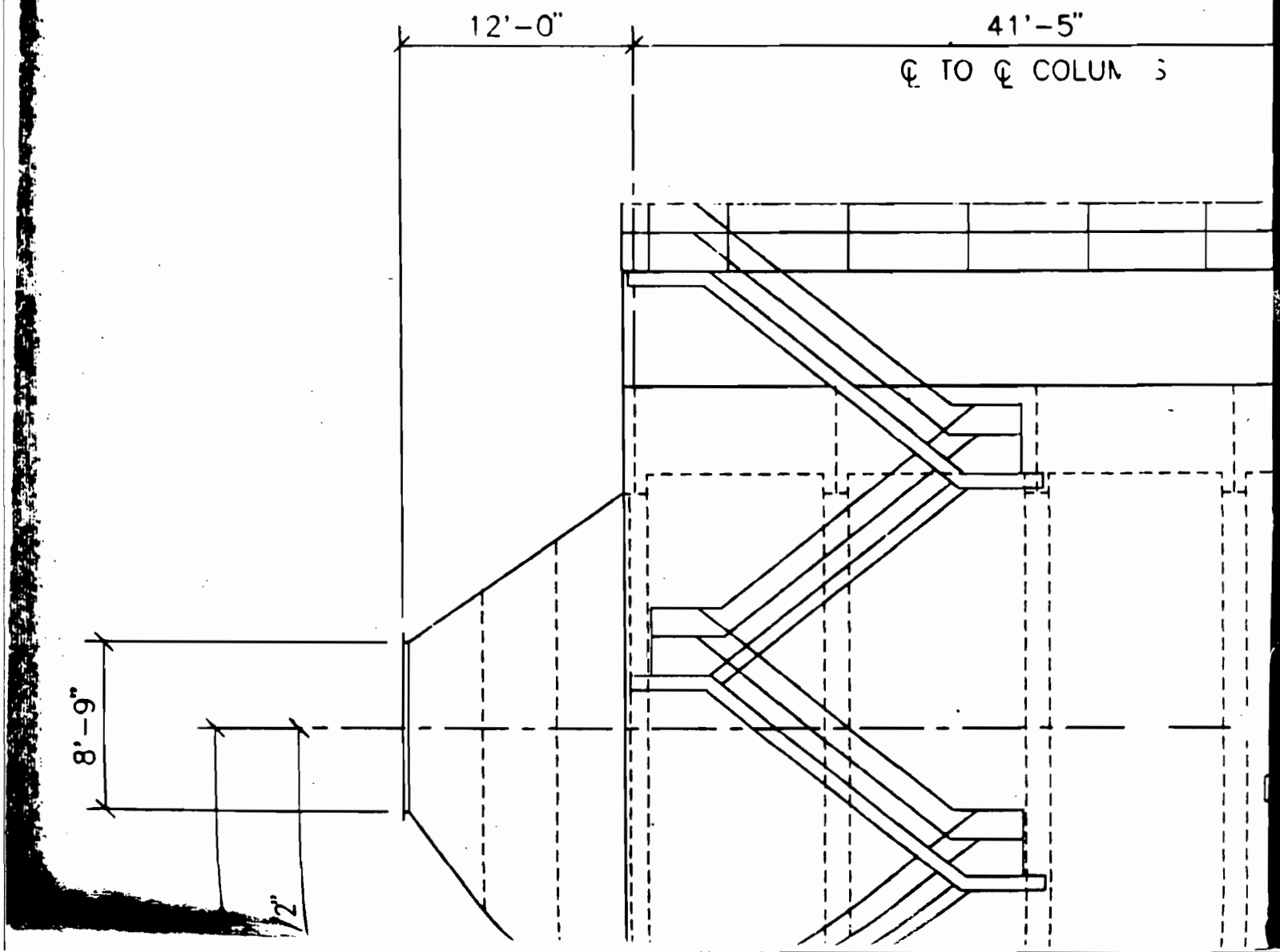

