

# **LIMB Demonstration Project Extension**

## **Detailed Design Report**

for

**Edgewater Plant Unit No. 4**

for

**U.S. Department of Energy**

**Pittsburgh Energy Technology Center**



**Babcock & Wilcox**  
a McDermott company

## Foreward

As there was no subtask requiring submission of a preliminary design we proceeded under Phase I to develop the final design. This report therefor is intended to satisfy the requirements of the following two scheduled deliverables:

2.3A - Preliminary Design Report

2.3B - Final Design Report

PRELIMINARY & FINAL  
DETAIL ENGINEERING DESIGN REPORT

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I. Introduction

The following Final Design Report (FDR) has been prepared as per the Co-operative Agreement No. DE-FC22-87PC79798 dated June 25, 1987, for Phase I Design and Permitting which includes "Coolside" Technology and LIMB Multiple Sorbent Injection. The report presents a narrative of the designs criteria developed for the flue gas humidifier and Coolside equipment together with drawings showing the process performance and design logic. In addition a complete listing is presented for all drawings prepared by Babcock & Wilcox and Stone & Webster, all equipment purchased for the project, and all general specification.

## II. PERFORMANCE OBJECTIVES

### BACKGROUND

#### EPA Base LIMB

The DOE LIMB Demonstration Project Extension is a continuation of the EPA Limestone Injection Multistage Burner (LIMB) Demonstration which is presently underway.

The EPA LIMB program was initiated in 1981, although work in related areas had been conducted by EPA and others prior to that time. The LIMB program is structured to provide an understanding of the controlling factors in the LIMB process and to establish a basis for private sector commercialization of the technology. EPA ultimately expects to show that LIMB is a low cost control technology capable of producing moderate SO<sub>2</sub> and NO<sub>x</sub> control (50-60 percent) with applicability for retrofit to the major portion of the existing coal-fired boiler population.

The basic goal of the LIMB demonstration is to extend LIMB technology development to a full-scale application on a representative wall-fired utility boiler. The successful retrofit of LIMB to an existing boiler is expected to demonstrate that (a) reductions of 50 percent or greater in SO<sub>2</sub> emissions and NO<sub>x</sub> reductions to below 0.5 lbs./10<sup>6</sup> BTU can be achieved at a fraction of the cost of add-on FGD systems, (b) boiler reliability, operability, and steam production can be maintained at levels existing prior to LIMB retrofit, and (c) technical difficulties attributable to LIMB operation, such as additional slagging and fouling, change in ash disposal requirements, and an increased particulate load, can be resolved in a cost-effective manner. The primary fuel to be used is an Ohio bituminous coal having a nominal sulfur content of 3 percent or greater.

After sorbent injection activities were started in July 1987, the applicability of flue gas humidification as a supplement to the LIMB process for the purpose of improving particulate collection and SO<sub>2</sub> capture efficiencies was evaluated. The reason for this investigation was that the LIMB process caused a sharp degradation in the performance of the electrostatic precipitator. This degradation was the result of three factors:

1. The dust loading to the ESP is more than double.
2. The particle size distribution of the injected sorbent is finer and therefore more difficult to capture than the normal flyash from coal combustion.
3. The sorbent has a chemical affinity for SO<sub>3</sub>. This will result in a lowering of the acid dew point and consequently increasing of the resistivity of the ash.

Humidification provided a low-cost option that would restore ESP performance on LIMB retrofitted boilers. In addition, humidification of flue gas has been shown to increase SO<sub>2</sub> capture by rendering sorbent particles more reactive. The amount of humidification required to improve SO<sub>2</sub> capture efficiency and to

restore ESP performance may present operational problems. The EPA Humidification program will result in a humidification system design aimed at minimizing operational problems and maximizing SO<sub>2</sub> capture and particulate removal enhancement. The effect of humidification will be determined during the EPA LIMB Demonstration testing at Ohio Edison's Edgewater Unit 4.

The incentives to humidify to as close an approach to saturation as possible are:

1. Particulate emissions from the small ESPs designed for burning high-sulfur coal can possibly be kept in compliance without the high cost of additional particulate collection area.
2. Additional SO<sub>2</sub> removal can be achieved by taking advantage of the unused sorbent from the boiler.

However, the extent of SO<sub>2</sub> removal will be strongly dependent upon how much the flue gas temperature is reduced. The risk of scaling, pluggage, and other operating problems also increases sharply as the gas temperature approaches adiabatic saturation.

It is because of the risk of scaling and pluggage that the humidification demonstration must be carried out in a bypass flue. With the humidifier installed in a bypass flue, initial operating problems will not interrupt boiler operation. Various operating conditions at closer approaches to saturation can be tried without fear of shutting down the boiler should a wall deposition problem develop. This bypass will be used for EPA humidification work and for the DOE LIMB and Coolside process demonstration, of which humidification is an integral part. Funding for the bypass will be provided as part of the DOE LIMB Demonstration Project Extension.

#### DOE LIMB DEMONSTRATION PROJECT EXTENSION OBJECTIVES

The purpose of the DOE LIMB Demonstration Project Extension is to extend the data base on LIMB technology and to expand DOE's list of Clean Coal Technologies by demonstrating the Coolside process as part of the project.

The main objectives of this project are:

1. To demonstrate the general applicability of LIMB technology by testing 3 coals and 4 sorbents (total of 11 coal/sorbent combinations - one coal/sorbent having been tested by EPA) at the Ohio Edison Edgewater plant.
2. To demonstrate that Coolside is a viable technology for improving precipitator performance and reducing sulfur dioxide emissions while acceptable operability is maintained.

To achieve these objectives, B&W has completed the final design under Phase I Design & Permitting, consistent with the DOE PON.

Since the DOE LIMB Demonstration Project Extension is a continuation of an ongoing EPA Project, it was necessary at the start of the project to divide Phase II into IIA and IIB to avoid project schedule delays on both projects. Phase IIA entailed certain site preparation and long-lead time item procurement activities which had to take place before actual construction and start-up could commence. Most of these activities were completed during the boiler outage originally scheduled by Ohio Edison from September 28, 1987 through December 20, 1987 to perform major turbine maintenance. The outage actually lasted until late January 1988. It provided the opportunity to perform the flue gas duct revisions needed for the tie-in of the bypass duct once its construction was complete.

Phase IIB consisted of Coolside/LIMB Construction, Start-up and Shakedown activities. This Phase started on August 26, 1987, one month prior to the outage "window". Time was needed to perform pre-outage activities and to assure that the outage construction work was organized and ready to begin on schedule. Phase IIB construction consisted primarily of the bypass flue, where the humidifier is installed, and the Coolside feed system.

Originally the bypass was to be completed in time to allow EPA humidification testing to be performed during the last four months of Base LIMB operation. However, preliminary LIMB test results indicated that electrostatic precipitator (ESP) performance suffered as a result of sorbent injection. Humidification is now considered necessary to improve ESP performance.

### III. PROCESS DESCRIPTIONS

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A. General

These descriptions are intended to show how the systems were designed to operate. References to equipment manufactures, sizes and materials have been left out and trade names only used where they provide easy identification of a unique design of equipment. Equipment is described in more detail in Section IV, which follows.

B. Humidification

1. Atomization Water Feed System

Water is supplied for humidification from the existing Unit No. 4 Boiler House service water system. The tie-in point is at elevation 239'-0" from the line originally used to supply cooling water to the bearings and variable speed drive for the I.D. Fan that was abandoned in 1980.

Water is first fed in parallel through the Atomizing Air Compressor first and second stage intercoolers and the auxiliary instrument air conditioner. It's pressure is boosted by an in-line pump to obtain the necessary flow through the intercoolers. The water is then either returned to the raw water intake channel through a back-pressure control valve or fed through a basket strainer into the Water Storage Tank through a level control valve.

From the storage tank the water is pumped through another duplex basket strainer to a flow control valve with inlet pressure held constant by a backpressure control valve which returns water to the tank. This system feeds water to the atomizer at a controlled rate to maintain a set approach to saturation flue gas temperature downstream of the Humidification Chamber.

At the spray deck elevation 270'-6" the water feeds through the third and final duplex basket strainer before splitting its flow to the North and South atomizer supply headers. Each header supplies eleven lances through a flow element, a three way air purge valve and an air operated ball valve. This last valve is operated by atomization air providing an intelock that stops water flow to each lance if air has not already been supplied to that lance. This prevents un-atomized water from entering the chamber.

The atomizer supply headers are vertical and to partially compensate for effects of static head on the atomization pressure two control valves, located afte the top four and before the bottom three take-offs, operate to maintain offsetting pressure drops between the three groups of atomizers.

## 2. Atomization Air Supply System

A centrifugal compressor mounted at floor elevation 239'-0" pulls air through an air inlet filter mounted on the roof at elevation 265'-0". In this three-stage compressor air passes through the first and second stage intercoders and moisture separators. Air is discharged from the third stage and goes directly to the receiver without after cooling.

From the receiver the air passes through a Y-type strainer and a control valve which maintains a set differential between the water and air header pressures. The air parallels the water by splitting into two vertical headers supplying eleven atomizers each on the North and South sides of the Humidification Chamber. The lines to each atomizer have manual shut-off valve and a Y-type filter.

## 3. Atomizer Water Injection System

After testing and reviewing the performance of commercially available atomizers the B&W Mark XII design was selected. This design was based on the B&W I-Jet atomizer used in dry-scrubbing contracts, scaled down for this application.

The optimum size of the atomizers and their array in the Humidification Chamber was developed by testing in consideration of residence time and wetting factors. Residence time had to be sufficient to allow evaporation of the atomized droplets of water before leaving the chamber. The distance from the wall was set to avoid impacting the wall while entraining the water droplets in the flue gas stream. The distance between atomizers was set to avoid droplets impacting one another and coalescing into large drops that would fall out of the gas stream and wet the floor of the chamber.

The atomizer array - 10 across on 12" centers and 11 rows vertically on 12" centers was built into the atomizer lance design. Eleven lances are inserted from each side, each including five atomizers mounted within an air foil section containing the water and compressed air piping and vent-air passageways. The water and compressed air are supplied from the headers through flexible hoses. The vent air is provided by sucking in ambient air through the lance wall mounting plate. The compressed air and water are mixed within the atomizer and blow out through orifices providing atomization. The vent air flows around the outside of the atomizers and prevents eddy currents from recirculating droplets which could wet the atomizer tips and cause a buildup of flyash to occur.

## 4. Bypass System

The Bypass System became necessary when OEC could not risk use of their existing flues for the Humidification Extension

Program as problems could cause the shut-down on Unit No. 4 with its power generating capability.

As a system the bypass provides a separate run of flue called the Humidification Chamber (see fig. 1) which is functionally in parallel with the existing flues running from the Airheater to the Electrostatic Precipitator (ESP). New flues connect the inlet to the chamber with the airheater outlet flue and the outlet of the chamber with the existing flue further downstream.

Modulating louver dampers are supplied to bring the Bypass System into operation or to take it out while the boiler is in operation. These may also be used for controlling the flow through the bypass when only a partial flow is required. Additionally guillotine shut-off dampers are used to isolate the bypass for internal maintenance with the boiler in operation.

B&W's standard 3-vane turning - vanes were supplied at all new flue bends.

Safety interlocks are applied to this system to insure against furnace overpressure precipitator or flues implosion and loss of gas path due to improper damper operations.

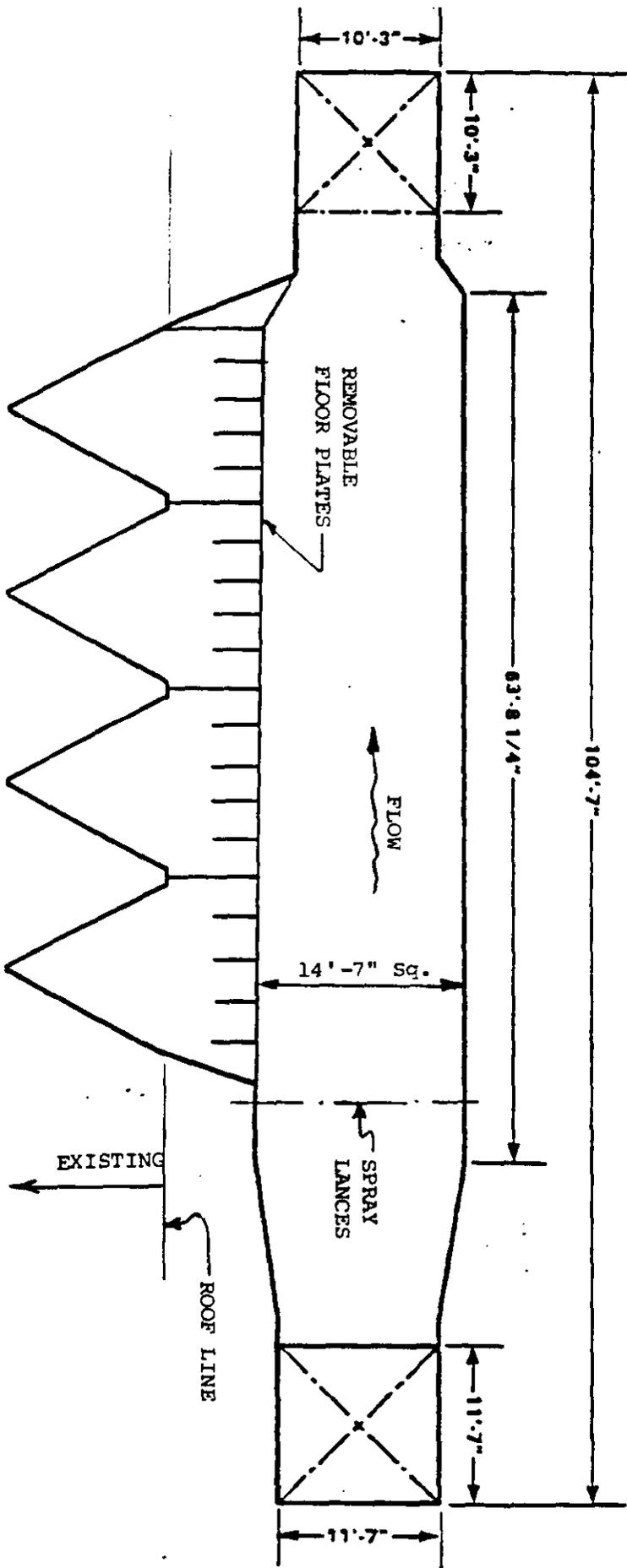
#### 5. Fluegas Reheat System

A condensing type steam coil reheater has been located in the existing flue just downstream of the ESP.

Steam is supplied from Boiler No. 13 steam drum through an existing spare nozzle. Reheat steam feeds through a pressure reducing station and a control valve operating to maintain a set fluegas temperature leaving the reheater. Reheat steam is branched to enter each of the four reheat sections through a shut-off valve.

Condensate leaves each section through a shut-off valve and an individual vertical drain line which drops to a level below the condensate tank water level before entering the drain header running to the tank. This design maintains a water seal between sections during normal variations in pressure drop through the individual sections and branch piping.

Condensate enters the side and leaves through the bottom of the Condensate Drain Tank. Flow to and from the tank is by gravity. A balancing line, without valving is run between the temperature control valve outlet to the steam side of the condensate tank. This maintains a constant pressure across the coils and all flow is generated by condensation rate and condensate head. A constant level of water is maintained in the tank, and the coil section drain legs, by a level control valve modulating the flow of condensate to the Unit No. 4 Condenser Hotwell. This valve is located close to the hotwell where the condensate enters below the water level through a disperser which minimizes the effects of the flashing.



**EDGEWATER HUMIDIFICATION DUCT**

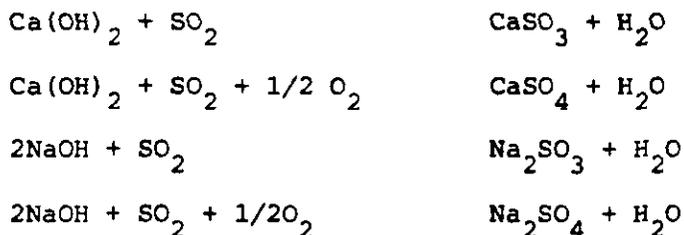
Figure 1

## C. Coolside

### General

The Coolside Process is a relatively simple process capable of removing up to 70 percent of the SO<sub>2</sub> from the boiler gases. As the flue gas temperature approaches the adiabatic saturation temperature, SO<sub>2</sub> removal increases. The flue gas temperature is lowered to approximately 148 F, 20 F above adiabatic saturation, by spraying water into the flue gas stream. Upstream of the humidification nozzles, dry hydrated lime is injected into the flue gas. In the humid atmosphere, the hydrated lime reacts with the SO<sub>2</sub>. A small amount of NaOH is injected with the humidification water to increase the activity of the hydrated lime.

The predominant overall reactions that take place in the humidified flue gas are as follows:



The actual reactions may be more complex than shown here since the effect of the sodium is greater than its stoichiometric equivalent. The waste solids contain unused hydrated lime, so recycling the solids (Ash) will increase the overall utilization and decrease the fresh sorbent rate.

#### 1. Lime Feed System

The existing lime feed system used on LIMB is used up to a point in the 4" hose feed to the existing distribution bottle for boiler furnace injection. From this point new hose directs the flow to a distribution bottle above the inlet flue to the Humidification Chamber. Lime is distributed from this point and released into the flue just ahead of the atomizer lance assemblies.

#### 2. Caustic Supply and Feed System

Caustic in the form of a 50% solution of NaOH will be unloaded from trucks into an insulated Caustic Tank where heating cables will maintain its temperature above 65°F. The caustic will be continuously pumped into a return loop maintaining a constant loop pressure by means of an orifice in the return line. The feed will flow from this loop through a control valve to the Water Storage Tank. The control valve will be modulated to maintain a set ion level in the tank. A mixer is required to disperse the NaOH throughout the stored atomization water. The water containing about 2% (wt) NaOH will be pumped in the normal fashion to the atomizers in the Humidification Chamber.

### 3. Ash Recycle System

Dry ash from the Unit No. 4 ESP is collected in the Ash Storage Silo through a vacuum type transport system. Recycled Ash for the Coolside process is removed at the silo discharge just ahead of the dry bulk unloading spout in controlled quantities. The ash falls through an air-lock of two rotary feeders, the first in series operating through an SCR controller. The returning air pockets on the lower feeder are vented to the ESP inlet flue.

Ash from the lower feeder drops into a blow-through type pneumatic pick-up and is conveyed through a rubber hose to a distribution bottle. The bottle is located above and close to the injection points just ahead of the humidification atomizer array.

Injection into the flue is through three lances, each lance carrying ash to three injection points providing an even release of ash across the flue area. All 9 points are fed by individual lines from the distribution bottle, care being taken to equalize the resistances found in each line.

Transport air is provided by a rental motor-driven compressor powered from the local city distribution lines.

### D. Electrical System

Power requirements for Humidification, Coolside and LIMB Extension were determined at an early stage to be beyond the available capacities the plant internal distribution system. Therefore, it was necessary to source all the electrical power requirements for operating these demonstrations from the switchyard, tapping in at the 23,000 VAC level. From this point Stone & Webster Engineering, Corporation (SWEC) designed an entirely separate distribution system for the electrical needs of everything on this project beyond base LIMB. There is no tie-in to alternate sources of power or other back-up whatsoever. This includes all power, control, lighting, and service requirements.

A description of the system and its equipment is contained in the Section VI of this report.

IV. EQUIPMENT DESCRIPTION - HUMIDIFICATION

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#### IV. Equipment Description

##### A. Design Criteria

The following design conditions are used for process flow calculations and equipment sizing for Humidification with lime injected in boiler furnace per LIMB technology.

##### 1. Sorbent

Hydrated Lime -  $\text{Ca(OH)}_2$   
Composition:  
     $\text{Ca(OH)}_2$             93%  
    Inerts<sup>2</sup>                7%  
Bulk Density:            30 lbs/ft<sup>3</sup>  
Particle Size:            5 micron ave.

##### 2. Coal

Composition (% by wt.)  
    C                      67.5  
    H                      4.8  
    S                      3.0  
    N                      1.2  
    O                      7.0  
    H<sub>2</sub>O                    6.5  
    Ash                    10.0  
    Cl                      0.0  
Heating Value 12,850 Btu/lb

##### 3. Operating Conditions

Boiler rating	Peak Load
Steam Flow	770,000 lbs/hr
F.G. Temp., AH outlet	310°F
Coal Flow	82,490 lbs/hr
SO <sub>2</sub> removal	50%
Stoichiometry (Ca:S)	2.5
Excess Air, AH Outlet	40%

Note: Refer to Humidification Flow Diagrams (process flow sheets) in Section III for material balances at various conditions.

##### B. Humidification Equipment - Water Side

##### 1. Water Storage Tank

##### a. General Information

Service: Atomization water supply reservoir  
Type: Cylindrical, welded steel plate, with cover.  
Fabricator: Milan Steel Fabricators.  
Standard: Based on API-650.

b. Design Details:

Size: 9'-0" Diameter x 12'-6" high.  
Medium: 5% NaOH @ 65.7 lbs/cu. ft. (68°F)  
Capacity: Filled 5948 gal's  
Working 5000 gal's  
Shell Material: 3/16" thick. C.S., A36  
Includes: Mixer support bridge  
Mixing baffles  
Access door in shell

c. Performance:

Storage Time: 1 hour at design conditions

d. Instrumentation

Level Transmitter (LT-1305):  
Type: Pressure Diaphragm  
Make: Bailey Controls Co.  
Model: BC7

Sodium-Ion Analyzer (LT-1306A)  
Type: In-Situ Probe  
Make: Leads & Northrup  
Model: 7972-1

2. Water Storage Tank Mixer

a. General Information:

Service: Mixing a 50% solution of NaOH into water to obtain a 5% solution.  
Type: Top entering, parallel shafts gear drive.  
Mfr: Mixing Equipment Company  
Model: "Lightning" Series 10, Model 15Q3

b. Design Details:

2" diameter x 130" shaft with two 33" diameter A-305 axial flow impellers, one with stabilizers.  
Motor: 3HP, Siemens-Allis. Inc., Type RG2-CH, TEFC, 1.15 SF, Frame 213TC, 120V space heaters.

3. Atomizing Water Pump

a. General Information:

Service: Pump water from storage tank to humidification atomizer assemblies (lances) in North and South spray deck enclosures.  
Type: Centrifugal, end-suction, direct driven,  
Mfr: Worthington Pump Div. - Dresser Industries  
Model: D-1011, Size 3 x 1 1/2 x 10

b. Design Details:

Materials: Ductile Iron Casing, Cast Iron impeller,  
channel steel base  
Coupling: Woods flexible with guard  
Seals: Stuffing box with Teflon packing  
Motor: 40 HP Reliance TEFC, Frame 324TS, 3600 RPM, 1.15  
SF, 120V space heater  
Mounting: Shop mounted on common base

c. Performance:

150 GPM at 425 FT. TDH with water.  
3550 RPM, 36 BHP, 0.35" max solids.

4. Water Strainers

a. General Information

Service: Screens out solids at three points in system  
with increasing fineness. See screen sizes  
below.

Type: Basket type, duplex  
Mfr: Ronningen - Petter  
Model: Duo-Fabri- Basket, D-SS-324-SE.

b. Design Details:

Housings: Two TP304 stainless steel with 3" flanged  
top-side inlet and bottom-center outlet.  
Hinged lid for basket replacement.

Valves: 3-way, T-ported, wrench operated ball valves for  
directing flow to one of the two housings.

Filtering Media:

1. 1/8" perforated strainer basket before entering  
storage tank
2. 10 mesh TP316 wire inlay basket in Atomizing Water  
Pump outlet line.
3. 40 mesh TP316 wire inlay basket in line prior to  
entering spray lance feed headers.

Gasket Material: Neoprene

C. Humidification Equipment - Air Side

1. Atomizing Air Compressor

a. General Information:

Service: Provide high pressure air to the atomizers.  
Type: Three-stage centrifugal - vertical split casing  
Mfr: Ingersoll - Rand Company  
Model; CENTAC Model No. CII-45M3-HP

b. Design Details:

Air End:

- Built-in helical gearing consisting of a bullgear and individual pinion gears sized so that each impeller runs at optimum speed.
- Stainless steel impellers with backward leaning vanes.
- Cast iron diffusers with pinned stainless steel vanes.
- Cartridge type air and oil seals.
- One radial vibration probe positioned in the "Y" plane for each impeller.
- Rigid fabricated steel baseplate.
- Intercoolers, cartridge type, built into the casing.
- Stainless steel mesh moisture separator for each air cooler, built into the casing.
- Externally mounted moisture separator located between second and third stages.
- Temperature switches, mounted at inlet of second and third stages, for high air temperature shutdown function--third stage temperature switch in discharge piping.
- Seal air pressure gauge.
- Condensate traps and piping for intercoolers.

Air System:

- Inlet throttle valve with pneumatic actuator and positioner.
- High pressure blowoff valve with pneumatic actuator and positioner.
- Safety relief valve, located between second and third stages.
- Inlet air filter.
- Bypass silencer.
- Three stage dollinger model AT-138 inlet filter.
- Interstage pressure and temperature gauges.
- Discharge pressure and temperature gauges.

Lube Oil System

- Integral lube oil reservoir built into the compressor baseplate.
- Positive displacement main oil pump, mounted on main driver outboard "stub" shaft.
- Pre- and post- lubrication oil pump with motor and an internal relief valve.
- Suction strainers on oil line inlets.
- Single element, 10 micron oil filter.
- Air cooled oil cooler.

- Temperature gauges upstream and downstream of oil cooler.
- Pressure gauge located downstream of oil filter.
- Pressure switch for low oil pressure shutdown function.
- Temperature switch for abnormal oil temperature shutdown function (high and low).
- Lube oil heater.
- Additional oil filter with transfer valves.
- Oil temperature control valve.

#### Motor

- 1250 HP 1.15 Service Factor.
- Open Drip Proof enclosure.
- Nominal rotating speed of 3600 RPM.
- 4160 Volts, 3 Phase, 60 Hertz.
- Class F Insulation.
- Sleeve Bearing Construction.
- Bearing Thermocouples.
- 110 Volt AC Space Heaters.
- Grease packed, flexible gear type spacer coupling and coupling guard for main driver.

#### c. Controls:

##### General Information:

The "Microcontroller", by Ingersoll Rand, is designed as an integral part of the CENTAC unit and shop mounted in a common assembly with the compressor.

##### Design:

The "Microcontroller" is a microprocessor-based system especially designed to monitor and automatically control and Ingersoll-Rand CENTAC centrifugal air compressor. The Microcontroller will handle all pressure control and health monitoring functions as well as control of all auxiliary devices. It also provides the following general functions:

- °Compressor motor starting
- °Monitoring of the operation of the compressor and causing automatic shutdown, if necessary.
- °Continuous control of delivered air pressure from the compressor.

The Microcontroller face plate and board are mounted in the door of a 48" x 32" x 12" NEMA-12 enclosure along with all lights, push buttons and selector switches included as part of the control package.

Microcontroller specific functions:

- Compressor ready to start light.
- Discharge air pressure indication.
- Vibration readout, alarm and shutdown.
- Modulate and auto-dual pressure control.
- High compressor air temperature readout, alarm and shutdown.
- Abnormal oil temperature readout, alarm and shutdown.
- Low oil pressure readout, alarm and shutdown.
- High compressor radial vibration shutdown.
- Surge alarm and unload.
- Current load limit control.
- Automatic low throttle valve control.
- Six cycle power outage ride through.
- Motor current readout.
- "First out" annunciation.
- Motor Bearing Temperature Readout.

Also Included:

- Seal air pressure interlock and local pressure transducer.
- Air pressure transducer for system air pressure.
- Solenoid water valves for intercoolers.
- Local Horn.

d. Performance:

Compressor Data

	Design	Minimum
Barometric Pressure (PSIA) .....	14.4	14.4
Inlet Pressure to Compressor (PSIA) .....	14.1	14.1
Inlet Air Temperature (DEGF) .....	100	-25
Relative Humidity (%) .....	100	20
Cooling Water Temperature (DEGF) .....	80	35
Capacity (ICFM) .....	4652*	4874
Discharge Pressure (PSIG) .....	150	150
Discharge Pressure (PSIA) .....	164.4	164.4
Power at Coupling (BHP) .....	1174	1541
Specific Power (BHP/100 ICFM) .....	25.24	31.62

Oil Cooler Data:

Maximum Ambient Air Temperature (DEGF) .....	95
Cooling Fan H.P. ....	3
Cooling Air Flow Rate (SCFM) .....	16,000

Motor Data:

Horsepower Output (Nameplate)	1250
Time Rating	Continuous
Temperature Rise (degC @ S.F.)	115
Method of Temperature Rise Indication	Resistance
RPM	3571
Rated Load (HP)	1174
Voltage	4160
Rated Load Amperes	156
Locked Rotor Amperes	780
Efficiency (Full Load - Calculated)	95.4
Power Factor (Full Load - Calculated)	90.3

2. Atomizing Air Receiver

a. General Information:

Service: Atomizing Air supply reservoir  
Type: Cylindrical welded steel plate with dished heads.  
Long axis vertical.  
Fabricator: Bremco Industries, Inc. through Prodco  
Equipment & Service Company  
Standard: ASME, Section VIII

b. Design Details:

Dimensions: 60" O.D. x 204" over heads  
Shell & Heads 1/2" thick. S-A.516 GT. 70  
Joints: Butt welded

c. Performance:

Capacity, gallons	2000
Working pressure, psig	200
Test pressure, psig	300
Temperature, °F	300

d. Connections & Penetrations

11" x 15" Manhole  
4" Air Inlet, 300 Lb. Flg.  
4" Air Outlet, 300 Lb. Flg.  
1 1/2" Drain, Sch. 40, SW.  
6" Relief Valve, 300 Lb. Flg.  
3/4" Press, Sch. 80, SW.

e. Mounted Accessories

3" Safety Relief Valve Consolidated, Model 1910KC.  
1" Air Trap, inverted bucket type Armstrong No. 213BVSU.

3. Auxiliary Instrument Air Supply

a. General Information:

All air requirements for Humidification and Coolside are supplied from the existing plant in the piping as designed. As original estimates are exceeded and the plant is struggling to keep existing compressors operational, the instrument air supply for these programs could not be guaranteed. A back-up source of instrument air from a 2" connection in the Atomizing Air Compressor discharge line was run back to the instrument air header. The following air dryer/conditioning equipment was procured to provide instrument quality air to the system:

-HiRoss Model W-140 water cooled aftercooler (shell and tube design) complete with air outlet thermometer, water outlet thermometer and water throttling valve on water outlet.

Service Conditions: 400 CFM compressed air at 150 PSIG and  
225°F (maximum)  
Cooling water inlet temperature - 85°F  
(maximum)

-HiRoss moisture separator with automatic moisture trap, inlet strainer, shut-off valve and bypass valves.

-Ingersoll Rand HR series dual tower heat reactivated desiccant dryer assembled on a self-supporting fabricated steel frame complete with:

- A. Safety relief valves on each tower
- B. Pressure gauges for each tower
- C. Visual dewpoint indicator
- D. Failure to cycle alarm
- E. I-R model 511G particulate after filter with built-in differential guage and three micron replaceable filter elements
- F. Desiccant - 15% activated Alumina and 85% Mobil Sorbead

D. Flue Gas Reheat System

1. Steam Coil Reheater (SCRH)

a. General Information:

Service: Heat humidified gas sufficiently above the acid dew-point to prevent condensation in the stack

Type: In-duct, condensing

Location: In the existing flue just downstream of the ESP outlet nozzle

Mfr: Aerofin Corp.

Model: Size 31TF x 14'-6" NTL, 2" ctrs,  
Type PDRP/return bend, 2" deep spacing, horizontal tubes, in-line,

b. Design Details:

Arrgt: 2 coils in face, 2 coils deep  
15'-0" wide x 12'-0" high, inside duct

Tubes: 1" O.D. x .065" wall, SA-514, Bare Tubes

Header: Fabricated steel, SA-515, GR70

Joints: Rolled and welded at header

Code: ASME, Section VIII, "U" stamped

Design conditions: 300 psig, 700°F

Hydrostatic test: 475 psig

c. Performance:

Flue gas flow (lb./hr.)	1,157,856
Entering Air Temp. (°F)	150
Leaving Air Temp. (°F)	190
Steam press. (psig)	300
Steam temp. (°F)	423
Condensate rate (lb./hr.)	14,875
Air friction ("w.g.)	1.5

2. Reheater Condensate Drain Tank

a. General Information:

Service: Collect condensate and maintain water level in coil drain lines to prevent steam bypassing.

Type: Butt welded, long axis vertical.

Mfr: A. Gunthard Co., Inc.

Size: 36" O.D. x 42" Tan-Tan, dished heads.

b. Design Details:

Design conditions: 350 psig, 436°F

Material: 1/2" thk sheel & heads, SA-516, GR70

Hydro -test press: 525 psig & hold 1 hour

Code: ASME, Seciton VIII, "U" stamped

c. Instruments Mounted:

Level transmitter:  
Type: Water column  
Mfr: Fisher Controls  
Model: Level-trol, 2390-249B  
Style F-3, electronic  
Indicator: Jerguson tubular gauge glass, Type 136

3. Reheat Piping

General: B&W designed the steam supply piping (sizes, materials, arrangement and stress analysis) and SWEC designed the hangers and supports based on B&W drawings and calculations and existing OEC structural drawings.

a. Steam Supply:

Utilizing an existing 2½" boiler steam drum nozzle as the source a 3" C.S. Sch.-80 pipe was run through a pressure reducing station and a flow control valve to the reheater.

b. Condensate Drain:

Drain lines from each of the four reheater sections drain to a common header which runs to the Reheater Condensate drain tank. From the tank the condensate runs to the condensor hotwell through a control valve which modulates flow to maintain tank level. All drain lines are 2", Sch. 80, C.S.

4. Instrumentation

Condensate Drain Tank Level Controller

Manufacturing: Fisher Controls  
Model: Level-Trol, type 2390-249B  
With: Jerguson Glass Water Gauge No. 136

E. Bypass System:

The bypass sytem was a necessary alternative to conducting tests in the existing flues where any need to "clean-up" or work internally would require a shut-down and loss of power generation from Unit No. 4. The location of the bypass on the roof of the boilerhouse was selected as most feasible. In occupying space formerly filled by a precipitor and flues, abandoned in 1980, the existing steel design loading could be utilitized and the existing precipitator hoppers could be used with the new equipment.

1. Humidification Chamber

a. General Information:

Service: To demonstrate the ability to reduce the flue gas temperature by adding water without fouling the gas path. An array of atomizers is installed at the inlet end.

Type: Simulates existing flues

Mfr: Fabrication sublet, per B&W Design

Size: 14'7" x 14'7" cross-section by 63'-8 1/2" long

Supports: Structural supports designed by SWEC.

b. Design Details:

Materials: 3/16" thk, A-36 plate

C10 x 15.3 channel stiffeners

W10 x 49 load collectors and support legs

Design Conditions:  $\pm 25$ "w.g. and 310°F

c. Hoppers:

The four (4) existing hoppers have been extended upward to connect to the bottom periphery of the chamber. An expansion joint is added in this connecting piece to accommodate the freely expanding chamber to the hoppers which are welded to the building steel. The hoppers will be plated over during initial operations, making a floor in the chamber 14'-7" below the chamber roof. If the amount of drop-out or accumulations in the chamber should necessitate its continuous removal the floor plates will be removed and the ash-removal system (described below) installed.

d. Penetrations:

The chamber will have the following penetrations in the sidewalls and roof:

12-5"- Observation doors

22-Atomizer lance assemblies

52-Clean out ports for air lancing

2-18" x 24" Access Doors

1-36" x 48" Equipment Panel

14-4" Test Ports, roof, inlet and outlet

3-4" Temperature Test ports

e. Instrumentation:

12-Load cells mounted on chamber support legs to monitor ash build-up in chamber.

Type: Kistler Morse, Model 533 Microcells

88-Thermocouples to monitor operating temperatures on walls floor and roof of chamber

Type: ARI Industries, Aeropad, Type T

Model No. T-57M-120E-T-4A

## 2. Connection Flues

### a. General Information:

We define the new flue from the existing airheater outlet flue to the Humidification Chamber as "Inlet Flue" and from the chamber back to the existing flue as the "Outlet Flue".

### b. Design:

As with the Humidification Chamber the flues are built to B&W standards. They use 3/16" thk., A-36 plate and are designed for  $\pm 25$ "w.g. and 310°F conditions.

### c. Penetrations:

18" x 24" Access doors provide access to all area of flues without crossing through dampers

7-4"-Test ports in inlet flues

7-4"-Test ports in outlet flues

3-4"-Temperature tests ports in outlet flue

3-4"-Temperature tests ports in inlet flue

6-4"-Gas analyzer test ports in outlet flue

3-4"-Gas analyzer test ports in inlet flue

3-4"-Temperature tests ports in existing flue downstream of bypass return point

2-2"-Flowmeter ports in inlet flue with

2-2"-Flowmeter support ports in opposite wall

### d. Instrument Mountings:

2- Flowmeter sensor probes

Type: Multi-point mass flowmeter

Mfr: Fluid Components, Inc.

Model: MT86 with three (3) sensors on each probe

2- Gas analyzer probes for CO<sub>2</sub> and H<sub>2</sub>O, one in inlet flue and one in outlet flue

Type: Heated dilution extractive type

Mfr: Enviroplan

Model: 2 point, time shared CEMEX with:

Sum X, SC-700 moisture analyzer and

ACS/Fuji CO<sub>2</sub> monitor

## 3. Flue Expansion Joints

### General Information:

Flue gas temperatures cause movement of the flues from the

anchor points. This is taken up by expansion joints which have to withstand the conditions of temperature, pressure and corrosion that could normally occur in the flues.

Design: Up to 1 3/8" movement - longitudinal  
Up to 1 3/8" movement - lateral - horizontal  
Up to 1/4" movement - lateral - vertical  
at ±35"w.g. and 350°F  
Type: Non-metallic fabric  
Mfr: RM ENGINEERED PRODUCTS, Inc.  
Model: Mark III, Flextra  
Spec: High temperature fluoroelastomer with 2-ply fabric reinforcement, 1/4" thk.

#### 4. Dampers

##### General Information:

Both shut-off and modulating dampers are required for the bypass system operations while the boiler is operating. Shut-off dampers must isolate the bypass system and allow men to enter the humidification chamber and connecting flues safely. They have also been installed in the existing flues to force all gas through the bypass when required. Modulating dampers are used to provide a gradual, non-shock transfer of flow to or from the bypass and to also control a percentage of the full flow through the bypass as required.

##### a. Shut-Off Damper: (4-required)

Design: There must be no leakage of gas in the direction of the bypass system. Electric drives are required. Signal blade position by 2 limit switches at both open and closed positions.  
Type: Guillotine, horizontal flow, vertical lift  
Mfr: Air Clean Damper Company, Inc.  
Model: Zero-Leak Slide Gate  
Size: 1-180" x 139" in bypass inlet flue  
1-123" x 123" in bypass outlet flue  
2-175.5 x 46" in existing flues  
Drives: Limitorque SMC/HBC  
Limit Switches: ACME EA-170

##### b. Modulating Dampers: (2-required)

Design: Low leakage, electric control drive.  
Type: Louver  
Mfr: Babcock & Wilcox Company  
Model: B&W Standard "Louver" damper  
Size: 10'-3" x 10'-3" each with 5 blades  
Drive: Limitorque SMC-031 with geared limit switch

F. Atomizing System

General Information:

Building on existing dry scrubber experience. B&W used the I-Jet atomizing spray technology as a basis for designing a system that would attain the necessary level of humidification during continuous operation. The design must therefore minimize internal pluggage or external build up on atomizers and fouling of the flues by water impingement, caking or accumulation from shedding or drop-out. Extensive model-testing at the B&W Alliance Research Center established the atomizer size and array at the entrance to the Humidification Chamber.

1. Atomizers:

Type:	Mini "I" Jet
Capacity:	0.80 GPM Each
Quantity:	110
Spray Angle	25° Inclusive
Holes, Quan/Diam:	4/.1065"
Air/Water Ratio:	.45

2. Lance Assemblies:

Design: The lance must carry multiple atomizers to achieve the 10 X 11 array and allow for:

- a. On-line replacement
- b. Low gas-side pressure drop
- c. Non-fouling of atomizer tips due to spray recycling under gas-flow conditions.
- d. An adequate support system.

#### Details:

Five atomizers are contained in one lance having an air-foil shaped housing about 3" X 9". The upstream larger diameter end of the foil is made of an outer and an inner header pipe. Air is fed through the outer annular area and water through the inner pipe to supply the atomizer. The lances are supported from an integral wall mounting flange, which is gasketed and bolted to the flue casing, and by an internal support frame at the center of the flue. A screened opening in the mounting flange allows ambient air to be drawn into the lance and through annular openings around each atomizer. This "Vent Air" is intended to keep the atomizer tips dry and free of flyash build-up.

### 3. Maintenance Hoist

#### Design:

Hand chain hoist to lift lances and move on monorail to maintenance bench.

Manufacture:	Accolift
Type:	Chain hoist with hook suspension
Model:	VH-1100
Capacity:	1100 Lbs.
Lift:	10 Ft.
Pull:	55.1 Lbs to lift full load
Trolley:	Accolift plain trolley, model VT-1100, max cap. 1100 lbs.

#### Feed Header System

##### a. Water Side:

After passing through the 40 mesh duplex strainer and a pressure control valve, located in the South spray deck enclosure, the 80 psig water splits into two 1½" lines feeding vertical headers on the North and South spray decks. Two control valves in each header partially compensate for static head differences to maintain a near-balanced pressure at the atomizers.

##### b. Air Side:

After passing through a "Y" - strainer with a 0.033" perforated basket, and a pressure control valve compressed air at 105 psig splits into two 3" lines feeding vertical headers, paralleling the water headers on each spray deck.

##### c. Interlock:

The feeds to each lance are valved and interlocked so that water can not enter the lance without atomizing air.

4. Controls & Instruments

Total Water Flow Meter: Tag No. FT-1600

Type: 2" Magnetic with integral signal converter  
Mfr.: Fischer & Porter  
Model: 10D1475 Mini-Mag X Magnetic Flowmeter  
ID50-1669 Converter

Total Air Flow Meter: Tag No. Ft-1500

Type: 4" Vortex with integral signal converter  
Mfr.: Fischer & Porter  
Model: 10LV3101AFBB1B Liquid Vortex Meter  
50LV311BIFC Converter

Individual Lance Water Flow Meter: Tag No.'s: 1601 R/L thru  
1611 R/L

Type: 1/2" Magnetic with integral converter  
Mfr.: Fischer & Porter  
Model: 10D1475 Mini-Mag X Magnetic Flowmeter ID50-1669  
Converter

Water Strainer Differential Pressure Switch: Tag No. DPT-1602

Type: Teflon diaphragm, 2-SPDT switches  
Mfr.: Ashcroft  
Model: D464TXUD with HM45IU

G. Insulation and Lagging

1. Bypass System:

a. General:

From the bypass inlet connection to the Humidification Chamber 2" of insulation is applied primarily for personnel protection. After humidification, including all of the chamber and outlet flues, 4" of insulation is applied as the temperature of the flue gas has been reduced to a controlled approach to saturation (ATS) for test purposes. Significant heat loss in these areas could cause condensation on internal surfaces.

b. Specification for pre-fabricated panels:  
Inlet Flues:

2" Intermediate Temperature Block, Mineral Fiber 8 lb/ft<sup>3</sup>, ASTM C-612 (class 4), .040" Stucco Emossed 4" X 1" Box-Ribbed Aluminum, .0025 aluminum foil, 2" X 2 5/8" 16 Ga. galvanized mesh chamber and outlet flue: same as for inlet flue except insulation is 4" thick.

c. Miscellaneous Specifications:

Support Steel (subgirt system): to support insulation between stiffeners is 14 Ga. aluminized steel, 14 Ga. C.S. and 3/16" C.S. flat and/or bent plate. Flashing: .050 Stucco Embossed aluminum. Screws: #14-300 Series S.S. with eoprene-backed washers. Pins: 10 Ga. aluminum on 18" centers. Washers: 2½" Sq. aluminum. Caulking: G.E. silicone. Draft Barriers: 18 Ga. C.S. pans 2" TIE Type II secured with pins and washers.

d. Construction:

Typical constructions are shown on drawings, Figures G1-1, G1-2, & G1-3, on the following pages.