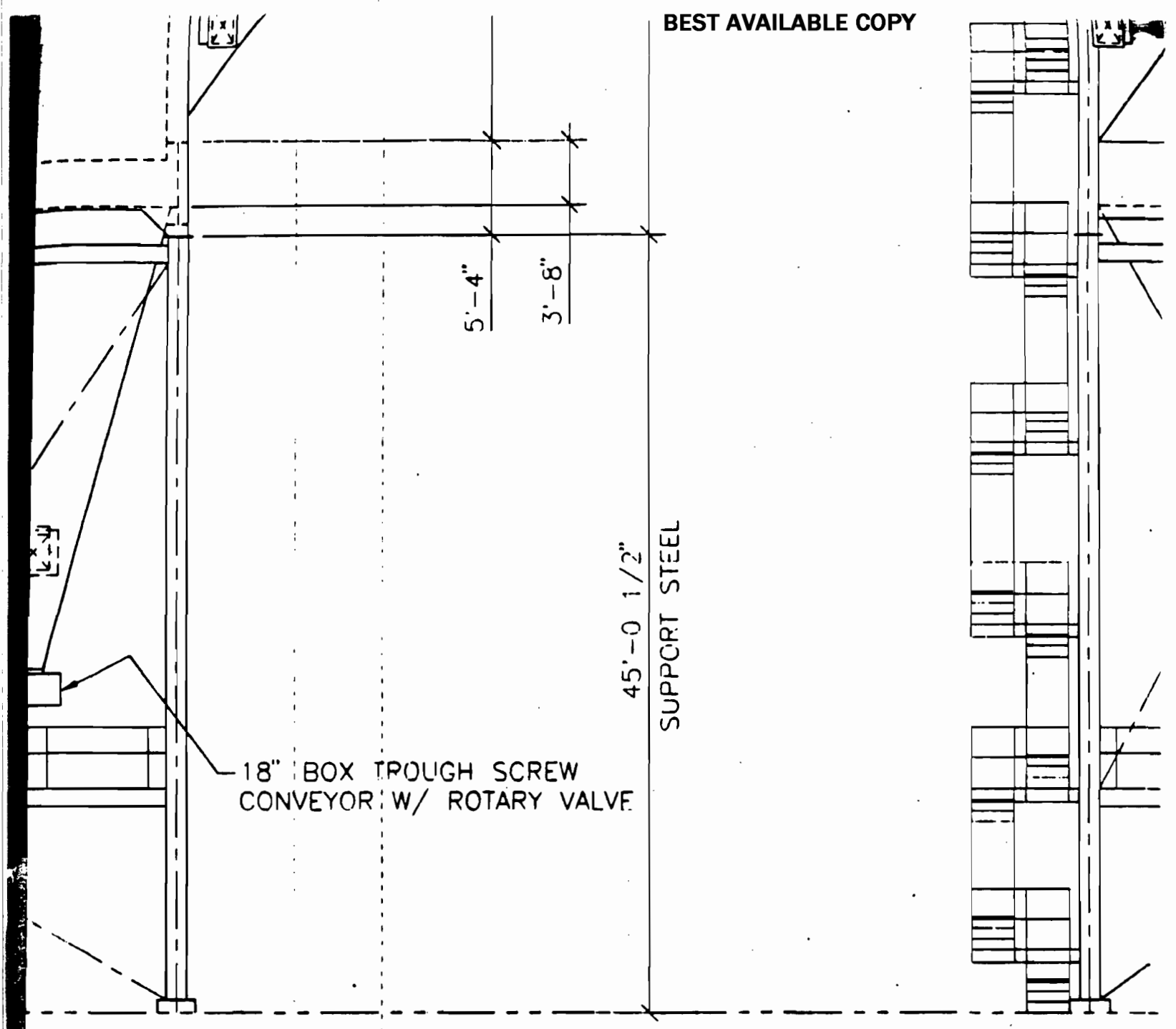

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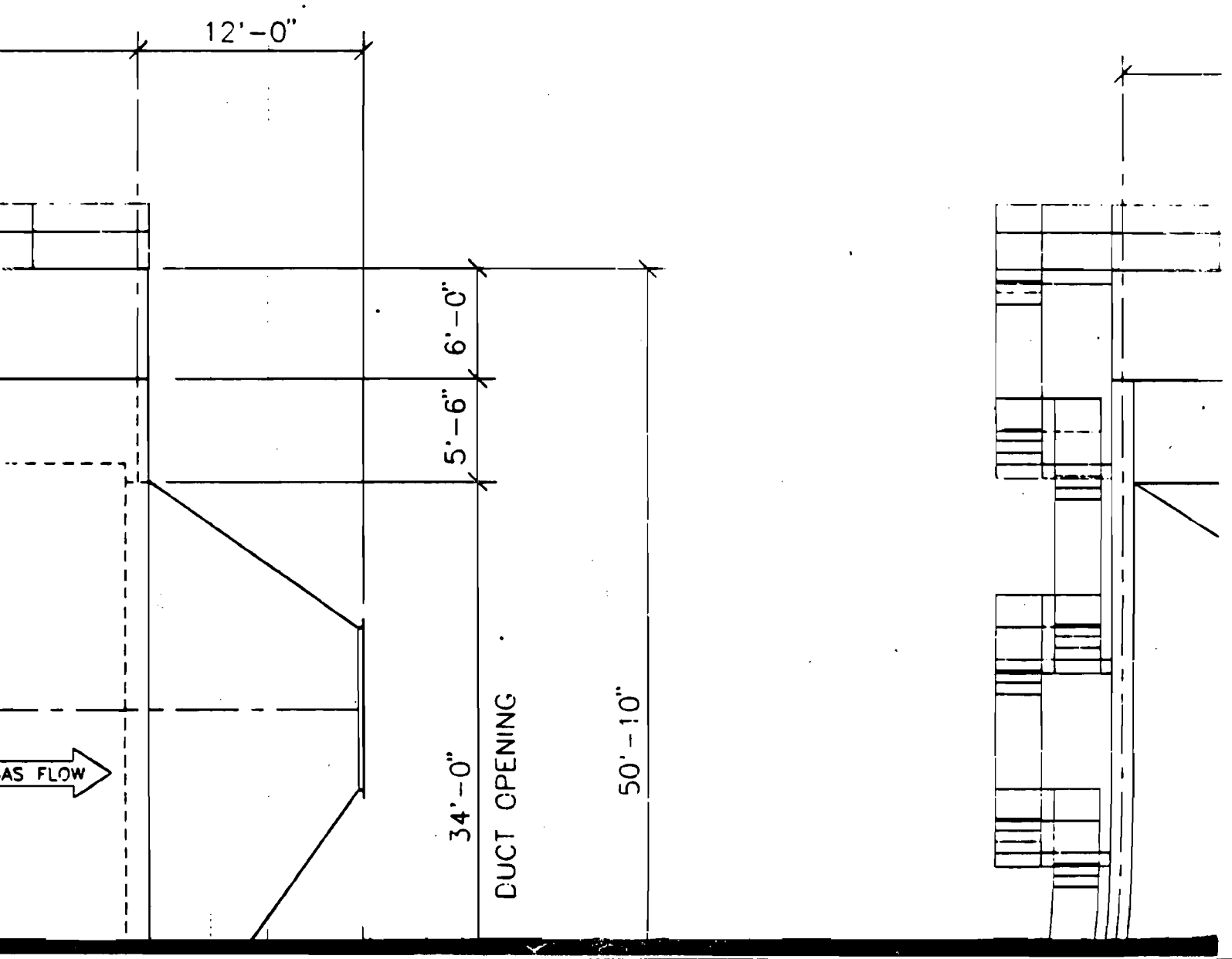