2. Reheat System Connecting Flues

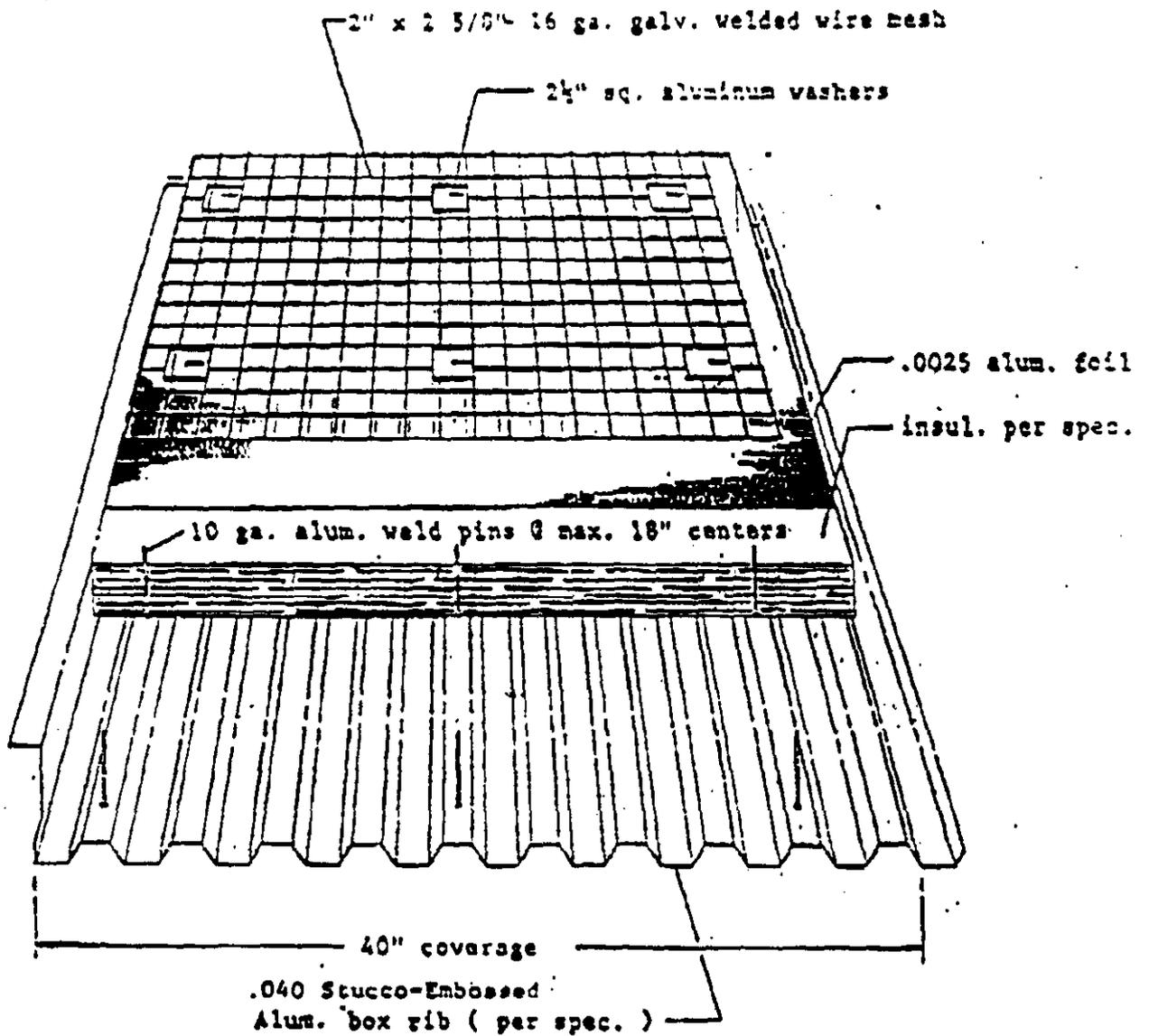
The same insulation and lagging specifications apply as for the Bypass System Outlet Flue, above in Section 1.

3. Piping

Piping insulation is designed in two categories:

- o For hot piping to retain heat and protect personnel.
- o For heat traced piping to prevent freezing.

Drawing 139255A following, is a B&W standard piping "Insulation Detail", showing thicknesses applied to various pipe sizes in both categories.



PRE-FABRICATED 4" BOX RIB PANEL

Fig. G1-1

.040 Stucco-Embossed  
Alum. Box-Ribbed panels  
w/2"

Duct Plate

14 ga. alum'd support steel  
60" long w/1/2" gap @ Butt ends

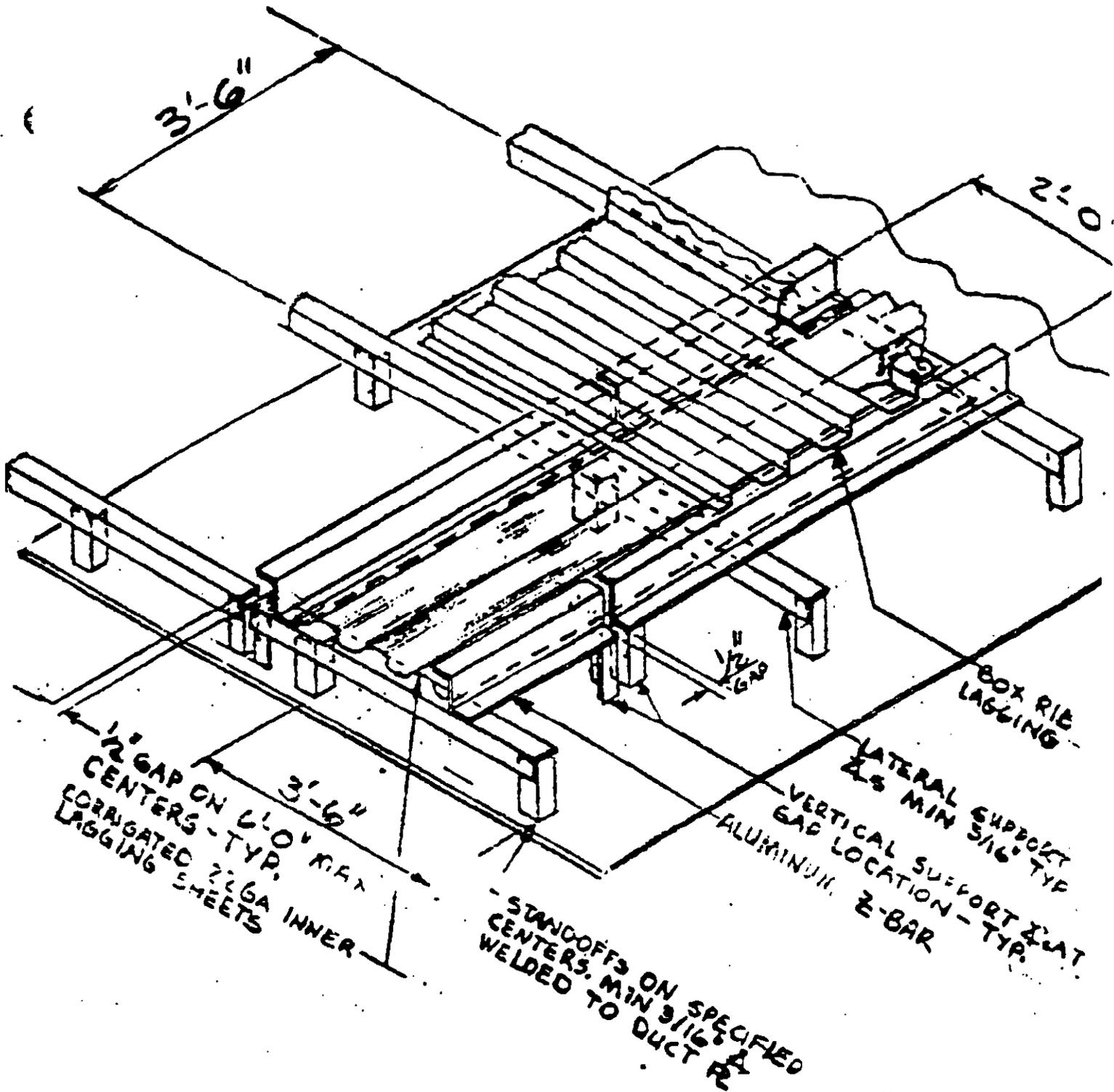
.050 Stucco-Embossed  
alum. corner flashing 90°

#14-300 series S.S. screws  
w/neoprene backed washers

TOP VIEW

90° CORNER FLASHING

Fig. G1-2

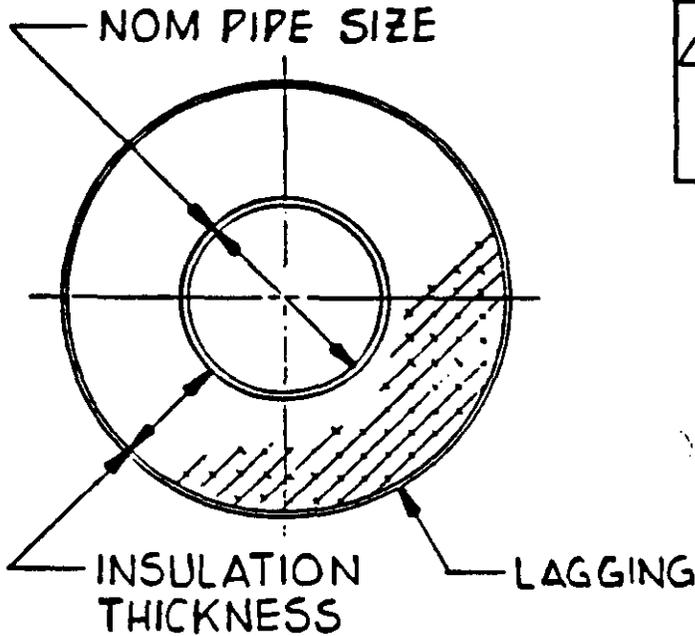


Roof Subgirt System

Fig. G1-3

Babcock & Wilcox  
a McDermott company

REVISIONS			
REV	DESCRIPTION	DATE	APPROVAL
1	CHGD NOTE 1, INSUL THK FOR NOTE 2 (ADD 10" INSUL THK. DAH/SD)	2/5/05	END



0-1 1/2"	1 1/2"	▲
2"	1 1/2"	
2 1/2"	▲	
3"		1"
3 1/2"		▲
4"		
4 1/2"	2"	
6"	2 1/2"	
8"	2 1/2"	1 1/2"
10"	2 1/2"	2"
NOM. PIPE SIZE	NOTE 1 INSULATION THICKNESS	NOTE 2

1. INSUL. THICKNESS SHOWN FOR STEAM & CONDENSATE PIPING IN REHEATER AREA.

2. INSUL. THICKNESS SHOWN FOR HEAT TRACED PIPING.

V. Equipment Description - Coolside

INDEX

- A. Definition (of "Coolside")
- B. Design Criteria
  - 1. Sorbent
  - 2. Coal
  - 3. Sodium Hydroxide -  $\text{Na(OH)}_2$
  - 4. Recycled Ash
  - 5. Operating Conditions
- C. Caustic System
  - 1. Holding Tank
  - 2. Pump
  - 3. Instrumentation
  - 4. Freeze Protection
- D. Coolside Solids Injection System
  - 1. Distribution Systems
  - 2. Lance Assemblies
- E. Coolside Solids Feed Systems
  - 1. Line Feed System
  - 2. Recycled Ash Feed System

A. Definition:

The Coolside process is designed to demonstrate improved SO<sub>2</sub> removal by injecting dry lime just upstream of humidifier while adding a small amount of NaOH to the humidification water. Recycled ash from the ESP will also be injected to utilize the unused lime in the ash decreasing the fresh lime required.

B. Design Criteria

1. Sorbent

Hydrated lime is identical to that described in Section A,1 above.

2. Coal

The coal analysis is identical to that described in Section A,2 above.

3. Sodium Hydroxide - Na(OH)<sub>2</sub>

Percent solution in water 50

Specific gravity 1.53

4. Recycled Ash (% by wt.)

Ca(OH) <sub>2</sub>	26.12
CaSO <sub>3</sub>	22.97
CaSO <sub>4</sub>	4.59
Na <sub>2</sub> SO <sub>3</sub>	5.73
Na <sub>2</sub> SO <sub>4</sub>	1.14
Inerts	3.22
Ash	36.25

5. Operating Conditions

a. Without recycled ash:

	Peak Load
Boiler rating	50
Percent SO <sub>2</sub> removal	50
Stoichiometry (Ca:S)	2.5
Flue gas temp. AH outlet	310
Excess air AH outlet	40
Lbs. NaOH/Lb Ca(OH) <sub>2</sub>	0.1
Percent NaOH utilization	100

b. Adding recycled ash:

Recycled ash rate, lbs/hr	17,300*
Max design rec. ash rate, lbs/hr	22,500

\*-Approximate amount of recycled ash developed by CONSOL in their test facility, based on the ESP hopper unloading rate of 36,000 lbs/hr.

c. Ambient conditions	
Barometric pressure, psia	14.4
Minimum temp., °F	-20
Maximum temp., °F	100
Design temp., °F	80
Humidity, lbs H <sub>2</sub> O/lb dry air	0.0130

## C. Caustic System

### General Information:

The existing caustic system for boiler water treatment was not available for LIMB use. Space and foundation requirements dictated that the new caustic tank be located outside of the building. The selected location is just North of the Acid & Caustic Building extension on the North side of the Unit No. 4 Boiler house. Caustic is pumped from this tank to the atomizing water storage tank on floor elevation 238'-0". Caustic is delivered at a constant pressure to a control valve which modulates its flow into the tank to maintain the sodium-ion level selected.

#### 1. Caustic Holding Tank

Design: 40 hrs. storage capacity at 2.8 gpm built to API-650 standard, covered, with spill containment and truck fill connection.

Type: Welded carbon steel shell, flat bottom resting on gravel base.

Size: 13'-0" diameter x 8'-9" high.

Details: Tank capacity - filled 8200 gals.

Working capacity 7200 gals.

Tank bottom plate 1/2" thk; A235, GRC

Tank shell & cover 3/8 thk; A235, GRC

Steel Containment: 18 ft. x 20 ft. area within a 42" high reinforced wall, all 1/4" C.S. plate.

Fabricator: Milan Steel Fabricators, Inc.

#### 2. Caustic Pump:

Design: 50 gpm capacity, 300 ft. TDH, MAS-023 Spec. motor

Type: Vertical, in-line, centrifugal

Mfr: Ingersoll-Rand

Model: VOC 2 x 1 1/2 x 8, chemliner Cast Iron casing and impeller

Motor: Reliance 20 H.P., 3600 RPM, TEFL, 1.15SF, Frame 256LP, 460/3/60.

#### 3. Instrumentation

##### a. Caustic Tank Level Transmitter

Design: Senses head pressure

Type: Tank shell mounting

Mfr: Bailey Controls Company  
Model: BC7, Working range 0-87"

b. Caustic Tank Level Indicator

Design: Direct reading at location. No glass.  
Type: Magnetic liquid level gauge  
Mfr: Kenco Engineering  
Model: "MAGNA-SITE" MLG-4.  
Length of indication 87".  
Magnetic float actuates external visual display denoting level.

4. Freeze Protection

General Information:

The 50% NaOH solution starts solidifying at 55°F so the tank temperature must be kept above this point.

Design: Maintain Solution in tank above 65°F by electrical heating when covered with 2" of fiber glass insulation.

Mfr: Chromalox

Type: Heat trace cable with controls

Model: SRLC-2CT self regulating cable 3 watts/ft. with 36" x 30" x 12" NEMA-4 control cabinet for local mounting.

D. Coolside Solids Injection Systems

General Information:

Both lime and recycled ash are injected in dry form into the bypass system ahead of the humidification chamber. As these injection points are the same a design including both systems was developed to share the same access platforms, monorail/hoist lifting rig, and injection lance assemblies.

1. Distribution Systems:

- a. Distribution bottles: Except for the bottom inlet cones two identical bottles, one for lime (4" inlet) and one for recycled ash (6" inlet) are supplied. The 20" diameter bottles are mounted vertically, with a flanged top and nine-2" screwed connections equally spaced around the perimeter for outlet hose connections.
- b. Distribution Hose: The nine (9) hoses from each bottle are run three (3) to each of the three(3) injection lance assemblies. Each lance is fed by three (3) ash and three (3) lime carrying hoses. Hoses are 2" I.D. Goodyear Flexwing.

- c. **Access & Support Structure:** The structure is mounted on the top of four (4) inlet flue support/stiffener columns and carries the platforms, monorail for lance assembly removal, (design load 500 lb.) and the two (2) distribution bottles with hose supports.

2. Lance Assemblies & Mounting

- a. **Design:** Lances made up of 1½" diam, SCH. 40, SS TP304, piping, bundled together and releasing Dry Sorbent and/or Ash at dimensioned release points. The pipes run through a ½" thick mounting plate which is bolted with gaskets to the top flange of the inlet boxes.

b. **Lance Inlet Boxes:**

**Design:** Boxes raise the lance support level above the insulation and lagging on the top of the flue providing access to the lance mounting bolts from the platform. There are five (5) lance locations as the two outer boxes are doubled in width to allow two alternate lance positions. When not in use bolted and gasketed cover plates seal-off each of the 16" square openings. The boxes and cover plates are insulated.

E. Coolside Solids Feed Systems

1. Lime Feed Systems:

It utilizes the existing feed system installed for the base LIMB demonstration phase. The 4" feed hose from the Accrison bin feeder will be rerouted and extended to the inlet to the Coolside Lime Distribution Bottle.

2. Recycled Ash Feed System:

The source of ash will be at the discharge from the existing Unit No. 4 - Ash Storage Silo in the 12" line to the dry unloading spout. From this point a new 12" pipe will cause the ash to drop vertically down through two new 12" rotary feeders in series. The upper feeder's speed will be controlled. The lower feeder will provide an air-lock against the air pressure in the transport line. An outlet adapter will direct the discharge from the lower feeder into its 8" diameter horizontal pick-up connecting piece.

A rental compressor will supply transport air through a flow control valve in a 4" line to the outlet adapter, entrain the ash and carry it to the distribution bottle through a 6" hose.

a. **Rotary Feeders: (2 req'd)**

**Design:** Maximum vanes required to reduce blowback

leakage, closed-end rotor with adjustable and replaceable wear resistant tips, outboard bearings, packing gland shaft seals and shaft-mounted zero-speed switch.

Size: 12" square inlet and outlet.

Mfr: Smoot Co.

Model: FT-14, Fall thru, Precision Aire, Rotary Airlock Feeder.

Drive: 1½ HP MOTOR, TEFC with gearhead and chain drive and guard.

Performance:

Capacity, lb/hr.	20,000
Density of ash, lbs/ft <sup>3</sup>	30-60
Rotor displacement, ft <sup>3</sup> /rev.	0.96
Feeder speed, RPM.	

Also included: Vented inlet for bottom feeder.  
"Straight thru" discharge adapter, 8" diam.

- b. Connecting piping and supports designed by B&W for sublet fabrication.
- c. 6" I.D. transport hose:  
Design: Erosion Corrosion Resistant  
Mfr: Goodyear  
Model: Tan Flextra, MK FH-20  
Details: Reinforced, Inner Lined

F. Atomizing System

General Information:

Building on existing dry scrubber experience. B&W used the I-Jet atomizing spray technology as a basis for designing a system that would attain the necessary level of humidification during continuous operation. The design must therefore minimize internal pluggage or external build up on atomizers and fouling of the flues by water impingement, caking or accumulation from shedding or drop-out. Extensive model-testing at the B&W Alliance Research Center established the atomizer size and array at the entrance to the Humidification Chamber.

1. Atomizers:

Type:	Mini "I" Jet
Capacity:	0.80 GPM Each
Quantity:	110
Spray Angle	25° Inclusive
Holes, Quan/Diam:	4/.1065"
Air/Water Ratio:	.45

## 2. Lance Assemblies:

Design: The lance must carry multiple atomizers to achieve the 10 X 11 array and allow for:

- a. On-line replacement
- b. Low gas-side pressure drop
- c. Non-fouling of atomizer tips due to spray recycling under gas-flow conditions.
- d. An adequate support system.

Details:

Five atomizers are contained in one lance having an air-foil shaped housing about 3" X 9". The upstream larger diameter end of the foil is made of an outer and an inner header pipe. Air is fed through the outer annular area and water through the inner pipe to supply the atomizer. The lances are supported from an integral wall mounting flange, which is gasketed and bolted to the flue casing, and by an internal support frame at the center of the flue. A screened opening in the mounting flange allows ambient air to be drawn into the lance and through annular openings around each atomizer. This "Vent Air" is intended to keep the atomizer tips dry and free of flyash build-up.

## 3. Maintenance Hoist

Design:

Hand chain hoist to lift lances and move on monorail to maintenance bench.

Manufacture:	Accolift
Type:	Chain hoist with hook suspension
Model:	VH-1100
Capacity:	1100 Lbs.
Lift:	10 Ft.
Pull:	55.1 Lbs to lift full load
Trolley:	Accolift plain trolley, model VT-1100, max cap. 1100 lbs.

## Feed Header System

a. Water Side:

After passing through the 40 mesh duplex strainer and a pressure control valve, located in the South spray deck enclosure, the 80 psig water splits into two 1½" lines feeding vertical headers on the North and South spray decks. Two control valves in each header partially compensate for static head differences to maintain a near-balanced pressure at the atomizers.

b. Air Side:

After passing through a "Y" - strainer with a 0.033" perforated basket, and a pressure control valve compressed air at 105 psig splits into two 3" lines feeding vertical headers, paralleling the water headers on each spray deck.

c. Interlock:

The feeds to each lance are valved and interlocked so that water can not enter the lance without atomizing air.

4. Controls & Instruments

Total Water Flow Meter: Tag No. FT-1600

Type: 2" Magnetic with integral signal converter  
Mfr.: Fischer & Porter  
Model: 10D1475 Mini-Mag X Magnetic Flowmeter  
ID50-1669 Converter

Total Air Flow Meter: Tag No. Ft-1500

Type: 4" Vortex with integral signal converter  
Mfr.: Fischer & Porter  
Model: 10LV3101AFBB1B Liquid Vortex Meter  
50LV311BIFC Converter

Individual Lance Water Flow Meter: Tag No.'s: 1601 R/L thru  
1611 R/L

Type: 1/2" Magnetic with integral converter  
Mfr.: Fischer & Porter  
Model: 10D1475 Mini-Mag X Magnetic Flowmeter ID50-1669  
Converter

Water Strainer Differential Pressure Switch: Tag No. DPT-1602

Type: Teflon diaphragm, 2-SPDT switches  
Mfr.: Ashcroft  
Model: D464TXUD with HM45IU

G. Insulation and Lagging

1. Bypass System:

a. General:

From the bypass inlet connection to the Humidification Chamber 2" of insulation is applied primarily for personnel protection. After humidification, including all of the chamber and outlet flues, 4" of insulation is applied as the temperature of the flue gas has been reduced to a controlled approach to

saturation (ATS) for test purposes. Significant heat loss in these areas could cause condensation on internal surfaces.

b. Specification for pre-fabricated panels:  
Inlet Flues:

2" Intermediate Temperature Block, Mineral Fiber 8 lb/ft<sup>3</sup>, ASTM C-612 (class 4), .040" Stucco Embossed 4" X 1" Box-Ribbed Aluminum, .0025 aluminum foil, 2" X 2 5/8" 16 Ga. galvanized mesh chamber and outlet flue: same as for inlet flue except insulation is 4" thick.

c. Miscellaneous Specifications:

Support Steel (subgirt system): to support insulation between stiffeners is 14 Ga. aluminized steel, 14 Ga. C.S. and 3/16" C.S. flat and/or bent plate. Flashing: .050 Stucco Embossed aluminum. Screws: #14-300 Series S.S. with eoprene-backed washers. Pins: 10 Ga. aluminum on 18" centers. Washers: 2 1/4" Sq. aluminum. Caulking: G.E. silicone. Draft Barriers: 18 Ga. C.S. pans 2" TIE Type II secured with pins and washers.

d. Construction:

Typical constructions are shown on drawings, Figures G1-1, G1-2, & G1-3, on the following pages.

2. Reheat System Connecting Flues

The same insulation and lagging specifications apply as for the Bypass System Outlet Flue, above in Section 1.

3. Piping

Piping insulation is designed in two categories:

- o For hot piping to retain heat and protect personnel.
- o For heat traced piping to prevent freezing.

Drawing 139255A following, is a B&W standard piping "Insulation Detail", showing thicknesses applied to various pipe sizes in both categories.

VI. Control Systems

BYPASS DAMPERS OPERATION & INTERLOCKS

DAMPER/DUCT PRESSURE INTERLOCK

FLUE GAS REHEATER OPERATION

## I. DESCRIPTION

The Humidification Chamber gas path configuration includes two guillotine dampers and a louver in the outlet ductwork of the Humidifier Chamber. In parallel to the Humidification Chamber is a normal operation duct. The normal operating gas path configuration would utilize this latter duct.

The guillotine dampers in the Humidification Chamber are used to provide a safe environment inside the chamber. A safe environment is necessary for personnel to enter the chamber for maintenance or cleaning. The louver damper is within the boundaries formed by the guillotine dampers. The louver damper is not for isolation but only to facilitate the reconfiguration of the gas path.

## II. OPERATION

Assuming the Unit is configured to humidify the gas leaving the boiler and an inspection of the Humidification Chamber is required, a reconfiguration of the boiler outlet gas path would proceed as described.

A slight reduction in load to allow ample margin in the I.D. Fan operation if operating at MCR conditions. System is to be notified prior to the reconfiguration to obtain the necessary clearances before the reconfiguring is to begin. The guillotines in the normal operating duct would then be opened by the Control Room Operator (CRO). The louver damper in the normal operating duct would then be released by the Interlock for operation. After the Interlock has verified that both guillotines have achieved their full open positions.

The louver damper in the normal operation duct must be opened slowly to 100% to avoid excursions in furnace pressure. The CRO has a control Hand/Auto (H/A) station which allows interaction with this damper. The CRO during this period is monitoring furnace pressure, I.D. Fan suction pressure and I.D. Fan speed to ensure that the unit is being safely operated. The control station logic is set up to prevent rapid movement of these dampers.

After achieving a stable operating point as indicated for the above parameters the louver damper in the Humidification Chamber ductwork is to be closed to 0%. This damper is controlled by a similar H/A control station and logic as the louver damper in the normal gas path.

## III. CONTROL

The louver damper control is through a HAND/AUTO(H/A) Control Station. The overall control of these dampers includes a provision which inhibits the operator from completely closing the damper during a single damper operation event. This is achieved by monitoring the damper position feedback and the signal to the damper drive. If the difference between these two signals exceeds a prescribed limit, the control signal will stop sending a positioning signal to the drive. The control resets upon release of the H/A Station.

Upon achieving 100% open of the normal operation duct louver damper and complete closure of the Humidification Chamber ductwork louver damper, the MFT Interlock Logic will release the Humidification Chamber guillotine dampers to be closed by the CRO. The CRO may then close these dampers. After all dampers are in the correct positions for this configuration the CRO may then return the Unit to the load as required by system.

The guillotine dampers are controlled by a Multi-State Device Driver (MSDR). The MSDR is a control station with three (3) states. The first state initiates an open command to the damper. The second state will stop the damper regardless of any previous command. The final state will initiate a close command to the damper.

The station will not allow a reversal in commands. That is, if the damper has been given an open command, a close command cannot be given to the damper drive until the damper is completely open or a stop has been initiated by the CRO. This scheme eliminates mechanical damage to the damper drive or the damper.

## DAMPER/DUCT PRESSURE INTERLOCK

The DAMPER/DUCT PRESSURE INTERLOCK is a fail safe addition to the current Boiler Master Fuel Trip Interlock. The purpose for this addition is to protect the boiler from upsets during a mechanical failure, an electrical failure, or an operator initiated reconfiguration of the outlet ductwork. This reconfiguration consists of changing the boiler outlet gas flow path from the Humidification Chamber to the normal operating ductwork. The location of this ductwork equipment is between the Air Heater Outlet and the Precipitator Inlet.

The reconfiguration of the boiler outlet flow gas path is accomplished through the proper sequential operation of louver and guillotine dampers. The Interlock addition is a "watchdog" to ensure that the dampers have not experienced a failure and that the operator has executed the reconfiguration sequence properly. In the unlikely event that this sequence is improperly executed, the interlock will initiate a Boiler Master Trip (MFT). The sequence of the MFT will be determined by the existing hard-wired relay logic.

The Governing Principle of the Interlock is to provide an open gas path from the Boiler to the Precipitator. An open gas path is determined by interregating limit switches that are associated with each damper. The guillotine dampers are physically provided with redundant limit switches in the open and closed positions. The louver dampers are not provided with limit switches. However, these dampers are equipped with position feedback transmitters. The Interlock reviews the louver damper position to ensure that it is not closed.

The Boiler Draft portion of this interlock system senses the boiler draft of the furnace. If the setpoint is reached the switch closes and sends a signal to the MFT relay system to shutdown the boiler by tripping the Forced Draft Fan. The Precipitator Inlet Pressure is sensed by a pressure switch to avoid implosion of the ductwork. This switch signal is sent to the MFT relay system to shut down the boiler by tripping the Induced Draft Fan. The boiler relay logic will continue to sequentially shut down the boiler to prevent a catastrophic failure if any of the three outlined conditions are present.

## FLUE GAS REHEATER NARRATIVE

The temperature of the flue gas leaving the precipitator must be above the adiabatic saturation temperature before it enters the Induced Draft Fan, Ductwork, and the Chimney. This temperature condition is necessary to guard against the very harmful effects caused by condensation of acid mists in the absence of alkalinity. During a Master Fuel Trip (MFT), the flue gas reheat system stays in service.

To accomplish the necessary protection of the equipment, the gas is reheated to 190F. This temperature is 65F  $\pm$  5F above the adiabatic saturation of the gas entering the Humidifier at Maximum Continuous Rating (MCR) of the boiler.

This degree of Reheat is achieved thru the use of an inline steam coil reheater at the outlet of the precipitator. The steam coil reheater is a steam condensing type complete with a condensate return system. The steam for the reheater is taken from an auxiliary connection on the boiler steam drum. This 1500 psig steam source from the drum is piped to a reducing station before the reheater. A Safety Valve is provided in this piping following the reducing station to protect the hardware in this system.

The arrangement of the steam coil reheat/condensate return equipment allows for self-draining of the reheat coil in the event of a MFT or any other excursion of the reheat steam flow. This self-draining feature protects the steam coil reheater from freezing during the winter months. The coil is also protected against freeze up on start up in the winter months in the same manner. This operation is ensured by the condensate return level tank being located below the steam reheat coils.

The technique used for the operation of this system is referred to as a Steam-Inlet and Condensate-Outlet Control. This scheme provides a method of quick response to changing gas conditions with load and the ability to operate at low boiler loads.

### I. Description

Downstream of and in the flow path of the flue gas leaving the precipitator is a steam coil reheater.

The steam for the reheater is taken from an auxiliary connection on the boiler steam drum. The condensate from the reheater is returned to the boiler cycle via a condensate return system.

The required steam flow to the steam coil gas reheater is determined by the mass flow rate of the gas through the coils, the coil surface area and the temperature differential between the steam and the flue gas. This amount of steam is relatively insensitive to attempts to control it by use of a steam flow control valve.

The auxiliary steam connection on the drum is supplied with manual double block and telltale valve arrangement before the steam pressure reducing station. The reducing station is followed by a safety valve to protect the piping, steam coil reheater, and the condensate level tank. This arrangement is provided for maintenance of all downstream equipment in the flue gas reheat system.

The steam pressure reducing station reduces the boiler drum pressure of 1500 psig to 300 psig. The reducing station is equipped with a bypass valve arrangement around the reducing valve. The control of the reducing station is through the use of a local pneumatic pressure controller operating at a constant pressure setpoint.

A single manual block valve is provided ahead of the steam flow control valve and reheater to isolate this system from steam flow when it is not in service. This valve is installed for operational convenience and not to provide isolation for maintenance. To isolate this control valve, reheater, or condensate return equipment refer to the paragraph above regarding the double block and telltale valving.

The flue gas reheater outlet temperature control is achieved through the use of a single control valve upstream of the steam coil reheater. This control valve is operated from the control panel and is used to trim the steam conditions as a function of the Induced Draft Fan Inlet Temperature. The I.D. Fan inlet temperature is compared to a setpoint temperature to provide a trim signal to the steam condition control valve.

The steam coil reheater is a bare tube heat exchanger. The heat exchanger is arranged with horizontal tubes between two headers. The horizontal tubes have a slight slope to allow the tubes to be self-draining during operation and shut-down. The tubes are installed as two coils, each coil is composed of two sections. The tubes in the coil are arranged in a staggered configuration four rows deep.

The steam coil reheater operates in a steam condensing mode thru the use of a pressure balancing line. This steam pressure balancing line is parallel to the reheat coils. That is, the reheater and balancing line are both piped from the downstream side of the steam condition control valve to the condensate level tank. The pressure balancing line enters the top of the tank. The steam coil reheater drain lines are routed to this tank in such a manner as to provide a water seal between the sections of the reheater. The water seal prevents steam short circuiting or condensate flooding of the reheater.

The condensate level tank provides the control required to maintain a water seal between the sections of the reheater and adequate hydraulic head for the condensate to drain back to the condensate hot well under the condensor. All of the condensate must pass through this tank prior to returning to the hot well. The condensate level tank is fitted with a thermostatic vent valve. This valve eliminates non-condensable gases from the condensate.

The condensate tank level is indicated and alarmed on the control panel. The level gauge is mounted on the tank and is compared to a level setpoint in the control system. The error signal is fed to a control valve in the condensate return line just upstream of the condensate hot well. The tank is also equipped with local temperature and pressure indicators.

The piping between the condensate level tank and hot well has a drain valve, conductivity meter, and a control valve with bypass. The drain valve is provided for operational and maintenance convenience. The conductivity meter is indicated and alarmed on the control panel. The control valve obtains its control signal from the control system to maintain level in the condensate level tank. This scheme prevents condensate from flashing in the condensate return piping. If the condensate were allowed to flash, the condensate return flow would instantaneously stop and then surge. This condition is potentially damaging to the reheat equipment and is characterized by a "banging" in the condensate return line.

DESCRIPTION OF MODIFICATIONS

ENGINEERED BY STONE & WEBSTER

for the  
BYPASS SYSTEM

LIMB DEMONSTRATION PROJECT  
AT THE OHIO EDISON COMPANY'S  
EDGEWATER STATION  
LORAIN, OHIO

Prepared for

BABCOCK & WILCOX COMPANY

August 1988

STONE & WEBSTER ENGINEERING CORPORATION



## DESCRIPTION OF MODIFICATIONS

This document provides a general description of the work performed for items engineered and designed by Stone & Webster Engineering Corporation (SWEC) for Babcock & Wilcox (B&W) for the addition of a bypass duct to the Humidification modifications of the LIMB Demonstration Project. The bypass duct provides a separate flue gas flow path in which the demonstration will take place at Ohio Edison's Edgewater Station in Lorain, Ohio.

The scope of the work is broken down into the following accounts:

### Description

1. Foundations and Structural Steel
2. Enclosures
3. Injection Water and Air Piping
4. Service Water, Instrument Air and Miscellaneous Piping
5. Heating, Ventilating and Air Conditioning
6. Ash Handling Modifications
7. Electrical Equipment
8. Electrical Systems Cable, Conduit, etc
9. Process Controls and Instrumentation

This description covers only adding the bypass to the base humidification modifications.



1. Foundations and Structural Steel

A. Equipment Foundations

Presently, there are no concrete equipment foundations associated with the Bypass System of the Humidification Modifications.

B. Structural Steel

Structural steel supports are provided for the following equipment:

- Damper supports and access platforms in existing outlet duct.
- Damper supports and access platforms in the new bypass duct.
- Bypass duct and humidification chamber supports and service platforms.
- Humidification Monitoring Room.
- Ash transport access platform.
- Reheater support steel.

Damper Supports and Access Platforms in Existing Outlet Duct

A new support structure is provided for the guillotine dampers in the existing outlet duct just outside and north of the powerhouse. The structure is an extension of the existing duct support tower between 30 and 31 line. Support and access is provided for the louver damper just upstream of the bypass duct intersection.

Damper Supports and Access Platforms in the New Bypass Duct

A support structure is provided for the guillotine damper in the bypass duct just south of the existing breeching. Support and access is also provided for the louver damper at the downstream intersection of the bypass duct to existing duct.

Bypass Duct and Humidification Chamber Supports and Service Platforms

A support structure is provided just above the existing powerhouse roof level for support of the new bypass duct. The chamber is supported on the powerhouse roof structure which is reinforced as required. Access and service platforms are provided adjacent to the new duct. The humidification chamber utilizes the existing abandoned precipitator ash hoppers below the existing boiler house roof. Modifications to the existing hoppers and structure were made.

Humidification Monitoring Room

A support structure is provided for the pre-engineered Monitoring Room building adjacent to the bypass duct and bearing on the duct support steel. Access from the boiler house roof is also provided.

### Ash Transport Access Platform

The existing access platform below the existing ash hoppers under the humidification chamber is to be reinforced for access to the new ash transport piping.

### Reheater Support Steel

A support structure is provided for the new steam Reheater between the precipitator outlet and the ID Fan inlet. Access is provided from the existing structure. Existing steel is modified and reinforced.

A monorail system for heater removal/installation is provided. A support structure and service platform is provided for the condensate return tank adjacent to the reheater area above the fan room roof.

## 2. Enclosures

### Humidification Monitoring Room

An insulated metal-sided enclosure with a raised computer style floor system is provided for the humidification monitoring room (approximately 16' x 16' x 10' high). The enclosure has an insulated metal deck roof and is completely equipped with mandoor, HVAC and lighting.

Support steel and a checkered plate roof cover are provided over that section of the boiler house roof which is open due to demolition at the retired precipitator and breeching. The existing roof curb is utilized to the extent possible.

New roofing is provided over the area under the retired precipitator inlet and outlet ducts which were removed.

## 3. Injection Water and Air Piping

The piping to convey the injection air and injection water from the compressor and pumps to the rooftop bypass location is provided for under the humidification scope.

## 4. Service Water, Instrument Air and Miscellaneous Piping

### Boiler and Sootblower Relief Valve Vent Relocations

Boiler and sootblower relief valve vents are relocated due to interferences with the humidification duct and associated structures on the boiler house roof. Pipe supports for the relocated vents are provided.

### Reheater Steam and Condensate Lines Pipe Supports

The flue gas reheater steam supply and condensate return lines with associated pipe supports are provided to convey steam from the boiler superheater to the reheater, and return condensate to the plant condenser, in accordance with B&W drawing No. 322342E.

## 5. Heating, Ventilating and Air Conditioning

### Monitoring Room

Two wall-mounted, self-contained air conditioners are provided to maintain room ambient temperature at 75°F during summer months. Each air conditioner is equipped with a control panel with adjustable thermostat, 4-way air flow control and filters. Each air conditioner is rated as follows:

Capacity	20,500 Bth
Electrical Power Supply	230/208 V - 1 Ph - 60 Hz
Thermostat Set Point	75°F
Air Delivery	485 cfm
Electrical Efficiency Ratio (EER)	9.2

For heating, three propeller-type, wall-mounted unit heaters rated at 15 kW each are provided to maintain room ambient temperature at 75°F during winter months. Each unit heater is automatically controlled via its wall-mounted thermostat.

## 6. Ash Handling Modifications

### Humidification Ash System

A temporary humidification ash system modification is provided to convey fly ash, which may fall out in the humidification chamber due to the large duct cross-section and corresponding low velocity, to a downstream higher velocity section for reentrainment with the flue gas. The system is provided for each of the four hoppers located below the humidification chamber, and is comprised of an isolation valve, a grinder, a mechanical separation device for large or heavy wetted ash particles, an ash blower, and associated 4-in. diameter carbon steel piping. The mechanical separator is provided to prevent reentrainment of large or sticky particles which may be likely to cause deposit buildup in the downstream flue gas duct. Should significant quantities of heavy or sticky particles accumulate in the mechanical separator system, the humidification system should be shutdown for correction of the humidification system malfunction.

## 7. Electrical Equipment

The account includes the motor control equipment for the bypass system.

### Motor Control Equipment

Motor control center equipment includes molded-case air circuit breakers and drawout-type, molded-case circuit breaker combination starters.

## 8. Electrical Systems Cable, Conduit, etc

This includes supply and installation of cable, raceway, grounding, lighting and distribution to all electrical loads installed as part of the bypass system of the humidification system.

### Cable Trays

Cable trays are ladder-type galvanized steel for all applications. Tray covers for power cable are ventilated. Solid covers are used for control and instrument cable.

### Conduit

Rigid galvanized steel conduit is used in all areas both indoor and outdoor.

### Power Cable

Cable for 480 V service is 600 V, triplexed, single, or three conductor, as required, with fire-resistant 90°C thermosetting insulation over each conductor and with an overall thermoplastic jacket on multiconductor cable. Conductors for all cables will be copper.

### Control Cable

Cable for control wiring is single and multiconductor copper with fire resistant 90°C thermosetting insulation over each conductor and with an overall thermoplastic jacket on multiconductor cables.

### Instrument Cable

Instrument cables are twisted pair and multiconductor copper with fire-resistant 90°C thermosetting insulation, shielded, with thermoplastic jacket overall.

Thermocouple extension wire is twisted pair of the iron-constantan type as required with fire resistant 90°C thermosetting insulation, shielded, with thermoplastic jacket overall.

### Lighting

Outdoor lighting is furnished for walkways in the roof area, and indoor lighting is provided in the monitoring room. The lighting system is a combination of fluorescent fixtures and high pressure sodium fixtures.

### Motors

Motors are provided with driven equipment.

### Grounding

New equipment is grounded as required by extending the existing grounding system using 2/0 and 4/0 bare copper cable. Motors are grounded using bare copper cable connected to building steel or grounding system.



9. Process Controls and Instrumentation

Pneumatic hook-ups are provided for all instruments in SWEC's Scope of Supply as well as for the humidification system, plus the mounting of those pneumatic instruments which are not in-line or direct-process-mounted.



DESCRIPTION OF MODIFICATIONS  
ENGINEERED BY STONE & WEBSTER  
for the  
HUMIDIFICATION AND SWITCHYARD SYSTEMS

LIMB DEMONSTRATION PROJECT  
AT THE OHIO EDISON COMPANY'S  
EDGEWATER STATION  
LORAIN, OHIO

Prepared For  
BABCOCK & WILCOX COMPANY

August 1988

STONE & WEBSTER ENGINEERING CORPORATION



## DESCRIPTION OF MODIFICATIONS

This document provides a general description of the work performed for items engineered and designed by Stone & Webster Engineering Corporation (SWEC) for Babcock & Wilcox (B&W) for the Humidification Process of the LIMB Demonstration Project. Unit No. 4 will be retrofitted to increase the humidity of the flue gas and thereby increase the collection efficiency of the precipitator.

The scope of the work is broken down into the following accounts:

### Description

1. Foundations and Structural Steel
2. Enclosures
3. Injection Water and Air Piping
4. Service Water, Instrument Air and Miscellaneous Piping
5. Heating & Ventilating
6. Electrical Equipment
7. Electrical Systems Cable, Conduit, etc.
8. Process Controls and Instrumentation

This description covers the base humidification and switchyard scope.



1. Foundations and Structural Steel

A. Equipment Foundations

Equipment foundations are provided for the following items:

- New Compressor
- Spray Water Storage Tank
- Atomizing Water Pump
- Spray Water Filter
- Air Receiver Tank
- 23 kV Transformer
- Oil Circuit Breaker
- Compressor Air Inlet Filter and Oil Cooler
- Spray Water Strainer

New Compressor

The new Compressor is set on the old I.D. fan motor pad which is modified to suit.

Spray Water Storage Tank

The Spray Water Storage Tank foundation consists of a reinforced concrete pad on the existing fan floor slab at El. 238'-0". The steel floor supports are reinforced.

Atomizing Water Pump

The Atomizing Water Pump foundation consists of a reinforced concrete pad on the fan room floor slab at El. 238'-0.

Spray Water Filter

The Spray Water Filter foundation consists of a reinforced concrete pad at the fan floor level.

Air Receiver Tank

A reinforced concrete pad is provided for the air receiver at the fan floor level.

23 kV Transformer

A 23 kV Transformer foundation is provided in the Unit 2 switchyard area. The foundation consists of a reinforced concrete pad with an oil retention pit.

Oil Circuit Breaker

A reinforced concrete pad foundation provides for the Oil Circuit Breaker. This foundation is located in the Unit 2 switchyard.



### Air Filter and Oil Cooler

Support pads are provided on the boiler room roof above the humidification compressor area for the air inlet filter and oil cooler.

### Spray Water Strainer

A support pad is provided for the strainer at the fan room floor elevation.

### B. Structural Steel

Structural steel supports are provided for the following equipment:

- Humidification Spray Deck Enclosures and access platforms.
- Instrument and Test Connection access platforms
- Bypass Silencer
- 4 kV - 480 V Transformer

### Humidification Spray Deck Enclosures

Support structures are provided for the spray deck enclosures adjacent to the humidification chamber and bearing on the duct support steel. Access from the boiler roof will also be provided.

### Instrument and Test Connection Access

Access ladders and platforms are provided to test connection areas from existing duct support steel as required.

### Bypass Silencer

A support frame is provided on the south exterior wall of the powerhouse adjacent to the humidification area. Access is via existing platform.

### 4 kV-480 V Transformer

A steel support structure and oil drip pan are provided for the 4 kV-480 V transformer on the power room roof at El. 178'-6". The roof support system is reinforced.



2. Enclosures

Weather enclosures are provided in the following areas:

- Humidification Spray Decks

Humidification Spray Deck Enclosures

The Humidification Spray Deck Enclosures consist of insulated metal sided enclosures with a standing seam, insulated, metal deck roof. The enclosures are approximately 20 ft x 20 ft x 17 ft high and 20 ft x 10 ft x 17 ft high each with one mandoor for access. A monorail and 1/2 ton manually operated hoist is provided for maintenance and removal of atomizer lances.



### 3. Injection Water and Air Piping

The injection water pump piping connects the pump suction to the storage tank and the pump discharge up to the spray deck enclosure. The injection air piping is provided to connect the air compressor suction to the ambient air inlet filter and connect the compressor discharge to the injection air receiver, the bypass silencer, and the injection lances at the spray deck.

The injection air line is insulated from the compressor outlet to the inlet of the injection lances. The piping is supported from existing structures below the roof with supplemental steel as required.



#### 4. Service Water, Instrument Air and Miscellaneous Piping

##### Extension of Existing Plant Fire Protection

The plant fire protection and detection system is extended as shown on 15164.09-PID-15-12 to provide heat detectors and water sprays for the new 1500 kVA transformer which is installed adjacent to two existing transformers at elevation 178'-6".

The new piping is connected downstream of the existing deluge valve. The piping material is galvanized steel. Because of the close proximity of the three transformers, all three will be sprayed if heat detectors detect fire at any of the three.

##### Extension of Existing Plant Cooling Water

Cooling water for the humidification compressor located at elevation 238'-0" is provided as shown on 15164.09-PID-9-8, by an extension of the line which presently supplies the forced draft fan. A portion of the cooling water will be diverted downstream of the compressor to provide water to the humidification water storage tanks.

Hose connections for area washdown are provided to the humidification compressor area and to the north and south spray deck enclosures which are located above the boiler house roof adjacent to the humidification chamber. The new carbon steel piping is supported from existing or new structures as required. The portion of the piping that is outdoors is heat-traced and insulated for freeze protection.

High point vents and low point drains are provided as required.

##### Extension of Existing Plant Air System

New plant air hose stations are added as shown on 15164.09-PID-12-6, at the humidification compressor and pump area and at the spray deck enclosures. The new carbon steel supply lines are fed from new tees in the existing plant air system supply to the fan room at El. 238'-0". The outdoor portion of the piping is supported from existing and new structures and is insulated and heat-traced.

##### Extension of Existing Instrument Air

The instrument air system is extended as shown on 15164.09-PID-12-6 to service the controls to the new reheater located between the precipitator and the induced draft fan. The new service is fed from a new tee in the existing instrument air supply line at the precipitator.

At the Unit 4 boiler house the instrument air system has been extended as shown on 15164.09-PID-12-6 to the humidification compressor and pump area, the spray deck enclosures and the monitoring room. The new services are fed from connections to the existing instrument air supply line at the LIMB booster air vent fan.



The outdoor portion of the piping is supported from existing and new structures, and is insulated and heat-traced.

#### Drain Piping

The boiler house drain system has been extended as shown on 15164.09-PID-9-8. Equipment drains are provided in the humidification compressor area for the compressor and routed to existing drains in the boiler house. A floor drain is located adjacent to the water storage tank. Floor drains are provided for the spray deck enclosures and routed to the boiler house floor drain system. Excess cooling water from the humidification compressor is drained through the existing equipment drain line for the retired induced draft fan and driver. The new 1500-kVA transformer is provided with a drain collection pan capable of collecting the entire contents of the transformer. Drains from the transformer pan are routed through a normally closed valve to the existing 4 in. transformer drain serving the two existing transformers.

A 4 in. stack drain is provided as required to convey potential stack condensate to the demineralizer room waste sump drain. This drain is constructed partly of high-silicon cast iron (Duriron) and partly of CPVC piping.



5. Heating, Ventilating and Air Conditioning System

Spray Deck Enclosures

A wall-mounted propeller type exhaust air fan with its associated intake and exhaust air motor-operated dampers is provided in each spray deck enclosure. The operation of the fans and motor-operated dampers is automatically controlled via their respective wall-mounted thermostats. Room ambient temperature during summer shall be maintained at or below 104°F.

The humidification spray system utilizes enclosure room air for vent air flow to the sprayheader. Each enclosure is provided with a wall-mounted pressure differential switch interlocked with a motor-operated intake air damper for makeup air when the sprays are operating. The pressure differential switch protects the enclosures from negative pressurization during operation of the sprays. An air duct with manual damper is provided to admit warm air from the boiler house to each enclosure for the spray system vent air during the winter months.

For heating, propeller-type, wall-mounted unit heaters at various capacities (2 at 15 kW each and 6 at 20 kW each) are provided to maintain room ambient temperature at 75°F during winter months. Each unit heater is controlled via its wall-mounted thermostat.

Electrical Equipment Room

A floor-mounted, horizontal ventilation unit to supply all outdoor fresh air in summer or a mixture of return air from room and outdoor fresh air in winter is provided to maintain room ambient temperature at or below 104°F in summer or at 75°F in winter, respectively. A vane axial, ceiling-hung exhaust fan with ductwork and dampers is provided to exhaust air from the room. A wall-mounted thermostat automatically controls the operation of the exhaust fan. A duct-mounted, bulb-type thermostat in the downstream ductwork of the ventilation unit is provided to control the supply air temperature. The exhaust fan rate is sized at 2000 cfm less than that of the total supply air rate of the ventilation unit for positive pressurization of the room. Replaceable filters in the ventilation supply air unit are provided for the filtration of outdoor or mixture air. The ventilation unit and exhaust fan are rated as follows:

	<u>Ventilation Unit</u>	<u>Exhaust Fan</u>
Fan Capacity	12,000 cfm	10,000 cfm
Static Pressure	2.0 in. W.G.	1 in. W.G.
HP	7.5 @ 460V-3Ph-60Hz	3 @ 460V-3Ph-60Hz
RPM	700	1200

For heating, two propeller-type, wall-mounted unit heaters rated at 15 kW each are provided to maintain room ambient temperature at 75°F during winter months. Each unit heater is controlled via its wall-mounted thermostat.

## 6. Electrical Equipment

This includes 23 kV switchyard modifications along with the addition of a 23 kV power circuit breaker, a 23 kV-4160 V transformer, 4160 V switchgear, 4160 V-480 V transformer, 480 V switchgear, 480 V motor control centers, associated protective relaying, metering, and distribution system. Also included is cable, raceway, grounding, lighting, communications, heat tracing and a low voltage distribution system installed as part of the humidification system.

See one line diagrams 15164.09-EE-1B and 15164.09-EE-1C for information on the electrical system arrangement.

### 23 kV Power Circuit Breaker

A 23 kV power circuit breaker is furnished for connection to the Ohio Edison 23 kV switchyard and is located in an existing empty bay. The circuit breaker is rated, 1200 A, 23 kV, 25.8 kV maximum voltage, with 20 kA maximum symmetrical interrupting capability. Two bushing type current transformers are furnished on each bushing. Current transformers are 1200:5A multiratio with a minimum accuracy class of C400.

### 23-4.16 kV Transformer

A 23-4.16 kV transformer is furnished for installation in the switchyard to feed the new 4160 V switchgear in the electrical equipment room. The transformer is rated 5000/5600 kVA, OA, 55/65°C, delta-grounded wye, with high voltage no load taps (2-2 1/2 percent above and 2-2 1/2 percent below normal voltage) and a 6 ohm, 400 amp neutral resistor. The specification for the transformer is based on Ohio Edison and Stone & Webster technical requirements.

The kVA rating of the transformer is based on monitoring sufficient starting voltage for the 1250 hp atomizing air compressor, assuming a 5.5 percent impedance. The cable from the transformer is rated at 3000-4000 kVA, depending on the loading of other cables in the duct bank. This rating is based on a maximum anticipated load for the humidification system of approximately 2000 kVA, and on minimizing the voltage drop to the 4160 V switchgear.

One bushing type current transformer, ratio 1200:5A multiratio with a minimum accuracy of C400, is furnished for each low voltage bushing, and two bushing type current transformers rated 3000:5A with a minimum accuracy class of C400 are furnished for each low voltage bushing. High voltage and low voltage lightning arrestors are also provided.

### 4.16 kV Switchgear

A 4.16 kV metal clad switchgear assembly is furnished for installation in the electrical equipment room. The switchgear consists of an incoming breaker section, three feeder breaker sections, one for the atomizing air compressor, one for a transformer feeder, and one spare breaker, and an instrument/voltage transformer section. The circuit breakers and bus are rated 1200 A, 250 mVA symmetrical interrupting. The specification for the  
STONE & WEBSTER

switchgear is based on Ohio Edison and Stone & Webster technical requirements.

4160-480 V Transformer

An outdoor, oil-filled 4160-480 V transformer is furnished for installation on the auxiliary bay roof at El. 178. The transformer is rated 1500 kVA, 55°C rise, delta-delta connected. The specification for the transformer is based on Ohio Edison and Stone & Webster technical requirements.

480V Switchgear

A 480 V switchgear assembly is furnished for 480 V power distribution and located in the electrical equipment room. The switchgear consists of an incoming breaker rated 2000 A, and four feeder breakers rated 800 A. The main bus is rated 2000 A. Overcurrent protection and ammeters are included.

Motor Control Center

Two motor control centers (MCCs) are provided, including molded case air circuit breakers and drawout type molded case circuit breaker combination starters. The main bus is rated 1200 A, 600 V, and the vertical buses are rated at 300 amp, 600 V, and are braced to withstand a short circuit of 42,000 A symmetrical. Motor control centers are type "B" with NEMA 12, dust-tight enclosures.

The Motor Control Centers are:

	<u>Voltage</u>	<u>INCOM. COMPT.</u>	<u>FVNR-NEMA SIZE</u>					<u>FVR SIZE 1</u>	<u>Circuit Breakers 100 A</u>	<u>Vertical Sections</u>
MCC #1	480 V	1200 A	4	1	1	1	-	2	12	6
MCC #2	480 V	1200 A	8	-	-	-	-	2	16	6

7. Electrical Systems Cable, Conduit, etc.

This includes installation of the 23 kV circuit breaker, 23-4.16 kV transformer, 4,160 V switchgear, 4,160-480 V transformer, 480 V switchgear and 480 V motor control centers, and supply and installation of cable, raceway, grounding, lighting, communications, distribution, and heat tracing transformers, and distribution to all electrical loads installed as part of the humidification system addition to the LIMB retrofit in accordance with One Line Diagram Nos. 15164.09-EE-1B and C and the following Motor and Load List.

MOTOR & LOAD LIST

<u>EQUIPMENT</u>	<u>RATING</u> <u>HP</u>	<u>QTY.</u>
Atomizing Air Compressor	1250	1
Oil Cooler Fan	3	1
Pre-Lube PP	3	1
Atomizing Water PP	40	1
Oil Heater	4 KW	1
Guillotine Damper DR	3.6	2
Guillotine Damper DR	6.4	1
Guillotine Damper DR	8.7	1
Louver Damper DR	0.33	2
Spray Deck Heaters	15 KW	2
Spray Deck Heaters	20 KW	6
Encl. Fans	0.75	2
Lump Breakers	10	4
Vacuum Blower	5	4
Monitor Room Heater	15 KW	3
Electric Room Heater	15 KW	2
Electric Room Air Hndl. Unit	7.5	1
Electric Room Vent Fan	3	1
Ltg. & Power XFMR	37.5 KVA	1
Ltg. & Power XFMR	25 KVA	1
Puff Rack Blowers	5	6
Hopper Heater	7 KW	4
Ash Recycle Blower	125	1

### 23 kV Circuit Breaker

The 23 kV circuit breaker is installed on a new concrete pad in a spare bay in the 23 kV switchyard. Disconnect switches are existing at the bus.

### 23-4.16 kV Transformer

The 23-4.16 kV transformer is installed near the 23 kV circuit breaker on a new pad with an oil containment pit.

### 4.16 kV Switchgear, 480 V Motor Control Centers, and 480 V Switchgear

The 4.16 kV switchgear, 480 V motor control centers, and 480 V switchgear are installed on concrete housekeeping pads in the electrical equipment room on El. 215.

### 4,160-480 V Transformer

The 4,160-480 V transformer is installed on the auxiliary bay roof at El. 178.

### Cable Trays

Cable Trays are ladder-type galvanized steel for all applications. Tray covers for power cable are ventilated. Solid covers are used for control and instrument cable.

### Conduit

Rigid galvanized steel conduit is used in all areas both indoor and outdoor.

### Power Cable

Cables for 4160 V service are 5000 V, triplexed, shielded, copper conductor with fire-resistant 90°C thermosetting insulation and thermoplastic jacket over each conductor.

Cables for 480 V service are 600 V, triplexed, single, or three conductor, as required, with fire-resistant 90°C thermosetting insulation over each conductor and with an overall thermoplastic jacket on multiconductor cable. Conductors for all cables are copper.

### Control Cable

Cable for control wiring is single and multiconductor copper, with fire resistant 90°C thermosetting insulation over each conductor and with an overall thermoplastic jacket on multiconductor cables.

### Instrument Cable

Instrument cables are twisted pair and multiconductor copper with fire-resistant 90°C thermosetting insulation, shielded, with thermoplastic jacket overall.

Thermocouple extension wire is twisted pair of the iron-constantan type as required with fire resistant 90°C thermosetting insulation, shielded, with thermoplastic jacket overall.

### Lighting

Indoor lighting is furnished in the compressor area at El. 238, the electrical equipment room, the humidification ash handling area, and the spray deck enclosures. The lighting system is a combination of fluorescent fixtures and high pressure sodium fixtures. Fixtures are suitable for each area as required. Emergency dc lighting is provided for safe egress. Exterior lighting is furnished on the roof, at the spray deck enclosure, and at access doors to the other buildings.

### Communications

The existing Gaitronics System is extended to include one speaker and page/party handset station each in the monitoring room, each spray deck enclosure, electrical equipment room, and near the damper drives.

### Grounding

New equipment is grounded as required by extending the existing grounding system using 2/0 and 4/0 bare copper cable. Motors are grounded using bare copper cable connected to building steel or grounding system. Ground rods are provided in the switchyard.

### Heat Tracing

Self-limiting heat trace cable is provided for freeze protection on outside air and water lines shown on Drawing Nos. 15164.09-PID-9-8 and 15164.09-PID-12-6. Two ambient thermostats and low temperature alarm thermostats are furnished with alarms.

8. Process Controls and Instrumentation

Pneumatic hook-ups are provided for all instruments in SWEC's Scope of Supply, as well as for the humidification system, plus the mounting of those pneumatic instruments which are not in-line or direct-process-mounted.



DESIGN BASIS

EDGEWATER COOLSIDE DEMONSTRATION

OHIO EDISON PROJECT

LORAIN, OHIO

1. Specifics of Edgewater Station No. 4 boiler include:

Steam Pressure, psig	1,480
Superheater Steam Temperature, °F	1,000
Peak Load Steam Rate, Mlb/hr	770
Name Plate Rate, MW	105
Boiler Manufacturer	B&W
Date Boiler Built	1957

2. Coal analysis and rate:

	<u>As Fired</u>
	<u>Wt%</u>
Carbon	67.50
Hydrogen	4.80
Sulfur	3.00
Oxygen	7.00
Nitrogen	1.20
Moisture	6.50
Ash	<u>10.00</u>
Total	100.00

HHV, Btu/lb 12,850

Design Coal Rate = 80,132 lbs/hr

3. The flue gas exiting the air preheater will be 300°F.
4. Heat and material balances will be based on two excess air levels of 25 and 42 percent at the humidifier inlet.
5. The flyash will be 80 percent of the total coal ash. The flyash and bottom ash will contain 6.3 wt. percent carbon.
6. The Coolside process design target will be to remove 70 percent of the humidifier inlet SO<sub>2</sub> assuming the humidifier and ESP are operated at a 20 F approach to the adiabatic saturation temperature.



Design Basis  
Page 2

7. A solution of 50 weight percent sodium hydroxide will be added to the humidification water at a rate of 0.1 pound of NaOH per pound of calcium hydroxide. The internal sodium utilization for all cases is assumed to be 100 percent. The feed system will be designed for 20 percent excess capacity.
8. Sodium hydroxide, 50 wt. percent solution, will be delivered by tank truck. Each truck will deliver 3,400 gallons. Two existing 5,000-gallon storage tanks, located in the water demineralization area of the boiler building, will provide in excess of 40 hours of storage at 2.8 gpm feed rate.
9. The hydrated lime sorbent is assumed to have the following composition:

	Wt%
Ca(OH) <sub>2</sub>	93.0
Inerts <sup>2</sup>	7.0

10. The hydrated lime feed system will supply sufficient sorbent to achieve a Ca/S molar ratio of 2.5 at peak load and provide a 10 to 1 turn down.
11. The hydrated lime feed rates will be based on a 20°F approach temperature and 70 percent SO<sub>2</sub> removal. For these conditions, the expected utilizations are:

Case	Fresh Feed Molar Ratios		Fresh Feed Utilizations, %			Recycle Rate, Lbs/Hr
	Ca/S	Na/Ca	Total Sorbent	Na	Ca	
1	1.91	0.185	33.5	100	27.3	0
2	1.45	0.185	44.1	100	38.9	17,300*

\*Based on ESP hopper unloading rate, see Item 14.

12. In the humidifier and ESP, SO<sub>2</sub> reacts with Ca(OH)<sub>2</sub> to produce CaSO<sub>3</sub> and CaSO<sub>4</sub>. The molar splits are assumed to be 85/15, respectively. Additionally, it is assumed that the sodium hydroxide reacts to form 85 percent Na<sub>2</sub>SO<sub>3</sub> and 15 percent Na<sub>2</sub>SO<sub>4</sub>.
13. The existing electrostatic precipitator will be used for particulate removal. The ESP will maintain an emission rate of 0.1 lb/MMBtu of particulate matter or less.



14. There is to be provision to feed recycle solids from the existing ash silo into the fresh sorbent feed to the humidifier. The solids recycle rate will be 17,300 lbs/hr. This corresponds to 36,000 lbs/hr of total solids from the ESP hoppers at the design bulk density. The recycle equipment will be designed for a maximum recycle solids rate of 22,500 lbs/hr and a turndown of at least 5 to 1.
15. The existing control systems used for the LIMB humidification demonstration will be used for the Coolside demonstration.
16. The humidification water system used for the LIMB humidification demonstration will be used for the Coolside demonstration.
17. Humidification water capacity is 85 gpm. This is sufficient humidification for the exit flue gas to achieve a 20°F approach to the adiabatic saturation temperature. The existing LIMB humidification atomizers will be used for the Coolside demonstration.
18. Atomization air will be fed at a constant rate of 18,000 lb/hr at 125 psig. This is an air-to-water ratio of 0.45 lb air/lb water for a water rate of 80 gpm. The atomization air temperature will be 150°F.
19. Shield air will be provided by aspiration of ambient air into the atomizer lances.
20. It is assumed that sufficient capacity for instrument air is available.
21. It is assumed that sufficient capacity for electrical power is available in the existing 4160 volt transformers to supply power to the Coolside process. The EPA Humidification modification work will supply these electrical requirements.
22. The ambient conditions are:

Barometric Pressure, psia	14.4
Minimum Ambient Temperature, °F	-20
Maximum Ambient Temperature, °F	100
Design Temperature, °F	80
Humidity, lbs water per lb dry air	0.0130



PROCESS DESCRIPTION

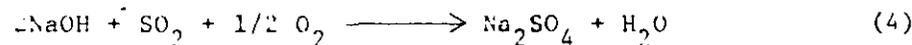
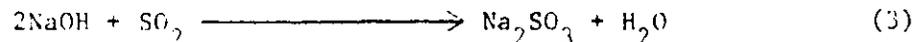
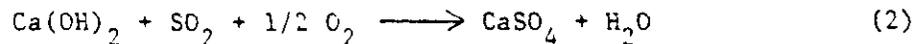
EDGEWATER COOLSIDE DEMONSTRATION

OHIO EDISON PROJECT

LORAIN, OHIO

The Coolside Process is a relatively simple process capable of removing up to 70 percent of the SO<sub>2</sub> from the boiler gases. As the flue gas temperature approaches the adiabatic saturation temperature, SO<sub>2</sub> removal increases. The flue gas temperature is lowered to approximately 148 F, 20 F above adiabatic saturation, by spraying water into the flue gas stream. Upstream of the humidification nozzles, dry hydrated lime is injected into the flue gas. In the humid atmosphere, the hydrated lime reacts with the SO<sub>2</sub>. A small amount of NaOH is injected with the humidification water to increase the activity of the hydrated lime.

The predominant overall reactions that take place in the humidified flue gas are as follows:



The actual reactions may be more complex than shown here since the effect of the sodium is greater than its stoichiometric equivalent.

Flow Cases

Four cases for the Coolside demonstration are shown in drawings SCL-000-8703-PI-1-D, -2-D, -3-D, and -4-D. Cases 1A and 1B are without recycle and Cases 2A and 2B are with recycle. The waste solids contain unused hydrated lime, so recycling the solids will increase the overall calcium utilization and decrease the fresh sorbent feed rate.

Cases 1A and 2A are based on 25 percent excess air to the humidifier, the expected lower limit, and Cases 1B and 2B are based on 42 percent excess air to the humidifier, the expected upper limit.



### Additive Storage and Feed Preparation

The existing LIMB demonstration sorbent storage and feed system will be used for the Coolside demonstration. The piping will be modified to feed the sorbent into the flue gas duct.

Dry hydrated lime is delivered by truck and unloaded pneumatically to the Storage Silo. The Storage Silo Baghouse controls the dust from the vent of the Storage Silo. From the Storage Silo, the hydrated lime is transferred pneumatically to the Feed Silo. The Feed Silo Baghouse controls the dust from the vent of the Feed Silo. The hydrated lime drops down to one of two parallel Sorbent Weight Loss Differential Weigh Feeders which control the hydrated lime feed rates to two parallel pneumatic transfer lines. The full boiler load hydrated lime feed rates are 11,433 lbs/hr for Cases 1A and 1B without solids recycle, and 8,680 lbs/hr for Cases 2A and 2B with solids recycle. Conveying air is used to transfer the hydrated lime in the two pneumatic lines to a single flow divider which separates the flow into four equal streams prior to injection into the flue gas duct.

Fifty percent NaOH solution is delivered by truck (3,400 gallons per truck). The NaOH solution is transferred to the Sodium Hydroxide Storage Tanks (T-101, T-102). From the tanks, the NaOH solution is piped through the NaOH Strainer (S-101) to the NaOH Pump (P-101). The NaOH pump injects a metered flow of the NaOH solution into the NaOH Mix Tank (T-103). The NaOH flow rate is controlled by the NaOH Pump which is set by the hydrated lime addition rate. The NaOH flow will be 0.1 pounds of NaOH per pound of  $\text{Ca}(\text{OH})_2$  for a maximum flow of 3.6 GPM at a Ca/S feed ratio of 2.5 moles per mole without solids recycle at full boiler load.

The NaOH Mix Tank Agitator A-101 mixes the NaOH and water. The NaOH/humidifying water is drawn from the NaOH Mix Tank through the Duct Injection Pump Strainer (S-102) by the Duct Injection Pump (P-102). From the Duct Injection Pump, the NaOH/humidifying water is piped through the Duct Injection Filter (FT-101) and to the atomization lances. The NaOH/humidifying water rate is controlled by a flow control valve which is reset by the flue gas temperature downstream of the water atomizers.

### Solids Removal

Solids in the flue gas are removed in the ESP and collected in the hoppers. From the ESP hoppers, the solids drop down into a pneumatic conveying line for transfer to the Ash Silo. The conveying system is a vacuum type which draws heated air into the system upstream of where the solids drop into the line. From the Ash Silo, the waste solids are mixed with water and loaded on trucks for transfer to the waste disposal site.



Process Description  
Page 3

Page 6

A separate solids removal system, designed by B&W, removes the solids from the humidification duct hoppers.

#### Solids Recycle for Cases 2A and 2B

For Cases 2A and 2B, solids are recycled to increase the overall calcium usage. Recycle solids drop from the existing Ash Silo to the Recycle Solids Weigh Feeder (WF-101). The Recycle Solids Weigh Feeder controls the total recycle solids rate at 17,231 lbs/hr, which corresponds to a solids rate of 36,000 lb/hr from the ESP hoppers. From the Recycle Solids Weigh Feeder, the recycle solids drop down to the Recycle Solids Rotary Valve (VR-101) which feeds the recycle solids into a pneumatic transfer line. Transport air is provided by the Recycle Solids Transport Blower (F-101). The transfer line injects the recycle solids into the fresh sorbent feed line prior to the flow divider.

#### Process Utilities

Humidification water, atomization air, and shield air will be provided by the same systems that were used for the LIMB demonstration.



OVERALL HEAT AND MATERIAL BALANCE - CASE 1A

EDGEWATER COOLSIDE DEMONSTRATION

OHIO EDISON PROJECT

LORAIN, OHIO

<u>IN</u>	<u>Flow Rate</u> <u>Lbs/Hr</u>	<u>Temp.</u> <u>F</u>	<u>Enthalpy</u> <u>Btu/Lb(1)</u>	<u>Heat Rate</u> <u>MBtu/Hr</u>
Flue Gas from Boiler	1,014,990	300	114.4	116,153
Hydrated Lime Feed	11,433	80	8.2	94
Hydrated Lime Transport Air	11,433	80	16.3	186
Shield Air	10,000	80	18.8	188
Atomization Air	18,000	150	21.7	391
Sodium Hydroxide	2,126	80	20.2	43
Humidification Water	37,755	90	30.0	1,133
Heat of Reaction				3,926
	<u>1,105,737</u>			<u>122,114</u>
<u>OUT</u>				
Flue Gas to Reheat	1,083,959	148	112.2	121,638
Solids to Disposal	21,778	148	21.9	476
	<u>1,105,737</u>			<u>122,114</u>

(1) Enthalpy basis is 0 at 60 F.



OVERALL HEAT AND MATERIAL BALANCE - CASE 1B

EDGEWATER COOLSIDE DEMONSTRATION

OHIO EDISON PROJECT

LORAIN, OHIO

<u>IN</u>	<u>Flow Rate</u> <u>Lbs/Hr</u>	<u>Temp.</u> <u>F</u>	<u>Enthalpy</u> <u>Btu/Lb(1)</u>	<u>Heat Rate</u> <u>MBtu/Hr</u>
Flue Gas from Boiler	1,145,708	300	109.7	125,680
Hydrated Lime Feed	11,433	80	8.2	94
Hydrated Lime Transport Air	11,433	80	16.3	186
Shield Air	10,000	80	18.8	188
Atomization Air	18,000	150	21.7	391
Sodium Hydroxide	2,126	80	20.2	43
Humidification Water	42,826	90	30.0	1,285
Heat of Reaction	-	-	-	3,926
	<u>1,241,526</u>			<u>131,793</u>
 <u>OUT</u>				
Flue Gas to Reheat	1,219,748	146	107.7	131,326
Solids to Disposal	21,778	146	21.5	467
	<u>1,241,526</u>			<u>131,793</u>

(1) Enthalpy basis is 0 at 60 F.



OVERALL HEAT AND MATERIAL BALANCE - CASE 2A

EDGEWATER COOLSIDE DEMONSTRATION

OHIO EDISON PROJECT

LORAIN, OHIO

<u>IN</u>	<u>Flow Rate</u> <u>Lbs/Hr</u>	<u>Temp.</u> <u>F</u>	<u>Enthalpy</u> <u>Btu/Lb(1)</u>	<u>Heat Rate</u> <u>MBtu/Hr</u>
Flue Gas from Boiler	1,014,990	300	114.4	116,153
Hydrated Lime Feed	8,680	80	8.3	72
Hydrated Lime Transport Air	8,680	80	16.3	141
Solids Recycle Transport Air	17,231	80	16.3	282
Shield Air	10,000	80	18.8	188
Atomization Air	18,000	150	21.7	391
Sodium Hydroxide	1,614	80	20.2	32
Humidification Water	37,947	90	30.0	1,138
Heat of Reaction	-	-	-	3,988
	<u>1,117,142</u>			<u>122,385</u>
 <u>OUT</u>				
Flue Gas to Reheat	1,098,373	147	111.1	121,990
Solids to Disposal	18,769	147	21.1	395
	<u>1,117,142</u>			<u>122,385</u>

(1) Enthalpy basis is 0 at 60 F.



OVERALL HEAT AND MATERIAL BALANCE - CASE 2B

EDGEWATER COOLSIDE DEMONSTRATION

OHIO EDISON PROJECT

LORAIN, OHIO

<u>IN</u>	<u>Flow Rate</u> <u>Lbs/Hr</u>	<u>Temp.</u> <u>F</u>	<u>Enthalpy</u> <u>Btu/Lb(1)</u>	<u>Heat Rate</u> <u>MBtu/Hr</u>
Flue Gas from Boiler	1,145,708	300	109.7	125,680
Hydrated Lime Feed	8,680	80	8.3	72
Hydrated Lime Transport Air	8,680	80	16.3	141
Solids Recycle Transport Air	17,231	80	16.3	282
Shield Air	10,000	80	18.8	188
Atomization Air	18,000	150	21.7	391
Sodium Hydroxide	1,614	80	20.2	32
Humidification Water	43,057	90	30.0	1,292
Heat of Reaction	-	-	-	3,988
	<u>1,252,970</u>			<u>132,066</u>
<u>OUT</u>				
Flue Gas to Reheat	1,234,201	146	106.7	131,678
Solids to Disposal	18,769	146	20.7	388
	<u>1,252,970</u>			<u>132,066</u>

(1) Enthalpy basis is 0 at 60 F.

INSTRUMENT LIST						
TAG NUMBER	DESCRIPTION	QUANTITY	MANUFACTURER	MODEL NUMBER	PURCHASE ORDER NUMBER	CALIBRATE RANGE SIG.
IAT-1727A	HID FAN FLUE GAS OUTLET CO2 ANAL	1	DUPONT/RADIAN		RADIAN	10-3000 ppm N/A
IAT-1727B	HID FAN FLUE GAS OUTLET CO2 ANAL	1	BECKMAN/RAD.		RADIAN	N/A
IAT-1727C	HID FAN FLUE GAS OUTLET CO2 ANAL	1	BECKMAN/RAD.		RADIAN	N/A
IAT-1727D	HID FAN FLUE GAS OUTLET NOX ANAL	1	THERMOELECT.		RADIAN	N/A
IAT-1727E	HID FAN FLUE GAS OUTLET THD ANAL	1	THERMOX/RAD.		RADIAN	N/A
IAT-1727F	HID FAN FLUE GAS OUTLET O2 ANAL	1	THERM-PAK/RAD.		RADIAN	N/A
IAT-1701C	HUMID OUTLET FLUE GAS SO2 ANAL	1	B&W-ARC	BFJNDU		10-3000 ppm 14-20ma
IAT-1701A	HUMID OUTLET FLUE GAS CO2 ANAL	1	TECS/FUJII		16350A078600DM	10-30% 14-20ma
IAT-1701B	HUMID OUTLET FLUE GAS H2O ANAL	1	SUM-X	ISX-700	16350A078600DM	10-30% 14-20ma
IAT-1701D	HUMID OUTLET FLUE GAS O2 ANAL	1	WESTINGHOUSE			10-15% 14-20ma
IAT-1728C	HUMID CHAMBER FLUE GAS INLET SO2 ANAL	1	B&W-ARC	BFJNDU		10-3000 ppm 14-20ma
IAT-1728A	HUMID CHAMBER FLUE GAS INLET CO2 ANAL	1	TECS/FUJII		16350A078600DM	10-30% 14-20ma
IAT-1728B	HUMID CHAMBER FLUE GAS INLET H2O ANAL	1	SUM-X	ISX-700	16350A078600DM	10-30% 14-20ma
IAT-1728D	HUMID CHAMBER FLUE GAS INLET O2 ANAL	1	WESTINGHOUSE			10-15% 14-20ma
ICF-1725	PREHEATER CONDENSATE CONDUCTIVITY XMTR	1	L & N			10-1000mah 14-20ma
IFE-1741	PREHEATER STEAM FLOW ORIFICE	1	BAILEY	N/A	16350A067159DM	10-20NLB/HR 14-20ma
IFT-1741	PREHEATER STEAM FLOW ORIFICE XMTR	1	BAILEY	18C2521511	16350A067159DM	10-500*H2O 14-20ma
ILT-1704	HUMID CHAMBER LOAD CELL XMTR	1	KISTLER-MORSE	954-B-21	16350A0643866V	10-100 % 14-20ma
ILT-2001	HUMID OUTLET DUCT LOAD CELL XMTR	1	KISTLER-MORSE	954-B-21	16350A0643866V	10-100 % 14-20ma
ILT-1712	CONDENSATE TANK LEVEL XMTR	1	FISHER	12390-249B	16350A0490276V	7 to 7in. 14-20ma
IPDT-1703	HUMID CHAMBER PRESS DIFF XMTR	1	BAILEY	18C1161131	16350A067159DM	10-1.5"H2O 14-20ma
IPI-1709	PREHEATER STEAM INLET PRESS IND	1	HASHCROFT	11279SSL-0-600	16350A0785926V	10-500 PSIG N/A
IPI-1710	CONDENSATE TANK PRESS IND	1	HASHCROFT	11279SSL-0-600	16350A0785926V	10-500 PSIG N/A
IPI-1771	PREHEATER REDUCING SATION PRESS IND	1	HASHCROFT	11279SSL-0-600	16350A0785926V	10-500 PSIG N/A
IPT-1738	AIR HEATER OUTLET PRESS XMTR	1	BAILEY	18C2421511	16350A067159DM	1-25-0"H2O 14-20ma
IPT-1739	PRECIP INLET PRESS XMTR	1	OHIO EDISON			1-25-0"H2O 14-20ma
IPT-1740	HID FAN INLET PRESS XMTR	1	OHIO EDISON			1-25-0"H2O 14-20ma
ITI-1707	PREHEATER STEAM INLET TEMP IND	1	HASHCROFT	1#50EL60E060	16350A0785926V	0-500 F N/A
ITI-1711	CONDENSATE TANK TEMP IND	1	HASHCROFT	1#50EL60E060	16350A0785926V	0-500 F N/A
ITI-1772	PREHEATER REDUCING SATION TEMP IND	1	HASHCROFT	1#50EL60E060	16350A0785926V	0-500 F N/A
ITT-1705A	*HUMID CHAMBER FLUE GAS INLET TEMP TC	5	ARI	1T-496M-168FT8A	16350A0790096D	0-350 F av
ITT-1706A	*HUMID CHAMBER FLUE GAS OUTLET TEMP TC	10	ARI	1T-496M-20FT8A-77	16350A0790096D	0-350 F av
ITT-1725A	*PRECIP FLUE GAS OUTLET TEMP TC	2	ARI	1T-496M-101FT8A-68	16350A0790096D	0-350 F av
ITT-1750A	*HUMID CHAMBER SKIN TEMP TC	28	ARI	1T-57M-120E-T-4A	16350A0790096D	0-350 F av
ITT-1765A	*PRECIP FLUE GAS INLET TEMP TC	2	ARI	1T-57M-120E-T-4A	16350A0790096D	0-350 F av
IZT-1704	FLUE GAS PATH LOWER DAMPER POSITION XMTR	1	BAILEY	1R020	16350A067159DM	0-100 % 14-20ma
IZT-1705	HUMID CHAMBER LOWER DAMPER POSIT XMTR	1	BAILEY	1R020	16350A067159DM	0-100 % 14-20ma
IDP-1301	SERVICE WATER STRAINER DIFF PRESS SWITCH	1	HASHCROFT	1#D464TXUD	16350A0785926V	0-10 PSI CONTACT
IDF-1403	ATOM WATER STRAINER DIFF PRESS SWITCH	1	HASHCROFT	1#D464TXUD	16350A0785926V	0-10 PSI CONTACT
ILT-1305	WATER STORAGE TANK LEVEL XMTR	1	BAILEY	18C7421511126	16350A067159DM	10-144"H2O 14-20ma
IPI-1300	SERVICE WATER STRAINER INLET PRESS IND	1	HASHCROFT	11279SSL-0-60	16350A0785926V	10-50 PSIG N/A
IPI-1306	SERVICE WATER STRAINER OUTLET PRESS IND	1	HASHCROFT	11279SSL-0-60	16350A0785926V	10-50 PSIG N/A
IPI-1402	ATOM WATER STRAINER INLET PRESS IND	1	HASHCROFT	11279SSL-0-200	16350A0785926V	10-180 PSIG N/A
IPI-1404	ATOM WATER STRAINER OUTLET PRESS IND	1	HASHCROFT	11279SSL-0-200	16350A0785926V	10-180 PSIG N/A
IPT-1304	SERVICE WATER BACK PRESS XMTR	1	BAILEY	18C5621511	16350A067159DM	10-50 PSIG 14-20ma
IPT-1405	ATOM WATER BACK PRESS XMTR	1	BAILEY	18C5721511	16350A067159DM	10-180 PSIG 14-20ma
IFI-1001	COMP COOLING WATER 1ST STAGE FLOW IND	1	UNIVERSAL	1LN-NSB1506M-16-32V1	16350A0509816V	10-150 GPM N/A
IFI-1002	COMP COOLING WATER 2ND STAGE FLOW IND	1	UNIVERSAL	1LN-NSB1506M-16-32V1	16350A0509816V	10-150 GPM N/A
IFI-1003	COMP OIL COOLER OUTLET FLOW IND	1	UNIVERSAL	1MN-MS8506M-16-150V	16350A0509816V	0-50 GPM N/A

\* - SEE P&amp;ID DRAWING FOR TAG NUMBERS NOT LISTED

INSTRUMENT LIST

TAG NUMBER	DESCRIPTION	QUAN	MANUFACTURER	MODEL NUMBER	PURCHASE ORDER NUMBER	CALIBRATE RANGE	SIG.
PSH-1100	AIR INLET FILTER DIFF PRESS SWICH	1	ASHCROFT	0464UXDA	6350A0785926V10-50	PSIG	CONTACT
PI-1005	COMP COOL WTR 1ST STAGE RETURN PRESS IND	1	ASHCROFT	1279SSL-0-60	6350A0785926V10-50	PSIG	N/A
PI-1106	COMP COOL WTR 2ND STAGE RETURN PRESS IND	1	ASHCROFT	1279SSL-0-60	6350A0785926V10-50	PSIG	N/A
PI-1007	COMP OIL COOLER INLET PRESS IND	1	ASHCROFT	1279SSL-0-100	6350A0785926V10-70	PSIG	N/A
PI-1102	COMP 1ST STAGE MOIS SEP PRESS IND	1	ING-RAND	SEE I-R MANUAL	6350A035177DU1		N/A
PI-1104	COMP 2ND STAGE MOIS SEP PRESS IND	1	ING-RAND	SEE I-R MANUAL	6350A035177DU1		N/A
PI-1108	COMP AIR HEADER PRESS IND	1	ING-RAND	SEE I-R MANUAL	6350A035177DU1		N/A
PI-1106	AIR RECEIVER TANK PRESS IND	1	ASHCROFT	1279SSL-0-200	6350A0785926V10-180	PSIG	N/A
PI-1302	SERVICE WATER INLET PRESS IND	1	ASHCROFT	1279SSL-0-60	6350A0785926V10-50	PSIG	N/A
PSL-1302	COMP OIL FILTER OUTLET PRESS SWCH	1	ING-RAND	SEE I-R MANUAL	6350A035177DU1		CONTACT
TC-1304	COMP OIL RESERVOIR TEMP CONT	1	ING-RAND	SEE I-R MANUAL	6350A035177DU1		14-20ma
TIIC-1306	COMPRESSOR OIL MIX TEMP CNTL	1	ING-RAND	SEE I-R MANUAL	6350A035177DU1		14-20ma
TI-1003	COMP COOL WTR 1ST STAGE RETURN TEMP IND	1	ASHCROFT	#50EL60E060	6350A0785926V10-150	F	N/A
TI-1004	COMP COOL WTR 2ND STAGE RETURN TEMP IND	1	ASHCROFT	#50EL60E060	6350A0785926V10-150	F	N/A
TI-1101	COMP 1ST STAGE MOIS SEP TEMP IND	1	ING-RAND	SEE I-R MANUAL	6350A035177DU1		N/A
TI-1103	COMP 2ND STAGE MOIS SEP TEMP IND	1	ING-RAND	SEE I-R MANUAL	6350A035177DU1		N/A
TI-1105	COMP AIR HEADER TEMP IND	1	ING-RAND	SEE I-R MANUAL	6350A035177DU1		N/A
TI-1300	COMPRESSOR MOTOR TEMP IND	1	ING-RAND	SEE I-R MANUAL	6350A035177DU1		N/A
TI-1301	COMPRESSOR MOTOR TEMP IND	1	ING-RAND	SEE I-R MANUAL	6350A035177DU1		N/A
TI-1303	SERVICE WATER INLET TEMP IND	1	ASHCROFT	#50EL60E060	6350A0785926V10-100	F	N/A
TI-1305	COMP OIL COOLER INLET TEMP IND	1	ING-RAND	SEE I-R MANUAL	6350A035177DU1		N/A
TS-1303	COMP OIL FILTER OUTLET TEMP SWCH	1	ING-RAND	SEE I-R MANUAL	6350A035177DU1		CONTACT
WPS-1602	ATOM WATER STRAINER DIFF PRESS SWITCH	1	ASHCROFT	10464TXND	6350A0785926V10-10	PSI	CONTACT
WE/FT-1500	COMP AIR VORTEX FLOW METER	1	F&P	110LV3101AFBB1B	6350A0761716V10-5000	CFM	14-20ma
WE/FT-1600	ATOM WATER MAG FLOW METER	1	F&P	11001475CJBC11BBLIE1	6350A0761716V10-160	GPM	14-20ma
PI-1506	COMP AIR PRESS IND	1	ASHCROFT	1279SSL-0-200	6350A0785926V10-180	PSIG	N/A
PI-1510L *	COMP AIR LANCE PRESS IND	22	ASHCROFT	1279SSL-0-200	6350A0785926V10-180	PSIG	N/A
PI-1601	ATOM WATER STRAINER INLET PRESS IND	1	ASHCROFT	1279SSL-0-200	6350A0785926V10-180	PSIG	N/A
PI-1603	ATOM WATER STRAINER OUTLET PRESS IND	1	ASHCROFT	1279SSL-0-200	6350A0785926V10-180	PSIG	N/A
PI-1640L *	ATOM WATER LANCE PRESS IND	22	ASHCROFT	1279SSL-0-200	6350A0785926V10-180	PSIG	N/A
PDT-1508L	COMP AIR BALANCE DIFF PRESS XMTR	1	BAILEY		6350A067159DM10-3	PSI	14-20ma
PDT-1508R	COMP AIR BALANCE DIFF PRESS XMTR	1	BAILEY		6350A067159DM10-3	PSI	14-20ma
PDT-1509L	COMP AIR BALANCE DIFF PRESS XMTR	1	BAILEY		6350A067159DM10-3	PSI	14-20ma
PDT-1509R	COMP AIR BALANCE DIFF PRESS XMTR	1	BAILEY		6350A067159DM10-3	PSI	14-20ma
PDT-1502	COMPRESSED AIR PRESS XMTR	1	BAILEY	1305721511	6350A067159DM10-180	PSIG	14-20ma
PDT-1604	ATOM WATER PRESS XMTR	1	BAILEY	1305721511	6350A067159DM10-180	PSIG	14-20ma
TI-1501	COMPRESSED AIR TEMP IND	1	ASHCROFT	#50EL60E060	6350A0785926V10-150	F	N/A
TT-1507	COMP AIR TC	1	ARI	1T-50B67M	6350A0790096010-150	F	N/A
TT-1607	ATOM WATER TC	1	ARI	1T-50B67F	6350A0790096010-150	F	N/A
FT-1601 *	LANCE WATER MAG FLOW METER	22	F&P	11001475CJBC11BBLIE1	6350A0761716V10-160	GPM	14-20ma
FT-2000	HUMIDIFIER INLET GAS FLOW	1	PCI	MT86 HT FLANGED	6350A0865036V10-1.5MLB/H		14-20ma
	AMBIENT AIR HUMIDITY	1	L&N				14-20ma
	SODIUM ION CONCENTRATION	1	L&N				14-20ma
	SODIUM STORAGE TANK LEVEL XMTR	1	BAILEY		6350A067159DM10-3		14-20ma
	SODIUM STORAGE TANK LEVEL SIGHT GLASS	1					
	RECYCLE TRANSPORT AIR PRESSURE	1					
	RECYCLE TRANSPORT AIR FLOW	1					

CONTRACT INFORMATION SHEET

<b>CONTROL VALVE SPECS</b>			DATE: 8/29/86			
<b>SERVICE:</b>						
ITEM			Actuator	STYLE <input checked="" type="checkbox"/> DIAPH. <input type="checkbox"/> PISTON <input type="checkbox"/>		
QUANTITY	1			SIZE		
APPLICATION	Additive Control			AIR TO ACTUATOR	<input type="checkbox"/> 6-30 <input checked="" type="checkbox"/> 3-15	
TAG B&W CUST.	FCV-1306			AIR FAILS VALVE TO	LOCK <input type="checkbox"/> OPEN <input type="checkbox"/> CLOSE <input checked="" type="checkbox"/>	
SIZE & TYPE	1" PNEV		Posi-tioner	HANDJACK TOP <input checked="" type="checkbox"/> SIDE <input type="checkbox"/>		
BODY	STYLE	ANGLE <input type="checkbox"/> GLOBE <input checked="" type="checkbox"/>		TYPE		
	END CONNECTIONS	<input type="checkbox"/> SWE <input type="checkbox"/> SCR.D. <input type="checkbox"/>		<input type="checkbox"/> 4-20 mA <input checked="" type="checkbox"/> 10-5 mA <input type="checkbox"/>		
		FLG. 150 LB ANSI RF <input checked="" type="checkbox"/>		<input type="checkbox"/> 6-30 psi <input type="checkbox"/> 3-15 psi <input type="checkbox"/>		
		<input type="checkbox"/> BWE Sched. _____		OUTPUT SIGNAL (Psi) <input type="checkbox"/> 6-30 <input checked="" type="checkbox"/> 3-15		
	Casting Rating _____		ACCESSORIES BYPASS <input type="checkbox"/> GAUGES <input checked="" type="checkbox"/> AIRSET <input checked="" type="checkbox"/>		INCREASE SIGNAL VALVE OPENS <input checked="" type="checkbox"/> CLOSSES <input type="checkbox"/>	
	<input type="checkbox"/>		316 SST <input type="checkbox"/> WCB Steel <input type="checkbox"/>		Pilot	
<input checked="" type="checkbox"/> C. S. _____ IRON <input type="checkbox"/>		TYPE				
NUMBER OF PORTS	TWO <input type="checkbox"/> ONE <input type="checkbox"/>		ACTION REVERSE <input type="checkbox"/> DIRECT <input type="checkbox"/>			
PUSH DOWN TO	OPEN <input type="checkbox"/> CLOSE <input checked="" type="checkbox"/>		MEASURING ELEMENT BOURBON TUBE <input type="checkbox"/> Bronze <input type="checkbox"/>			
FLOW DIRECTION	UP <input checked="" type="checkbox"/> DOWN <input type="checkbox"/>		BELLOWS <input type="checkbox"/> Steel <input type="checkbox"/>			
TRIM	TRIM NUMBER			Range _____ Psig SST <input type="checkbox"/>		
	CAGE AND/OR BUSHING MATERIAL	STD. <input checked="" type="checkbox"/>		OUTPUT (Psig) <input type="checkbox"/> 6-30 <input type="checkbox"/> 3-15		
	SEAT RING MATERIAL	<input checked="" type="checkbox"/> 316 SS STD. <input type="checkbox"/>		MOUNTING REMOTE <input type="checkbox"/> Csg. <input type="checkbox"/> YOKE <input type="checkbox"/>		
	MATERIAL	<input checked="" type="checkbox"/> 316 SS STD. <input type="checkbox"/>		AIRSET <input type="checkbox"/>		
		GUIDING TOP <input type="checkbox"/> CAGE <input checked="" type="checkbox"/>		AIRSET MOUNTING NIPPLE <input type="checkbox"/> YOKE <input type="checkbox"/>		
		TOP & BOTTOM <input type="checkbox"/> PORT <input type="checkbox"/>		INPUT SIGNAL (mA) <input type="checkbox"/> 4-20 <input type="checkbox"/> 10-50		
BALANCE	UNBALANCED <input type="checkbox"/> Balanced <input checked="" type="checkbox"/>		OUTPUT SIGNAL (Psig) <input type="checkbox"/> 6-30 <input type="checkbox"/> 3-15			
BONNET	PORT SIZE	<input type="checkbox"/> FULL <input type="checkbox"/>		Trans-ducer		
		LINEAR <input type="checkbox"/> O.O. <input type="checkbox"/>				ACTION REVERSE <input type="checkbox"/> DIRECT <input type="checkbox"/>
		<input type="checkbox"/> EQUAL PERCENT. <input checked="" type="checkbox"/>		MOUNTING PIPE <input type="checkbox"/> Csg. <input type="checkbox"/> YOKE <input type="checkbox"/>		
	SHUTOFF CLASS	<input type="checkbox"/> STD. <input checked="" type="checkbox"/>		AIRSET W/GAUGE <input type="checkbox"/>		
	STYLE	<input type="checkbox"/> EXT. NO. <input type="checkbox"/> STD. <input checked="" type="checkbox"/>		SERVICE CONDITIONS		
	BOSS SIZE	<input type="checkbox"/> STD. <input type="checkbox"/>				THROTTLING <input type="checkbox"/> ON-OFF <input type="checkbox"/> PRV <input type="checkbox"/> RELIEF <input type="checkbox"/>
PACKING	<input type="checkbox"/> Lam. Graphite TFE <input checked="" type="checkbox"/>		FLOWING MEDIA 50% So1 NaOH			
	<input type="checkbox"/> Lubr. & Iso. Valve <input type="checkbox"/>		Minimum Normal Maximum			
	<input type="checkbox"/> TFE Asb.		SPECIFIC GRAVITY 1.50 1.53 1.56			
BONNET	<input type="checkbox"/> STD. <input checked="" type="checkbox"/>		INLET TEMPERATURE 60 70 80			
PACK. FLG.	<input type="checkbox"/> STD. <input checked="" type="checkbox"/>		INLET PRESSURE (Psig) 10 15 25			
Notes and/or Special Constructions  Service: Control flow of NaOH solution to atomizing water storage tank to maintain a set percentage of NaOH in H <sub>2</sub> O.  * Vendor to supply a plot of Cv us percent open.			INLET VAPOR PRESSURE _____			
			ΔP SIZING (Psi) 10 10 10			
			ΔP SHUTOFF (Psi) 10 15 25			
			FLOW RATE, Give Units GPM 0.9 3.6 5.0			
			REQ'D FLOW COEFF., Cv <input checked="" type="checkbox"/> C <sub>2</sub> <input type="checkbox"/> C <sub>3</sub> <input type="checkbox"/>			
			VALVE COEFFICIENT _____			
RECOVERY COEFF., Km <input type="checkbox"/> C <sub>1</sub> <input type="checkbox"/>						
NOISE LEVEL (dBA) _____						
LINE SIZE (in.) _____						
<b>WORKSHEET</b>						