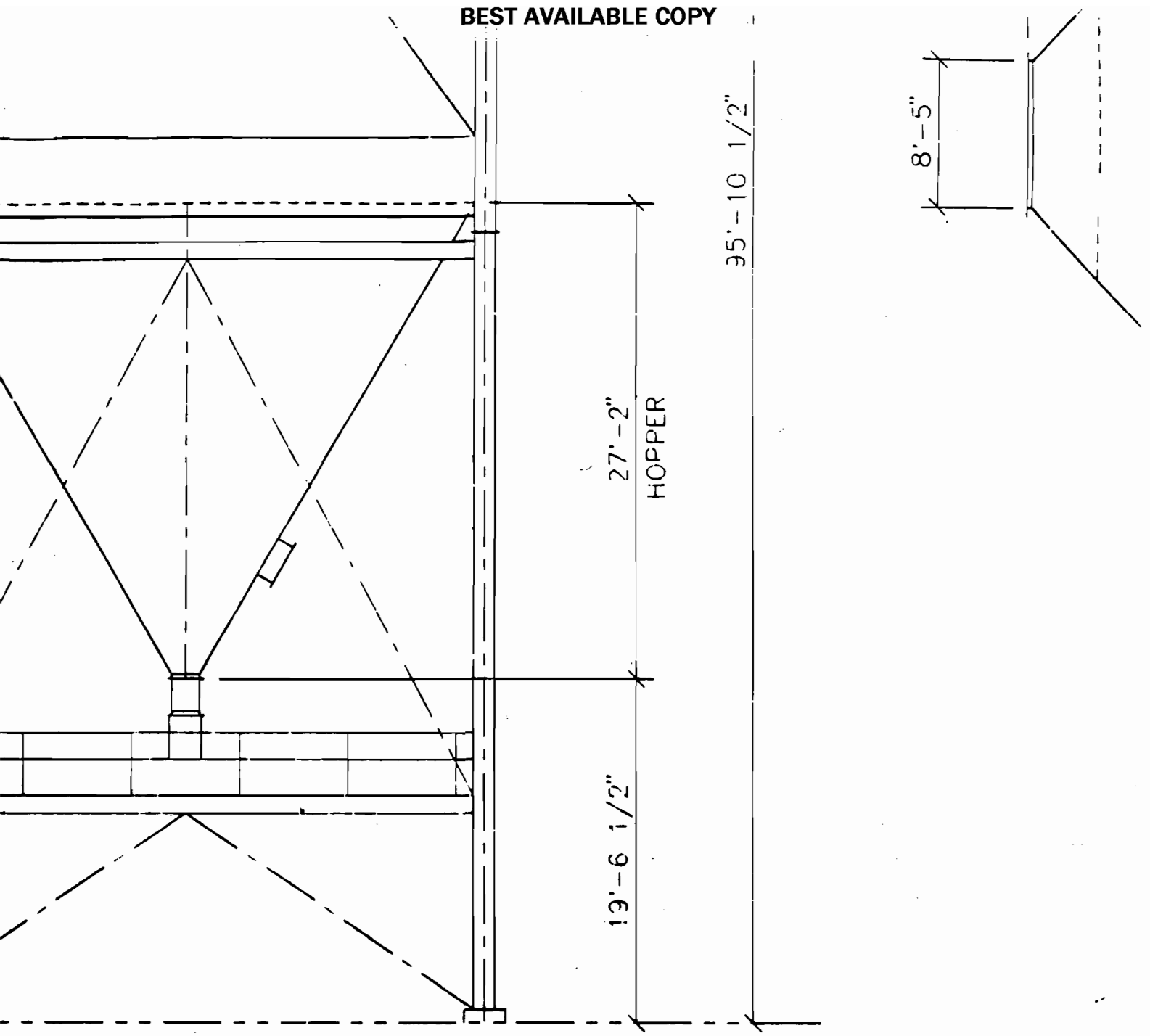