REL. NO. AND DATE	CONTRACT NO.	COMP. NO.	FILE NO.
	892-1171-22		CRD-1171

CONTRACT INFORMATION SHEET

<b>CONTROL VALVE SPECS SERVICE:</b>									
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REL. NO. AND DATE			CONTRACT NO.		COMP. NO.		FILE NO.	
			892-1153-64				CRD-1153	

CONTRACT INFORMATION SHEET

ITEM NO.	SERVICE	QTY	SIZE	J. T. NO.	MAKE	TYPE	MODEL NO.	END IN	P. O. NOS.	MISC INFO	CUST. TAG NO.	OPERATION		DES. TEMP.	DES. PRESS.	A.O.
												Hand	Mod			
1	CAUSTIC TANK TRUCK FILL S.O.	1	3	2	CRANE	GATE	47 X UF	4			C-1313	X		80F	150P	
2	CAUSTIC TANK DRAIN	1	2	2	VOGT	GATE	FIG. 353	4			C-1316	X		80F	150P	
3	CAUSTIC PUMP INLET ISO.	1	2	2	VOGT	GATE	FIG. 12111	2			C-1309	X		80F	150P	
4	CAUSTIC PUMP DISCHARGE ISO.	1	1 1/2	2	CONTRAMATICS	BALL	C1622BC	2			C-1311	X		80F	150P	
5	CAUSTIC FEED FLOW CONTROL	1	1	2	FISHER	GLOBE	667-F7-359D	4		SEE 73X-9	FCV-1306	X	X	80F	150P	*
6	CAUSTIC FEED LINE DRAIN	1	1	2	CONTRAMATICS	BALL	C1622BC	2			C-1314	X		80F	150P	
7	CAUSTIC FEED LINE DRAIN	2	1	2	CONTRAMATICS	BALL	C1622BC	2			C-1315	X		80F	150P	
8	CONTAINMENT DRAIN S.O.	1	2	2	VOGT	GATE	FIG. 12111	3			C-1318	X		80F	ATOMS	*
9	INSTRUMENT MISC. S.O.	10	1/2		JAMESBURY	BALL	21-36361T									
10	INSTRUMENT MISC. S.O.	52	1/2		JAMESBURY	BALL	21-2200TT									
11	ABANDONED RELIEF VALVE TELL-TALE FOR S.O. VALVE	2	1/2	5	ROCKWELL	GLOBE	FIG. 66124-F22	2		UNIVALVE	V-1801	X	X	1050F	1650P	STEAM
12	MATERIAL: (1) = 316 SS (2) = CS BODY/SS TRIM (3) = RUBBER SEAT/SS TRIM (4) = BRASS/BRONZE (5) = F22 CHR. MOLY										V-1802					
13	END CONNS: (1) = RING WELD (2) = SOCKET WELD (3) = SCREWED (4) = FLANGED (5) = FLG SPACERS SS															
14	* - 50% SOLUTION OF NaOH in H <sub>2</sub> O															
15	NOTE: PERF GROUP TO PREPARE SPECS SHEETS FOR MODULATING SERVICE															

REL. NO. AND DATE \_\_\_\_\_ CONTRACT NO. 892-1171-22 COMP. NO. \_\_\_\_\_ FILE NO. CRD-1171

CONTRACT INFORMATION SHEET

ITEM NO.	SERVICE	QTY	SIZE	1/2" IN	1" IN	MAKE	TYPE	MODEL NO.	END USE	P. O. NO. S	MISC INFO	RAW TAG NO.	CUST. TAG NO.	OPERATION		DES TEMP	DES PRESS	A.O.	
														Hand	Mod				On/Off
1	REHEAT STEAM SUPPLY SHUT-OFF REHEATER AREA	1	3	2		CRANE	GLOBE	151-1/2 X	1			R-1706		X	X	425F	300P	STM	
2	REHEATER STEAM FLOW CONTROL	1	3	2		FISHER	GLOBE	667-END	4	SPECS. ON CIS 73X-7		R-1708		X	X	425F	350P	STM	
3	REHEATER CONTROL VALVE ISOLATION	2	3	2		CRANE	GATE	33-1/2 X U	1			R-1707		X	X	425F	300P	STM	
4	REHEATER CONTROL VALVE BYPASS	1	3	2		CRANE	GLOBE	151-1/2X	1			R-1710		X	X	425F	300P	STM	
5	REHEATER COILS INLET SHUT-OFF	4	2 1/2	2		CRANE	GLOBE	151-1/2X	2			R-17 (30, 31, 32, 33)		X	X	425F	300P	STM	
6	REHEATER COILS DRAIN SHUT-OFF	4	2	2		VOGT	GLOBE	SM12141	2			R-17 (34, 35, 36, 37)		X	X	425F	300P	WTR	
7	CONDENSATE TANK VENT SHUT-OFF	1	3/4	2		VOGT	GATE	SM12111	2			R-1711		X	X	425F	300P	STM	
8	CONDENSATE TANK VENT AIR ELIMINATOR	1	3/4	1		ARMSTRONG	THERMO-TRAP	TTF-1	2	THERMOSTATIC VENT OF AIR FROM STEAM		R-1724		X	X	425F	300P	STM	
9	COND. TANK LEVEL TRANSMITR ISOLATION	2	1 1/2	2		VOGT	GATE	SM13111	2	FULL PORT		R-1713		X	X	425F	300P	STM	
10	COND. RETURN FLOW CONTROL	1	2	2		FISHER	GLOBE	667-ED	4	SPECS. ON CIS 73X-8		R-1714		X	X	425F	300P	SAT	
11	COND. CONTROL VALVE ISOLATION	2	2	2		VOGT	GATE	SM12111	2			R-1716		X	X	425F	300P	WTR	
12	COND. CONTROL VALVE BYPASS	1	2	2		VOGT	GLOBE	SM12141	2			R-1719		X	X	425F	300P	WTR	
13	REHEAT STEAM PRESS. CONTROL	1	1	2		FISHER	GLOBE	667-EHS	4	SPECS. ON CIS-73X-6		R-1702		X	X	622F	1650P	STM	
14	MATERIAL: (1) = 316 SS (2) = CS BODY/SS TRIM (3) = RUBBER SEAT/SS TRIM (4) = BRASS/BRONZE																		
15	END CONNS: (1) = RING WELD (2) = SOCKET WELD (3) = SCREWED (4) = FLANGED (5) = FLG SPACERS SS																		
16	NOTE: PERF GROUP TO PREPARE SPEC SHEETS FOR MODULATING SER.																		
17																			

EL. NO. AND DATE

CONTRACT NO.

COMP. NO.

FILE NO.

892-1171-22

CRD-1171

CONTRACT INFORMATION SHEET

ITEM NO.	SERVICE	QTY	SIZE	J-TYPE	MAKE	TYPE	MODEL NO.	END IN	P. O. NO. S	MISC INFO	CUST. TAG NO.	OPERATION		DES TEMP	DES PRESS	A.O.
												File	Mod			
1	ATOMIZING WATER FLOW CONTROL VALVE	1	2 1/2	2	FISHER	GLOBE	667-ED	4		DR. 3.5-19950-111	H-1603	X			150F	
2	ATOMIZING WATER AUTOMATIC SHUT-OFF	1	2 1/2	2	DEMCO	BUTTERFLY	2149-1212319	4		SOL. PILOT	H-1601	X	2		150P	
3	ATOMIZING WATER MANUAL SHUT-OFF	1	2 1/2	2	DEMCO	BUTTERFLY	2149-1212319	4			H-1600	X			150P	
4	ATOMIZING WATER SUPPLY LINE CHECK	1	2 1/2	2	CRANE	SWING CHECK	147	4			H-1604		X		150F	
5	ATOMIZING WATER SEC. STAINER SELECTOR	2	3	1	RONN-PETTER	3-WAY BALL WITH STRAINER		4		COMES W/ STRAINER	H-1605	X	SELECT		150F	
6	ATOMIZER SPRAY WATER SHUT-OFF	20	3/4	1	JAMESBURY	BALL	21-3600-TT	3			H-16(10)	X	X		150F	
7	ATOMIZER 3-WAY WATER & PURGE AIR SELECTOR	20	3/4	1	W	3-WAY BALL		3			H-16 (20)	X	SELECT		150F	
8	ATOMIZER SPRAY WATER AIR INTER-LOCK	20	3/4	1	JAMESBURY	BALL	21-3600-TT	3		WITH CYL. OPER. SPRING RETURN	H-16 (30)		X		150F	
9	ATOMIZER SPRAY WATER SHUT-OFF	2	3/4	1	JAMESBURY	BALL	21-3600-TT	3			H-1660	X	X		150F	
10	ATOMIZER SPRAY WATER AIR INTER LOCK	2	3/4	1	JAMESBURY	BALL	21-3600-TT	3		WITH CYL. OPER. SPRING RETURN	H-1662	X	X		150F	
11																
12																
13																
14																
15	MATERIAL: (1) = 316 SS (2) = CS BODY/SS TRIM (3) = RUBBER SEAT/SS TRIM (4) = BRASS/BRONZE															
16	END CONNS: (1) = RING WELD (2) = SOCKET WELD (3) = SCREWED (4) = FLANGED (5) = FLG SPACERS SS															
17	NOTE: PERF GROUP TO PREPARE SPEC SHEETS FOR MODULATING SERVICE															

REL. NO. AND DATE	CONTRACT NO.	COMP. NO.	FILE NO.
	892-1153-64		CRD-1153

CONTRACT INFORMATION SHEET

LINE NO.	SERVICE	QTY	SIZE	1" MAT.	MAKE		End LIN	P. O. NOS.	RAW TAG NO.	OPERATION		DES TEMP PRESS A.O.
					TYPE	MODEL NO.				Hand Flw	On/Off Mod	
1	RAW WATER STRAINER 3-WAY SELECTOR	2	3"	1	RONN. PETER BALL WITH STRAINER	4B-2236-TT	4	WITH STRAINER 150 # FLG	W-1300	X	X	150F 150P WTR
2	COMPR. COOLING WATER RETURN DRAIN	1	1	2	JAMES BURY BALL	4B-2236-TT	3		W-1302	X	X	150F 150P WATER
3	RAW WATER BACK PRESSURE CONTROL	1	3	2	FISHER GLOBE	657-ED	4	SPEC'S ON CIS 73X-3	W-1304	X	X	150F 150P WTR
4	RAW WATER TO STORAGE TANK LEVEL CONTROL	1	2 1/2"	2	FISHER GLOBE	667-ED	4	SPEC'S ON CIS 73X-4	W-1305	X	X	150F 150P WTR
5	SERVICE WATER STORAGE TANK DRAIN	1	4	2	CRANE GATE	47XU	4		W-1406	X	X	150F 150P WTR
6	ATOMIZING WATER PUMP INLET ISOLATION	1	3	2	DEMCO BUTTERFLY	2150-1212311	4		W-1400	X	X	150F 150P WTR
7	ATOMIZING WATER PUMP DISCHARGE DRAIN	1	2	2	JAMESBURY BALL	4B-2236-TT	3		W-1401	X	X	150F 150P WTR
8	ATOMIZING WATER STRAINER 3-WAY SELECTOR	2	3	1	RONN-PETT BALL WITH STRAINER	JAMESBURY	4	WITH STRAINER	W-1402	X	X	150F 150P WTR
9	ATOMIZING WATER SUPPLY LINE VENT	1	1	2	JAMESBURY BALL	4B-2236-TT	3		W-1403	X	X	150F 150P WTR
10	ATOMIZING WATER BACK PRESSURE CONTROL	1	2	2	FISHER GLOBE	657-ED	4	SPEC'S. ON CIS 73X-5	W-1405	X	X	150F 150P WTR
11	ATOMIZING WATER RETURN FLOW SHUT-OFF	1	2 1/2"		BALL				W-1407	X	X	150F 150P WTR
12	ATOMIZING WATER HEADER RETURN DRAIN S.O.	1	3"	1	P.B.M BALL	MP-H-19-F152	4	3-WAY SIDE ENTRY CYL. OPEN	W-1408	X	X	150F 150P WTR
13	MATERIAL: (1) = 316 SS (2) = CS BODY/SS TRIM (3) = RUBBER SEAT/SS TRIM (4) = BRASS/BRONZE											
14	END CONNS: (1) = RING WELD (2) = SOCKET WELD (3) = SCREWED (4) = FLANGED (5) = FLG SPACERS SS											
17	NOTE: PERF GROUP TO PREPARE SPEC SHEETS FOR MODULATING SERVICE											

DEL. NO. AND DATE

CONTRACT NO.

COMP. NO.

FILE NO.

892-1153-64

CRD-1153

CONTRACT INFORMATION SHEET

ITEM NO.	SERVICE	QUANTITY	SIZE	1" IN	MAKE	TYPE	MODEL NO.	END BODY IN OUT	P. O. NOS.	MISC INFO	B&W TAG NO.	CUST. TAG NO.	OPERATION		DES. TEMP.	DES. PRESS.	A.O.	
													Hand	Mod				
1	COOLING WATER SHUT-OFF TO ATOM, AIR COMPR.	1	3	2	DEMCO	BUTTERFLY	2150-1212311	4			AC-1000		X	X	150F			
2	COOLING WATER RETURN SHUT-OFF FROM AIR COMPR.	1	3	2	DEMCO	BUTTERFLY	2150-1212311	4			AC-1001		X	X	150F			
3	COOLING WATER BRANCH TO FIRST STAGE INTER COOLER	1	2	2	YOGT	GLOBE	12141	3			AC-1002		X	X	150F			
4	C.W. FROM FIRST STAGE COMPR. INTER COOLER	1	2	2	JAMESBURY	BALL	4B-2236TT	3			AC-1003		X	X	150F			
5	C.W. TO 2ND STAGE COMPR. INTER COOLER	1	2	2	YOGT	GLOBE	12141	3			AC-1004		X	X	150F			
6	C.W. FROM 2ND STAGE COMPR. INTER COOLER	1	2	2	JAMESBURY	BALL	4B-2236TT	3			AC-1005		X	X	150F			
7	BACKFLUSH FOR COMPR. FIRST STAGE INTER CLR.	1	2	2	PBM	4-WAY		4	4-WAY BOTT. ENTRY		AC-1006		X	X	150F			
8	BACKFLUSH FOR COMPR. 2ND STAGE INTER COOLER	1	2	2	PBM	4-WAY		4	4-WAY BOTT. ENTRY		AC-1007		X	X	150F			
9	INSTRUMENT AIR SUPPLY 5.0.	1	1/2	2	JAMESBURY	BALL	4B-2236-TT	3			AC-1008		X	X	150F			
10	AIR RECEIVER OVER PRESSURE SAFETY RELIEF	1	W	2	PRESS. RELIEF			4			AC-1107				150P			
11	AIR RECEIVER DRAIN	1	2	2	JAMESBURY	BALL	4B-2236-TT	3			AC-1108		X	X	150F			
12																		
13																		
14																		
15	MATERIAL: (1) = 316 SS (2) = CS BODY/SS TRIM (3) = RUBBER SEAT/SS TRIM (4) = BRASS/BRONZE																	
16	END CONNS: (1) = RING WELD (2) = SOCKET WELD (3) = SCREWED (4) = FLANGED (5) = FLG SPACERS SS																	
17	NOTE: PERFORM GROUP TO PREPARE SPEC SHEETS FOR MODULATING SERVICE																	

TEL. NO. AND DATE	CONTRACT NO.	COMP. NO.	FILE NO.
	892-1153-64		CRD-1153

CONTRACT INFORMATION SHEET

ITEM NO.	SERVICE	QTY	SIZE	TYPE	MAKE	END IN	P. O. NO. S.	MISC INFO	CUST. TAG NO.	OPERATION		DES TEMP	FLUID	A.O.
										Hand	Mod			
1	ATOM'G AIR SUPPLY HEADER MANUAL SHUT-OFF	1	4	2	CRANE	4			H-1500	X	X	150F	AIR	
2	ATOM'G AIR SUPPLY AUTOMATIC SHUT-OFF	1	4	2	CRANE	4		WITH SOL. PILOT & ACTUATOR	H-1501	X	X	150P	AIR	
3	ATOMIZING AIR SUPPLY STRAINER DRAIN	1	1/2	2	VOGT	3			H-1502	X	X	150F	AIR	
4	AIR SUPPLY TO ATOMIZERS PRESS. CONTROL	1	4	2	FISHER	4		SPEC'S ON CIS 73x-1	H-1503	X	X	150F	AIR	
5	AIR PRESSURE CONTROL VALVE ISOLATION	2	4	2	CRANE	4			H-1504	X	X	150F	AIR	
6	AIR PRESSURE CONTROL VALVE BYPASS	1	4	2	GLOBE	4			H-1505	X	X	150P	AIR	
7	ATOMIZER AIR SHUT-OFF	20	1	2	JAMESBURY	3			H-15 (10 THUR-19) - (R&L)	X	X	150F	AIR	
8	STRAINER - COMPR. AIR TO EACH ATOMIZER	20	1	1	MUELLER	3		SCREEN MAT. S.S. S-15(10) PERFORATION SIZE = 0.033" - (R&L)				150P	AIR	
9	STRAINER - COMPR. AIR TO ATOMIZERS	1	4	1	MUELLER	4		SCREEN MAT. S.S. PERFORATION SIZE = 0.033"	S-1502			150P	AIR	
10	ATOMIZER AIR SHUT-OFF	2	1	2	JAMESBURY	3			H-1560 (R&L)	X	X	150F	AIR	
11														
12														
13														
14														
15	MATERIAL: (1) - 316 SS (2) - CS BODY/SS TRIM (3) - RUBBER SEAT/SS TRIM (4) - BRASS/BRONZE													
16	END CONNS: (1) - RING WELD (2) - SOCKET WELD (3) - SCREWED (4) - FLANGED (5) - FLG SPACERS SS													
17	NOTE: PERF GROUP TO PREPARE SPEC SHEETS FOR MODULATING SERVICE													

REL. NO. AND DATE: \_\_\_\_\_ CONTRACT NO. 892-1153-64 COMP. NO. \_\_\_\_\_ FILE NO. CRD-1153



CONTRACT INFORMATION SHEET

<b>CONTROL VALVE SPECS SERVICE:</b>		SPRAY WATER TANK LEVEL CONTROL			
1	ITEM	QUANTITY	STYLE	<input checked="" type="checkbox"/> DIAPH. <input type="checkbox"/> PISTON <input type="checkbox"/>	
2	APPLICATION	1	SIZE	VENDOR TO SPECIFY	
3	TAG	WATER	AIR TO ACTUATOR	<input type="checkbox"/> 6-30 <input checked="" type="checkbox"/> 3-15	
4	B&W CUST.	W-1305	AIR FAILS VALVE TO	LOCK <input type="checkbox"/> OPEN <input type="checkbox"/> CLOSE <input checked="" type="checkbox"/>	
5	SIZE & TYPE	VENDOR TO SPECIFY	HANDJACK	TOP <input checked="" type="checkbox"/> SIDE <input type="checkbox"/>	
6	BODY	STYLE	Posi-tioner	TYPE	
		END CONNECTIONS	<input type="checkbox"/> SWE <input type="checkbox"/> SCRD. <input type="checkbox"/> FLG. <input checked="" type="checkbox"/> ANSI RF <input type="checkbox"/> <input type="checkbox"/> BWE Sched. <input type="checkbox"/> Casting Rating <input type="checkbox"/>	INPUT SIGNAL	<input type="checkbox"/> 4-20 mA <input checked="" type="checkbox"/> 10-5 mA <input type="checkbox"/> <input type="checkbox"/> 6-30 psi <input type="checkbox"/> 3-15 psi <input checked="" type="checkbox"/>
		MATERIAL	<input checked="" type="checkbox"/> 316 SST <input type="checkbox"/> WCB Steel <input type="checkbox"/> <input checked="" type="checkbox"/> CARBON STEEL <input type="checkbox"/> IRON	OUTPUT SIGNAL (Psi)	<input type="checkbox"/> 6-30 <input type="checkbox"/> 3-15
		NUMBER OF PORTS	TWO <input type="checkbox"/> ONE <input checked="" type="checkbox"/>	ACCESSORIES	BYPASS <input type="checkbox"/> GAUGES <input type="checkbox"/> AIRSET <input checked="" type="checkbox"/>
7	TRIM	PUSH DOWN TO	Pilot	INCREASE SIGNAL VALVE	
		FLOW DIRECTION	UP <input type="checkbox"/> DOWN <input checked="" type="checkbox"/>	OPENS <input checked="" type="checkbox"/> CLOSSES <input type="checkbox"/>	
		TRIM NUMBER		TYPE	
		CAGE AND/OR BUSHING MATERIAL	STD. <input type="checkbox"/>	ACTION	REVERSE <input type="checkbox"/> DIRECT <input type="checkbox"/>
8	BONNET	SEAT RING MATERIAL		MEASURING ELEMENT	
		MATERIAL	<input checked="" type="checkbox"/> 316 A16 <input type="checkbox"/> STD. <input type="checkbox"/>	BOURBON TUBE <input type="checkbox"/> Bronze <input type="checkbox"/> BELLOWS <input type="checkbox"/> Steel <input type="checkbox"/> Range. _____ Psi. SST <input type="checkbox"/>	
		GUIDING	TOP <input type="checkbox"/> CAGE <input type="checkbox"/> TOP & BOTTOM <input type="checkbox"/> PORT <input type="checkbox"/>	OUTPUT (Psi)	<input type="checkbox"/> 6-30 <input type="checkbox"/> 3-15
		BALANCE	UNBALANCED <input type="checkbox"/> Balanced <input checked="" type="checkbox"/>	MOUNTING	REMOTE <input type="checkbox"/> Csg. <input type="checkbox"/> YOKE <input type="checkbox"/>
9	Notes and/or Special Constructions	PORT SIZE		AIRSET	
		SHUTOFF CLASS	<input type="checkbox"/> FULL <input checked="" type="checkbox"/>	AIRSET MOUNTING	NIPPLE <input type="checkbox"/> YOKE <input type="checkbox"/>
		STYLE	<input type="checkbox"/> LINEAR <input type="checkbox"/> Q.O. <input type="checkbox"/> <input type="checkbox"/> EQUAL PERCENT. <input checked="" type="checkbox"/>	INPUT SIGNAL (mA)	<input type="checkbox"/> 4-20 <input type="checkbox"/> 10-50
		BOSS SIZE	<input type="checkbox"/> STD. <input checked="" type="checkbox"/>	OUTPUT SIGNAL (Psi)	<input type="checkbox"/> 6-30 <input type="checkbox"/> 3-15
10	1. VALVE SHOULD BE 70-80% OPEN AT NORMAL CONDITIONS	PACKING		ACTION	REVERSE <input type="checkbox"/> DIRECT <input type="checkbox"/>
		BONNET	<input type="checkbox"/> Lam. Graphite <input type="checkbox"/> TFE <input type="checkbox"/> <input type="checkbox"/> Lubr. & Iso. Valve <input type="checkbox"/> <input type="checkbox"/> TFE Asb.	MOUNTING	PIPE <input type="checkbox"/> Csg. <input type="checkbox"/> YOKE <input type="checkbox"/>
		PACK. FLG.	<input type="checkbox"/> STD. <input checked="" type="checkbox"/>	AIRSET W/GAUGE	<input type="checkbox"/>
		2. VENDOR SHOULD PROVIDE A FEED BACK POSITIONER WITH A 4-20 MA OUTPUT.			
11	3. INSTRUMENT AIR IS AVAILABLE AT 80-120 PSIG	SERVICE CONDITIONS			
		THROTTLING <input checked="" type="checkbox"/> ON-OFF <input type="checkbox"/> PRV <input type="checkbox"/> RELIEF <input type="checkbox"/>	FLOWING MEDIA		WATER
		Minimum Normal Maximum			
		SPECIFIC GRAVITY			1.0 1.0 1.0
12	*4. VENDOR SHOULD PROVIDE A PLOT OF C <sub>v</sub> VERSUS PERCENT OPEN OF THE VALVE <sup>v</sup>	INLET TEMPERATURE			90 90 90
		INLET PRESSURE (Psi)			40 40 40
		INLET VAPOR PRESSURE			36.068 36.068 36.068
		Δ P SIZING (Psi)			15 15 15
13	RECOVERY COEFFICIENT	Δ P SHUTOFF (Psi)			50 50 50
		FLOW RATE, Give Units GPM			38 57 81
		REQ'D FLOW COEFF., C <sub>v</sub> <input checked="" type="checkbox"/> C <sub>g</sub> <input type="checkbox"/> C <sub>p</sub> <input type="checkbox"/>			8.5 13 18
		VALVE COEFFICIENT			VENDOR TO SPECIFY
14	NOISE LEVEL (dba)	RECOVERY COEFF., K <sub>m</sub> <input type="checkbox"/> C <sub>1</sub> <input type="checkbox"/>			
		LINE SIZE (in.)			3
		PSIG			WORKSHEET

REL. NO. AND DATE	CONTRACT NO.	COMP. NO.	FILE NO.
EPA/OHIO EDISON HUMIDIFICATION	892-1153-64		CRD-1153

CONTRACT INFORMATION SHEET

<b>CONTROL VALVE SPECS SERVICE:</b>		SPRAY WATER BACK PRESSURE CONTROL		
ITEM				
QUANTITY	1			
APPLICATION	WATER (+FUTURE 7.5% NaOH)			
TAG B&W CUST.	W-1405			
SIZE & TYPE	VENDOR TO SPECIFY			
BODY	STYLE	ANGLE <input type="checkbox"/> GLOBE <input checked="" type="checkbox"/>		
	END CONNECTIONS	<input type="checkbox"/> SWE SCRD. <input type="checkbox"/> FLG. <input checked="" type="checkbox"/> ANSI RF <input type="checkbox"/> <input type="checkbox"/> BWE Sched. _____ Casting Rating _____		
		<input type="checkbox"/> 316 SST <input type="checkbox"/> WCB Steel <input type="checkbox"/> <input checked="" type="checkbox"/> CARBON STEEL IRON <input type="checkbox"/>		
	NUMBER OF PORTS	TWO <input type="checkbox"/> ONE <input checked="" type="checkbox"/>		
PUSH DOWN TO	OPEN <input type="checkbox"/> CLOSE <input checked="" type="checkbox"/>			
FLOW DIRECTION	UP <input checked="" type="checkbox"/> DOWN <input type="checkbox"/>			
TRIM	TRIM NUMBER			
	CAGE <del>AND/OR</del> MATERIAL	STD. <input type="checkbox"/> <input checked="" type="checkbox"/> 17-4PH		
	SEAT RING MATERIAL	STD. <input type="checkbox"/>		
	MATERIAL	<input checked="" type="checkbox"/> 316 A16 STD. <input type="checkbox"/>		
GUIDING	TOP <input type="checkbox"/> CAGE <input type="checkbox"/>			
	TOP & BOTTOM <input type="checkbox"/> PORT <input type="checkbox"/>			
BALANCE	UNBALANCED <input type="checkbox"/> Balanced <input checked="" type="checkbox"/>			
PORT SIZE	<input type="checkbox"/> FULL <input checked="" type="checkbox"/>			
	<input type="checkbox"/> LINEAR <input type="checkbox"/> Q.O. <input type="checkbox"/> <input type="checkbox"/> EQUAL PERCENT. <input checked="" type="checkbox"/>			
SHUTOFF CLASS	STD. <input checked="" type="checkbox"/>			
STYLE	<input type="checkbox"/> EXT. NO. STD. <input checked="" type="checkbox"/>			
BOSS SIZE	STD. <input checked="" type="checkbox"/>			
BONNET	PACKING	<input type="checkbox"/> Lam. Graphite TFE <input type="checkbox"/> <input type="checkbox"/> Lubr. & Iso. Valve <input type="checkbox"/> <input type="checkbox"/> TFE Asb.		
	BONNET	STD. <input checked="" type="checkbox"/>		
	PACK. FLG.	STD. <input checked="" type="checkbox"/>		
Notes and/or Special Constructions		THROTTLING <input checked="" type="checkbox"/> SERVICE CONDITIONS ON-OFF <input type="checkbox"/> PRV <input type="checkbox"/> RELIEF <input type="checkbox"/> FLOWING MEDIA WATER		
1. CONTROL VALVE TO HAVE STELLITE COATED PLUG/SEAT COMBINATION 2. VALVE SHOULD BE 70-80% OPEN AT NORMAL CONDITIONS 3. VENDOR SHOULD PROVIDE A FEED BACK POSITIONER WITH A 4-20 MA OUTPUT 4. INSTRUMENT AIR IS AVAILABLE AT 80-120 PSIG *5. VENDOR SHOULD PROVIDE A PLOT OF CV VERSUS PERCENT OPEN OF THE VALVE		SPECIFIC GRAVITY (*) 1.0 1.0 1.0 INLET TEMPERATURE 90 90 90 INLET PRESSURE (Psig) 180 180 180 INLET VAPOR PRESSURE 36.068 36.068 36.068 ΔP SIZING (Psi) 130 130 130 ΔP SHUTOFF (Psi) 200 200 200 FLOW RATE, Give Units GPM 44 68 150 REQ'D FLOW COEFF., C <sub>v</sub> <input checked="" type="checkbox"/> C <sub>g</sub> <input type="checkbox"/> C <sub>g</sub> <input type="checkbox"/> 3.6 6 14 VALVE COEFFICIENT VENDOR TO SPECIFY RECOVERY COEFF., K <sub>m</sub> <input type="checkbox"/> C <sub>1</sub> <input type="checkbox"/> NOISE LEVEL (dBA) LINE SIZE (in.) 2½		
		WORKSHEET		
REL. NO. AND DATE		CONTRACT NO.	COMP. NO.	FILE NO.
EPA/OHIO EDISON HUMIDIFICATION		892-1193-	64	CRD-1153

\* - FOR FUTURE 7.5% NaOH S.G. = 1.08

CONTRACT INFORMATION SHEET

CONTROL VALVE SPECS SERVICE:																																																																																																																																																																																													
ITEM	R.H. STEAM PRESS. CONT																																																																																																																																																																																												
QUANTITY	1																																																																																																																																																																																												
APPLICATION	STEAM																																																																																																																																																																																												
TAG	B&W	R-1702																																																																																																																																																																																											
	CUST.	VENDOR TO SPECIFY																																																																																																																																																																																											
SIZE & TYPE																																																																																																																																																																																													
BODY	STYLE	ANGLE <input type="checkbox"/> GLOBE <input checked="" type="checkbox"/>																																																																																																																																																																																											
	END CONNECTIONS	<input type="checkbox"/> SWE	<input type="checkbox"/> SCRD. <input type="checkbox"/>																																																																																																																																																																																										
		FLG. <input checked="" type="checkbox"/>	<input type="checkbox"/> ANSI RF <input type="checkbox"/>																																																																																																																																																																																										
		<input type="checkbox"/> BWE Sched.																																																																																																																																																																																											
		Casting Rating _____																																																																																																																																																																																											
		<input type="checkbox"/>																																																																																																																																																																																											
		316 SST <input type="checkbox"/> WCB Steel <input type="checkbox"/>																																																																																																																																																																																											
		<input checked="" type="checkbox"/> CARBON STEEL IRON <input type="checkbox"/>																																																																																																																																																																																											
	NUMBER OF PORTS	TWO <input type="checkbox"/> ONE <input checked="" type="checkbox"/>																																																																																																																																																																																											
	PUSH DOWN TO	OPEN <input type="checkbox"/> CLOSE <input type="checkbox"/>																																																																																																																																																																																											
FLOW DIRECTION	UP <input checked="" type="checkbox"/> DOWN <input checked="" type="checkbox"/>																																																																																																																																																																																												
TRIM	TRIM NUMBER																																																																																																																																																																																												
	CAGE AND/OR BUSHING MATERIAL	<input checked="" type="checkbox"/> 17-4 PH STD. <input type="checkbox"/>																																																																																																																																																																																											
	SEAT RING MATERIAL	<input checked="" type="checkbox"/> STELLITE COATED <input type="checkbox"/>																																																																																																																																																																																											
	MATERIAL	<input checked="" type="checkbox"/> STELLITE COATED <input type="checkbox"/>																																																																																																																																																																																											
	GUIDING	TOP <input type="checkbox"/> CAGE <input type="checkbox"/>																																																																																																																																																																																											
	BALANCE	TOP & BOTTOM <input type="checkbox"/> PORT <input type="checkbox"/>																																																																																																																																																																																											
	UNBALANCED <input type="checkbox"/> Balanced <input checked="" type="checkbox"/>																																																																																																																																																																																												
BONNET	PORT SIZE	<input type="checkbox"/> FULL <input checked="" type="checkbox"/>																																																																																																																																																																																											
		LINEAR <input type="checkbox"/> Q.O. <input type="checkbox"/>																																																																																																																																																																																											
		<input type="checkbox"/> EQUAL PERCENT. <input checked="" type="checkbox"/>																																																																																																																																																																																											
	SHUTOFF CLASS	<input type="checkbox"/> STD. <input checked="" type="checkbox"/>																																																																																																																																																																																											
	STYLE	<input type="checkbox"/> EXT. NO. <input checked="" type="checkbox"/> STD. <input checked="" type="checkbox"/>																																																																																																																																																																																											
	BOSS SIZE	<input type="checkbox"/> STD. <input checked="" type="checkbox"/>																																																																																																																																																																																											
	PACKING	<input type="checkbox"/> Lam. Graphite TFE <input type="checkbox"/>																																																																																																																																																																																											
		<input type="checkbox"/> Lubr. & Iso. Valve <input type="checkbox"/>																																																																																																																																																																																											
		<input type="checkbox"/> TFE Asb.																																																																																																																																																																																											
	BONNET	<input type="checkbox"/> STD. <input checked="" type="checkbox"/>																																																																																																																																																																																											
PACK. FLG.	<input type="checkbox"/> STD. <input checked="" type="checkbox"/>																																																																																																																																																																																												
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CONTRACT INFORMATION SHEET

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SST <input type="checkbox"/>				OUTPUT (Psig)	<input type="checkbox"/> 6-30 <input type="checkbox"/> 3-15 <input type="checkbox"/>				MOUNTING	REMOTE <input type="checkbox"/> Csg. <input type="checkbox"/> YOKE <input type="checkbox"/>				AIRSET					AIRSET MOUNTING	NIPPLE <input type="checkbox"/> YOKE <input type="checkbox"/>				INPUT SIGNAL (mA)	<input type="checkbox"/> 4-20 <input type="checkbox"/> 10-50 <input type="checkbox"/>				OUTPUT SIGNAL (Psig)	<input type="checkbox"/> 6-30 <input type="checkbox"/> 3-15 <input type="checkbox"/>				ACTION	REVERSE <input type="checkbox"/> DIRECT <input type="checkbox"/>				MOUNTING	PIPE <input type="checkbox"/> Csg. <input type="checkbox"/> YOKE <input type="checkbox"/>				AIRSET W/GAUGE		
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		892-1171-22		CRD-1171																																																																																																																												

CONTRACT INFORMATION SHEET

<b>CONTROL VALVE SPECS SERVICE:</b>									
ITEM		R.H. COND. THK - LEVEL CONT			Actuator		STYLE <input checked="" type="checkbox"/> DIAPH. <input type="checkbox"/> PISTON <input type="checkbox"/>		
QUANTITY		1			AIR TO ACTUATOR		VENDOR TO SPECIFY		
APPLICATION		WATER			AIR FAILS VALVE TO		LOCK <input type="checkbox"/> OPEN <input type="checkbox"/> CLOSE <input checked="" type="checkbox"/>		
TAG		R-1717			HANDJACK		TOP <input checked="" type="checkbox"/> SIDE <input type="checkbox"/>		
B&W CUST.		VENDOR TO SPECIFY			TYPE		4-20 mA <input checked="" type="checkbox"/> 10-5- mA <input type="checkbox"/>		
SIZE & TYPE		STYLE <input type="checkbox"/> ANGLE <input type="checkbox"/> GLOBE <input checked="" type="checkbox"/>			Posi-tioner		6-30 psi <input type="checkbox"/> 3-15 psi <input type="checkbox"/>		
BODY		END CONNECTIONS <input type="checkbox"/> SWE SCRD. <input type="checkbox"/> FLG. <input checked="" type="checkbox"/> ANSI RF <input type="checkbox"/> <input type="checkbox"/> BWE Sched. <input type="checkbox"/> Casting Rating <input type="checkbox"/>			Pilot		OUTPUT SIGNAL (Psi) <input type="checkbox"/> 6-30 <input type="checkbox"/> 3-15 <input checked="" type="checkbox"/>		
		MATERIAL <input checked="" type="checkbox"/> 316 SST <input type="checkbox"/> WCB Steel <input type="checkbox"/> <input checked="" type="checkbox"/> CARBON STEEL <input type="checkbox"/> IRON <input type="checkbox"/>					ACCESSORIES BYPASS <input type="checkbox"/> GAUGES <input type="checkbox"/> AIRSET <input checked="" type="checkbox"/>		
		NUMBER OF PORTS TWO <input type="checkbox"/> ONE <input checked="" type="checkbox"/>					INCREASE SIGNAL VALVE OPENS <input checked="" type="checkbox"/> CLOSSES <input type="checkbox"/>		
		PUSH DOWN TO OPEN <input checked="" type="checkbox"/> CLOSE <input type="checkbox"/>					TYPE		
TRIM		FLOW DIRECTION UP <input type="checkbox"/> DOWN <input checked="" type="checkbox"/>			Trans-ducer		ACTION REVERSE <input type="checkbox"/> DIRECT <input type="checkbox"/>		
		TRIM NUMBER					MEASURING ELEMENT BOURBON TUBE <input type="checkbox"/> Bronze <input type="checkbox"/>		
		CAGE AND/OR BUSHING MATERIAL STD. <input type="checkbox"/>					BELLOWS <input type="checkbox"/> Steel <input type="checkbox"/>		
		BUSHING MATERIAL <input checked="" type="checkbox"/> 17-4 PH					Range. _____ Psig. SST <input type="checkbox"/>		
BONNET		SEAT RING MATERIAL <input checked="" type="checkbox"/> STELLITE COATED <input type="checkbox"/>			AIRSET		OUTPUT (Psi) <input type="checkbox"/> 6-30 <input type="checkbox"/> 3-15 <input type="checkbox"/>		
		MATERIAL <input checked="" type="checkbox"/> STELLITE COATED <input type="checkbox"/>					MOUNTING REMOTE <input type="checkbox"/> Csg. <input type="checkbox"/> YOKE <input type="checkbox"/>		
		GUIDING TOP <input type="checkbox"/> CAGE <input type="checkbox"/> TOP & BOTTOM <input type="checkbox"/> PORT <input type="checkbox"/>					AIRSET MOUNTING NIPPLE <input type="checkbox"/> YOKE <input type="checkbox"/>		
		BALANCE UNBALANCED <input type="checkbox"/> Balanced <input checked="" type="checkbox"/>					INPUT SIGNAL (mA) <input type="checkbox"/> 4-20 <input type="checkbox"/> 10-50 <input type="checkbox"/>		
PORT SIZE		<input type="checkbox"/> FULL <input checked="" type="checkbox"/>			SERVICE CONDITIONS		THROTTLING <input checked="" type="checkbox"/> ON-OFF <input type="checkbox"/> PRV <input type="checkbox"/> RELIEF <input type="checkbox"/>		
SHUTOFF CLASS		<input type="checkbox"/> LINEAR <input type="checkbox"/> Q.O. <input type="checkbox"/> <input type="checkbox"/> EQUAL PERCENT. <input checked="" type="checkbox"/>			FLOWING MEDIA		WATER		
STYLE		<input type="checkbox"/> EXT. NO. STD. <input checked="" type="checkbox"/>			SPECIFIC GRAVITY		Minimum Normal Maximum		
BOSS SIZE		<input type="checkbox"/> STD. <input checked="" type="checkbox"/>			INLET TEMPERATURE (°F)		1.0		
PACKING		<input type="checkbox"/> Lam. Graphite TFE <input type="checkbox"/>			INLET PRESSURE (Psi)		422		
		<input type="checkbox"/> Lubr. & Iso. Valve <input type="checkbox"/>			INLET VAPOR PRESSURE		300		
BONNET		<input type="checkbox"/> TFE Asb. <input type="checkbox"/>			Δ P SIZING (Psi)		15		
PACK. FLG.		<input type="checkbox"/> STD. <input checked="" type="checkbox"/>			Δ P SHUTOFF (Psi)		350		
Notes and/or Special Constructions		REQ'D FLOW COEFF., C <sub>v</sub> <input checked="" type="checkbox"/> C <sub>g</sub> <input type="checkbox"/> C <sub>p</sub> <input type="checkbox"/>			VALVE COEFFICIENT		VENDOR TO SPECIFY		
		1. CONTROL VALVE TO HAVE STELLITE COATED PLUG 1 SEAT COMBINATION			RECOVERY COEFF., K <sub>m</sub> <input type="checkbox"/> C <sub>1</sub> <input type="checkbox"/>				
		2. VENDOR TO PROVIDE A FEEDBACK POSITIONER WITH A 4-20MA OUTPUT.			NOISE LEVEL (dBA)				
		3. INSTRUMENT AIR IS AVAILABLE AT 80-120 PSIG.			LINE SIZE (in.)		3		
4. VENDOR SHOULD PROVIDE A PLOT C <sub>v</sub> VERSUS PERCENT OPEN TO THE VALVE		WORKSHEET							
REL. NO. AND DATE		CONTRACT NO.			COMP. NO.		FILE NO.		
		892-1171-22					CRD-1171		

CONTRACT INFORMATION SHEET

<b>CONTROL VALVE SPECS</b>																																																													
SERVICE: Atomizing Water Flow Control																																																													
ITEM																																																													
QUANTITY	1																																																												
APPLICATION	water (+future 7.5%NaOH)																																																												
TAG	B&W	H-1603																																																											
CUST.																																																													
SIZE & TYPE	vendor to specify																																																												
BODY	STYLE	ANGLE <input type="checkbox"/> GLOBE <input checked="" type="checkbox"/>																																																											
	END CONNECTIONS	<input type="checkbox"/> SWE SCRD. <input type="checkbox"/> FLG. X ANSI RF <input type="checkbox"/> <input type="checkbox"/> BWE Sched. _____ Casting Rating _____																																																											
		<input type="checkbox"/> 316 SST <input type="checkbox"/> WCB Steel <input type="checkbox"/> <input checked="" type="checkbox"/> carbon steel IRON <input type="checkbox"/>																																																											
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TRIM	PUSH DOWN TO	OPEN <input type="checkbox"/> CLOSE <input checked="" type="checkbox"/>																																																											
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	TRIM NUMBER																																																												
	CAGE AND/OR	STD. <input type="checkbox"/>																																																											
BONNET	BUSHING MATERIAL	<input checked="" type="checkbox"/> 17-4PH																																																											
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	MATERIAL	<input checked="" type="checkbox"/> 316 A16 STD. <input type="checkbox"/>																																																											
	GUIDING	TOP <input type="checkbox"/> CAGE <input type="checkbox"/>																																																											
Notes and/or Special Constructions	TOP & BOTTOM	<input type="checkbox"/> PORT <input type="checkbox"/>																																																											
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PACK. FLG.	<input type="checkbox"/> STD. <input checked="" type="checkbox"/>																																																												
Notes and/or Special Constructions 1) Control valve to have stellite coated plug/seat combination. 2) Valve should be 70-80% open at normal conditions. 3) Vendor should provide a feed back positioner with a 4-20 mh output. 4) Instrument air is available at 80-120 psig. * 5) Vendor should provide a plot of Cv versus percent open of the valve. * For future 7.5% NaOH S.G. = 1.08																																																													
Actuator STYLE <input checked="" type="checkbox"/> DIAPH. <input type="checkbox"/> PISTON <input type="checkbox"/> SIZE Vendor to specify AIR TO ACTUATOR <input type="checkbox"/> 6-30 <input type="checkbox"/> 3-15 <input checked="" type="checkbox"/> AIR FAILS VALVE TO LOCK <input type="checkbox"/> OPEN <input type="checkbox"/> CLOSE <input checked="" type="checkbox"/> HANDJACK TOP <input checked="" type="checkbox"/> SIDE <input type="checkbox"/>					Positioner TYPE _____ Input Signal <input type="checkbox"/> 4-20 mA <input checked="" type="checkbox"/> 10-5 mA <input type="checkbox"/> <input type="checkbox"/> 6-30 psi <input type="checkbox"/> 3-15 psi <input type="checkbox"/> OUTPUT SIGNAL (Psi) <input type="checkbox"/> 6-30 <input type="checkbox"/> 3-15 <input checked="" type="checkbox"/> ACCESSORIES BYPASS <input type="checkbox"/> GAUGES <input type="checkbox"/> AIRSET <input checked="" type="checkbox"/> INCREASE SIGNAL VALVE OPENS <input checked="" type="checkbox"/> CLOSSES <input type="checkbox"/>																																																								
Pilot TYPE _____ ACTION REVERSE <input type="checkbox"/> DIRECT <input type="checkbox"/> MEASURING ELEMENT BOURBON TUBE <input type="checkbox"/> Bronze <input type="checkbox"/> BELLOWS <input type="checkbox"/> Steel <input type="checkbox"/> Range _____ Psig. SST <input type="checkbox"/> OUTPUT (Psig) <input type="checkbox"/> 6-30 <input type="checkbox"/> 3-15 <input type="checkbox"/> MOUNTING REMOTE <input type="checkbox"/> Csg. <input type="checkbox"/> YOKE <input type="checkbox"/> AIRSET _____ AIRSET MOUNTING NIPPLE <input type="checkbox"/> YOKE <input type="checkbox"/>					Transducer INPUT SIGNAL (mA) <input type="checkbox"/> 4-20 <input type="checkbox"/> 10-50 <input type="checkbox"/> OUTPUT SIGNAL (Psig) <input type="checkbox"/> 6-30 <input type="checkbox"/> 3-15 <input type="checkbox"/> ACTION REVERSE <input type="checkbox"/> DIRECT <input type="checkbox"/> MOUNTING PIPE <input type="checkbox"/> Csg. <input type="checkbox"/> YOKE <input type="checkbox"/> AIRSET W/GAUGE <input type="checkbox"/>																																																								
SERVICE CONDITIONS THROTTLING <input checked="" type="checkbox"/> ON-OFF <input type="checkbox"/> PRV <input type="checkbox"/> RELIEF <input type="checkbox"/> FLOWING MEDIA Water <table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th></th> <th>Minimum</th> <th>Normal</th> <th>Maximum</th> </tr> </thead> <tbody> <tr> <td>SPECIFIC GRAVITY (*)</td> <td>1.0</td> <td>1.0</td> <td>1.0</td> </tr> <tr> <td>INLET TEMPERATURE</td> <td>90</td> <td>90</td> <td>90</td> </tr> <tr> <td>INLET PRESSURE (Psig)</td> <td>180</td> <td>180</td> <td>180</td> </tr> <tr> <td>INLET VAPOR PRESSURE</td> <td>36.068</td> <td>36.068</td> <td>36.068</td> </tr> <tr> <td>ΔP SIZING (Psi)</td> <td>60</td> <td>40</td> <td>20</td> </tr> <tr> <td>ΔP SHUTOFF (Psi)</td> <td>200</td> <td>200</td> <td>200</td> </tr> <tr> <td>FLOW RATE, Give Units</td> <td>38</td> <td>57</td> <td>81</td> </tr> <tr> <td>REQ'D FLOW COEFF., Cv <input type="checkbox"/> Cg <input type="checkbox"/> Cc <input type="checkbox"/></td> <td>5</td> <td>9</td> <td>18</td> </tr> <tr> <td>VALVE COEFFICIENT</td> <td colspan="3">Vendor to specify</td> </tr> <tr> <td>RECOVERY COEFF., Km <input type="checkbox"/> c1 <input type="checkbox"/></td> <td colspan="3"></td> </tr> <tr> <td>NOISE LEVEL (dBA)</td> <td colspan="3"></td> </tr> <tr> <td>LINE SIZE (in.)</td> <td colspan="3">2-1/2</td> </tr> </tbody> </table>											Minimum	Normal	Maximum	SPECIFIC GRAVITY (*)	1.0	1.0	1.0	INLET TEMPERATURE	90	90	90	INLET PRESSURE (Psig)	180	180	180	INLET VAPOR PRESSURE	36.068	36.068	36.068	ΔP SIZING (Psi)	60	40	20	ΔP SHUTOFF (Psi)	200	200	200	FLOW RATE, Give Units	38	57	81	REQ'D FLOW COEFF., Cv <input type="checkbox"/> Cg <input type="checkbox"/> Cc <input type="checkbox"/>	5	9	18	VALVE COEFFICIENT	Vendor to specify			RECOVERY COEFF., Km <input type="checkbox"/> c1 <input type="checkbox"/>				NOISE LEVEL (dBA)				LINE SIZE (in.)	2-1/2		
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CONTRACT NO. 892-1153-64					COMP. NO.		FILE NO. CRD-1153																																																						

CONTRACT INFORMATION SHEET

1	<b>CONTROL VALVE SPECS</b>	SERVICE: Service Water Back Pressure Control					
2							
3	ITEM		Actuator	STYLE	<input checked="" type="checkbox"/> DIAPH. <input type="checkbox"/> PISTON <input type="checkbox"/>		
4	QUANTITY	1		SIZE	Vendor to Specify		
5	APPLICATION	Water		AIR TO ACTUATOR	<input type="checkbox"/> 6-30 <input type="checkbox"/> 3-15 <input checked="" type="checkbox"/>		
6	TAG	B&W CUST. W-1304		AIR FAILS VALVE TO	LOCK <input type="checkbox"/> OPEN <input type="checkbox"/> CLOSE <input checked="" type="checkbox"/>		
7	SIZE & TYPE	Vendor to Specify	Posi - tioner	HANDJACK	TOP <input checked="" type="checkbox"/> SIDE <input type="checkbox"/>		
8	BODY	STYLE		ANGLE <input type="checkbox"/> GLOBE <input checked="" type="checkbox"/>	TYPE		
9		END CONNECTIONS		<input type="checkbox"/> SWE	SCRD. <input type="checkbox"/>	INPUT SIGNAL	<input type="checkbox"/> 4-20 mA <input checked="" type="checkbox"/> 10-5- mA <input type="checkbox"/>
10				FLG. <input checked="" type="checkbox"/>	ANSI RF <input type="checkbox"/>	<input type="checkbox"/>	6-30 psi <input type="checkbox"/> 3-15 psi <input type="checkbox"/>
11			<input type="checkbox"/> BWE Sched.		OUTPUT SIGNAL (Psi)	<input type="checkbox"/> 6-30 <input type="checkbox"/> 3-15 <input checked="" type="checkbox"/>	
12	Casting Rating			ACCESSORIES	BYPASS <input type="checkbox"/> GAUGES <input type="checkbox"/> AIRSET <input checked="" type="checkbox"/>		
13	TRIM	<input type="checkbox"/>		INCREASE SIGNAL VALVE	OPENS <input type="checkbox"/> CLOSSES <input checked="" type="checkbox"/>		
14		316 SST <input type="checkbox"/> WCB Steel <input type="checkbox"/>	<input type="checkbox"/>	TYPE			
15		<input checked="" type="checkbox"/> Carbon Steel	IRON <input type="checkbox"/>	ACTION	REVERSE <input type="checkbox"/> DIRECT <input type="checkbox"/>		
16		NUMBER OF PORTS	TWO <input type="checkbox"/> ONE <input checked="" type="checkbox"/>	Pilot	MEASURING ELEMENT	BOURBON TUBE <input type="checkbox"/> Bronze <input type="checkbox"/>	
17	PUSH DOWN TO	OPEN <input type="checkbox"/> CLOSE <input checked="" type="checkbox"/>	BELLOWS		<input type="checkbox"/> Steel <input type="checkbox"/>		
18	FLOW DIRECTION	UP <input checked="" type="checkbox"/> DOWN <input type="checkbox"/>	OUTPUT (Psi)		<input type="checkbox"/> 6-30 <input type="checkbox"/> 3-15 <input type="checkbox"/>		
19	TRIM NUMBER		MOUNTING		REMOTE <input type="checkbox"/> Csg. <input type="checkbox"/> YOKE <input type="checkbox"/>		
20	Trans - ducer	CAGE AND/OR	STD. <input type="checkbox"/>	AIRSET	<input type="checkbox"/>		
21		BUSHING MATERIAL	<input checked="" type="checkbox"/> 316 SS	AIRSET MOUNTING	NIPPLE <input type="checkbox"/> YOKE <input type="checkbox"/>		
22		SEAT RING MATERIAL	<input type="checkbox"/> STD. <input type="checkbox"/>	INPUT SIGNAL (mA)	<input type="checkbox"/> 4-20 <input type="checkbox"/> 10-50 <input type="checkbox"/>		
23		MATERIAL	<input checked="" type="checkbox"/> 316 A16	OUTPUT SIGNAL (Psi)	<input type="checkbox"/> 6-30 <input type="checkbox"/> 3-15 <input type="checkbox"/>		
24	SERVICE CONDITIONS	GUIDING	TOP <input type="checkbox"/> CAGE <input type="checkbox"/>	ACTION	REVERSE <input type="checkbox"/> DIRECT <input type="checkbox"/>		
25		TOP & BOTTOM <input type="checkbox"/> PORT <input type="checkbox"/>	MOUNTING	PIPE <input type="checkbox"/> Csg. <input type="checkbox"/> YOKE <input type="checkbox"/>			
26		BALANCE	UNBALANCED <input type="checkbox"/> Balanced <input checked="" type="checkbox"/>	AIRSET W/GAUGE	<input type="checkbox"/>		
27		PORT SIZE	<input type="checkbox"/> FULL <input checked="" type="checkbox"/>				
28	FLOWING MEDIA	LINEAR <input type="checkbox"/> Q.O. <input type="checkbox"/>	THROTTLING <input checked="" type="checkbox"/>	ON-OFF <input type="checkbox"/>	PRV <input type="checkbox"/>		
29		<input type="checkbox"/> EQUAL PERCENT. <input checked="" type="checkbox"/>	FLOWING MEDIA	Water			
30		SHUTOFF CLASS	<input type="checkbox"/> STD. <input checked="" type="checkbox"/>	SPECIFIC GRAVITY	1.0	1.0	
31		BONNET PACKING	STYLE	<input type="checkbox"/> EXT. NO. <input type="checkbox"/> STD. <input checked="" type="checkbox"/>	INLET TEMPERATURE F	90	
32	BOSS SIZE		<input type="checkbox"/> STD. <input checked="" type="checkbox"/>	INLET PRESSURE (Psi)	40		
33	<input type="checkbox"/> Lam. Graphite		TFE <input type="checkbox"/>	INLET VAPOR PRESSURE mm Hg	36.000	36.000	
34	<input type="checkbox"/> Lubr. & Iso. Valve		<input type="checkbox"/>	Δ P SIZING (Psi)	35	35	
35	<input type="checkbox"/> TFE Asb.	<input type="checkbox"/>	Δ P SHUTOFF (Psi)	50	50		
36	Notes and/or Special Constructions	BONNET	<input type="checkbox"/> STD. <input checked="" type="checkbox"/>	FLOW RATE, Give Units GPM	219		
37		PACK. FLG.	<input type="checkbox"/> STD. <input checked="" type="checkbox"/>	REQ'D FLOW COEFF., C <sub>v</sub> <input checked="" type="checkbox"/> C <sub>g</sub> <input type="checkbox"/> C <sub>g</sub> <input type="checkbox"/>	31		
38				VALVE COEFFICIENT			
39				RECOVERY COEFF., K <sub>m</sub> <input type="checkbox"/> C <sub>1</sub> <input type="checkbox"/>			
40			NOISE LEVEL (dBA)				
41			LINE SIZE (in.)	3			
42			WORKSHEET				
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## B&W DRAWING LIST

### HUMIDIFICATION

321755E	Flow Diagram, Peak Ld, 20°F ATS, #Air/#H2O = 0.45
321756E	Flow Diagram, Peak Ld, 20°F ATS, #Air/#H2O = 0.45
321757E	Flow Diagram, Peak Ld, 50°F ATS, #Air/#H2O = 0.45
321758E	Flow Diagram, MCR, 50°F ATS
321759E	Flow Diagram, Control Ld., 50°F ATS
321750E	P&ID Symbol Nomenclature
321751E	Flue Gas Stream
321752E	Water Feed System
321753E	Atomizing Air Compressor
321754E	Humidification
321744E	D/E Arrgt. Water Storage Tank - Plan View
321745E	D/E Arrgt. Water Storage Tank - Sections & Views
321746E	D/E Arrgt. Water Storage Tank - Sections & Views

### BYPASS SYSTEM (Humidification Extension)

9823J	Gen. Arrgt., Structural Loads, Notes & Symbols
9824J	Gen. Arrgt., Plan View
9825J	Gen. Arrgt., Sections A-A & B-B
9826J	Gen. Arrgt., Sections C-C & D-D
319389E	Composite: Humidification & Existing Equipment
319391E	Precipitator & Flue Cut-Lines & Modification (Existing)
319931E	Field Alt'n, Airheater Outlet Flue Cut-Lines
319932E	Field Alt'n, Airheater Outlet Flue Cut-Lines
319933E	Field Alt'n, Airheater Ties
319934E	I.D. Fan Inlet Cut Lines, Cover & Stabilizers
319935E	Field Alt'n, Airheater Outlet Flue, Sectn's & Views
321761E	D/E Arrgt., Key Plan-Bypass Flues
321762E	D/E Arrgt., Mark No. Index
321763E	D/E Arrgt., Airheater Outlet Flue
321764E	D/E Arrgt., Chamber Inlet Flue
321765E	D/E Arrgt., Chamber Outlet Flue
321766E	D/E Arrgt., By-Pass Return Flue
421617E	Erection Arrangement - Sprayer Rapper System
421618E	Details - Sprayer Rapper System
421619E	Details - Sprayer Rapper System
321767E	D/E Arrgt., Flue Supports
321768E	D/E Arrgt., Sections & Views
321769E	D/E Arrgt., Sections & Views
321770E	D/E Arrgt., Platform Sections & Views
322332E	D/E Arrgt., Humid. Chamber, Notes, Key Plan & Index
322333E	D/E Arrgt., Side View, Humidification Chamber
322334E	D/E Arrgt., Plan View, Humidification Chamber
322335E	D/E Arrgt., Section & Views
322336E	D/E Arrgt., Section & Views
322337E	D/E Arrgt., Sprayer Support, Sections & Views
322338E	D/E Arrgt., Section & Views
322338E	D/E Arrgt., Platforms

BYPASS SYSTEM (Humidification Extension) (continued)

166290E Expansion Joint Bolting Pattern  
322340E D/E Arrgt., Platforms, Sections & Views  
322329E Assembly 18 X 24 Access Door  
322330E Assembly & Detail 18 X 24 Access Door Frame  
322331E Assembly & Detail 18 X 24 Access Door Frame  
323738E D/E Arrgt. Bypass Return Flue Connection  
323739E Assembly 18 X 24 Access Door  
191989C D/E Arrgt. - Boiler Relief Vent & Blind Flange  
420973E D/E Arrgt. - Damper Access Platform Additions  
133841A Louver Damper Tolerances  
137189B Damper Seal Gland  
137198B Detail Louver DPR IDL & TRN  
137199B Damper Lever Details  
170582B Key Argt. Humid Ext Insl/Lag  
170583B Key Argt. Humid Ext Insl/Lab  
37010C Door Detail Wide Angle  
184325C Louver Dpr Brg For 2 7/16 Sft  
146292D Door Frame For Dbs Door  
166287D Field Weld Schedule, Pressure  
166288D Field Weld Schedule, Pressure  
283125E Std Sect & Det For Louver Dpr  
323742E A&D Louver Damper 5-Sing-Bld  
322341E Arrgt. Wide Angle Observation Door  
158858D Det. Arrgt. & Erection Notes - Flues  
166700D D/E Arrgt. Louver Damper Drive Support  
00323733E Mark No Index Humid Ext Mod  
00323734E D/E Arrgt. Humid Ext R H  
00323735E D/E Arrgt. Humid Ext R H S&V  
00323736E D/E Arrgt. Guillotine Dpr Inst  
00323737E D/E Arrgt. By-Pass Fl Conn  
00323740E Assy & Det Access Door Frame  
00323741E Assy & Det Inner Access Door  
00411405E Det Shop Assembled Corners

COOLSIDE

420963E D/E Arrgt. Ash & Lime Injection Hose  
420964E D/E Arrgt. Distribution Bottle Platform Sheet 1  
420965E D/E Arrgt. Distribution Bottle Platform Sheet 2  
420966E D/E Arrgt. Distribution Bottle Platform Sheet 3  
420967E D/E Arrgt. Distribution Bottle Platform Sheet 4  
420968E D/E Arrgt. Ash Rotary Feeders  
420969E D/E Arrgt. Solids Lance Inlet Box  
420970E D/E Arrgt. Distribution Bottle Feed Hose, Sheet 1  
420971E D/E Arrgt. Distribution Bottle Feed Hose, Sheet 2  
420972E D/E Arrgt. Distribution Bottle Feed Hose, Sheet 3  
420974E D/E Arrgt. Caustic Tank  
420975E D/E Arrgt. Caustic Piping  
420976E Field Alt'n - Water Storage Tank Mixer Instl'n

BYPASS SYSTEM (Humidification Extension) (continued)

166300D Distribution Bottles, Ash & Sorbent  
420977E P&ID Ash Reinjection System  
420988E Field Alteration - Dust Collector At Feed Silo  
191971C Assy & Detail - Mounting For 5.5" Obs. Door

FLUE GAS REHEAT SYSTEM

9828J General Arrgt. - Reheater  
319397E Reheater Condensate Tank  
322342E Steam and Condensate Piping  
322343E Piping Loads, Notes & Material List  
319398E Field Alt'n, Reheater Drum & Condenser Conn's

INSTRUMENTATION

416091E Arrgt. of Instrument Comms, Humid Extension  
416092E Arrgt. of Thermocouples, Humid Chamber  
171756A Diff. Press On Flue Work  
171758A Compr. Air Balance DP Switch  
171759A Press. Transmitter Above Line W/Vent  
171760A Water Storage Tank Level Transmitter  
171629A TC Installation Detail In Elbolet  
167398A Pressure Indicator W/Syphon  
167399A Pressure Gauge W/ Syphon - Tank  
171757A Atom. Water Strainer - PDS  
171761A Pressure Indicator Installation Detail  
171762A Pressure Indicator Installation Detail  
171763A Pressure Indicator Installation Detail  
171764A Thermometer With Thermowell  
171787A Field Assembly Diff. Pressure Switch  
171788A Flow Instrument Below Line  
161673B Instrument PVF Bill of Material  
223698B TC Inst. Bill Of Matl  
223699B Perm TC Inst Detail  
223700B Perm TC Inst Detail  
223701B Perm TC Inst Detail  
223702B Perm TC Inst Detail  
223703B Perm TC Inst Detail  
223704B Perm TC Inst Detail  
223705B Perm TC Inst Detail  
223706B Perm TC Inst Detail  
223707B Perm TC Inst Detail  
223708B Perm TC Inst Detail  
223709B Perm TC Inst Detail  
416093E A&D 6 Mount Inst. Rack  
013054B Fondu SO2 Analyzer Power Supply Interconnection Drawing  
013054B Fondu SO2 Analyzer I/O Rack Interconnection Drawing  
013054B Fondu SO2 Analyzer Function Board Interconnection Drawing  
013054B Fondu SO2 Analyzer Computer Interconnection Drawing  
013054B Fondu SO2 Analyzer Scanning Mirror & V/I Conv. Inter. Dwg.  
161673B Instrumentation Bill Of Materials

## INSULATION

003729A	Thermal Barriers
009938A	Ins. On CSG
023579A	Application Pipe Insulation
028438A	Lagg On Tubes & Pipes
028446A	Appl Louver Type Damper
039734A	Sugg Method Of Fasten Lag
139255A	Insulation Detail
168621A	Insl Det
168622A	Insl Det
168623A	Insl Det Exp Jt
168624A	Insl Det
168625A	Insl Det Access Door
168626A	Insl Det Air Lance
168627A	Insl Det Sprayer
168628A	Insl Det Obs Door
168629A	Insl Det
168630A	Insl Det
168631A	Insl Det
168632A	Insl Det Test Port
168633A	Insl Det
168634A	Insl Det
168635A	Insl Det
168636A	Insl Det Condensate Tank
168637A	Insl Det Access Door
168638A	Insl Det Buil Dpr

## WELD SCHEDULES

166287D	Field Weld Schedule - Press. Parts
166288D	Field Weld Schedule - Press. Parts
166289D	Field Weld Schedule - Press. Parts

## FIELD ALTERATIONS

420904E	F/A Rotary Valve Insal'n @ Lime Day Bin Disch.
322328E	F/A Sorbent Piping
319398E	F/A Reheater Steam Source Conn. @ Boiler & Condensate Conn. at Hotwell

STONE & WEBSTER DRAWING LIST

MECHANICAL

15164.09-EM-202A General Arrgt - Humid Comp & Pump  
15164.09-FP-1A Yard Piping  
15164.09-EP-12A Humidification Area Piping  
15164.09-EB-10A Humid. Spray Deck Enclosure HVAC & Piping  
15164.09-EB-10B Vent Elect Eq. Rm. Fire Prot & Dr. Trans Area  
Area Fire Protection  
15164.09-FB-11A Stack Drain Piping  
P&ID  
15164.09-PID-9-8 Cooling Water & Drain Extension  
15164.09-PID-12-6 Inst & Service Air Extension  
15164.09-PID-15-12 Fire Protection Modification  
15164.09-8-12 Bill Of Material Dwg EP-12A  
15164.10-EP-11A Boiler Relief Modifications  
15164.10-EP-11B Boiler Relief Piping Modification  
15164.10-EP-13A Humidification Ash Piping  
BILL MATERIAL  
15164.10-EP-14A Ash Recycle Piping  
15164.10-EP-15A Caustic System Modification  
P&ID  
15164.10-PID-17-5 Humidification Ash Handling  
15164.10-PID-17-7 Ash Recycle System  
15164.10-PID-13-10 Caustic System Modification  
PIPE SUPPORTS  
15164.10-BZ-13A Ash Piping  
15164.10-BZ-11A Boiler Relief Piping Modification  
15164.10-BZ-42E Reheat Steam & Condensate  
15164.10-EZ-12A Humid Area PP Support Location & Details  
15164.10-PID-0-2 P&ID List Of Symbols

STRUCTURAL STEEL

HUMIDIFICATION MODIFICATIONS  
15164.09-ES-2A Atomizer Spray Enclosure Support - Plan, Sect. & Details  
15164.09-ES-2B Humidification Wtr. Tk & Compressor Support El. 238'-0"  
Plans, Sect & Dets  
15164.09-ES-2C Misc. Humidification Equip. Supports Plans, Sect. &  
Details  
CONCRETE  
15164.09-EC-2A Humidification Switchyard Equip. Fdns - Plan, Sect. &  
Details  
15164.09-EC-2B Misc. Humidification Equip. Support Pads  
15164.09-ES-1E Additional Column Loads  
BYPASS/COOLSIDE MODIFICATIONS  
15164.10-ES-3A By-Pass Duct Support Steel El 270'-6"  
15164.10-ES-3B By-Pass Duct Support - Boiler Rm Roof El. 264'-0"  
15164.10-ES-3C By-Pass Duct Support - Sect & Details - Sh 1  
15164.10-ES-3D By-Pass Duct Support - Sect & Details - Sh 2  
15164.10-ES-3E Exist Precip Hopper Mods - Plan, Sects & Details

STRUCTURAL STEEL (continued)

15164.10-ES-3F Ductwork Damper Access Platforms - Plans Sect & Details  
15164.10-ES-3G Silencer & Delumper Platform Plan, Sect & Details  
15164.10-ES-3H Fluegas Reheater Support Steel - Plan, Sect & Details

ELECTRICAL

15164.09-EE-1B One Line Diagram 23KV/4KV  
15164.09-EE-1C One Line Diagram 480V MCC Sh 1  
15164.09-EE-80A Lighting  
15164.09-EE-80B Lighting  
15164.09-EE-80C Lighting  
15164.09-EE-80E Heat Tracing  
15164.09-EE-3H W.D. Flyash Cont. Interface  
15164.09-EE-3M Wiring Diag 120/208 VAC Power Pnls  
15164.09-CE-201B Lighting Fixture Sch. Sht.  
15164.09-EE-3L W.D. Misc Humidification Inst Devices  
15164.09-EE-3B W.D. Monitoring Room Pnls  
15164.09-EE-3A Network 90 Sys & Annunciator Sys (Exist)  
15164.09-EE-8A W.D. 4 KV Swgr & Air Compressor  
15164.09-ESK-3A Panel 23 C/R Outline & Steel Details  
15164.09-ESK-5A AC Elem Diag. Limb 23 KV Feeder Prot  
15164.09-ESK-5B AC Elem Diag. Limb TransF 4.16 KV Fdr Prot  
15164.09-ESK-6A DC Flem Diag LIMB 23/4.16 KV Fdr Prot  
15164.09-ESK-6B DC Flem Diag Closed Circuit - Bkr B340  
15164.09-EE-9D W.D. OCB, X Fmr & 23/CR PNL  
15164.09-EE-9E W.D. MCC & Details Sh 1  
15164.09-EE-9F W.D. MCC & Details Sh 2  
15164.09-EE-9G W.D. MCC & Details Sh 3  
15164.09-ESK-6C DC Flfm Flem Trip Circuit - Bkr B340  
15164.09-CSK-3AC Panel 23 C/R Term Blk Arrgt  
15164.09-SE-101-BA Humid Ash Removal & Bypass Sys  
15164.09-SE-101-BB Humid Ash Removal & Bypass Sys  
15164.09-SE-101-BC Misc Pnls Comp & Pumps  
15164.09-SE-101-BD Vent Fans, Reheaters Blowers  
15164.09-SE-101-BE Ann & Net 90  
15164.09-EE-16A Pwr Hse Equipt Arrgts, Sills & Gnd Plan  
15164.09-EE-9H W.D. MCC & 480V Load Center  
15164.09-EE-16C Switch Yard Area Equipt Arrgt Cnd's & Gnd Plan  
15164.09-EE-16F Cable Tray & Conduit Pln Blr Roof El. 264'-0"  
15164.09-EE-16E Tray Plan Cont Rm Swbd Area & Aqcs Area  
15164.09-EE-16G Boiler Area Tray Plans And Details  
15164.09-EE-16D Misc. Cnd. Dwg. Monitoring Rms & Ash Recycle Areas  
15164.09-SE101BF MCC 2 Sh 6  
15164.09-SE101BG MCC 2 Sh 7  
15164.09-SE101BH MCC 2 Sh 8  
15164.09-SE101BJ MCC 2 Sh 9  
15164.09-SE101BK MCC 2 Sh 10  
15164.09-SE101BL Air Compressor & Misc 120 VAC  
15164.09-SE101BM T/C Cables  
15164.09-SE101BN T/C Cables

ELECTRICAL (continued)

15164.09-SE101BP	T/C Cables
15164.09-SE101BQ	T/C Cables
15164.09-SE101BR	T/C Cables
15164.09-SE101BS	T/C Cables & Inst Cables
15164.09-SE101BT	Inst Cables
15164.09-SE101BU	Inst Cables
15164.09-SE101BV	Inst Cables
15164.09-SE101BW	Heat Tracing
15164.09-SE101BX	Heat Tracing
15164.09-SE101BZ	Cable Schedule
15164.09-SE101BY	Cable Schedule
15164.09-SE63C-1	Cable List-Heat Tracing

ARCHITECTURAL

15164.10-EA-3A	Boiler Room El 264'-0" Roof Framing Plan & Details
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ASSIGNED VENDOR DRAWING INDEX NUMBER	VENDOR DWG. NUMBER	SHT. NO.	REV.	DRAWING DESCRIPTION	VENDOR	B&W PURCHASE ORDER NUMBER
V-1153-001-1	RW-160564	1/1	B	D-1011 CENTRIFUGAL PUMP DIMENSIONS	WORTHINGTON PUMP	635-0A0-41800 DU
V-1153-001-2	A-19644 (Pg. 9)	1/1	NA	CENTRIFUGAL PUMP PERFORMANCE CURVE	WORTHINGTON PUMP	635-0A0-41800 DU
V-1153-001-3	2013-3 (Pg. 18)	1/1	NA	CENTRIFUGAL PUMP GENERAL DATA	WORTHINGTON PUMP	635-0A0-41800 DU
V-1153-001-4	2013-3 (Pg. 20)	1/1	NA	CENTRIFUGAL PUMP GENERAL DATA	WORTHINGTON PUMP	635-0A0-41800 DU
V-1153-001-5	2013-3 (Pg. 22)	1/1	NA	CENTRIFUGAL PUMP NOISE LEVEL DATA	WORTHINGTON PUMP	635-0A0-41800 DU
V-1153-001-6	RW-177789 (Pg. 28)	1/1	NA	CENTRIFUGAL PUMP SECTIONAL	WORTHINGTON PUMP	635-0A0-41800 DU
V-1153-001-7	NA (Pg. 29)	1/1	NA	CENTRIFUGAL PUMP PARTS LIST	WORTHINGTON PUMP	635-0A0-41800 DU
V-1153-001-8	602531-1	1/1	NA	CENTRIFUGAL PUMP MOTOR DIMENSION SHT.	WORTHINGTON PUMP	635-0A0-41800 DU
V-1153-001-9-1/2	E0038A-B-002	1/2	NA	PUMP MOTOR PERFORMANCE DATA	WORTHINGTON PUMP	635-0A0-41800 DU
V-1153-001-9-2/2	E0038A-B-002	2/2	NA	PUMP MOTOR PERFORMANCE CURVES	WORTHINGTON PUMP	635-0A0-41800 DU
V-1153-002-1	D1-C-62	1/1	0	R & P MODEL 324 DUO FABRI-BASKET SE	PRODCO EQUIP. & SER.	635-0A0-44595 FM
V-1153-003-1	87-33-B31	1/1	0	COMPRESSED AIR RECEIVER	PRODCO EQUIP. & SER.	635-0A0-41744 DU
V-1153-005-1	72-180-657-001	1/1	1	CT NAMEPLATE STAMPING	SIEMENS	635-0A0-58459 60
V-1153-005-2	72-180-658-003	1/1	2	MECHANISM STAMPING	SIEMENS	635-0A0-58459 60
V-1153-005-3	72-180-659-004	1/1	1	SP BREAKER NP STAMPING	SIEMENS	635-0A0-58459 60
V-1153-005-4	72-280-269-404	1/1	1	CT CURVES	SIEMENS	635-0A0-58459 60
V-1153-005-5	72-280-376-401	1/1	3	SP BUSHING OUTLINE	SIEMENS	635-0A0-58459 60
V-1153-005-6	72-280-400-479	1/1	1	SP OUTLINE 25.8-23-1200	SIEMENS	635-0A0-58459 60
V-1153-005-7	72-380-150-408	1/1	1	CT DIAGRAM	SIEMENS	635-0A0-58459 60
V-1153-005-8	72-480-180-423	1/1	2	ELEMENTARY DIAGRAM	SIEMENS	635-0A0-58459 60
V-1153-005-9	72-480-181-423	1/1	2	CONNECTION DIAGRAM	SIEMENS	635-0A0-58459 60
V-1153-006-1	19A796B	1/1	C	POSITION TRANSMITTER, SERIES 4200	FISHER CONTROLS	635-0A0-53338 DA
V-1153-006-2	AU6181	1/1	J	STL. VALVE BODY, STD. BONNET, TAG #W1503	FISHER CONTROLS	635-0A0-53338 DA
V-1153-006-3	10A5920	1/1	D	DIAPHRAGM ACTUATOR, TYPE 657-3590	FISHER CONTROLS	635-0A0-53338 DA
V-1153-006-4	19A796B	1/1	C	POSITION TRANSMITTER, SERIES 4200	FISHER CONTROLS	635-0A0-53338 DA
V-1153-006-5	AU6181	1/1	J	STL. VALVE BODY, STD. BONNET, TAG #W1603	FISHER CONTROLS	635-0A0-53338 DA
V-1153-006-6	10A5919	1/1	F	DIAPHRAGM ACTUATOR, TYPE 657-3590	FISHER CONTROLS	635-0A0-53338 DA
V-1153-006-7	19A796B	1/1	C	POSITION TRANSMITTER, SERIES 4200	FISHER CONTROLS	635-0A0-53338 DA
V-1153-006-8	AU6181	1/1	J	STL. VALVE BODY, STD. BONNET, TAG #W1304	FISHER CONTROLS	635-0A0-53338 DA
V-1153-006-9	10A5920	1/1	D	DIAPHRAGM ACTUATOR, TYPE 657-3590	FISHER CONTROLS	635-0A0-53338 DA
V-1153-006-10	19A796B	1/1	C	POSITION TRANSMITTER, SERIES 4200	FISHER CONTROLS	635-0A0-53338 DA
V-1153-006-11	AU6181	1/1	J	STL. VALVE BODY, STD. BONNET, TAG #W1305	FISHER CONTROLS	635-0A0-53338 DA
V-1153-006-12	10A5919	1/1	F	DIAPHRAGM ACTUATOR, TYPE 657-3590	FISHER CONTROLS	635-0A0-53338 DA
V-1153-006-13	19A796B	1/1	C	POSITION TRANSMITTER, SERIES 4200	FISHER CONTROLS	635-0A0-53338 DA
V-1153-006-14	AU6181	1/1	J	STL. VALVE BODY, STD. BONNET, TAG #W1405	FISHER CONTROLS	635-0A0-53338 DA
V-1153-006-15	10A5920	1/1	D	DIAPHRAGM ACTUATOR, TYPE 657-3590	FISHER CONTROLS	635-0A0-53338 DA
V-1153-007-1	T14124SKA	1/1	NA	TB-800-2.5-4P ACTUATOR w/LIMIT SWITCHES	AUTOMAX	635-0A0-49011 DE
V-1153-007-2	A-41395-E	1/1	NA	CLASS 150 WEDGE GATE VALVE DIMENSION SHEET	CRANE CO.	635-0A0-49011 DE
V-1153-007-3	A-43748-A	1/1	NA	CLASS 150 SWING CHECK VALVE DIMENSION SHT.	CRANE CO.	635-0A0-49011 DE
V-1153-007-4	B-42815-W	1/1	NA	150 LB. GLOBE VALVE DIMENSION SHEET	CRANE CO.	635-0A0-49011 DE
V-1153-007-5	P-9784	1/1	0	SERIES 4000 3PC BALL VALVE ASSY./DIM. SHT.	JAMESBURY CORP.	635-0A0-49011 DE
V-1153-007-6	P-9785	1/1	0	SERIES 4000 3PC BALL VALVE ASSY./DIM. SHT.	JAMESBURY CORP.	635-0A0-49011 DE
V-1153-007-7	S-2485	1/1	F	SER. 2000, MODEL A BALL VLV. ASSY./DIM. SHT.	JAMESBURY CORP.	635-0A0-49011 DE
V-1153-007-8	S-2486	1/1	F	SER. 2000, MODEL A BALL VLV. ASSY./DIM. SHT.	JAMESBURY CORP.	635-0A0-49011 DE
V-1153-007-9	S-3265	1/1	A	ACTUATED CLINCHER BALL VALVE DIMENSION SHT.	JAMESBURY CORP.	635-0A0-49011 DE
V-1153-007-10	NP-17-F15	1/1	1	NP-17, 3-WAY BALL VALVE ASSY./DIM. SHT.	PBM INC.	635-0A0-49011 DE

ASSIGNED VENDOR DRAWING INDEX NUMBER	VENDOR DWG. NUMBER	SHT. NO.	REV.	DRAWING DESCRIPTION	VENDOR	B&W PURCHASE ORDER NUMBER
V-1153-007-11	F-46342	1/1	4	CLASS 800 GLOBE VALVE ASSY./DIM. SHT.	VOGT	
V-1153-007-12	F-46662	1/1	4	CLASS 800 GATE VALVE ASSY./DIM. SHT.	VOGT	
V-1153-010-1	AN-4.0-761SS-E5	1/1	0	Y-TYPE STRAINER, NO.761SS, 4"	MUELLER STEAM	635-0A0-54079 BV
V-1153-010-2	AN-1.0-861SS-A1	1/1	0	Y-TYPE STRAINER, NO.861SS, 1"	MUELLER STEAM	635-0A0-54079 BV
V-1153-013-1-1/5	DB115080A	1/5	A	NET 90 - CABINET ARRANGEMENT	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-1-2/5	DB115080A	2/5	A	NET 90 - CABINET ARRANGEMENT	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-1-3/5	DB115080A	3/5	A	NET 90 - POWER WIRING	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-1-4/5	DB115080A	4/5	A	NET 90 - POWER WIRING	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-1-5/5	DB115080A	5/5	A	NET 90 - POWER WIRING	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-1/31	DB115081A	1/31	A	NET 90 - EXTERNAL PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-2/31	DB115081A	2/31	A	NET 90 - EXTERNAL PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-3/31	DB115081A	3/31	A	NET 90 - EXTERNAL PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-4/31	DB115081A	4/31	A	NET 90 - EXTERNAL PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-5/31	DB115081A	5/31	A	NET 90 - EXTERNAL PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-6/31	DB115081A	6/31	A	NET 90 - EXTERNAL PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-7/31	DB115081A	7/31	A	NET 90 - EXTERNAL PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-8/31	DB115081A	8/31	A	NET 90 - EXTERNAL PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-9/31	DB115081A	9/31	A	NET 90 - EXTERNAL PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-10/31	DB115081A	10/31	A	NET 90 - EXTERNAL PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-11/31	DB115081A	11/31	A	NET 90 - CONFIGURATION PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-12/31	DB115081A	12/31	A	NET 90 - CONFIGURATION PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-13/31	DB115081A	13/31	A	NET 90 - CONFIGURATION PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-14/31	DB115081A	14/31	A	NET 90 - CONFIGURATION PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-15/31	DB115081A	15/31	A	NET 90 - CONFIGURATION PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-16/31	DB115081A	16/31	A	NET 90 - CONFIGURATION PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-17/31	DB115081A	17/31	A	NET 90 - CONFIGURATION PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-18/31	DB115081A	18/31	A	NET 90 - CONFIGURATION PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-19/31	DB115081A	19/31	A	NET 90 - CONFIGURATION PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-20/31	DB115081A	20/31	A	NET 90 - CONFIGURATION PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-21/31	DB115081A	21/31	A	NET 90 - CONFIGURATION PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-22/31	DB115081A	22/31	A	NET 90 - CONFIGURATION PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-23/31	DB115081A	23/31	A	NET 90 - CONFIGURATION PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-24/31	DB115081A	24/31	A	NET 90 - CONFIGURATION PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-25/31	DB115081A	25/31	A	NET 90 - CONFIGURATION PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-26/31	DB115081A	26/31	A	NET 90 - CONFIGURATION PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-27/31	DB115081A	27/31	A	NET 90 - CONFIGURATION PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-28/31	DB115081A	28/31	A	NET 90 - CONFIGURATION PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-29/31	DB115081A	29/31	A	NET 90 - CONFIGURATION PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-30/31	DB115081A	30/31	A	NET 90 - CONFIGURATION PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-2-31/31	DB115081A	31/31	A	NET 90 - CONFIGURATION PCU 12, MADR 3	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-3-1/4	DB115082A	1/4	A	NET 90 - EXTERNAL PCU 12, MADR 2	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-3-2/4	DB115082A	2/4	A	NET 90 - EXTERNAL PCU 12, MADR 2	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-3-3/4	DB115082A	3/4	A	NET 90 - EXTERNAL PCU 12, MADR 2	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-3-4/4	DB115082A	4/4	A	NET 90 - EXTERNAL PCU 12, MADR 2	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-4-1/4	DB115083A	1/4	A	NET 90 - EXTERNAL PCU 12, MADR 5	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-4-2/4	DB115083A	2/4	A	NET 90 - EXTERNAL PCU 12, MADR 5	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-4-3/4	DB115083A	3/4	A	NET 90 - EXTERNAL PCU 12, MADR 5	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-4-4/4	DB115083A	4/4	A	NET 90 - EXTERNAL PCU 12, MADR 5	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-5-1/13	DB115084A	1/13	A	NET 90 - EXTERNAL PCU 11, MADR 2	BAILEY CONTROLS	635-0A0-67159 DM

ASSIGNED VENDDR DRAWING INDEX NUMBER	VENDOR DWG. NUMBER	SHT. NO.	REV.	DRAWING DESCRIPTION	VENDOR	B&W PURCHASE ORDER NUMBER
V-1153-013-5-2/13	DB115084A	2/13	A	NET 90 - EXTERNAL PCU 11, MADR 2	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-5-3/13	DB115084A	3/13	A	NET 90 - EXTERNAL PCU 11, MADR 2	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-5-4/13	DB115084A	4/13	A	NET 90 - EXTERNAL PCU 11, MADR 2	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-5-5/13	DB115084A	5/13	A	NET 90 - EXTERNAL PCU 11, MADR 2	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-5-6/13	DB115084A	6/13	A	NET 90 - EXTERNAL PCU 11, MADR 2	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-5-7/13	DB115084A	7/13	A	NET 90 - EXTERNAL PCU 11, MADR 2	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-5-8/13	DB115084A	8/13	A	NET 90 - EXTERNAL PCU 11, MADR 2	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-5-9/13	DB115084A	9/13	A	NET 90 - EXTERNAL PCU 11, MADR 2	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-5-10/13	DB115084A	10/13	A	NET 90 - EXTERNAL PCU 11, MADR 2	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-5-11/13	DB115084A	11/13	A	NET 90 - EXTERNAL PCU 11, MADR 2	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-5-12/13	DB115084A	12/13	A	NET 90 - EXTERNAL PCU 11, MADR 2	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-013-5-13/13	DB115084A	13/13	A	NET 90 - EXTERNAL PCU 11, MADR 2	BAILEY CONTROLS	635-0A0-67159 DM
V-1153-016-1	IR1124	1/1	0	125 LB. SWING CHECK VALVE (FLANGED ENDS)	HAMMOND VALVE CORP.	635-0A0-60563 DA
V-1153-016-2	IR1140	1/1	0	125 LB. D.S.&Y. GATE VALVE (FLANGED ENDS)	HAMMOND VALVE CORP.	635-0A0-60563 DA
V-1153-016-3	83-14B-01	1/1	A	2" BALL VALVE DIMENSION SHEET	APOLLO	635-0A0-60563 DA
V-1153-016-4	NO NUMBER	1/1	0	SERIES WA/WL BUTTERFLY VALVE DIM. SHEET	CENTERLINE	635-0A0-60563 DA
V-1153-020-1	14A70B1	1/1	B	STEEL VALVE BODY, DESIGN V100	FISHER CONTROLS	635-0A0-68100 DA
V-1153-020-2	16A0640	1/1	C	CASING MTD. ELECTRO-PNEUM. TRDCER., TYPE 546	FISHER CONTROLS	635-0A0-68100 DA
V-1153-020-3	19A796B	1/1	C	POSITION TRANSMITTER, TYPE 4200 SERIES	FISHER CONTROLS	635-0A0-68100 DA
V-1153-020-4	10B9653	1/1	A	DIAPHRAGM ACTUATOR F MTS., TYPE 1051-3610J	FISHER CONTROLS	635-0A0-68100 DA
V-1153-029-1	NO NUMBER	1/1	0	PERFORMANCE DATA SCHEDULE	CARRIER	635-0A0-73205 BA
V-1153-029-2	39E-212-5	1/1	0	HEATING, VENTILATING OR FAN ONLY UNIT	CARRIER	635-0A0-73205 BA
V-1153-029-3	39E-212-10	1/1	0	HORIZONTAL DRAW-THRU CENT. STA. WEATHERMAKERCARRIER	CARRIER	635-0A0-73205 BA
V-1153-029-4	39E-233-2	1/1	0	COMBINATION FILTER MIXING BOX	CARRIER	635-0A0-73205 BA
V-1171-001-1	8X7234	1/1	0	GENERAL ARR. ,CENTAC C11-45M3-HP	INGERSOLL-RAND	635-0A0-35177 DU
V-1171-001-2	1X9160	1/1	A	500 F RTD/TRANSMITTER ASSEMBLY	INGERSOLL-RAND	635-0A0-35177 DU
V-1171-001-3	3X2145	1/1	0	SILENCER-STODDARD	INGERSOLL-RAND	635-0A0-35177 DU
V-1171-001-4	1319640	1/1	0	CON. BOLTING INSTR.:A1-128,138&187	INGERSOLL-RAND	635-0A0-35177 DU
V-1171-001-5	32815-5	1/1	1	FILTER: AIR INTAKE/SILENCER	INGERSOLL-RAND	635-0A0-35177 DU
V-1171-001-6-1/2	7X5527	1/2	B	ELECTRICAL SCHEMATIC	INGERSOLL-RAND	635-0A0-35177 DU
V-1171-001-6-2/2	7X5527	2/2	B	ELECTRICAL SCHEMATIC	INGERSOLL-RAND	635-0A0-35177 DU
V-1171-001-7	7X5408	1/1	A	PNEUMATIC SCHEMATIC	INGERSOLL-RAND	635-0A0-35177 DU
V-1171-001-8	7X5525	1/1	C	PROCESS AND INSTRUMENTATION DIAG.	INGERSOLL-RAND	635-0A0-35177 DU
V-1171-001-9	8X362B	1/1	J	PROCESS AND INSTR. DIAG. SYMBOLS	INGERSOLL-RAND	635-0A0-35177 DU
V-1171-001-10-1/2	7X5596	1/2	C	GENERAL ARR. ,CENTAC C11-45M3-HP	INGERSOLL-RAND	635-0A0-35177 DU
V-1171-001-10-2/2	7X5596	2/2	C	GENERAL ARR. ,CENTAC C11-45M3-HP	INGERSOLL-RAND	635-0A0-35177 DU
V-1171-001-11	C4596AA	1/1	1	MOTOR OUTLINE (WESTINGHOUSE)	INGERSOLL-RAND	635-0A0-35177 DU
V-1171-001-12	7903A79	1/1	1	MOTOR WIRING SCHEMATIC	INGERSOLL-RAND	635-0A0-35177 DU
V-1171-001-13	7903A49	1/1	1	MOTOR BEARING RTD SCHEMATIC DIAGRAM	INGERSOLL-RAND	635-0A0-35177 DU
V-1171-001-14	8627A07	1/1	1	MOTOR SPACE HEATER SCHEMATIC DIAG.	INGERSOLL-RAND	635-0A0-35177 DU
V-1171-001-15	639-0003	1/1	1	OIL COOLER, I-R P/W 1X10585	INGERSOLL-RAND	635-0A0-35177 DU
V-1171-001-16	1X10585	1/1	A	AIR COOLED OIL COOLER 2CIIMS DATA SHEET	INGERSOLL-RAND	635-0A0-35177 DU
V-1171-001-17	NO NUMBER	1/1	NA	MOTOR DATA FORM (OHIO EDISON CO.)	INGERSOLL-RAND	635-0A0-35177 DU
V-1171-001-18	A-30238	1/1	A	6" TYPE 12-R ENTRAINMENT SEPARATOR	INGERSOLL-RAND	635-0A0-35177 DU
V-1171-001-19	608992-409	1/1	0	MOTOR DIMENSION SHEET - RELIANCE ELEC.	INGERSOLL-RAND	635-0A0-35177 DU
V-1171-001-20	V54829.000	1/2	0	A-C MOTOR PERFORMANCE CURVES	INGERSOLL-RAND	635-0A0-35177 DU
V-1171-001-21	V54829.000	2/2	0	A-C MOTOR PERFORMANCE CURVES	INGERSOLL-RAND	635-0A0-35177 DU