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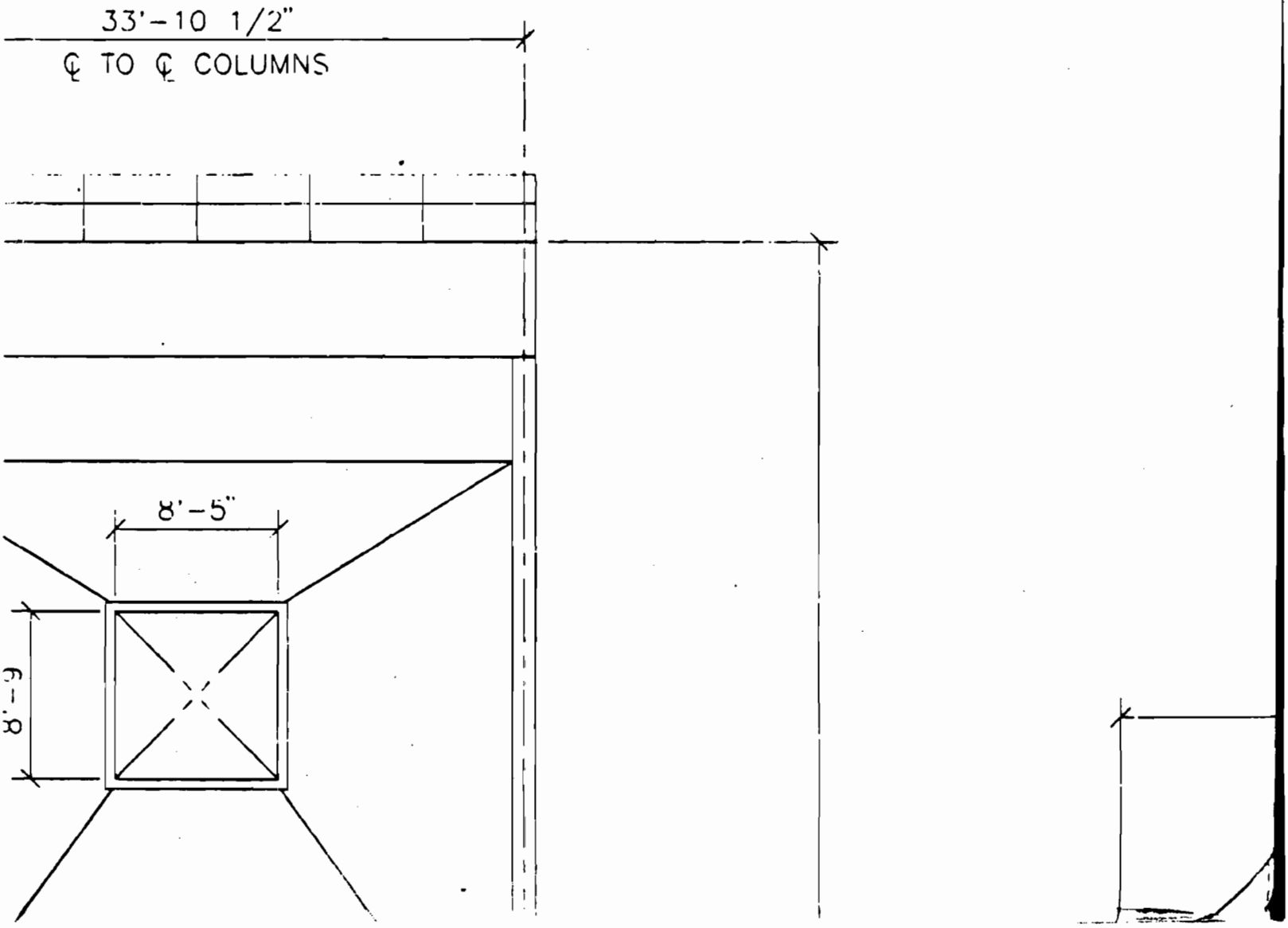