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V-1171-001-22	V54B29.000	1/1	0	A-C MOTOR PERFORMANCE DATA	INGERSOLL-RAND	635-0A0-35177 DU
V-1171-001-23	7X5422	1/1	A	PANEL OUTLINE MICROPROCESSOR	INGERSOLL-RAND	635-0A0-35177 DU
V-1171-002-1-1/1	AC-3235-1	1/2	A	ZERO-LEAK SLIDE-GATE, 180"X139"	AIR CLEAN DAMPER CO.	635-0A0-36316 DA
V-1171-002-1-2/2	AC-3235-1	2/2	A	ZERO-LEAK SLIDE-GATE, 180"X139"	AIR CLEAN DAMPER CO.	635-0A0-36316 DA
V-1171-002-2-1/2	AC-3235-2	1/2	A	ZERO-LEAK SLIDE-GATE, 175.5"X46"	AIR CLEAN DAMPER CO.	635-0A0-36316 DA
V-1171-002-2-2/2	AC-3235-2	2/2	A	ZERO-LEAK SLIDE-GATE, 175.5"X46"	AIR CLEAN DAMPER CO.	635-0A0-36316 DA
V-1171-002-3-1/2	AC-3235-3	1/2	A	ZERO-LEAK SLIDE-GATE, 123"X123"	AIR CLEAN DAMPER CO.	635-0A0-36316 DA
V-1171-002-3-2/2	AC-3235-3	2/2	A	ZERO-LEAK SLIDE-GATE, 123"X123"	AIR CLEAN DAMPER CO.	635-0A0-36316 DA
V-1171-002-4	AC-3235-1,2,3-W	1/1	0	ZERO-LEAK SLIDE-GATE, WIRING DET.	AIR CLEAN DAMPER CO.	635-0A0-36316 DA
V-1171-002-5	AC-3235-AM	1/1	0	ACTUATOR WIRING DIAGRAM	AIR CLEAN DAMPER CO.	635-0A0-36316 DA
V-1171-003-1	SK-2416	1/1	E	FLU GAS STEAM COIL REHEATER	AEROFIN CORP.	635-0A0-38919 DE
V-1171-004-1	RL-7422-744 EJ	1/3	A	EXPANSION JOINT MATERIAL LIST	RM ENG. PRODUCTS	635-0A0-40906 FM
V-1171-004-2	RL-7422-744 EJD	2/3	0	EXPANSION JOINT DATA SHEET	RM ENG. PRODUCTS	635-0A0-40906 FM
V-1171-004-3	RL-7422-744 BU	3/3	A	EXPANSION JOINT BACK-UP BAR DIM.	RM ENG. PRODUCTS	635-0A0-40906 FM
V-1171-004-4	RL-7422-804 EJ	1/4	0	EXPANSION JOINT MATERIAL LIST	RM ENG. PRODUCTS	635-0A0-40906 FM
V-1171-004-5	RL-7422-804 EJD	2/4	0	EXPANSION JOINT DATA SHEET	RM ENG. PRODUCTS	635-0A0-40906 FM
V-1171-004-6	RL-7422-804 BU	3/4	0	EXPANSION JOINT BACK-UP BAR DIM.	RM ENG. PRODUCTS	635-0A0-40906 FM
V-1171-004-7	RL-7422-804 BA	4/4	0	EXPANSION JOINT WELD-IN BAFFLE	RM ENG. PRODUCTS	635-0A0-40906 FM
V-1171-005-1	04-571-0214-3	1/1	A	LIMITORQUE VALVE CONTROLS	LIMITORQUE CORP.	635-0A0-40851 DA
V-1171-005-2	16-476-0771-3	1/1	0	WIRING DIAGRAM	LIMITORQUE CORP.	635-0A0-40851 DA
V-1171-005-3	16-477-1133-3	1/1	0	WIRING DIAGRAM	LIMITORQUE CORP.	635-0A0-40851 DA
V-1171-005-4	NA	1/1	NA	ELECTRIC ACTUATOR - CERTIFIED INF. SHT.	LIMITORQUE CORP.	635-0A0-40851 DA
V-1171-008-1	48-061-63	1/1	NA	DIMENSION SHEET, 15 kV BUSHING, TYPE RJ	WESTINGHOUSE ELECT.	635-0A0-59685 60
V-1171-008-2	2D61067	1/1	2	TRANSFORMER WIRING DIAGRAM	WESTINGHOUSE ELECT.	635-0A0-59685 60
V-1171-008-3	9310D98	1/1	4	TRANSFORMER TERMINAL DETAIL	WESTINGHOUSE ELECT.	635-0A0-59685 60
V-1171-008-4	48-061-57A	1/1	NA	DIMENSION SHEET, BULK TYPE "RJ" BUSHING	WESTINGHOUSE ELECT.	635-0A0-59685 60
V-1171-008-5	2D60288	1/1	1	SUBSTATION TRANSFORMER OUTLINE	WESTINGHOUSE ELECT.	635-0A0-59685 60
V-1171-008-6	6764D26	1/1	22	UNIVERSAL PRODUCT LINE OUTLINE DETAILS	WESTINGHOUSE ELECT.	635-0A0-59685 60
V-1171-008-7	9768ABB	1/1	1	NAMEPLATE	WESTINGHOUSE ELECT.	635-0A0-59685 60
V-1171-009-1	B87-37476-01	1/1	A	ROCKWELL 3" GLOBE STOP VALVE	ROCKWELL INTL.	635-0A0-47445 DB
V-1171-013-1	19A7196	1/1	D	FISHER LEVEL-TROL CONTROLLER	A. E. EHRKE & CO.	635-0A0-49027 6V
V-1171-014-1	18-658-537-426	1/1	2	5 kV TYPE REFERENCE LIST DRAWING	SIEMENS	635-0A0-58460 60
V-1171-014-2	18-812-493-402	1/1	2	UNIT #02 THREE LINE SCHEMATIC	SIEMENS	635-0A0-58460 60
V-1171-014-3	18-812-493-401	1/1	2	UNIT #01 THREE LINE SCHEMATIC	SIEMENS	635-0A0-58460 60
V-1171-014-4	18-482-077-441	1/1	2	MASTER WIRING DIAGRAM	SIEMENS	635-0A0-58460 60
V-1171-014-5	18-482-077-402	1/1	2	UNIT #02 WIRING DIAGRAM	SIEMENS	635-0A0-58460 60
V-1171-014-6	18-482-077-401	1/1	2	UNIT #01 WIRING DIAGRAM	SIEMENS	635-0A0-58460 60
V-1171-014-7	18-745-732-440	1/1	2	GENERAL SWITCHGEAR INFORMATION	SIEMENS	635-0A0-58460 60
V-1171-014-8	18-658-537-626	1/1	1	SHIP LIST	SIEMENS	635-0A0-58460 60
V-1171-014-9	18-745-732-701	1/1	1	ACCESSORIES 80008-40	SIEMENS	635-0A0-58460 60
V-1171-014-10	18-745-731-701	1/1	1	NAMEPLATE ENGRAVING	SIEMENS	635-0A0-58460 60
V-1171-014-11	18-723-364-410	1/1	3	CIRCUIT BREAKER SCHEMATIC & WIRING DIAGRAM	SIEMENS	635-0A0-58460 60
V-1171-014-12	18-812-495-703	1/1	1	FIXED PORTION BILL OF MAT. & BREAKER ACCES.	SIEMENS	635-0A0-58460 60

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V-1171-014-13	18-812-493-701	1/1	3	PANEL ARRANGEMENT BILL OF MATERIALS	SIEMENS	635-0A0-58460 60
V-1171-014-14	18-812-493-480	1/1	1	SIDE VIEWS	SIEMENS	635-0A0-58460 60
V-1171-014-15	18-812-493-460	1/1	1	PANEL DRAWINGS	SIEMENS	635-0A0-58460 60
V-1171-014-16	18-812-493-404	1/1	1	UNIT #04 THREE LINE SCHEMATIC	SIEMENS	635-0A0-58460 60
V-1171-014-17	18-812-493-400	1/1	1	NOTE DRAWING	SIEMENS	635-0A0-58460 60
V-1171-014-18	18-812-493-403	1/1	1	UNIT #03 THREE LINE SCHEMATIC	SIEMENS	635-0A0-58460 60
V-1171-014-19	18-461-679-401	1/1	2	"5 KV" SWITCHGEAR INSALLATION INSTRUCTIONS	SIEMENS	635-0A0-58460 60
V-1171-014-20	18-482-077-403	1/1	1	UNIT #03 WIRING DIAGRAM	SIEMENS	635-0A0-58460 60
V-1171-014-21	18-482-077-404	1/1	1	UNIT #04 WIRING DIAGRAM	SIEMENS	635-0A0-58460 60
V-1171-014-22	18-482-077-450	1/1	1	GENERAL ARRANGEMENT	SIEMENS	635-0A0-58460 60
V-1171-015-1-1/2	263A4206	1/2	A	LOW VOLTAGE CURRENT TRANSFORMER CURVE	GENERAL ELECTRIC CO.	635-0A0-58457 60
V-1171-015-1-2/2	263A4206	2/2	A	LOW VOLTAGE CURRENT TRANSFORMER CURVE	GENERAL ELECTRIC CO.	635-0A0-58457 60
V-1171-015-2-1/2	263A4270	1/2	A	NEUTRAL CURRENT TRANSFORMER CURVE	GENERAL ELECTRIC CO.	635-0A0-58457 60
V-1171-015-2-2/2	263A4270	2/2	A	NEUTRAL CURRENT TRANSFORMER CURVE	GENERAL ELECTRIC CO.	635-0A0-58457 60
V-1171-015-3-1/2	263A9949	1/2	A	HIGH VOLTAGE CURRENT TRANSFORMER CURVE	GENERAL ELECTRIC CO.	635-0A0-58457 60
V-1171-015-3-2/2	263A9949	2/2	A	HIGH VOLTAGE CURRENT TRANSFORMER CURVE	GENERAL ELECTRIC CO.	635-0A0-58457 60
V-1171-015-4-1/2	32B128066	1/2	B	OUTLINE - INTERMEDIATE ARRESTER	GENERAL ELECTRIC CO.	635-0A0-58457 60
V-1171-015-4-2/2	32B128066	2/2	B	OUTLINE - INTERMEDIATE ARRESTER	GENERAL ELECTRIC CO.	635-0A0-58457 60
V-1171-015-5	198B2658	1/1	B	OUTLINE - OIL FILLED TRANSFORMER	GENERAL ELECTRIC CO.	635-0A0-58457 60
V-1171-015-6	254B2301	1/1	B	NAMEPLATE	GENERAL ELECTRIC CO.	635-0A0-58457 60
V-1171-015-7	3945B357	1/1	B	OUTLINE - NEUTRAL BUSHING	GENERAL ELECTRIC CO.	635-0A0-58457 60
V-1171-015-8	161D2448	1/1	D	OUTLINE - TRANSFORMER(AUTO-GAS SEALED)	GENERAL ELECTRIC CO.	635-0A0-58457 60
V-1171-015-9-1/3	161D2781	1/3	0	CONNECTION DIAGRAM	GENERAL ELECTRIC CO.	635-0A0-58457 60
V-1171-015-9-2/3	161D2781	2/3	0	CONNECTION DIAGRAM	GENERAL ELECTRIC CO.	635-0A0-58457 60
V-1171-015-9-3/3	161D2781	3/3	2	CONNECTION DIAGRAM	GENERAL ELECTRIC CO.	635-0A0-58457 60
V-1171-015-10	318A2437	1/1	1	NAMEPLATE	GENERAL ELECTRIC CO.	635-0A0-58457 60
V-1171-015-11	318A5508	1/1	0	NAMEPLATE	GENERAL ELECTRIC CO.	635-0A0-58457 60
V-1171-017-1	19A7968	1/1	C	POSITION TRANSMITTER, SERIES 4200	FISHER CONTRDLS	635-0A0-53338 DA
V-1171-017-2	17A1939	1/1	D	STL. VALVE BODY, STD. BONNET, TAG #R1702	FISHER CONTROLS	635-0A0-53338 DA
V-1171-017-3	10A5919	1/1	F	DIAPHRAGM ACTUATOR, TYPE 667-3590	FISHER CONTROLS	635-0A0-53338 DA
V-1171-017-4	19A7968	1/1	C	POSITION TRANSMITTER, SERIES 4200	FISHER CONTROLS	635-0A0-53338 DA
V-1171-017-5	AU6181	1/1	J	STL. VALVE BODY, STD. BONNET, TAG #R1708	FISHER CONTROLS	635-0A0-53338 DA
V-1171-017-6	10A5919	1/1	F	DIAPHRAGM ACTUATOR, TYPE 667-3590	FISHER CONTROLS	635-0A0-53338 DA
V-1171-017-7	19A7968	1/1	C	POSITION TRANSMITTER, SERIES 4200	FISHER CONTROLS	635-0A0-53338 DA
V-1171-017-8	AU6181	1/1	J	STL. VALVE BODY, STD. BONNET, TAG #R1717	FISHER CONTROLS	635-0A0-53338 DA
V-1171-017-9	10A5919	1/1	F	DIAPHRAGM ACTUATOR, TYPE 667-3590	FISHER CONTROLS	635-0A0-53338 DA
V-1171-017-10	AL7330	1/1	F	DIAPHRAGM ACTUATOR, TYPE 667	FISHER CONTROLS	635-0A0-53338 DA
V-1171-017-11	18A9062	1/1	A	PNEUM. INDICATING PRESS. CTRL., TYPE 4195	FISHER CONTROLS	635-0A0-53338 DA
V-1171-018-1	SM-1102-B	1/1	NA	TTF-1 THERMOSTATIC TRAP DIMENSION SHEET	ARMSTRONG	635-0A0-49015 DE
V-1171-018-2	B-40024	1/1	A6	300 LB. GLOBE VALVE ASSEMBLY & DIM. SHEET	CRANE CO.	635-0A0-49015 DE
V-1171-018-3	A-41400-E	1/1	NA	300 LB. WEDGE GATE VALVE ASSY. & DIM. SHEET	CRANE CO.	635-0A0-49015 DE
V-1171-018-4	F-46342	1/1	2	GLOBE VALVE ASSEMBLY & DIMENSION SHEET	VOGT	635-0A0-49015 DE
V-1171-018-5	F-46907	1/1	2	CLASS 800 GATE VALVE ASSY. & DIM. SHEET	VOGT	635-0A0-49015 DE
V-1171-018-6	F-49260	1/1	2	CLASS 800 GATE VALVE ASSY. & DIM. SHEET	VOGT	635-0A0-49015 DE
V-1171-021-1	1900K	1/1	4	SAFETY RELIEF VALVE, 3", 1910KC	CONSOLIDATED	635-0A0-54942 DA
V-1171-022-1	18-658-545-460	1/1	2	REFERENCE DRAWING LIST	SIEMENS	635-0A0-66402 60

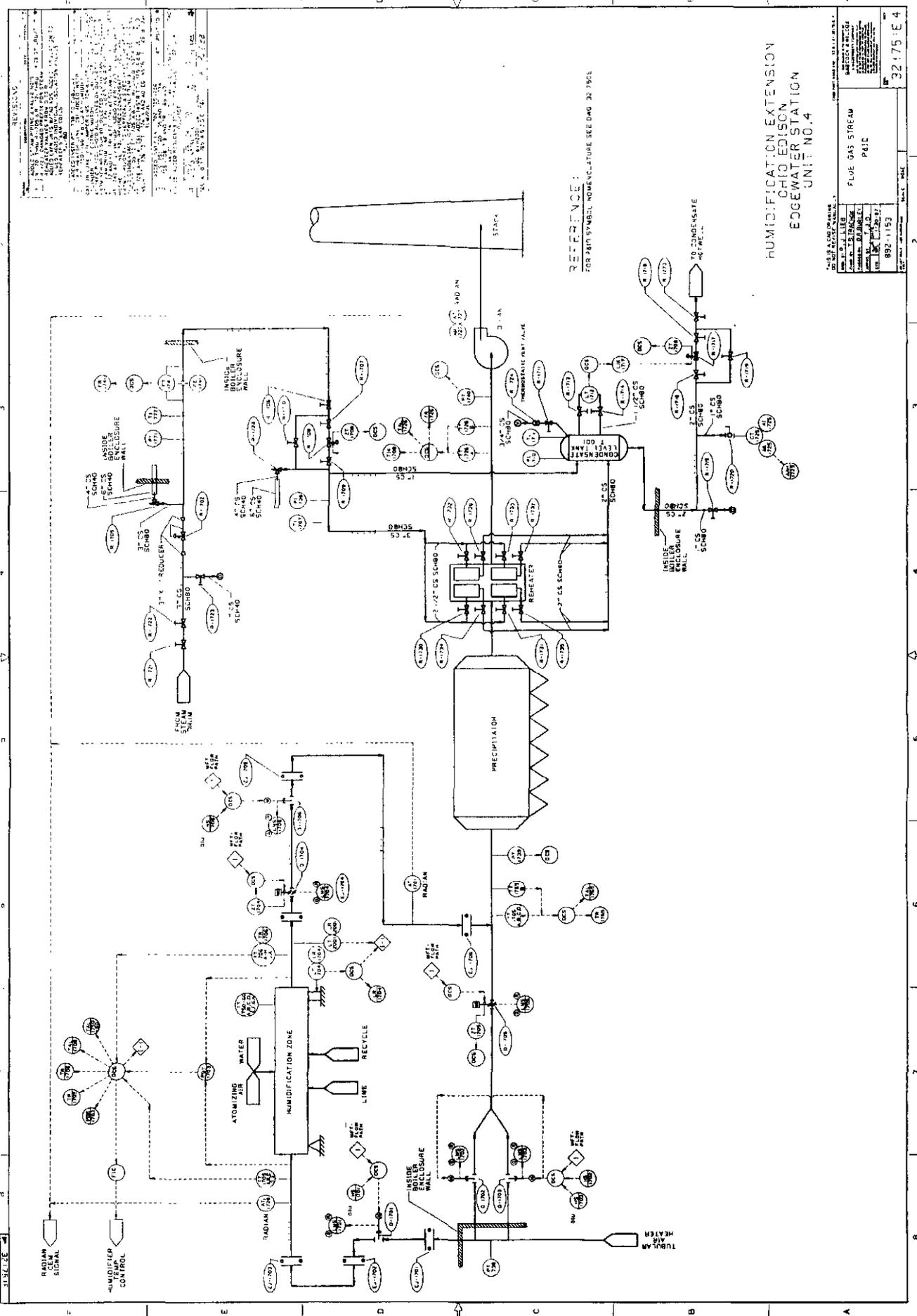
ASSIGNED VENDOR DRAWING INDEX NUMBER	VENDOR DWG. NUMBER	SHT. NO.	REV.	DRAWING DESCRIPTION	VENDOR	B&W PURCHASE ORDER NUMBER
V-1171-022-2	18-745-837-601	1/1	1	SHIPPING LIST	SIEMENS	635-0A0-66402 6D
V-1171-022-3	18-738-602-401	1/1	4	AIR CIRCUIT BREAKER WIRING DIAGRAM	SIEMENS	635-0A0-66402 6D
V-1171-022-4	18-738-601-421	1/1	3	MAN. OPER. AIR CIRCUIT BREAKER WIRING DIAG.	SIEMENS	635-0A0-66402 6D
V-1171-022-5	18-812-361-401	1/1	2	PANEL DRAWING	SIEMENS	635-0A0-66402 6D
V-1171-022-6	18-812-361-701	1/1	3	PANEL ARRANGEMENT BILL OF MATERIALS	SIEMENS	635-0A0-66402 6D
V-1171-022-7	18-812-361-801	1/1	1	NAMEPLATE ENGRAVING	SIEMENS	635-0A0-66402 6D
V-1171-022-8	18-482-147-401	1/1	1	GENERAL ARRANGEMENT DRAWING	SIEMENS	635-0A0-66402 6D
V-1171-022-9	18-482-147-411	1/1	2	THREE LINE DRAWING	SIEMENS	635-0A0-66402 6D
V-1171-022-10	18-482-147-421	1/1	1	SCHEMATIC DIAGRAM	SIEMENS	635-0A0-66402 6D
V-1171-022-11	18-482-147-422	1/1	1	SCHEMATIC DIAGRAM	SIEMENS	635-0A0-66402 6D
V-1171-022-12	18-482-147-431	1/1	2	SECTION 1 WIRING DIAGRAM	SIEMENS	635-0A0-66402 6D
V-1171-022-13	18-482-147-432	1/1	2	SECTION 2 WIRING DIAGRAM	SIEMENS	635-0A0-66402 6D
V-1171-022-14	18-482-147-433	1/1	1	SECTION 3 WIRING DIAGRAM	SIEMENS	635-0A0-66402 6D
V-1171-022-15	18-482-147-451	1/1	1	MASTER WIRING DIAGRAM	SIEMENS	635-0A0-66402 6D
V-1171-022-16	18-482-147-801	1/1	3	FIXED PORTION BILL OF MATERIALS	SIEMENS	635-0A0-66402 6D
V-1171-022-17	18-476-487-423	1/1	1	INSTALLATION INST.-INDOOR TYPE "R" SWGR.	SIEMENS	635-0A0-66402 6D
V-1171-025-1	25-135-447-421	1/1	3	JUA OVERLOAD CURRENT RANGE & SETTING INST.	SIEMENS	635-0A0-65255 DR
V-1171-025-2	25-153-091-404	1/1	1	SPECIAL FEATURES	SIEMENS	635-0A0-65255 DR
V-1171-025-3	25-153-091-403	1/1	1	FUSED DISCONNECT/CIRCUIT BREAKER DEFINITION	SIEMENS	635-0A0-65255 DR
V-1171-025-4	25-153-027-491	1/1	1	20" DEEP STD. MCC ELEVATION & CONDUIT SPACE	SIEMENS	635-0A0-65255 DR
V-1171-025-5-1/2	09-001-56125-01	1/2	5	MCC #01 SPECIFICATIONS/UNIT IDENTIFICATION	SIEMENS	635-0A0-65255 DR
V-1171-025-5-2/2	09-001-56125-01	2/2	5	MCC #01 SPECIFICATIONS/UNIT IDENTIFICATION	SIEMENS	635-0A0-65255 DR
V-1171-025-6-1/2	09-001-56125-02	1/2	6	MCC #02 SPECIFICATIONS/UNIT IDENTIFICATION	SIEMENS	635-0A0-65255 DR
V-1171-025-6-2/2	09-001-56125-02	2/2	6	MCC #02 SPECIFICATIONS/UNIT IDENTIFICATION	SIEMENS	635-0A0-65255 DR
V-1171-025-7	25-205-533-403	1/1	2	FLOOR PLAN	SIEMENS	635-0A0-65255 DR
V-1171-025-8	25-210-184-423	1/1	3	SIZE 1,2,3,4 FVR COMB STARTER WIRING DIAG.	SIEMENS	635-0A0-65255 DR
V-1171-025-9	25-210-184-424	1/1	3	SIZE 1,2,3 FVNR COMB STARTER WIRING DIAG.	SIEMENS	635-0A0-65255 DR
V-1171-025-10	25-205-935-406	1/1	1	MCC SPACE HEATER WIRING DIAGRAM	SIEMENS	635-0A0-65255 DR
V-1171-025-11	25-153-073-431	1/1	1	DUAL CIRCUIT BREAKERS 15 THRU 100 AMP	SIEMENS	635-0A0-65255 DR
V-1171-027-1	BB1811	1/1	0	INSTALLATION LINE - GRUENDLER LUMP BREAKER	GRUENDLER	635-0A0-60560 DR
V-1171-032-1	D-88-025	1/1	0	8 IN. C-37N.D. CAST 150# KNIFE GATE VALVE	FABRI-VALVE	635-0A0-63533 DA
V-1171-034-1	T1-0054	1/1	A	A TYPICAL 533 M'CELL INSTALLATION	KISTLER-MORSE CORP.	635-0A0-64386 BV
V-1171-034-2	T1-0091	1/1	A	WIRING DIAGRAM, 954 LEVEL INDICATOR	KISTLER-MORSE CORP.	635-0A0-64386 BV
V-1171-037-1	539-88	1/1	0	6" FLEXICORE ROOF PLAN	FLEXICORE SYSTEMS	635-0A0-68201 AD
V-1171-037-2	539-88	1/1	1	6" FLEXICORE SCHEDULE	FLEXICORE SYSTEMS	635-0A0-68201 AD
V-1171-037-3	NA	1/1	NA	FLEXICORE STANDARDS/NOTES	FLEXICORE SYSTEMS	635-0A0-68201 AD
V-1171-039-1	A600-30095-1	1/1	2	PROBE HEATER CONTROL ASSEMBLY	ENVIROPLAN INC.	635-0A0-78600 DM
V-1171-039-2	B600-50130	1/1	0	SAMPLE/HOLD WIRING DIAGRAM	ENVIROPLAN INC.	635-0A0-78600 DM
V-1171-039-3	B600-50131	1/1	0	SYSTEM AIR FLOW	ENVIROPLAN INC.	635-0A0-78600 DM
V-1171-039-4	B600-50132	1/1	0	SOL/STATUS RELAY PURGE/SAMPLE SELECT	ENVIROPLAN INC.	635-0A0-78600 DM
V-1171-039-5	B600-50133	1/1	1	SOL - CALIBRATION RELAY ASSEMBLY	ENVIROPLAN INC.	635-0A0-78600 DM
V-1171-039-6	B600-50134	1/1	0	TIMING SEQUENCE	ENVIROPLAN INC.	635-0A0-78600 DM
V-1171-039-7	B600-50139	1/1	0	AIR FILTERING SYSTEM	ENVIROPLAN INC.	635-0A0-78600 DM
V-1171-039-8	C600-30148	1/1	0	TIMER ASSEMBLY STACK SYSTEM	ENVIROPLAN INC.	635-0A0-78600 DM
V-1171-039-9	C600-30149	1/1	0	UMBILICAL INTERFACE ENCLOSURE	ENVIROPLAN INC.	635-0A0-78600 DM

ASSIGNED VENDOR DRAWING INDEX NUMBER	VENDOR DWG. NUMBER	SHT. NO.	REV.	DRAWING DESCRIPTION	VENDOR	B&N PURCHASE ORDER NUMBER
V-1171-039-10	C600-50145	1/1	0	INTERCONNECT PANEL WIRING	ENVIROPLAN INC.	635-0A0-78600 DM
V-1171-039-11	C600-50146	1/1	0	REAR VIEW - CEMEX CABINET	ENVIROPLAN INC.	635-0A0-78600 DM
V-1171-039-12	C600-50147	1/1	0	FRONT VIEW - CEMEX CABINET	ENVIROPLAN INC.	635-0A0-78600 DM
V-1171-039-13	C600-50152	1/1	0	GENERAL SYSTEM FLOW	ENVIROPLAN INC.	635-0A0-78600 DM
V-1171-039-14	C600-50167	1/1	0	H2O GENERAL FLOW	ENVIROPLAN INC.	635-0A0-78600 DM
V-1171-039-15	D600-50014	1/1	1	GENERAL CEMEX PROBE INSTALLATION	ENVIROPLAN INC.	635-0A0-78600 DM
V-1171-039-16	D600-5001B	1/1	0	SYSTEM INTERCONNECT	ENVIROPLAN INC.	635-0A0-78600 DM
V-1171-044-1	EX-11287-1	1/1	B	HUMID. ASH COLLECTOR COVER - 55 GAL. DRUM	EFFOX, INC.	635-0A0-80165 DA
V-1171-045-1	17-1377	1/1	1	O.E.- EDGEWATER PLANT: LIMB PROJECT(MODIF.) AUTOMATIC SPRINKLER		635-0A0-80162 DE
V-1171-060-1	003632	1/1	0	MT86 HT FLANGED - NEMA 4 PROBE & ELEC. ENCL.FCI		635-0A0-86503 G4
V-1171-060-2	012761	1/1	0	MT86 WIRING DIAGRAM	FCI	635-0A0-86503 G5
V-1171-060-3	S.O. 14761	1/1	0	POINT LOCATION FOR MT86	FCI	635-0A0-86503 G6
V-1171-074-1	263C152	1/1	12	REFERENCE GAS SET FOR OXYGEN ANALYZER	WESTINGHOUSE	635-0A1-01987 G4
V-1171-074-2	3D37826	1/1	3	OUTLINE & INST. DIGITAL ELEC. PKG. NEMA 4	WESTINGHOUSE	635-0A1-01987 G5
V-1171-074-3	3D38008	1/1	2	ENCLOSURE ARRGT., NEMA 4 FOR OXYGEN PROBE	WESTINGHOUSE	635-0A1-01987 G6
V-1171-074-4	3D38011	1/1	0	HOUSING	WESTINGHOUSE	635-0A1-01987 G7
V-1171-074-5-1/2	6630065	1/2	5	INST. FOR O2 ANALYZER PROBES 218/225/240	WESTINGHOUSE	635-0A1-01987 G8
V-1171-074-5-2/2	6630065	2/2	5	INST. FOR O2 ANALYZER PROBES 218/225/240	WESTINGHOUSE	635-0A1-01987 G9
V-1171-092-1-1/2	A-7942	1/2	0	MAGNETIC LEVEL GAUGE, MODEL NO. ML6-C	KENCO ENGINEERING	635-0A1-12107 G4
V-1171-092-1-2/2	A-7942	2/2	0	MAGNETIC LEVEL GAUGE, MODEL NO. ML6-C	KENCO ENGINEERING	635-0A1-12107 G5
V-1171-094-1	P0047	1/1	D	4" BOX MOUNTING DETAILS	TBI-BAILEY CONTROLS	635-0A1-11819 DM
V-1171-094-2	P0077-B	1/1	C	MODEL 543 INSTALLATION EXAMPLE	TBI-BAILEY CONTROLS	635-0A1-11819 DM
V-1171-094-3	P0362-B	1/1	D	T8557 REPLACEABLE STYLE pH SENSOR	TBI-BAILEY CONTROLS	635-0A1-11819 DM

) XI. SIGNIFICANT DRAWINGS  
(Included in this section)

321751E-4	FLUE GAS STREAM - P&ID
321752E-4	WATER FEED SYSTEM - HUMID EXTENSION - P&ID
321753E-4	ATOMIZING AIR COMPRESSOR - P&ID
321754E-4	HUMIDIFICATION - P&ID
420977E-0	ASH REINJECTION SYSTEM - P&ID
321755E-0	HUMIDIFICATION FLOW DIAGRAM - PEAK LOAD 20°F ATS (AIR TO WATER RATIO 0.45 LB./LB.)
9824J-2	GEN. ARRGT. (BYPASS) PLAN VIEW
9825J-2	GEN. ARRGT. (BYPASS) SECTIONS A-A & B-B
9826J-2	GEN. ARRGT. (BYPASS) SECTIONS C-C & D-D
9828J-2	GEN. ARRGT. HUMIDIFICATION EXTENSION REHEATER
15164.09-EE-1B	ONE-LINE DIAGRAM 23KV/4KV (ELECTRICAL)
15164.09-EM-202A	GEN. ARRGT. - HUMID COMPRESSOR & PUMP.





REVISIONS

NO.	DATE	BY	DESCRIPTION
1	11-15-54	W. J. ...	...
2	11-15-54	W. J. ...	...
3	11-15-54	W. J. ...	...
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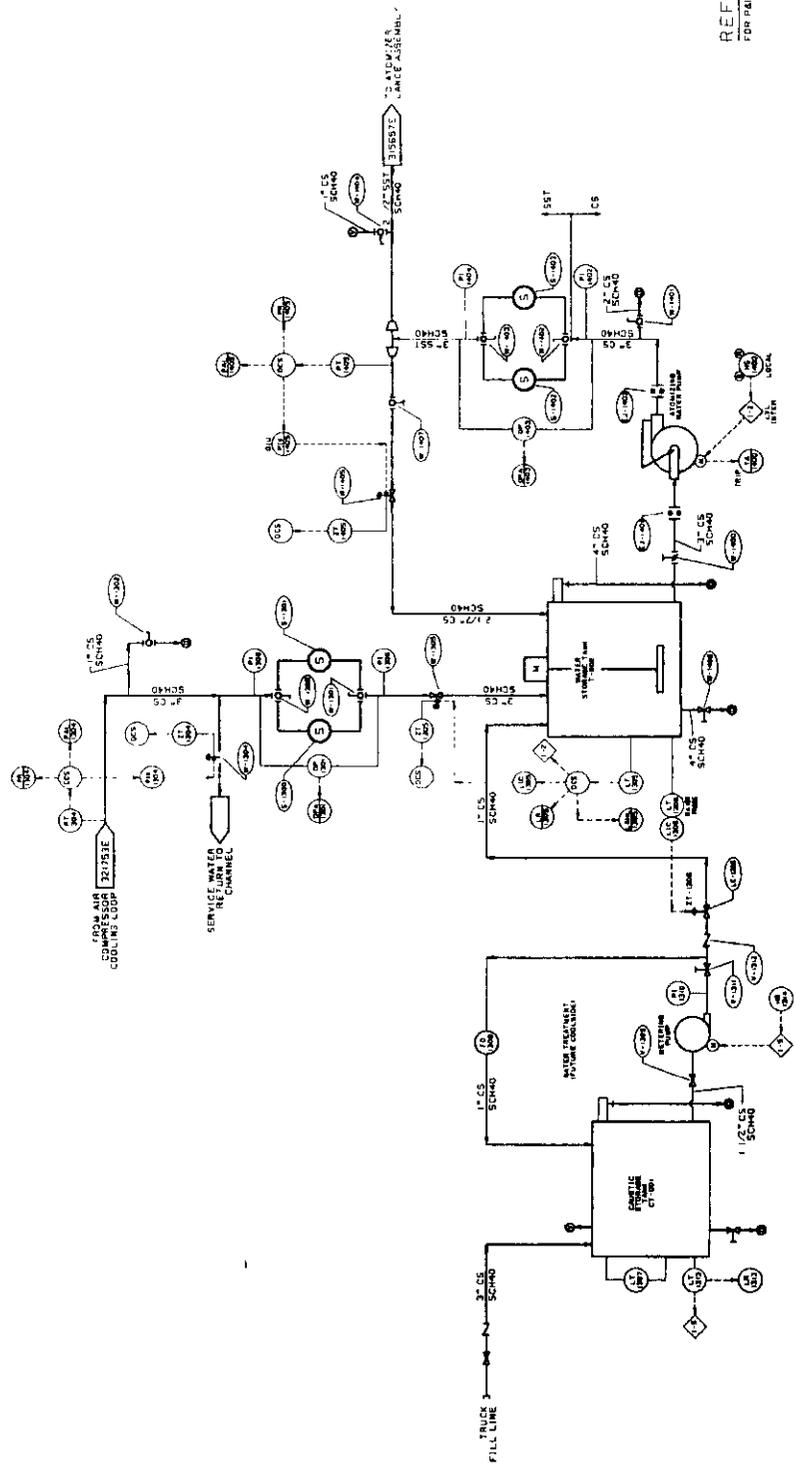
REFERENCE:  
FOR PIPE SYMBOL NOMENCLATURE SEE DWG 32-7501

HUMIDIFICATION EXTENSION  
CHIO EDISON  
EDGEWATER STATION  
UNIT NO. 4

2-15-54 (REVISED)

DESIGNED BY	W. J. ...
CHECKED BY	...
APPROVED BY	...
DATE	11-15-54
PROJECT NO.	892-1153
SCALE	AS SHOWN
TITLE	FLUE GAS STREAM PAJIC
DWG NO.	32-751E-4

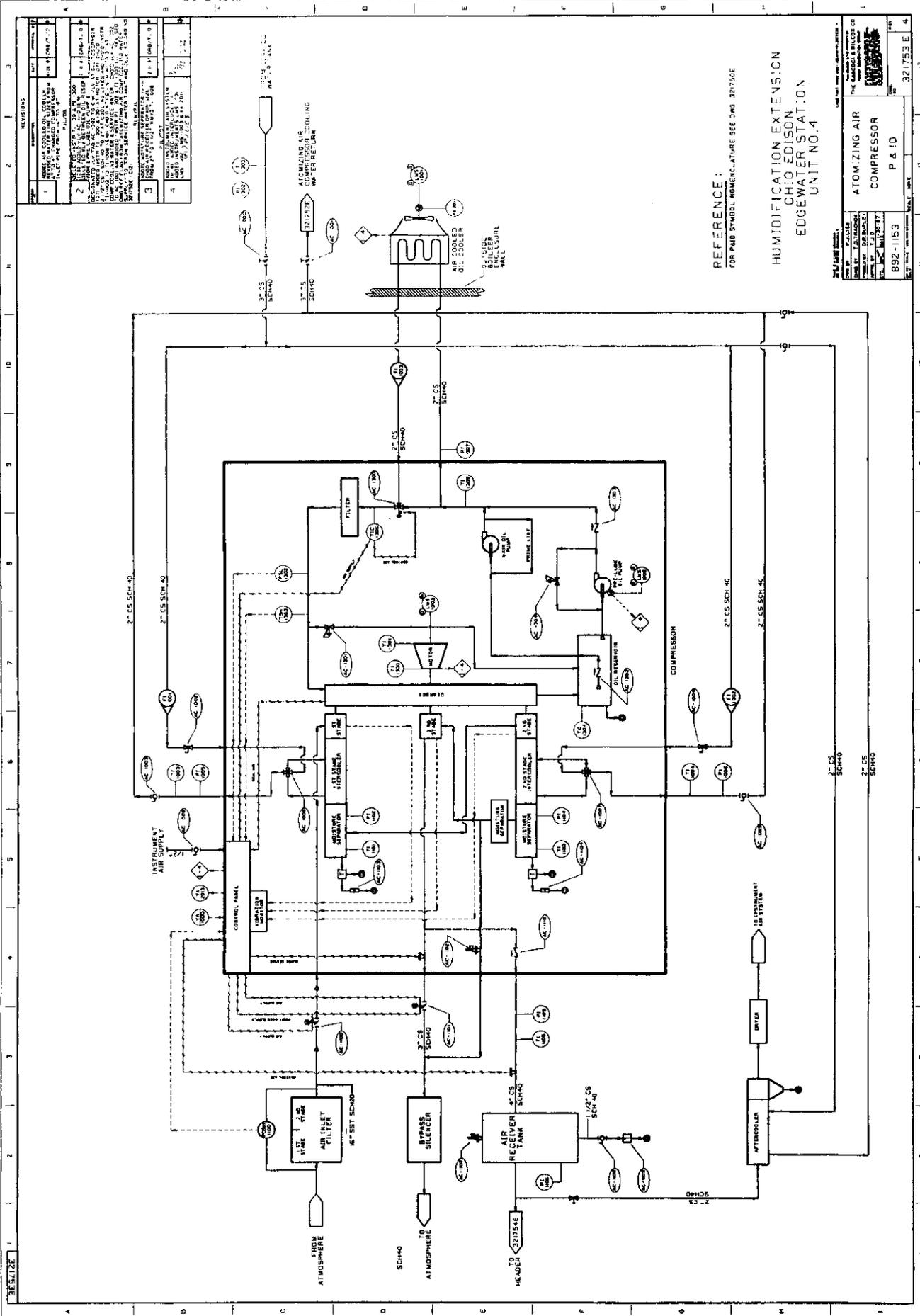
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REFERENCE:  
FOR PAID SYMBOLS, VOLUME, DATE, SEE DWG. 37 750E

HUMIDIFICATION EXTENSION  
CHIO EDISON  
EDGEWATER STATION  
UNIT NO. 4

DATE: 10/15/54	BY: [Signature]
CHECKED: [Signature]	SCALE: 1/8" = 1'-0"
APPROVED: [Signature]	NO. 892-1153
PROJECT: CHIO EDISON	DATE: 10/15/54
DESCRIPTION: HUMIDIFICATION EXTENSION PAID	NO. 32 1752E 4



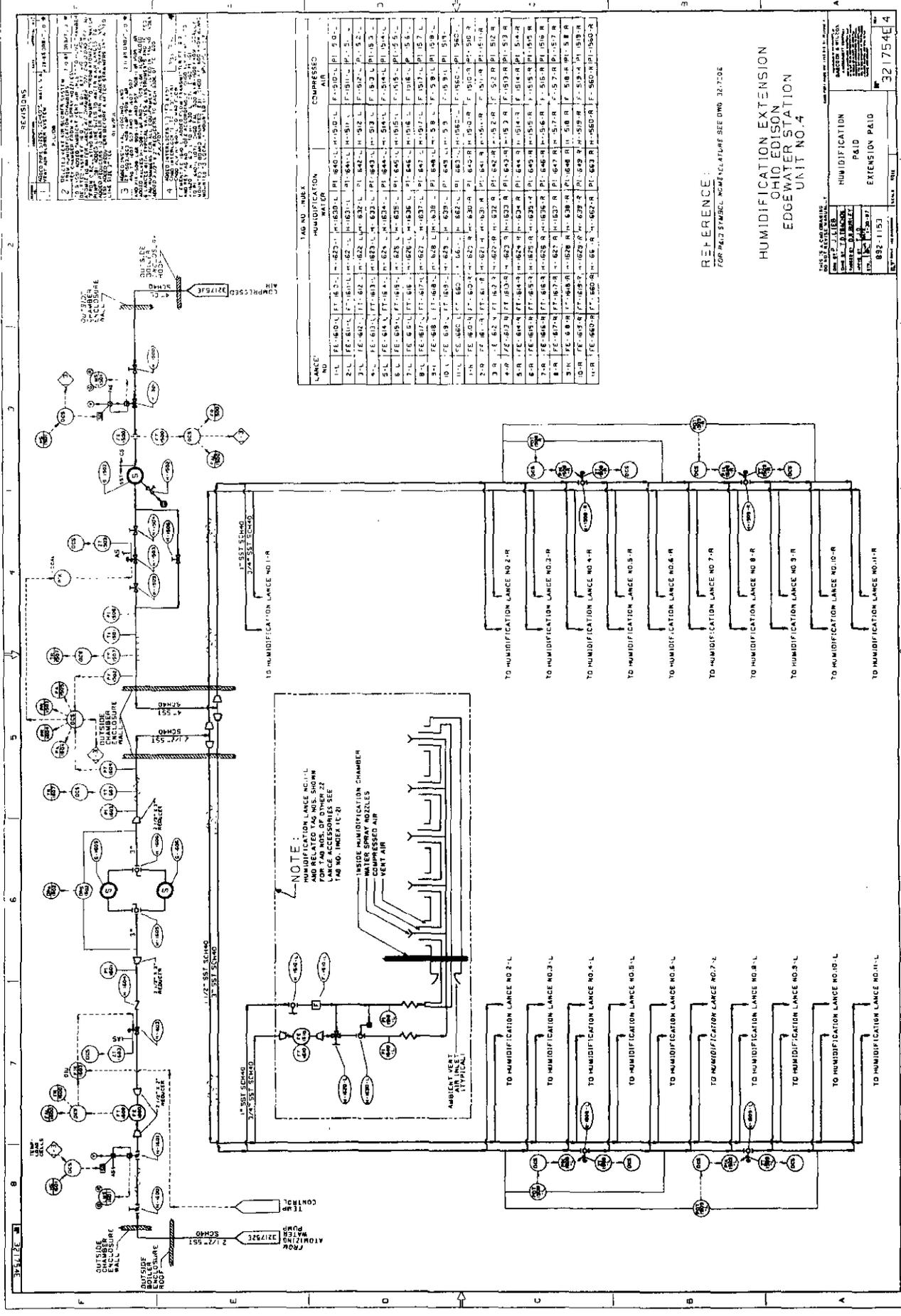
NO.	REVISIONS	DATE	BY	CHKD.
1	DESIGN AND CONSTRUCTION OF UNIT NO. 4	10/1/53	J. H. CAMP	J. H. CAMP
2	REVISION TO UNIT NO. 4	10/1/53	J. H. CAMP	J. H. CAMP
3	REVISION TO UNIT NO. 4	10/1/53	J. H. CAMP	J. H. CAMP
4	REVISION TO UNIT NO. 4	10/1/53	J. H. CAMP	J. H. CAMP

REFERENCE:  
FOR PIPE SYMBOL NOMENCLATURE SEE DWG. 321753E

HUMIDIFICATION EXTENSION  
OHIO EDISON  
EDGE WATER STATION  
UNIT NO. 4

PROJECT NO.	321753E
DATE	10/1/53
BY	J. H. CAMP
CHKD.	J. H. CAMP
SCALE	AS SHOWN
TITLE	ATOMIZING AIR COMPRESSOR P & ID

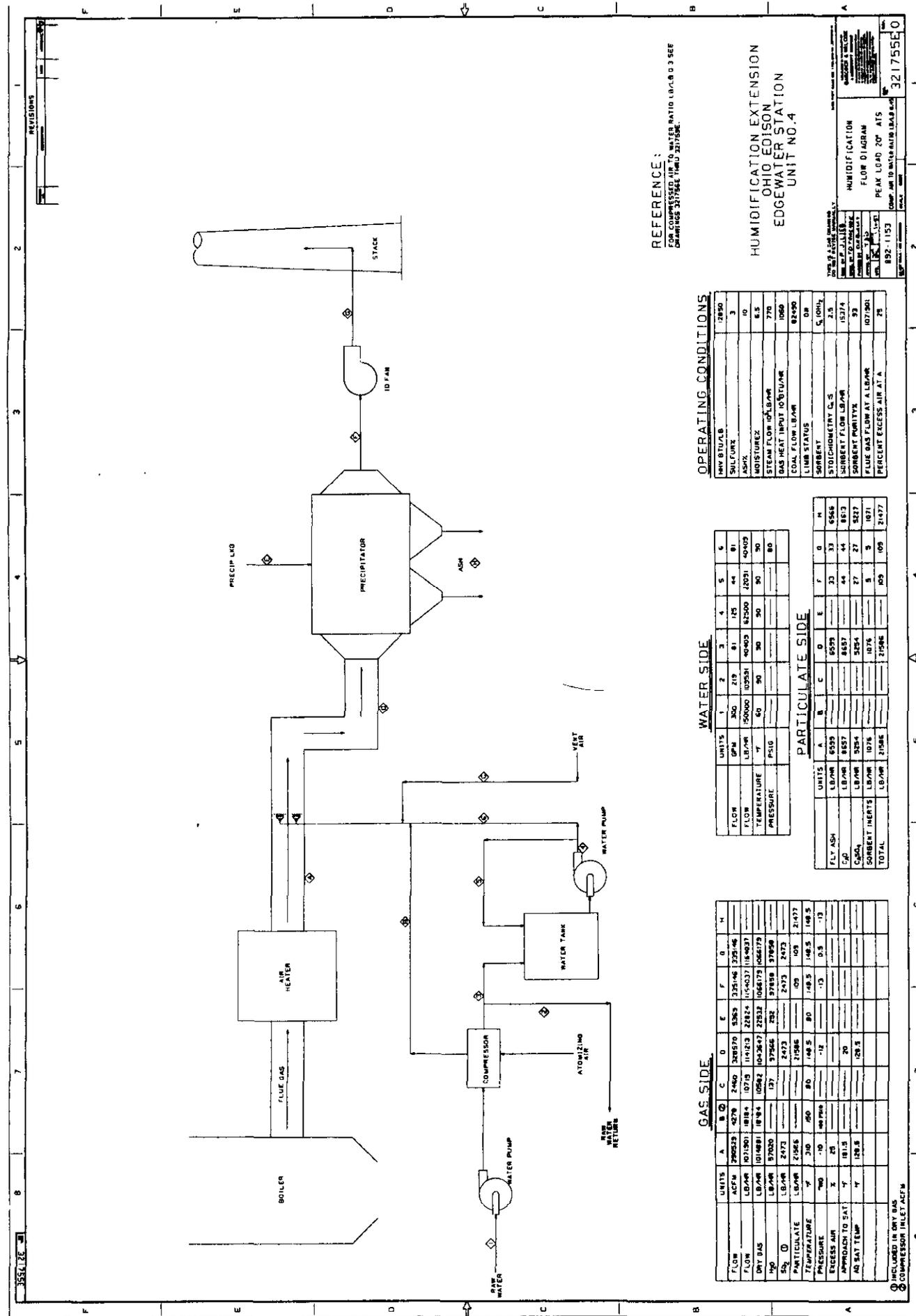




REVISIONS

1. APPROVED FOR CONSTRUCTION BY THE ENGINEER.
2. THIS SCHEMATIC IS A PART OF THE CONTRACT DOCUMENTS FOR THE EXTENSION OF THE HUMIDIFICATION SYSTEM AT THE OHIO EDISON EDGEWATER STATION. IT IS TO BE USED IN CONNECTION WITH THE CONTRACT DOCUMENTS AND THE CONTRACT AGREEMENT. IT IS NOT TO BE USED FOR ANY OTHER PURPOSE.
3. THIS SCHEMATIC IS A PART OF THE CONTRACT DOCUMENTS FOR THE EXTENSION OF THE HUMIDIFICATION SYSTEM AT THE OHIO EDISON EDGEWATER STATION. IT IS TO BE USED IN CONNECTION WITH THE CONTRACT DOCUMENTS AND THE CONTRACT AGREEMENT. IT IS NOT TO BE USED FOR ANY OTHER PURPOSE.
4. THIS SCHEMATIC IS A PART OF THE CONTRACT DOCUMENTS FOR THE EXTENSION OF THE HUMIDIFICATION SYSTEM AT THE OHIO EDISON EDGEWATER STATION. IT IS TO BE USED IN CONNECTION WITH THE CONTRACT DOCUMENTS AND THE CONTRACT AGREEMENT. IT IS NOT TO BE USED FOR ANY OTHER PURPOSE.

LANCE NO.	TAG NO.	INDEX	HUMIDIFICATION WATER	COMPRESSION AIR
1-L	FE-160-L	FT-162-L	PI-163-L	PI-164-L
2-L	FE-161-L	FT-163-L	PI-164-L	PI-165-L
3-L	FE-162-L	FT-164-L	PI-165-L	PI-166-L
4-L	FE-163-L	FT-165-L	PI-166-L	PI-167-L
5-L	FE-164-L	FT-166-L	PI-167-L	PI-168-L
6-L	FE-165-L	FT-167-L	PI-168-L	PI-169-L
7-L	FE-166-L	FT-168-L	PI-169-L	PI-170-L
8-L	FE-167-L	FT-169-L	PI-170-L	PI-171-L
9-L	FE-168-L	FT-170-L	PI-171-L	PI-172-L
10-L	FE-169-L	FT-171-L	PI-172-L	PI-173-L
11-L	FE-170-L	FT-172-L	PI-173-L	PI-174-L
12-L	FE-171-L	FT-173-L	PI-174-L	PI-175-L
13-L	FE-172-L	FT-174-L	PI-175-L	PI-176-L
14-L	FE-173-L	FT-175-L	PI-176-L	PI-177-L
15-L	FE-174-L	FT-176-L	PI-177-L	PI-178-L
16-L	FE-175-L	FT-177-L	PI-178-L	PI-179-L
17-L	FE-176-L	FT-178-L	PI-179-L	PI-180-L
18-L	FE-177-L	FT-179-L	PI-180-L	PI-181-L
19-L	FE-178-L	FT-180-L	PI-181-L	PI-182-L
20-L	FE-179-L	FT-181-L	PI-182-L	PI-183-L
21-L	FE-180-L	FT-182-L	PI-183-L	PI-184-L
22-L	FE-181-L	FT-183-L	PI-184-L	PI-185-L
23-L	FE-182-L	FT-184-L	PI-185-L	PI-186-L
24-L	FE-183-L	FT-185-L	PI-186-L	PI-187-L
25-L	FE-184-L	FT-186-L	PI-187-L	PI-188-L
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32-L	FE-191-L	FT-193-L	PI-194-L	PI-195-L
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37-L	FE-196-L	FT-198-L	PI-199-L	PI-200-L
38-L	FE-197-L	FT-199-L	PI-200-L	PI-201-L
39-L	FE-198-L	FT-200-L	PI-201-L	PI-202-L
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43-L	FE-202-L	FT-204-L	PI-205-L	PI-206-L
44-L	FE-203-L	FT-205-L	PI-206-L	PI-207-L
45-L	FE-204-L	FT-206-L	PI-207-L	PI-208-L
46-L	FE-205-L	FT-207-L	PI-208-L	PI-209-L
47-L	FE-206-L	FT-208-L	PI-209-L	PI-210-L
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49-L	FE-208-L	FT-210-L	PI-211-L	PI-212-L
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54-L	FE-213-L	FT-215-L	PI-216-L	PI-217-L
55-L	FE-214-L	FT-216-L	PI-217-L	PI-218-L
56-L	FE-215-L	FT-217-L	PI-218-L	PI-219-L
57-L	FE-216-L	FT-218-L	PI-219-L	PI-220-L
58-L	FE-217-L	FT-219-L	PI-220-L	PI-221-L
59-L	FE-218-L	FT-220-L	PI-221-L	PI-222-L
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81-L	FE-240-L	FT-242-L	PI-243-L	PI-244-L
82-L	FE-241-L	FT-243-L	PI-244-L	PI-245-L
83-L	FE-242-L	FT-244-L	PI-245-L	PI-246-L
84-L	FE-243-L	FT-245-L	PI-246-L	PI-247-L
85-L	FE-244-L	FT-246-L	PI-247-L	PI-248-L
86-L	FE-245-L	FT-247-L	PI-248-L	PI-249-L
87-L	FE-246-L	FT-248-L	PI-249-L	PI-250-L
88-L	FE-247-L	FT-249-L	PI-250-L	PI-251-L
89-L	FE-248-L	FT-250-L	PI-251-L	PI-252-L
90-L	FE-249-L	FT-251-L	PI-252-L	PI-253-L
91-L	FE-250-L	FT-252-L	PI-253-L	PI-254-L
92-L	FE-251-L	FT-253-L	PI-254-L	PI-255-L
93-L	FE-252-L	FT-254-L	PI-255-L	PI-256-L
94-L	FE-253-L	FT-255-L	PI-256-L	PI-257-L
95-L	FE-254-L	FT-256-L	PI-257-L	PI-258-L
96-L	FE-255-L	FT-257-L	PI-258-L	PI-259-L
97-L	FE-256-L	FT-258-L	PI-259-L	PI-260-L
98-L	FE-257-L	FT-259-L	PI-260-L	PI-261-L
99-L	FE-258-L	FT-260-L	PI-261-L	PI-262-L
100-L	FE-259-L	FT-261-L	PI-262-L	PI-263-L
101-L	FE-260-L	FT-262-L	PI-263-L	PI-264-L
102-L	FE-261-L	FT-263-L	PI-264-L	PI-265-L
103-L	FE-262-L	FT-264-L	PI-265-L	PI-266-L
104-L	FE-263-L	FT-265-L	PI-266-L	PI-267-L
105-L	FE-264-L	FT-266-L	PI-267-L	PI-268-L
106-L	FE-265-L	FT-267-L	PI-268-L	PI-269-L
107-L	FE-266-L	FT-268-L	PI-269-L	PI-270-L
108-L	FE-267-L	FT-269-L	PI-270-L	PI-271-L
109-L	FE-268-L	FT-270-L	PI-271-L	PI-272-L
110-L	FE-269-L	FT-271-L	PI-272-L	PI-273-L
111-L	FE-270-L	FT-272-L	PI-273-L	PI-274-L
112-L	FE-271-L	FT-273-L	PI-274-L	PI-275-L
113-L	FE-272-L	FT-274-L	PI-275-L	PI-276-L
114-L	FE-273-L	FT-275-L	PI-276-L	PI-277-L
115-L	FE-274-L	FT-276-L	PI-277-L	PI-278-L
116-L	FE-275-L	FT-277-L	PI-278-L	PI-279-L
117-L	FE-276-L	FT-278-L	PI-279-L	PI-280-L
118-L	FE-277-L	FT-279-L	PI-280-L	PI-281-L
119-L	FE-278-L	FT-280-L	PI-281-L	PI-282-L
120-L	FE-279-L	FT-281-L	PI-282-L	PI-283-L
121-L	FE-280-L	FT-282-L	PI-283-L	PI-284-L
122-L	FE-281-L	FT-283-L	PI-284-L	PI-285-L
123-L	FE-282-L	FT-284-L	PI-285-L	PI-286-L
124-L	FE-283-L	FT-285-L	PI-286-L	PI-287-L
125-L	FE-284-L	FT-286-L	PI-287-L	PI-288-L
126-L	FE-285-L	FT-287-L	PI-288-L	PI-289-L
127-L	FE-286-L	FT-288-L	PI-289-L	PI-290-L
128-L	FE-287-L	FT-289-L	PI-290-L	PI-291-L
129-L	FE-288-L	FT-290-L	PI-291-L	PI-292-L
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132-L	FE-291-L	FT-293-L	PI-294-L	PI-295-L
133-L	FE-292-L	FT-294-L	PI-295-L	PI-296-L
134-L	FE-293-L	FT-295-L	PI-296-L	PI-297-L
135-L	FE-294-L	FT-296-L	PI-297-L	PI-298-L
136-L	FE-295-L	FT-297-L	PI-298-L	PI-299-L
137-L	FE-296-L	FT-298-L	PI-299-L	PI-300-L
138-L	FE-297-L	FT-299-L	PI-300-L	PI-301-L
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140-L	FE-299-L	FT-301-L	PI-302-L	PI-303-L
141-L	FE-300-L	FT-302-L	PI-303-L	PI-304-L
142-L	FE-301-L	FT-303-L	PI-304-L	PI-305-L
143-L	FE-302-L	FT-304-L	PI-305-L	PI-306-L
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154-L	FE-313-L	FT-315-L	PI-316-L	PI-317-L
155-L	FE-314-L	FT-316-L	PI-317-L	PI-318-L
156-L	FE-315-L	FT-317-L	PI-318-L	PI-319-L
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160-L	FE-319-L	FT-321-L	PI-322-L	PI-323-L
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163-L	FE-322-L	FT-324-L	PI-325-L	PI-326-L
164-L	FE-323-L	FT-325-L	PI-326-L	PI-327-L
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168-L	FE-327-L	FT-329-L	PI-330-L	PI-331-L
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170-L	FE-329-L	FT-331-L	PI-332-L	PI-333-L
171-L	FE-330-L	FT-332-L	PI-333-L	PI-334-L
172-L	FE-331-L	FT-333-L	PI-334-L	PI-335-L
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174-L	FE-333-L	FT-335-L	PI-336-L	PI-337-L
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176-L	FE-335-L	FT-337-L	PI-338-L	PI-339-L
177-L	FE-336-L	FT-338-L	PI-339-L	PI-340-L
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183-L	FE-342-L	FT-344-L	PI-345-L	PI-346-L
184-L	FE-343-L	FT-345-L	PI-346-L	PI-347-L
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192-L	FE-351-L	FT-353-L	PI-354-L	PI-355-L
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202-L	FE-361-L	FT-363-L	PI-364-L	PI-365-L
203-L	FE-362-L	FT-364-L	PI-365-L	PI-366-L
204-L	FE-363-L	FT-365-L	PI-366-L	PI-367-L
205-L	FE-364-L</			



REFERENCE:  
FOR COMPRESSED AIR TO WATER RATIO LB/AIR Q 3 SEE  
DRAWING 321755E.

HUMIDIFICATION EXTENSION  
OHIO EDISON  
EDGEWATER STATION  
UNIT NO.4

OPERATING CONDITIONS

INLET DUST	12950
SULFUR	3
ASH	10
MOISTURE	6.5
STEAM FLOW 100 LB/AIR	770
GAS HEAT INPUT 10 <sup>6</sup> BTU/AIR	1060
COAL FLOW LB/AIR	82490
LIMB STATUS	DR
SORBEST	5.00%
STOICHIOMETRY G/S	2.5
SORBERT FLOW LB/AIR	15274
SORBERT PURITY	93
FLUE GAS FLOW AT A LB/AIR	107901
PERCENT EXCESS AIR AT A	25

WATER SIDE

UNITS	1	2	3	4	5	6
FLOW	300	219	81	125	44	81
LB/AIR	50000	10251	10403	82500	2031	40405
TEMPERATURE °F	50	50	50	50	50	50
PRESSURE PSIG						80

PARTICULATE SIDE

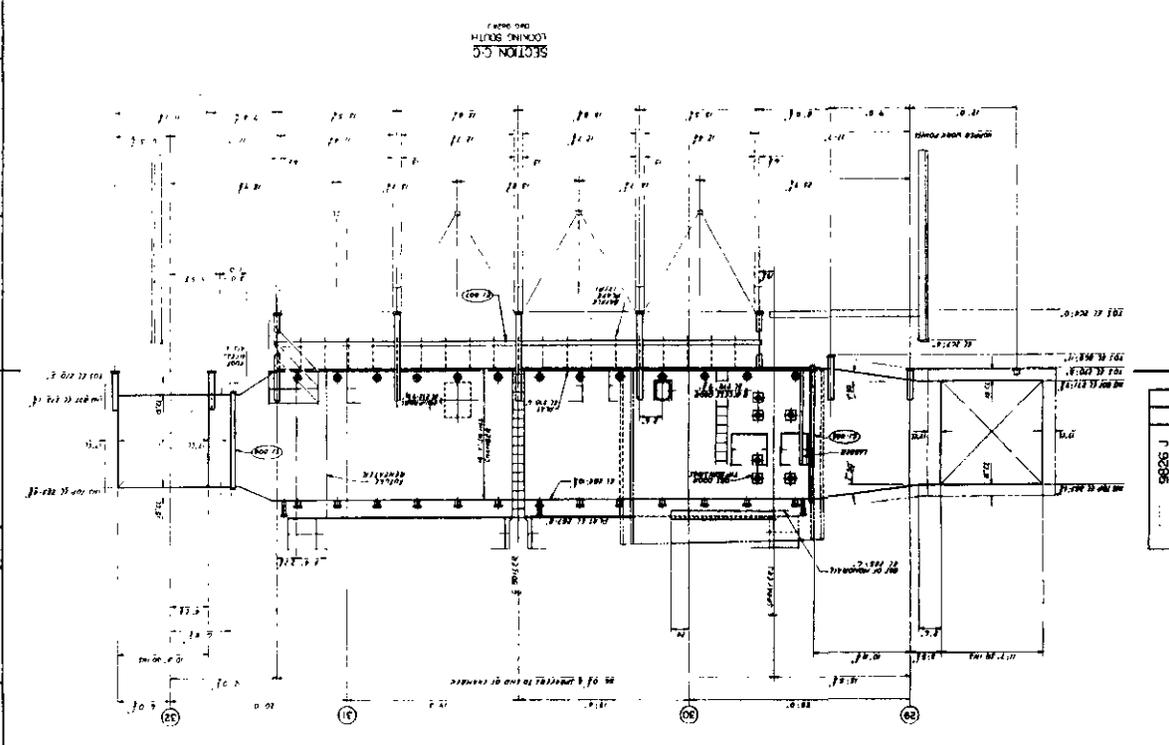
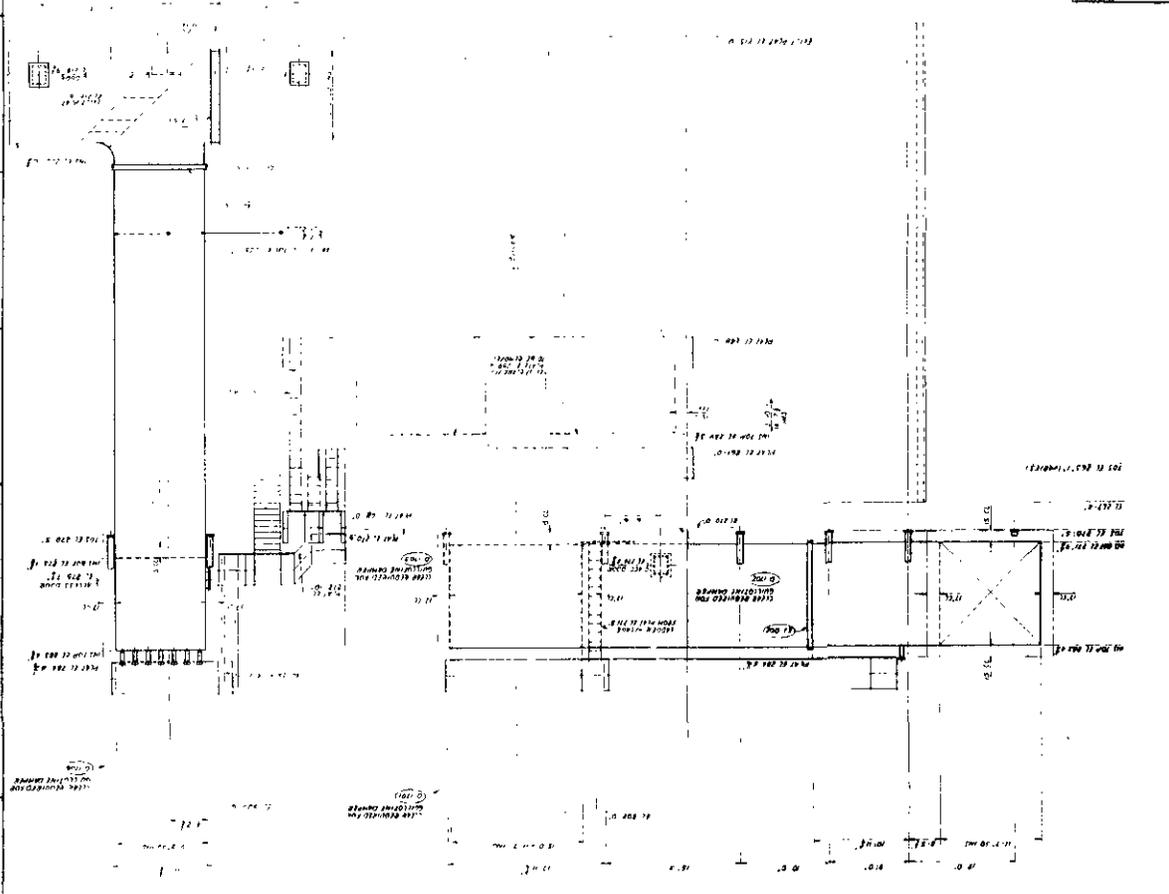
UNITS	A	B	C	D	E	F	G	H
FLY ASH	6595			6595		33	33	6588
CaO	8637			8637		44	44	8613
SO <sub>2</sub>	3254			3254		27	27	3217
SORBERT	1076			1076		5	5	1071
TOTAL	21586			21586		105	105	21477

GAS SIDE

UNITS	A	B	C	D	E	F	G	H
FLOW	290223	4278	2460	308570	5363	325146	325146	
LB/AIR	1071501	1814	10715	1141213	22824	1144037	1144037	
TEMPERATURE °F	1014881	1014	10262	1042647	22832	1066179	1066179	
MOISTURE	97020	137	97665	232	97859	97859		
SO <sub>2</sub>	2473		2473		2473	2473		
PARTICULATE	21586		21586		105	105	21477	
TEMPERATURE °F	210	260	80	146.5	80	146.5	146.5	
PRESSURE	70	40	40	10	10	10	10	
APPROX TO SAT	Y	Y	Y	Y	Y	Y	Y	
AD SAT TEMP	120.5		120.5		120.5		120.5	

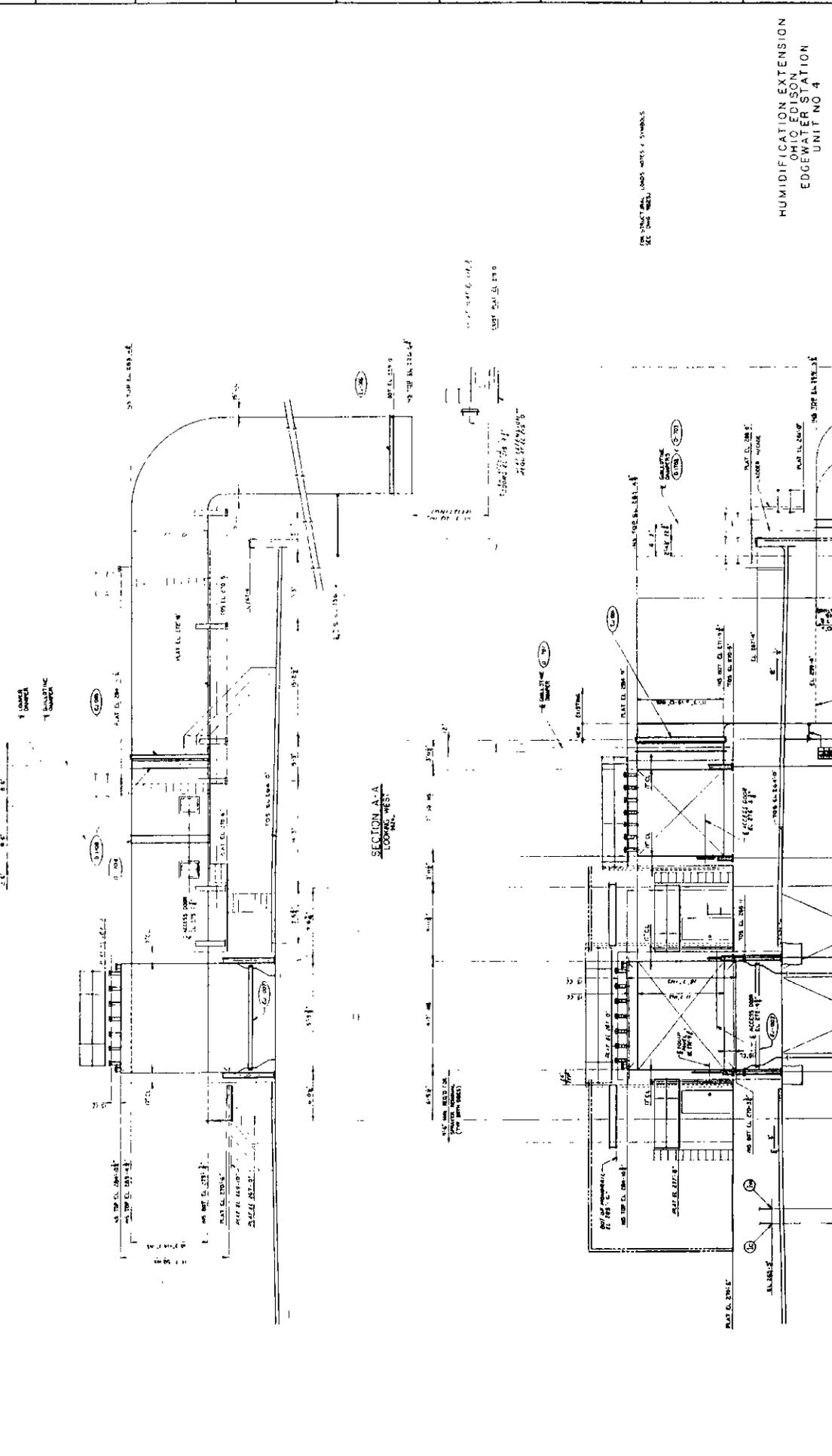
① INCLUDED IN DRY GAS  
② COMPRESSOR INLET ACFM





REVISED	DATE	BY	REASON
1	10/15/54	J.P.	INITIALS
2	11/15/54	J.P.	REVISIONS
3	12/15/54	J.P.	REVISIONS
4	1/15/55	J.P.	REVISIONS
5	2/15/55	J.P.	REVISIONS
6	3/15/55	J.P.	REVISIONS
7	4/15/55	J.P.	REVISIONS
8	5/15/55	J.P.	REVISIONS
9	6/15/55	J.P.	REVISIONS
10	7/15/55	J.P.	REVISIONS
11	8/15/55	J.P.	REVISIONS
12	9/15/55	J.P.	REVISIONS
13	10/15/55	J.P.	REVISIONS
14	11/15/55	J.P.	REVISIONS
15	12/15/55	J.P.	REVISIONS

1. LOWER DIVISION  
1. HALLWAY  
1. HALLWAY



SECTION A-A  
LOOKING WEST

SECTION B-B  
LOOKING WEST

CONCRETE WALL, CONCRETE FLOOR, CONCRETE CEILING  
SEE DRAWING

HUMIDIFICATION EXTENSION  
OHIO EDISON  
EDGEWATER STATION  
UNIT NO. 4

NO. 9825 J	DATE	BY	REVISIONS
1	10/15/54	J.P.	INITIALS
2	11/15/54	J.P.	REVISIONS
3	12/15/54	J.P.	REVISIONS
4	1/15/55	J.P.	REVISIONS
5	2/15/55	J.P.	REVISIONS
6	3/15/55	J.P.	REVISIONS
7	4/15/55	J.P.	REVISIONS
8	5/15/55	J.P.	REVISIONS
9	6/15/55	J.P.	REVISIONS
10	7/15/55	J.P.	REVISIONS
11	8/15/55	J.P.	REVISIONS
12	9/15/55	J.P.	REVISIONS
13	10/15/55	J.P.	REVISIONS
14	11/15/55	J.P.	REVISIONS
15	12/15/55	J.P.	REVISIONS

GENERAL ARRANGEMENT  
HUMIDIFICATION EXTENSION  
SECTIONS 'A-A' & 'B-B'

852-1171

9825 J

10/15/54

J.P.

INITIALS

REVISIONS

REVISIONS

REVISIONS

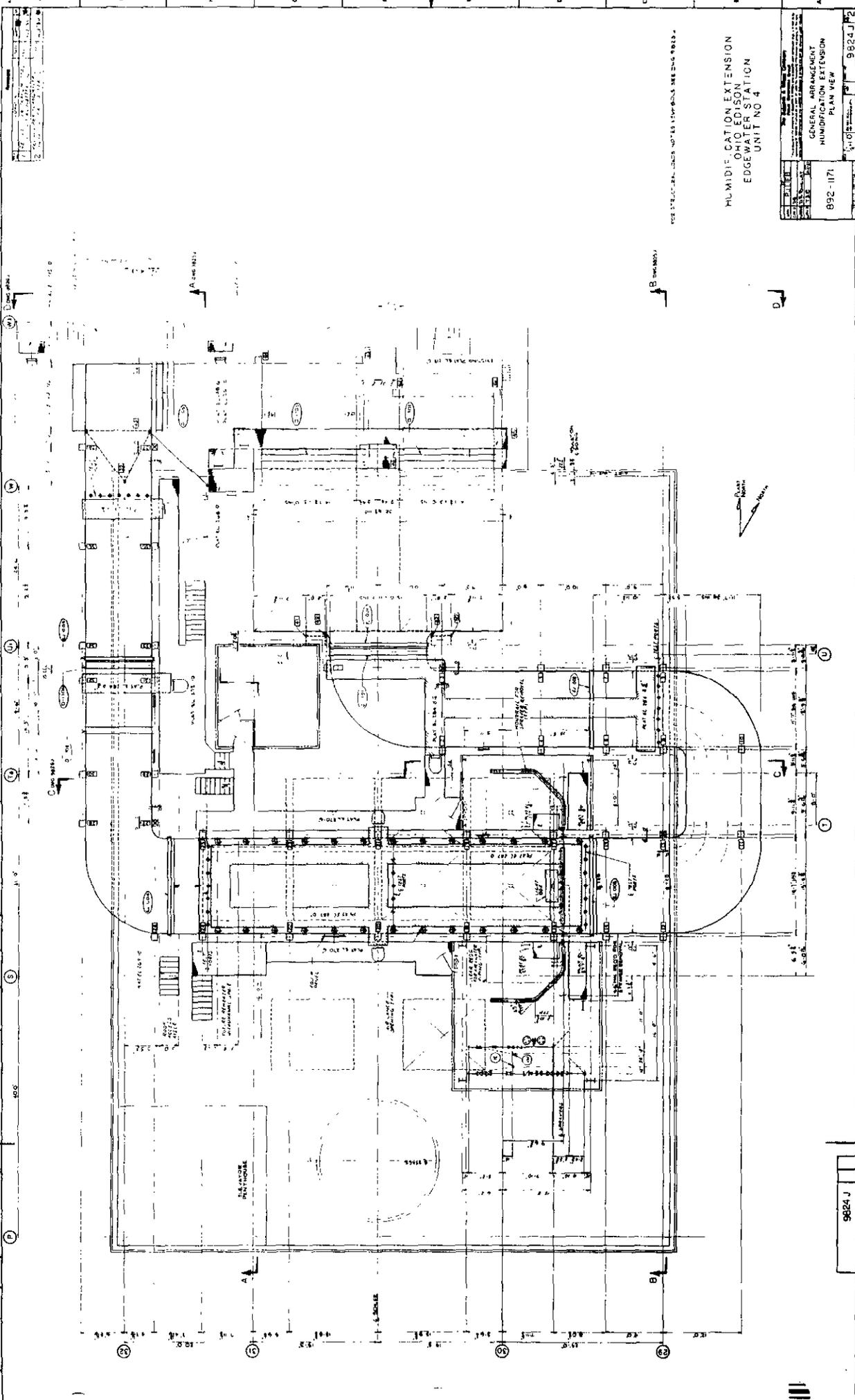
REVISIONS

REVISIONS

REVISIONS

REVISIONS

REVISIONS



SEE 1-2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000

HUMIDIFICATION EXTENSION  
 CHICAGO STATION  
 EDGEWATER STATION  
 UNIT NO. 4

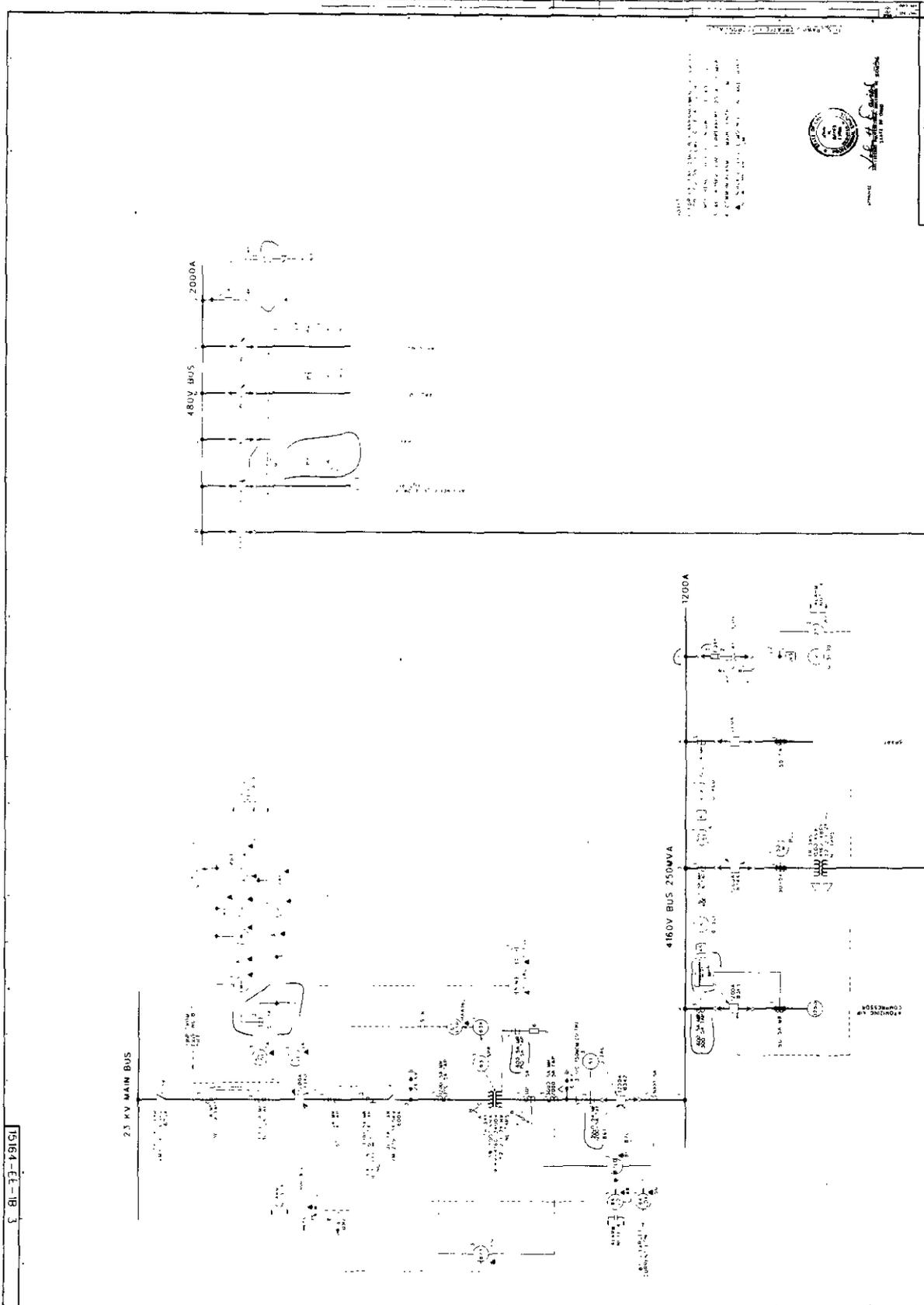
PROJECT NO.	9824 J
DATE	
DESIGNED BY	
CHECKED BY	
APPROVED BY	
GENERAL ARRANGEMENT HUMIDIFICATION EXTENSION PLAN VIEW	
892-1171	
9824 J	9824 J P2

9824 J





15164-EE-1B-3



LIMB PROJECT  
 ONE LINE DIAGRAM  
 HUMIDIFICATION SYSTEM  
 CHIL-LEVINUM EIGHT WATER STATION  
 STONE ISLAND COUNTY, PENNSYLVANIA  
 DRAWING 15164-EE-1B-3

NO.	DESCRIPTION	DATE	BY	CHECKED
1	ISSUED FOR CONSTRUCTION	10/15/14	J. J. ...	J. J. ...
2	REVISION	11/10/14	J. J. ...	J. J. ...
3	REVISION	11/10/14	J. J. ...	J. J. ...
4	REVISION	11/10/14	J. J. ...	J. J. ...
5	REVISION	11/10/14	J. J. ...	J. J. ...
6	REVISION	11/10/14	J. J. ...	J. J. ...
7	REVISION	11/10/14	J. J. ...	J. J. ...
8	REVISION	11/10/14	J. J. ...	J. J. ...
9	REVISION	11/10/14	J. J. ...	J. J. ...
10	REVISION	11/10/14	J. J. ...	J. J. ...



JAMES J. ...  
 PENNSYLVANIA  
 PROFESSIONAL ENGINEER  
 NO. ...



LIMB COOLSIDE SPECIFICATIONS

LIST AND INDEX

STONE & WEBSTER ENGINEERING CORPORATION

<u>SPECIFICATION NUMBER</u>	<u>DATE</u>	<u>DESCRIPTION</u>
15164-C-009	12-24-86	Specification for Instrument Installation
15164-C-016	11-19-87	* Specification for Control & Relay Panel 23 C/R
15164-C-017	1-29-88	Memorandum of Technical Requirements for Flyash Handling, Humidification
15164-C-018	2-19-88	Memorandum of technical requirements for North and South Enclosure Negative Pressure Protection
15164-C-019	2-19-88	Memorandum of technical requirements for Electrical Equipment Room Modulating Air Damper
15164-C-020	2-19-88	Memorandum of technical requirement for Misc. Thermostats for Humidification
15164-E-004	10-8-86	Specification for Electrical Installation
15164-E-005	6-25-87	* Specification for 24kV Power Circuit Breaker
15164-E-005	9-1-87	* Addendum 1
15164-E-006	7-7-87	* Specification for 5000 kVA, 23 k V-2400/4160 V Distribution Substation Power Transformer
15164-E-006	9-8-87	* Addendum 1
15164-E-007	7-1-87	* Specification for 5 k V Metal - Clad Switchgear
15164-E-007	9-9-87	* Addendum 1
15164-E-008	6-29-87	* Specification for 1500 k VA, 4160 - 480 V Pad-Mounted Substation Transformer

LIMB COOLSIDE SPECIFICATIONS

LIST AND INDEX

STONE & WEBSTER ENGINEERING CORPORATION

<u>SPECIFICATION NUMBER</u>	<u>DATE</u>	<u>DESCRIPTION</u>
15164-E-009	9-16-87	* Specification for 480 Volt Switchgear
15164-E-009	11-17-87	* Addendum 1
15164-E-010	9-16-87	Specification for Insulated 5000 V Power Cable
15164-E-011	12-7-87	* Specification for 480 Volt Motor Control Centers
15164-E-012	1-14-88	Specification for Insulated 600 Volt Power Cable
15164-E-013	2-9-88	Specification for 600 V Fire- Resistant Control and Instrument Cable
15164-M-001	8-20-86	Specification for Mechanical Installation
15164-M-002	2-29-88	Memorandum of Technical Requirements for Piping
15164-M-003	10-31-86	Specification for Thermal Insulation
15164-M-004	1-15-88	Specification for Valves
15164-M-009	1-4-88	Specification for Ventilation Equipment for Electrical Equipment Room and Spray Deck Enclosures
15164-M-010	11-12-87	Memorandum of Technical Requirements for Electrical Unit Heaters
15164-M-014	1-19-88	Spec. for Centrifugal Fans (Flyash Blower)
15164-M-015	1-15-88	Specification for Stainless Steel Expansion Joints
15164-M-016	1-19-88	Memorandum of technical requirements for Miscellaneous Items Humidification Ash Handling System

LIME COOLSIDE SPECIFICATIONS

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<u>SPECIFICATION NUMBER</u>	<u>DATE</u>	<u>DESCRIPTION</u>
15164-M-017	2-26-88	* Memorandum of technical requirements for XFMR Fire Protection System
15164-M-018	4-12-88	Memorandum of technical requirements for Monitoring Room AC & H&V
15164-S-003	7-16-86	Specification for Roofing and Siding
15164-S-005	6-26-87	Specification for Structural Steel Fabrication and Erection
15164-S-006	6-22-87	Specification for Structural Steel Fabrication and Erection
15164-S-007	6-14-87	Specification for Foundation Work
15164-S-008	3-23-88	Specification for Pre-Engineered Building
15164-S-009	9-30-87	* Specification for Roofing and Siding

BABCOCK & WILCOX COMPANY

<u>SPECIFICATION NUMBER</u>	<u>DATE</u>	<u>DESCRIPTION</u>
2A6-1W-1W.	11-23-87	Product Specification - General Service Piping
892-1171-B	10-31-88	* NaOH Purchase Specification
892-1171-A	11-4-88	* Specification for Removal of Ash

\* Significant Specifications included in this section.

J.O. No. 15164.09  
Spec. No. 15164-C-016

November 19, 1987  
Revision 1

Specification for  
CONTROL AND RELAY PANEL 23-C/R

Limestone Injection Multistage Burner (LIMB)  
Demonstration Project  
Ohio Edison Company's  
Edgewater Station

Babcock & Wilcox Company (Owner)

APPROVED

	<u>Signature</u>	<u>Date</u>
Preparer	<u><i>J. Stanger</i></u>	<u>11-17-87</u>
Lead Engineer	<u><i>C.R. Conroy</i></u>	<u>11/17/87</u>
Project Engineer	<u><i>J. H. David</i></u>	<u>11/19/87</u>

Stone & Webster Engineering Corporation (ENGINEER)  
Boston, Massachusetts

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Appendix A - Drawings and Diagrams

1.0 GENERAL1.1 Scope

This specification details the technical and quality assurance requirements for the complete fabrication and delivery of a control and relay panel for the LIMB Demonstration Project being conducted by Babcock and Wilcox at Ohio Edison Company's Edgewater Station, Unit No. 4.

Any omissions in this specification shall not relieve the seller of his obligation to furnish a control and relay panel that is complete and operates in a satisfactory manner as determined by the Purchaser.

1.2 Definitions

Terms used throughout this specification are defined as follows:

- |                        |  |
|------------------------|--|
| Seller                 | - The company accepting the overall responsibility for fulfilling the requirements of this specification   |
| Engineers              | - Stone & Webster Engineering Corporation (SWEC), a Massachusetts corporation, or its duly authorized agencies restricted to the performance of the particular duties entrusted to them by the Purchaser   |
| Purchaser<br>(Owner)   | - Babcock & Wilcox Company   |
| Approved               | - This word, when applied by the engineers to the Seller's drawings or documents, means that the drawings or documents are satisfactory in that the Engineers have not observed any statement or feature that appears to deviate from the requirements. The Seller shall retain the entire responsibility for complete conformance with all of the requirements.   |
| Approved<br>as Revised | - These words, when applied by the Engineers to the Seller's documents, mean that the documents are approved as defined above, except that the changes shown are necessary to be in conformance with the requirements. On the basis that the Seller shall retain the entire responsibility for compliance with all of the requirements, the Seller shall either: <ol style="list-style-type: none"> <li>a. Incorporate the changes into his document and resubmit to the Engineers, or</li> <li>b. Inform the Engineers that the changes cannot be made without prejudice to the Seller's</li> </ol> |

responsibility under warranty, and resubmit them with full explanation of the reasons thereof.

### 1.3 Furnished by the Seller

The Seller shall furnish equipment, materials and services as necessary to provide the herein specified control and relay panel. The Seller will be responsible for the integrity, proper installation, connection, and operation of the wiring internal to the control and relay panel.

The Seller's responsibilities include, but are not limited to:

- Factory fabrication and assembly of control and relay panel 23-C/R in accordance with this specification and drawings contained in Appendix A.
- Furnishing of all equipment mounted on or within this panel
- Preparation of drawings and documentation
- Internal control and relay panel wiring
- Shop testing of the control and relay panel
- Delivery of the completely assembled, wired and tested control and relay panel

### 1.4 Furnished by the Purchaser

The Purchaser will furnish equipment, materials and services as follows:

- All labor and equipment necessary for unloading, storage, and installation of the panel at the jobsite
- Channel type sills on which this panel shall be mounted
- Steel detail drawing of the panel as contained in Appendix A
- Control and relay panel outline drawing as contained in Appendix A
- Control and relay panel equipment list as contained in Appendix A
- Elementary diagram applicable to this panel
- Terminal block arrangement sketch as contained in Appendix A.

### 1.5 Project Type, Location, and Site Conditions

The equipment specified will be used for protection and control of a new transformer and related bus. This is part of Babcock & Wilcox's LIMB Demonstration Project at Ohio Edison Company's Edgewater Station, Unit No. 4 located in Lorain, Ohio. Edgewater Station is located on the shore of Lake Erie.