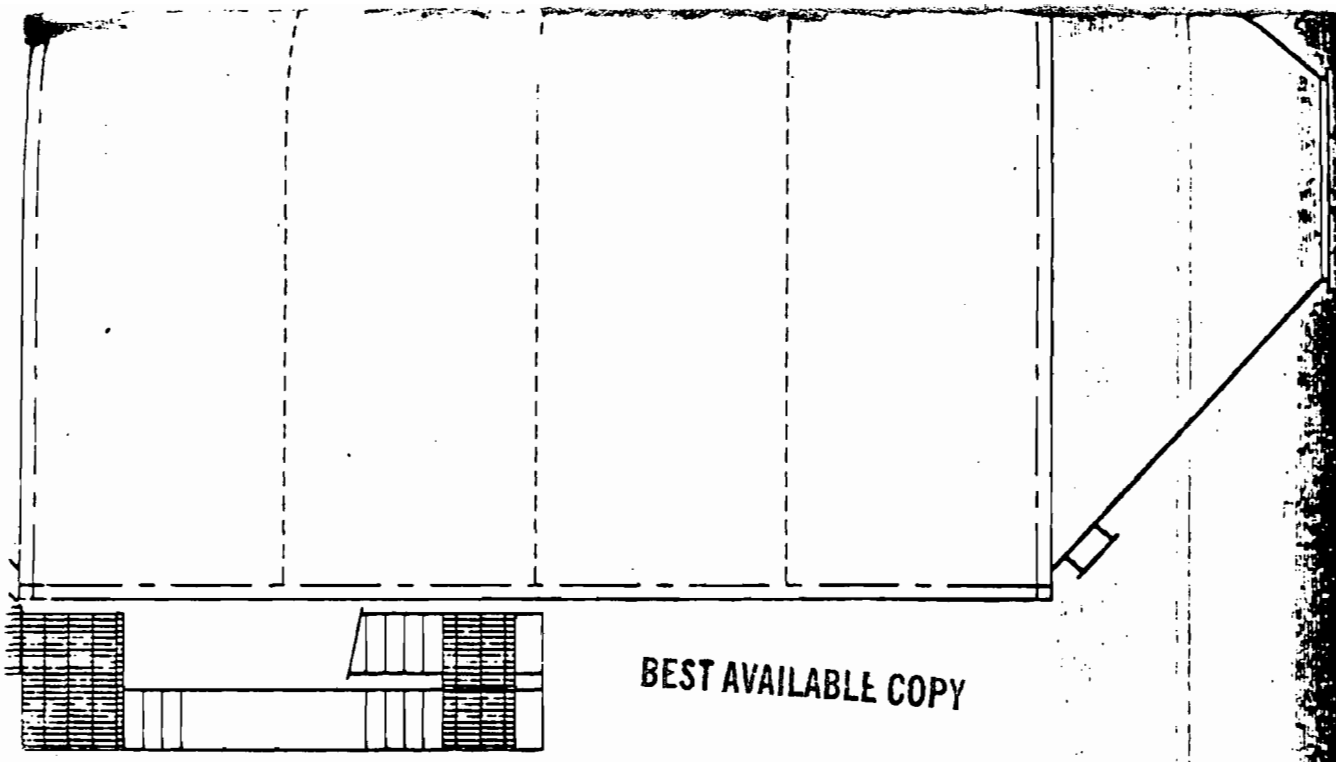

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PLAN VIEW

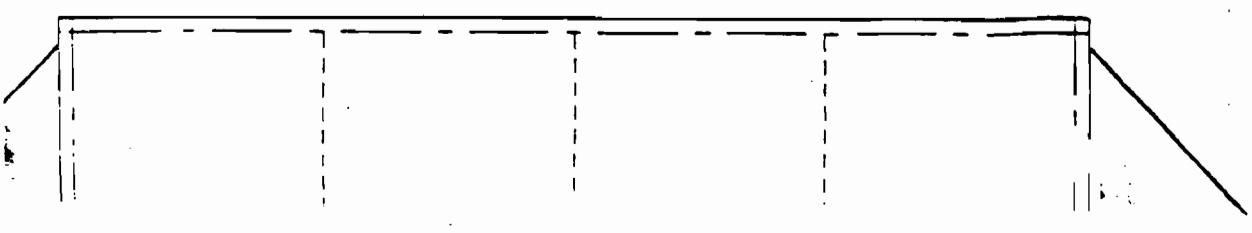
SC-23-16-4x9

NOTE: ALL DIMENSIONS ARE APPROXIMATE

ENVIRONMENTAL ELEMENTS CORPORATION	PRELIMINARY ARRANGEMENT POLYSIUS CORP. FOR FLORIDA ROCK NEWBERRY, FLORIDA	
DRAWN: TBT	SIZE: D	DRAWING NUMBER: 15290-2110-D1
DATE: 04-25-95	SCALE: 1/8" = 1'-0"	SHEET: 1 OF

LTR	DESCRIPTION	BY

65'-5" OVERALL



TERESA'S DATA - ESP

FLORIDA ROCK DATA

Actual volumetric Flow rate:
194,000 ACFM Compound operation
200,00 ACFM Direct Operation

Maximum Dry Standard Flow Rate:
144,000 dscfm Compound Operation
125,500 dscfm Direct Operation

Exit temperature: 205 degrees F Compound Operation
356 degrees F Direct Operation

Direct Operation: Preheater/Precalciner/Kiln gases bypass raw mill, exhaust to ESP.

Compound Operation: Preheater/Precalciner/Kiln gases flow through raw mill, then exhaust

Emission Standard Kiln: 0.2 lb/ton kiln feed (preheater feed) dry basis
Emission Standard Cooler: 0.1 lb/ton kiln feed (preheater feed) dry basis

Kiln (preheater) feed : 149.9 TPH
Clinker production: 95.8 TPH

Control Efficiency: PM10= 99.9 %