The site is accessible via truck and rail. Maximum and minimum design ambient temperatures are 95°F and 0°F, respectively.

## 2.0 TECHNICAL REQUIREMENTS

### 2.1 General

The control and relay panel shall be a complete assembly, ready for installation on the Purchaser's supplied sills.

The Seller shall drill and cut the panel and provide all necessary mounting details. He shall mount on and within the panel all items of equipment and devices called for in the drawings, diagrams, and material lists of this specification.

The attached equipment list shows definitive descriptions of all panel items and who they shall be furnished by. No substitutions shall be made for any items specifically described and identified without the express written consent of the Purchaser.

All equipment mounted on or within the control and relay panel shall be located as to be easily accessible. Each item of equipment, whether front or internally mounted, shall be readily removable without the removal of other items.

### 2.2 Panels and Supports

#### 2.2.1 General

The relay and control panel shall be a rugged, self-supporting structure.

The Seller is responsible for the detailed panel and framing design. This design shall follow the outline and steel detail drawings included with this specification. Alternate fabrication details may be proposed by the bidder. These alternate details shall be presented in addition to the base proposal.

All framing and reinforcing members, wiring, instruments, relays, and devices shall be located and mounted so as to prevent restricted access to other devices for the purpose of removal, calibration, or the installation of future equipment.

All adhesive labels, terminals, and terminal marking shall be visible and readily accessible.

Panel components and devices such as terminal blocks, and cable ties shall be manufactured of non-PVC material complying with the provisions of ASTM D635, burning time 0-5 seconds.

#### 2.2.2 Structure

Cold-rolled steel of not less than 1/8 in. thick (approximately 11 gauge) shall be used for panel front, sides, and other surfaces. All corners shall be smoothly rounded. The minimum radius of curvature shall be 1/32 inch.

Panels, supporting structures, and panel stiffening members shall be steel. Welded and bolted construction shall be used. No welding, bolts, or bolt holes shall show from the front of the panel.

Angle iron framework shall be used as required to provide rigid panels that are square and plumb.

Stiffening members shall be used on the back of the panel, as required, to prevent any panel distortion before or during shipment and during installation.

Steel plate, used for the front and sides, shall be welded or bolted to the panel frame and reinforcing members.

Necessary internal brackets and/or structural steel framework shall be furnished to support all instruments and devices, wireways, incoming cable, wiring, terminals, as indicated on the material list.

Particular care shall be taken to ensure that the panel is smooth, flat, and free from dents, cracks, or other imperfections; and that cutting and fabrication do not result in warping, buckling, or other distortion.

All cutouts for mounting equipment shall be made by drilling, punching, sawing, or other Purchaser approved methods. All cutout edges shall be deburred and smooth finished.

### 2.3 Internal Wiring and Terminal Blocks

#### 2.3.1 Internal Wiring

Wire for the Seller provided panel internal wiring, except as otherwise noted, shall be stranded, tinned copper switchboard wire, NEC type SIS, with 600 volt, flame resistant, crosslinked polyethylene insulation, in accordance with ICEA S-66-524, General Electric Company "Vulkene", Type S157275, or equal as approved by the Purchaser. Wire shall be capable of passing the flame test of UL 44 Section 85, displaying long-term moisture stability and excellent aging properties. Polyvinylchloride insulation shall not be used. Conductor size shall be 14 AWG unless otherwise indicated on the drawings.

External cabling will enter the panel from above and below as indicated on Engineers sketches and will consist of multiple conductor cables. All wires will connect to terminal blocks installed inside of the panel as shown in Appendix A.

Ample space shall be provided for the entrance of external cables to the panel and for routing to their designating point within the panel.

Panel internal wiring shall be accomplished in a neat and orderly manner. Any two or more wires run together shall be clamped or tied in straight lay

bundles at no more than 15 inch intervals. Ties or clamps shall be nonmetallic. Wiring shall be arranged so as to be readily accessible for inspection and maintenance, and in no case shall the wiring arrangement impede access to the panel mounted devices or spaces provided for future equipment.

The Seller shall be responsible for all control and relay panel internal wiring of panel mounted components in accordance with elementary diagrams furnished by the Engineers and control wiring diagrams furnished by the Seller.

AMP Special Products PIDG or Thomas and Betts "Sta-Kon" industrial preinsulated, grip-pressure type, ring-tongue lug connectors with copper sleeves and insulated sleeves or Engineer approved equal shall be used for all connections; including relays, switches and terminal blocks. "Equal" terminal connectors shall consist of seamless metal sleeves or brazed seams on the barrel. Soldered terminals or butted seams on terminal connectors shall not be used. The terminal conductor manufacturer's recommended crimping tool shall be used and must utilize a ratchet mechanism which requires complete closing of the tool before it can be released. The crimping tool shall not be altered in any way without the recommendation or approval of the manufacturer. Each wire shall be continuous between terminations. No intermediate splices shall be used. All spare contacts from relays are to be wired and terminated to terminal blocks.

If any panel mounted item is not available for installation prior to the scheduled shipment of the relay and control panel, wire ends shall be exactly formed to the configurations required, with terminals and identifying sleeves applied, ready for connection. The Seller shall obtain written approval from the purchaser before shipment of the relay and control panel having a shortage of equipment.

Where low level instrumentation circuits (0-1 ma dc, 0-10 V dc, etc) are required within a panel, the wiring shall be No. 18 AWG minimum, rated 300 V, 90° C, stranded, tinned copper twisted pair and shielded with XLPE insulation, and shall be capable of passing the flame test of UL 44 Section 85. Instrument wiring shall be bundled and run separate from power and control wiring within a panel.

### 2.3.2 Terminal Blocks

All terminal blocks for incoming external cables and additional terminal blocks required for internal panel wiring shall be supplied by the Seller in accordance with the equipment list.

Identification on all terminal blocks shall be the terminal block numbers and wire numbers as shown on the internal wiring diagrams provided by the Seller. All connections to panel mounted equipment shall be made on one side of the terminal blocks. No more than two wires shall terminate on any one terminal block point. When two wires terminate on one terminal, the ring tongue connectors shall be placed back-to-back. A sufficient number of spare terminal blocks shall be installed to provide a total of at least 20 percent unused terminal points for field use. Nut supplied with terminal block stud to be removed prior to installation of ring spade. No double nutting will be allowed.

### 2.3.3 Grounding

A copper ground bus of minimum  $\frac{1}{2}$  inch by 1 inch size shall be installed at the bottom and across the full width of the panel. It shall be drilled at each end for extension and shall have a Burndy Type YA-2N indent compression type lug bolted to it near each end for the Purchaser's 4/0 AWG ground cable. This ground bus shall be connected to all panel steel and to the cases of all panel instruments. All panel mounted equipment requiring a ground shall have a single wire for each circuit thus grounded, wired independently to the ground bus and fastened thereto with a terminal lug. All points which are grounded shall be tested for continuity to ground prior to further panel testing.

Ground wires shall be installed so as to be visible and accessible after all other wiring has been completed.

### 2.3.4 Nameplates and Markings

A complete list of designations for engraving will be provided by the Purchaser for Seller's use.

Each front mounted piece of equipment shall have a black-white-black lamacoid nameplate listing the Purchaser's equipment number in letters 5/32 in. high, engraved to expose the white. Nameplate shall be in accordance with Appendix A and attached by double sided adhesive tape to the panel.

All equipment within the panel shall be clearly identified by means of permanent adhesive labels.

### 2.3.5 Internal Lighting and Convenience Outlet

The relay and control panel shall be provided with a polarized, duplex grounding type convenience receptacle. This receptacle shall be energized from the Purchaser's 120 Vac, single phase, 60 Hz supply.

Convenience power wiring within the panel shall be in rigid conduit or intermediate metallic tubing. The interior of the panel shall be lighted by suitably located incandescent lighting fixture with lamp. Fixture and lamp shall be suitable for use on Purchaser's 120 Vac, single phase, 60 Hz supply. A switch shall be installed in the panel to control the lighting in this panel.

### 2.4 Welding

All welding shall be in accordance with the Seller's standard welding procedure. Welders shall be qualified in accordance with a nationally recognized standard (e.g. AWS D1.1).

All welds shall meet the following criteria:

No cracks shall be acceptable.

The sum of diameters of porosity shall not exceed 3/8 inch in any 6 square inches of weld surface, with the dimension along the centerline of the weld not exceeding 6 inches. The maximum size of any one pore shall not exceed 3/32 inch. Where the weld area is less than 6 square inches, or the length of the weld at the centerline is less than 6 inches, the acceptable sum of porosity diameters shall be scaled proportionally.

All weld craters shall be filled to the full cross-section of the weld.

Undercut which exceeds 1/32 inch or 10 percent of the thinner member, whichever is less, shall not be acceptable.

Weld reinforcement, shall be 0 inch to 1/8 inch maximum between abutting surfaces and shall have a gradual transition (30 degree maximum) to the plane of the base metal surfaces.

#### 2.5 Shop Cleaning and Painting

After completion of cutting and fabrication of the panel, and before the installation of any panel mounted components, remove all traces of grease and oil. Where residual traces remain that are not capable of being removed with solvents, steam cleaning agents shall be employed. Mill scale, rust, and foreign matter shall be removed by blast cleaning in accordance with SSPC SP6 (Steel Structures Painting Council) using Black Beauty crushed slag, or very fine silica sand, mesh size Minus 80. Corners, edges, and weld seams shall be smooth and completely free of scratches or pits. The surface shall be steam phosphatized.

Particular care shall be taken to ensure that all panel surfaces, both exterior and interior, including welded seams and exposed surfaces of supporting and stiffening members, whether or not normally visible, are properly cleaned, primed, and painted.

The exterior and interior surfaces of the duplex relay and control panel are to be painted DuPont "Dulax" Code #93-22098 Seafoam Green.

The Seller's proposal shall describe in detail the procedures and materials to be used for surface preparation and painting. Procedures shall conform to the recommendations of the manufacturers of the materials.

Primer shall be spray applied (or brush applied in areas inaccessible to spray painting) with a minimum of two coats to a dry film thickness of no less than 6.0 mils.

The exterior surface of the control and relay panel shall have the primer sanded, once it is thoroughly dry, with No. 320 and No. 400 grit sandpaper. Final coats shall be spray applied (or brush applied in areas inaccessible to spray painting) with a minimum of two coats to a dry thickness of 1.5 mils per coat. After the final finish coating is dry, any ripples or runs in the finish coats shall be made smooth by buffing with steel wool or emery cloth.

The interior surface of the control and relay panel shall have final coats spray applied (or brush applied in areas inaccessible to spray painting) with a minimum of two coats to a dry thickness of 1.5 mils per coat. The finish coat shall completely hide the primer without skips or thin spots and shall be relatively free of clusters, bubbles, pinholes, sags, runs, or other significant surface defects. An infrequent and minor run, sag, or bubble shall not be grounds for rejection.

All Seller supplied paint shall be free from one lot. The Seller shall ship one pint of finish paint with the control and relay panel.

### 3.0 QUALITY ASSURANCE

#### 3.1 Quality Assurance Program Requirements

The Seller shall have in effect at all times a QA Program to verify that all items and services, including subcontracted items and services, comply with the requirements of the specification and its attachments.

The Program shall clearly establish the authority and responsibility of those responsible for the QA Program. Persons performing quality functions shall have sufficient and well defined responsibility and authority to enforce quality requirements, to identify, initiate, recommend, and provide solutions to quality problems, and to verify the effectiveness of the solutions.

The Seller shall identify, in purchase documents to his suppliers, all applicable quality and QA requirements imposed by the Purchaser's specification on the Seller and shall ensure compliance thereto.

##### 3.1.1 Purchaser's/Seller's Quality Assurance Interface

The Purchaser shall have the right to perform inspection of the equipment and work performed under this specification. The Purchaser also reserves the right to utilize a third party Contractor to perform inspections in the Seller's facilities. The inspection may include, but are not limited to, surveys, in-progress inspections, audits, witnessing tests, document review, and final inspection.

##### 3.1.2 Preproduction Review

Prior to the start of fabrication, the Seller shall review the Purchase Order, specification, drawings, diagrams, and other contractual documents. The Seller shall demonstrate his understanding of these documents and shall provide the Purchaser with his methods of complying with those requirements.

#### 3.2 Tests

Procedures for the following examinations and tests shall be submitted to the Purchaser for review and approval prior to their use.

The tests required by this specification are as follows:

##### 3.2.1 In-Production Tests

The Seller shall be responsible for compliance with his standard in-production test procedures which progressively check the assembly and wiring systems.

##### 3.2.2 Tests after Assembly

The following tests shall be performed after the complete assembly of relay and control panel.

### 3.2.2.1 Device Check

Check the contact configuration on all auxiliary relays having reversible contacts and verify conformance with the normally open and normally closed positions shown on the relay development diagram.

Check the contact configuration on all control and instrument switches, selector switches, and pushbuttons and verify conformance with the switch contact diagrams. Verify that the contact operates in each switch position as indicated on the switch contact diagrams. Verify that all switches with spring return action return to the intended positions freely and without binding.

Check all devices to ensure complete conformance with the material list.

### 3.2.2.2. Wiring Check

Make point to point check with wiring diagrams, check for correct wire markings and terminal block markings, and verify that all connections are correct and tight. All wiring terminations shall be connected to the specific device terminals as shown on the wiring diagrams. Make an electrical continuity test on each conductor. Nonconformances shall be corrected.

### 3.2.2.3 Insulation Resistance Tests

The control and relay panel, with all equipment mounted and wired, shall have wiring and connected equipment megger tested for insulation resistance to ground. Megger tests shall be made between wires connected together at terminal blocks and the panel and framework. Special equipment mounted on the panel but not connected to terminal blocks shall not be tested. Any special static or other devices not capable of withstanding the tests specified shall not be tested. Drawout type relays and devices shall be in their operating (inserted) position during tests, and all other panel devices, except as noted above, shall be connected.

Insulation resistance test shall be made on the group of wires connected to each single terminal block. Tests shall be made with a 1,000 volt megger operated continuously for at least 60 seconds, and a steady state value of 5 megohms or more is acceptable. Wire groups testing less than 5 megohms shall be checked to determine whether the wires or the connected devices are responsible for the low reading. If the wires are responsible, the condition shall be corrected, and the group retested. If a connected device is responsible, its identification shall be noted on the test report, and the megohm test reading for the wire group alone shall be recorded. Any group tested which shows a value under 50 percent of the average value for all groups shall be checked to determine and correct the cause and then be retested.

The groups of wires tested shall be identified on the test report by terminal block numbers. Ambient temperature and relative humidity shall be recorded. Megohm readings shall be recorded at 30 seconds and 60 seconds, and any group showing decreasing insulation resistance during this interval shall be checked to determine and correct the cause of the decrease and shall be retested.

#### 3.2.2.4 Records System

A records system shall be established and maintained that provides for the identification and correlation of test records and certificates.

All test results shall be recorded with noneraseable ink. Whiting out or otherwise obliterating of the recorded results of test information or other documentation is prohibited. If an error or correction is made, a single line shall be drawn through the original entry taking care not to render it illegible. The correction shall be initialed and dated by the person making the correction.

#### 3.2.2.5 Final Inspection and Check of Records

The Seller shall be responsible for inspecting the control and relay panel and checking the applicable records, prior to shipment, to verify that all specification requirements have been complied with.

#### 3.2.2.6 Documentation by the Seller

All records and documents required to comply with this specification shall be retained in the Seller's file for a period of five years after the contract requirements of manufacture have been complied with. At the expiration of this five year period, the Purchaser shall be provided the option of receipt and/or retention of all records.

#### 4.0 SHIPPING

The Seller shall be responsible for the shipment of the control and relay panel. This includes the scheduling and hiring of the necessary rigging and trucking personnel and equipment required to transport the panel from the Seller's place of manufacture to the Edgewater Station. The truck used to transport the control and relay panel shall be specifically designed for the transportation of delicate electronic equipment, and shall be provided with "air-ride" or other suitable suspension system capable of protecting the control and relay panel from undue shock or vibration during transit.

Upon completion of the control and relay panel, after all tests have been completed, and at least three working days prior to scheduled crating and shipping, the Seller shall notify the Purchaser at the following addresses:

Babcock & Wilcox Company  
Attn. Mr. P. O. Rodemyer  
20 South Van Burren Avenue  
P.O. Box 351  
Barberton, Ohio 94203-0351

The finish of the panel shall be protected in the best practical manner against abrasion or other damage during preparation for shipment and while in transit. Sprayed on coatings are not acceptable for this purpose. Sheet plastic may be used for protection of paint and against entrance of moisture.

Relays, instruments and devices shall, where appropriate, have moving parts firmly blocked and glass or plastic doors, windows, and faces adequately padded to prevent damage during shipment.

Instrument doors and hinged covers shall be held closed with pressure sensitive tape. Subject to the approval of the Purchaser, any instruments or devices believed incapable of safely withstanding handling and shipment while panel mounted shall be removed and shipped separately, preferably in their original shipping containers.

The control and relay panel shall be suitably crated, boxed, or otherwise prepared for shipment to prevent damage during handling and shipping. The box or crate shall contain a detailed packing list. All openings shall be properly protected to prevent the entrance of dirt or debris. All parts which, of necessity due to physical size or arrangement, may be exposed to the weather shall be adequately protected by suitable waterproofing. It shall be the responsibility of the Seller to take any other precautions required to reasonably ensure jobsite arrival of the control and relay panel in an undamaged and satisfactory working condition.

The shipping crate or box shall be plainly marked on the outside with the gross weight, the Purchaser's name, shipping address, job number, purchase order number, and the name of the items enclosed.

Structural steel lifting beams or removable lifting eyes required for lifting the control and relay panel shall be supplied by the Seller. The lifting beams shall be sufficiently rigid to distribute evenly all strains which may be imposed in handling. The method of preparation for shipment, and means of off-loading and setting in place shall be approved by the Purchaser.

If necessary to prevent twisting or bending of panel and framework while uncrating, handling, and setting the panel in place, temporary braces or supports shall be provided and so located that they may be left in place until the panel is installed in its permanent position. The equipment shall be packaged for indoor storage.

5.0 SUPPLEMENTAL PROVISIONS5.1 Deviations and Nonconformances

No deviation or nonconformance from this specification or applicable federal, state, or local codes and standards invoked by this specification shall be accepted until approved by the Engineers. Deviations are considered departures from any requirement of this specification. Uncorrectable nonconformances are considered to be conditions which cannot be corrected within the specification requirements by rework or replacement.

The Seller shall promptly document and notify the Engineers of all deviations and nonconformances from the specification (such as deviations from applicable codes and/or drawings). Further manufacturing after detection of any deviation or nonconformance prior to the Engineer's approval shall be at the Seller's risk. No departure from the specification shall be binding on any party until an addendum or revision to the specification has been issued by the Engineers.

5.2 Correspondence

All correspondence from the Seller shall consist of an original plus two copies and shall contain the following subject heading:

Purchase Order No. (later)  
 J.O. No. 15164.09  
 Control and Relay Panel 23-C/R  
 LIMB Demonstration Project  
 Edgewater Station, Unit No. 4  
 Babcock & Wilcox Company

Bid documents and contractual correspondence relative to or affecting prices, terms, conditions, price adjustment, deliveries, return of materials for credit, routing of shipment, or that which changes the price or scope of an order even though also discussing engineering matters shall be addressed to:

Babcock & Wilcox Company  
 Purchasing Department  
 20 South Van Burren Avenue  
 P.O. Box 351  
 Barberton, Ohio 44203-0351

Copy to:

Mr. John H. Davies  
 Stone & Webster Engineering Corporation  
 P.O. Box 2325 245/6  
 Boston, Massachusetts 02107

Correspondence relative to inspection, expediting, technical matters, and transmittal of manufacturer's drawings, spare parts list, and operating instructions shall be addressed to:

Babcock & Wilcox Company  
 Attn: Mr. P.O. Rodemyer  
 20 South Van Burren Avenue  
 P.O. Box 351  
 Barberton, Ohio 44203-0351

with a copy to Mr. Davies of Stone & Webster.

### 5.3 Subsuppliers

Should the Seller propose to purchase from another supplier any of the equipment, material, or services specified herein, he shall, upon request, identify the subsupplier for the specific equipment, material, or services itemized by the Engineers.

To the extent that they apply, the Seller shall impose on each of the subsuppliers the complete requirements of this specification. He shall be directly responsible that the subsuppliers are completely aware of all of these requirements, and that they abide thereby.

### 5.4 Release for Material Purchase or Fabrication

Written approval to the Seller to start fabrication of the equipment covered by this specification will be provided by the Purchaser. Fabrication is to be based on drawings and procedures reviewed and approved by the Engineers as required by the specification.

### 5.5 Installation, Operating, and Maintenance Instructions

No later than one month before initial shipment, the Seller shall submit to the Engineers' Project Engineer 12 bound copies of a complete installation, operating, and maintenance manual for the equipment furnished, including instructions for individual components. All final instructions shall be certified by the manufacturer as applicable to the equipment furnished, and shall be specifically identified, such as by serial number. The Seller shall inscribe the following identification on the cover; the words OPERATION AND MAINTENANCE MANUAL, the name and location of the equipment, the name of the manufacturer, and the contract number. The manual shall include the names, addresses, and telephone numbers of other equipment suppliers, and of the local representatives. The manual shall have a table of contents and be assembled to conform to the table of contents with the tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in. The manual shall include: wiring and control diagrams with data to explain detailed operation and control of each item of equipment; description of function of each principal item of equipment; vender's instruction books for relays, meters, switches, transducers, etc., mounted on this panel; installation instructions; maintenance instructions; safety precautions, diagrams, and illustrations; test procedures; and performance data.

One additional set of instructions, certified by the manufacturer, shall be packed and sent with the equipment to the jobsite. A parts identification list shall accompany each set of instructions. This list shall include section and/or outline prints or illustrations identifying each numbered

part and location in relation to the equipment as a whole. The parts list for equipment shall indicate the source of supply and recommended spare parts.

#### 5.6 Data and Drawings

After the order is placed, the Seller shall submit all drawings in accordance with the agreed-upon schedule. The drawings submitted shall show the following:

1. All physical outlines, as required, to show the overall size and space requirements (including that for dismantling and maintenance) and the interrelationship of the various components
2. Cross sections and details, as required, to satisfy the Engineers and Purchaser that all components are in conformance with the intent of the specification and are satisfactory from the standpoint of design and physical arrangement
3. All information required by the Engineers for the design and location of all connecting Purchaser-furnished structural or electrical items such as steel supports, cables, conduit, etc.
4. Weight of the equipment and distribution of the static and other loads
5. All drawings and documentation listed in Section 2.0 Technical Requirements

As a minimum, the following data and drawings are required:

1. Panel steel detail drawings
2. Panel physical outlines, as required, to show the overall size and space requirements and the interrelationship of the various components
3. Instruction books for relays, meters, switches, transducers, etc. mounted on this panel
4. Cross sections and details, as required, to satisfy the Engineers and Purchaser that all components are in conformance with the intent of the specification and are satisfactory from the standpoint of design and physical arrangement
5. Panel internal wiring diagrams
6. Bill of Materials
7. Details of special features

The Engineers' job order number and purchase order number shall be shown on each drawing.

All drawings submitted shall be in the form of one good quality reproducible and three good, sharp, black and white, direct contact prints of the Seller's original drawing.

After review by the Engineers, one direct contact print marked APPROVED or APPROVED AS REVISED will be returned to the Seller. If marked APPROVED AS REVISED, the required changes shall be incorporated by the Seller, clearly identified, and be resubmitted to the Engineers. If the Seller elects not to incorporate the revisions, he shall inform the Engineers that the suggested revisions cannot be made without prejudice to the Seller's responsibility under warranty.

Arrangements for production scheduling and procurement of the necessary materials shall not be deferred pending approval of drawings.

The Engineers and Purchaser reserve the right to reproduce any drawing or print received from the Seller, as may be required during the design and construction of this project and the preparation of a plant manual, despite any notice prohibiting the same appearing on the drawing or print.

#### 5.7 Proposal Requirements

Deviations from any of the Engineer's requirements must be clearly defined along with the reason(s) for the proposed change(s).

#### 5.8 Schedule

The following schedule, or a revision of it, as agreed upon by the Seller and the Engineers before the purchase order is placed and included with the purchase order, shall be binding upon the Seller.

<u>Milestone</u>	<u>Date</u>
1. Bid due date	*
2. Award purchase order	*
3. Initial drawing submittal	4 Weeks ARO
4. Equipment delivery date	14 Weeks ARO

\* See Commercial Data Accompanying this proposal.

#### 5.9 Delivery

Delivery shall be made by enclosed truck.

APPENDIX A

Drawings and Diagrams

1. Panel 23 C/R Outline and Steel Details, Dwg. No. 15164-ESK-3A
2. Equipment list - Panel 23 C/R, Dwg. No. 15164-ESK-3AA, Sh 1 to 6
3. AC Elem. Diagram - LIMB 23 kV Feeder Prot.- Dwg. No. 15164-ESK-5A
4. AC Elem. Diagram - LIMB Transf. and 4.16 kV Fdr Prof.-  
Dwg. No. 15164-ESK-5B
5. DC Elem. Diagram - LIMB 23/4.16 kV Feeder Prot,  
Dwg. No. 15164-ESK-6A
6. DC Elem. Diagram - Close circuit - OCB B340, Dwg. No. 15164-ESK-6B
7. DC Elem. Diagram Trip Circuit - OCB B340, Dwg. No. 15164-ESK-6C
8. Terminal Block Arrangement - Panel 23 C/R, Dwg. No. 15164<sup>S</sup>-SK-3AC
9. Nameplate Schedule - Panel 23 C/R, Sketch 15164<sup>c</sup>-SK-3AB

NAMEPLATE SCHEDULE - PANEL 23C/R

FOR NAMEPLATE ITEM NUMBERS AND LOCATION SEE PANEL 23C/R OUTLINE AND STEEL DETAILS DWG 15164-ESK-3A

ITEM NO	NAMEPLATE SIZE	ENGRAVING LETTER HGH	ENGRAVING	
			FIRST LINE	SECOND LINE
a	1" x 4"	3/8"	FDR - LIMB	
b	3/4" x 3"	5/32"	50-51	LIMB TR 4OC
c			50-SIG	LIMB TR NEUTRAL OC
d			BKR B340	
e			86T	LIMB TR TRIP AUX
f			87T	LIMB TR DIFFERENTIAL
g			51W	LIMB TR GROUND
h			50N	LIMB TR GROUND
i			94LD	4.16 KV LEAD TRIP AUX
j			87LD	4.16 KV LEAD DIFF
k			TS-M	TEST-METERING
l			TS-86T	TEST-LIMB TR PROT CKT
m				
n			CONTROL POWER	4.16KV LEAD DIFF CKT

DATE	9/16/57	11/16/57					TITLE:	REP:
PREP.	VJZ	VJZ					NAMEPLATE SCHEDULE	
CHECK	5 CRC	4 CRC	3	2	1		- PANEL 23C/R	
APPR.							EDGEWATER UNIT 4-LIMB	SKETCH
							BABCOCK & WILCOX CO	15164-SK-3AB

Notes:

1. All equipment listed is furnished by the panel manufacturer
2. For panel layout see Dwg. No. 15164-ESK-3A
3. Panel Specification No. 15164-C-016

EQUIPMENT LIST - PANEN 23 C/R													
4.16 KV SWITCHGEAR FEEDER CONTROL & PROTECTION													
EDGEWATER UNIT 4 - LIMB													
BARCOCK & WILCOX CO.													
STONE & WEBSTER ENGINEERING CORPORATION													
		15164-ESK-3AA											
		SH. 1 CONT. ON SH. 2											
8	7	6	5	4	3	2	1	1/16-87	V/EPC	V/EPC			

**EQUIPMENT LIST**

REV	ITEM NO	INSTR OR DEV NO	QTY	PROV BY	DESCRIPTION	SERVICE	REMARKS
	1	50/51	3		G.E. Type IAC51 non-directional inverse time overcurrent relay with instantaneous trip unit. Time unit range of 2-16 amps and instantaneous unit range of 10-80 amps SI case. Model No. 12IAC51B806A	Transformer 23 kV winding phase protection	
	2	50/51G	1		G.E. Type IAC51 non-directional inverse time overcurrent relay with instantaneous trip unit. Time unit range of 0.5-4amps and instantaneous unit range of 10-80 amps SI case. Model No. 12IAC51B805A	Transformer 23 kV winding ground protection	
	3	87T	3		Westinghouse Type NU harmonic restraint differential relay with 35% sensitivity. Single phase, 60 Hz, DPST contacts, 0.2/2.0A dc indicating contactor switch. FT-31 case. Style No. 1962553	Transformer differential protection	
	4	51N	1		G.E. Type IAC51 non-directional inverse time overcurrent relay. Time unit range of 2-16 amps. SI case. Model No. 12IAC51A802A	Transformer 4.16 kV neutral protection	
	5	50N	1		G.E. Type PJC instantaneous overcurrent relay, One unit, calibration range .5-2A, drawout case, self reset, SI case. Model No. 12PJCI1A1VIA	Transformer sudden pressure relay supervision	
	6	87LD	3		Basler Electric Model BE1-87G solid state variable percentage differential relay. Single phase, sensitivity range 0.1-1.6A, N.O. contact output, instantaneous, 125 V dc power supply, current operated target, push-to-energize output, auxiliary relay with N.O. contact, semi-flush mounting, SI case. Style No. SLE-A1J-BOC1F	4.16 kV switchgear lead differential protection	

STONE & WEBSTER ENGINEERING CORPORATION

15164-ES K-3AA  
SH. 2 CONT. ON SH. 3



8	7	6	5	4	3	2	1	<i>J.P.C.</i>
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EQUIPMENT LIST

REV	ITEM NO	INSTR OR DEV NO	QTY	PROV BY	DESCRIPTION	SERVICE	REMARKS
	7	94-LD	1		Westinghouse Type AR auxiliary relay, high threshold, 70 V dc pickup, single unit, 125 V dc rating, 4 N.O. contacts with two 0.2/2.0 amp indicating contactor switches FT-11 case. Style No. 774B471A18	4.16 kv switchgear lead differential protection	Mounted inside Panel
	8	94-LDX	1		Westinghouse Type SG auxiliary relay, 125 V dc, DPDT, front connected with solid cover. Style No. 293B254A20	Relay 87LD target current control	Mounted inside Panel
2	9	86-T	1		Westinghouse Type WL auxiliary tripping relay, 10 stages, spring operated, solenoid tripped, hand reset, 125 V dc coil, 5 NO and 5 NC contacts, with modern oval handle.	Transformer fault tripping relay	Mounted inside panel
	10	63PSP	1		G.E. Type HAA auxiliary relay, single unit, 125 V dc continuous rating, front connected, molded case with glass window in cover with an external resistor of 650 ohm. Model NO. 12HAA16C2	Transformer TR 341 sudden pressure aux. relay monitoring	Mounted inside panel
	11	74-86T 74-86LD 74-340T	3		Potter Brumfield auxiliary relay, series KRPL1DG, 125 V dc coil, with No. 27E122 socket and 2 Kohm, 5w resistor.	Control power monitoring	Mounted inside panel
2	12	A	3		AC ammeter, G.E. Type AB-40, transformer rated, 5A rating, scale 0-300 amp. CT ratio 300:5 amp Cat No. 50-103 131 LSRX	Feeder amps	

8	7	6	5	4	3	2	11-16-87	1	VECA	STONE C WEBSTER ENGINEERING CORPORATION
										15164-ES K-3AA SH. 3 CONT. ON SH. 4



EQUIPMENT LIST

REV	ITEM NO	INSTR OR DEV NO	QTY	PROV BY	DESCRIPTION	SERVICE	REMARKS
2	13	W	1		AC Wattmeter, G.E. Type AB-40, 2 element, 3 phase, 3 wire, 60 Hz, transformer rated 0-6500 kW scale. CT ratio 300-5 amps, PT ratio 23 kV/115 V Cat No. 50-103-22.A	Feeder Watts	
2	14	VAR	1		AC Wattmeter, G.E. Type AB-40, 2 element 3 phase, 3 wire, 60 Hz, transformer rated, 0-3000 KVAR scale, CT ratio 300-5 amp PT ratio 23kV/115 V Cat No. 50-103 32.A	Feeder Vars	
	15	PH-Shift	1		Phase Shifting transformer, G.E. Type MC-63, voltage rating 120 V, 3 phase, 3 wire Cat No. 8600K92001	Used with Item 14	Mounted inside panel
2	16	WH	1		G.E. type DSM-63 Switchboard Watthour Meter, 3 phase 3 wire, Primary reading 300 amp, 23 kV phase-to-phase. CT ratio 60:1, PT ratio 200:1 with D-72 pulse initiator	Feeder Watthours	
2	17	C W-VAR	1		Watt-Var transducer, Scientific Columbus, Exceltronic, 2 element, 3 phase, 3 wire, $\pm 2\%$ accuracy. To have common ground watt and var outputs with a minimum range of 40-110% calibration, Nominal input 5A, 120 V. CT ratio 300-5A (60:1), PT ratio 23 kV-115 V (200:1) Rated output + 1mA into 0-10 Kohm load resistor. Self powered. Model No. XLWV31K5A4-"Modified"	Feeder Watts-Vars-SCADA input	Mounted inside panel
	18				Not used.		

STONE & WEBSTER ENGINEERING CORPORATION

15164-ESK-3AA

SH.4 CONT. ON SH. 5



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EQUIPMENT LIST

REV	ITEM NO	INSTR OR DEV NO	QTY	PROV BY	DESCRIPTION	SERVICE	REMARKS
2	19	C A	1		Current transducer, Scientific Columbus, Exceltronic, 5A full scale current, $\pm 2.25\%$ accuracy. CT ratio 300-5A (60:1) 1mA output at rated input into 0-10 Kohm load resistor. Model No. CT510A2	Feeder amps - SCADA input	Mounted inside panel
2	20	CS/B340	1		Control switch Westinghouse Type W, momentary contact type, spring return, with pull-to-lock position, modern pistol grip handle. Style No. 1645848	Bkr B340 Control	
2	21		1		Indicating light, G.E. Type ET-6 with Type T2 bulb and integrally mounted resistor rated 125 V dc, series resistor 3300 ohm with red cap. Cat No. 6105700-G43R	Bkr close position indication	
2	22		1		Indicating light, G.E. Type ET-6 with Type T2 bulb and integrally mounted resistor rated 125 V dc, series resistor 3300 ohm with green cap. Cat No. 6105700-G43G	Bkr open position Indication	
	23A		1		Indicating light G.E. Type ET-6 with Type T2 bulb and integrally mounted resistor, rated 125 V dc Series resistor 3300 ohm, with white cap	Transformer diff. circ. control power monitoring	
	23B		1		Same as item 23A	4.16 kV svgr. feeder diff. circ. control power monitoring	
	24	TS-M	1		Test switch, superior, Cat No. 891-B, surface mounting, back connected, with metal cover Cat No. 4386-BC	Feeder metering	

8	7		6		5	4	3	2	1	11-6-87	1	DRP	STONE & WEBSTER ENGINEERING CORPORATION	15164-ESK-3AA	SH. 5 CONT. ON SH. 6
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**EQUIPMENT LIST**

REV	ITEM NO	INSTR OR DEV NO	QTY	PROV BY	DESCRIPTION	SERVICE	REMARKS
	25	TS-86T	1		Test switch, Superior, Cat No. 1417-B surface mounting, back connected with metal cover Cat No. 4386-BC	Transformer differential circuit	Mounted inside panel
	26		1		Resistor, Ohmite, 150 ohm, +10 percent, ceramic, wire wound, 10 watt, with mounting lug, Cat. No. L25J150	Use with Item 6	Mounted inside panel
	27		1		Convenience outlet - 3 wire, polarized to provide 120 V ac single phase 60 Hz		Mounted inside panel
	28		1		Internal lighting fixture with On-Off control switch		Mounted inside panel
2	29		As read		Terminal block, Maraton, Series 1500, Stud connector, 12 terminal, with marking strip. Cat. No. 1512ST		Mounted inside panel
2	30		As read		<del>Terminal block, 4-point-choosing-7B Penn-Union-Type-600469</del>		<del>Mounted inside panel</del>
2	31		2		Fused disconnect switch, 2 pole, 30 A rating, 125 V dc operating voltage, with two 20A fuses.		Mounted inside panel

STONE & WEBSTER ENGINEERING CORPORATION

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15164-ESK-3AA

SH. 6 CONT. ON SH.

Final

J.O. No. 15164.09  
Spec. No. 15164-E-005

Bid Specification 1.10  
1.11

Specification for 1.14

23 KV POWER CIRCUIT BREAKER 1.16

Limestone Injection Multistage Burner (LIMB) 1.18  
Demonstration Project 1.19  
Ohio Edison Company's 1.20  
Edgewater Station 1.21

Babcock & Wilcox Company (Owner) 1.23

APPROVED 1.26

Signature Date 1.28

Preparer	<u><i>C. J. Allington</i></u>	<u>6/18/87</u>	1.30
Lead Engineer	<u><i>E. O. Thwait</i></u>	<u>6/16/87</u>	1.31
Project Engr.	<u><i>J. H. Daniel</i></u>	<u>6/25/87</u>	1.32

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Boston, Massachusetts

J.O. No. 15164.09  
Spec. No. 15164-E-005

Bid Specification 1.10  
1.11

Addendum 1 9/1/87

Specification for 1.14

23 kV POWER CIRCUIT BREAKER 1.16

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Demonstration Project 1.19  
Ohio Edison Company's 1.20  
Edgewater Station 1.21

Babcock & Wilcox Company (Owner) 1.23

1.0 SCOPE

This Addendum No. 1 summarizes all changes to the specification to date.

2.0 CHANGES

<u>ITEM</u>	<u>CHANGES TO SPECIFICATION</u>	
1	Delete: Page 1 of 12 (Specification Details) Add: Page 1 of 12 (Specification Details) attached	

APPROVED 1.26

	<u>Signature</u>	<u>Date</u>	
Preparer	<i>M.C. Vachek</i>	<i>Sept 1, 1987</i>	1.30
Lead Engineer	<i>D.V. Dubetta</i>	<i>9/13/87</i>	1.31
Project Engr.	<i>J.H. Davis</i>	<i>9-8-87</i>	1.32

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Stone & Webster Engineering Corporation (Engineer)  
Boston, Massachusetts

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1.0	<u>GENERAL</u>	1.8
1.1	<u>Scope</u>	1.11
	This specification details the performance, design and manufacturing requirements for furnishing and delivering a 23 kV power circuit breaker for the LIMB Demonstration Project being conducted by Babcock and Wilcox at Ohio Edison Company's Edgewater Station, Unit No. 4.	1.12 1.13 1.14 1.16
1.2	<u>Definitions</u>	1.17
	Terms used throughout this specification are defined as follows:	1.18
	Seller - The company accepting the overall responsibility for fulfilling the requirements of this specification	1.20
	Engineers - Stone & Webster Engineering Corporation (SWEC), a Massachusetts corporation, or its duly authorized agencies restricted to the performance of the particular duties entrusted to them by the Purchaser	1.21 1.22 1.23
	Purchaser - Babcock & Wilcox Company	1.26
	(Owner)	1.27
	Approved - This word, when applied by the Engineers to the Seller's drawings or documents, means that the drawings or documents are satisfactory in that the Engineers have not observed any statement or feature that appears to deviate from the requirements. The Seller shall retain the entire responsibility for complete conformance with all of the requirements.	1.33 1.34 1.36 1.38
	Approved - These words, when applied by the Engineers to the Seller's documents, mean that the documents are approved as defined above, except that the changes shown are necessary to be in conformance with the requirements. On the basis that the Seller shall retain the entire responsibility for compliance with all of the requirements, the Seller shall either:	1.41 1.42 1.44 1.46 1.47
	as Revised	
	a. Incorporate the changes into his document and resubmit to the Engineers, or	1.50
	b. Inform the Engineers that the changes cannot be made without prejudice to the Seller's responsibility under warranty, and resubmit them with full explanation of the reasons therefor.	1.51 1.52
1.3	<u>Furnished by Seller</u>	1.54
	The Seller shall furnish equipment, material and services as follows:	1.55

<u>Item</u>	<u>Quantity</u>	<u>Description</u>	
			1.59
1	1	23 kV power circuit breaker in accordance with the attached specification and documentation	2.2 2.3 2.4
2		Drawings and documentation	2.6
3		Installation instructions	2.8
4		Operation and maintenance manual	2.10 2.11
1.4		<u>Furnished by Purchaser</u>	2.15
		The Purchaser shall furnish:	2.17
		1. Handling, unloading and installation	2.20
		2. External control wiring.	2.21
			2.22
1.5		<u>Project Type, Location, and Site Conditions</u>	2.25
		The equipment specified will be used in an existing 23 kV switchyard for power supply to other electrical loads. This is part of Babcock & Wilcox's LIMB Demonstration Project at Ohio Edison Company's Edgewater Station, Unit No. 4 located in Lorain, Ohio. Edgewater Station is located on the shore of Lake Erie.	2.27 2.29 2.31
		The site is accessible via truck and rail. Maximum and minimum design ambient temperatures are 95°F and 0°F, respectively.	2.33

2.0 TECHNICAL REQUIREMENTS

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Substation(s)  
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BT-6 23 KV THROUGH 138 KV POWER CIRCUIT BREAKER SPECIFICATION

2-1 Scope  
2-2 Dielectric and Live Part Clearance Requirements  
2-3 Bushing and Insulator Requirements  
2-4 Construction and Accessories  
2-5 Operating Mechanism  
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2-14 Tests  
2-15 Preliminary Data and Drawings  
2-16 Final Drawings  
2-17 Inspection

DRWG. NO. 0-GN-ED-116A SH. 5 POWER CIRCUIT BREAKER CONTROL SCHEMATIC

OE-LRS-20 SPECIFICATION FOR INSULATING OIL

DRWG. NO. T21699-0386-A Sh. 1 SUPERIOR TECHNOLOGY INC. 26 POLE

CIRCUIT BREAKER TEST SWITCH

J.O. No. 15164.09  
Specification No. 15164-E-005

SPECIFICATION DETAILS  
(Symmetrical Current Rating ANSI C37.06)

RATING

Nominal Voltage: 23 kV Rated Current: 1200A  
Maximum Voltage: 25.8 kV  
Maximum Symmetrical Interrupting Capability 20000 A

OPERATING MECHANISM

Control Voltage 125 volts DC, self-contained rectifier required when control voltage specified is AC.  
Trip Voltage 125 volts DC Heater Voltage 120 volts AC

BUSHING TYPE CURRENT TRANSFORMERS

<u>Bushing Location</u>	<u>No. Per Bushing</u>	<u>Ratio (5 tap)</u>	<u>Minimum Accuracy Class</u>	<u>Application</u>
1-3-5	2	1200:5A MR	C400	Relaying
2-4-6	2	1200:5A MR	C400	Relaying

BUSHING LINEAR COUPLERS None

<u>Bushing locations</u>	<u>No. Per Bushings</u>	<u>Ratio</u>

EXPECTATIONS AND SPECIAL REQUIREMENTS

None

STATIONS(S) NO. UNITS

Edgewater 1

The following attachments are part of this specification:

Control schematic O-GN-ED-116A Sh. 5 Revision C  
Specification for insulating oil OE-LRS-20 Revised 4-85  
Superior Technology Inc., 26 Pole Circuit  
Breaker Test Switch-T-21C99-F Dwg. #T21699-0386-A

OHIO EDISON COMPANY  
SPECIFICATION FOR  
POWER CIRCUIT BREAKERS  
23 kV THROUGH 138 kV

Spec. # BT-6

2-1 SCOPE

o Circuit breakers covered by this specification shall be three pole, outdoor and may be either oil insulated or SF<sub>6</sub> insulated and may be a dead-tank or live-tank design. Vacuum interrupters are not acceptable. Circuit breakers shall be in accordance with the latest ANSI Standard C-37 insofar as is consistent with this specification. The required ratings appear on page 1.

2-2 DIELECTRIC AND LIVE PART CLEARANCE REQUIREMENTS

o Breakers shall be capable of withstanding all dielectric requirements indicated by ANSI Standard C-37.06-1979, Table 6.

o Breakers shall be designed so that the following vertical clearances between bottom of breaker frame and unguarded live parts are maintained:

Nominal System Voltage	-	<u>138 kV</u>	<u>69 kV</u>	<u>34.5 kV</u>	<u>23 kV</u>
Vertical Live Part Clearance		146 in.	126 in.	120 in.	114 in.

o Oilless circuit breakers containing one atmosphere (0 psig) of gas in the interrupter chamber shall be able to withstand a 60 HZ voltage of 1.5 P.U. L-G across the open contacts.

2-3 BUSHING AND INSULATOR REQUIREMENTS

o Bushing electrical characteristics for oil circuit breakers shall be in accordance with IEEE Std. 24-1984, Table 1. These characteristics along with the bushing strike requirements are tabulated below. These characteristics shall also apply to the bushings of dead-tank oilless breakers and the insulators of live-tank oilless breakers. Bushings shall not be gapped.

Nominal System Voltage	<u>138 kV</u>	<u>69 kV</u>	<u>34.5 kV</u>	<u>23 kV</u>
Low Frequency (Dry 1 min.) rms	310 kV	160	80	60
Low Frequency (Wet 10 sec.) rms	275 kV	140	75	50
Impulse FW Withstand	650 kV	350 kV	200 kV	150 kV
Minimum Creep	92 in.	48 in.	26 in.	17 in.
Minimum Strike	41 in.	24 in.	13 in.	13 in.

2-3 BUSHING AND INSULATOR REQUIREMENTS (Cont'd)

- ° Oil filled bushings shall have a power factor test tap which shall be suitable for power factor testing without disconnecting the bushing from the line lead. Isolated flange design is not acceptable. The power factor of the bushing shall be indicated on the nameplate.
- ° Oil circuit breaker bushings manufactured by General Electric, McGraw Edison or Westinghouse are acceptable. Bulk type bushings are not acceptable.
- ° Copper terminals are to be supplied by the manufacturer and shall be threaded stud type. Threaded studs shall have 12 UNF-2A threads and shall be of 1-1/2" diameter through 1600 ampere rating and of 2" or larger diameter above 1600 amperes.
- ° Terminal connectors will be supplied by the purchaser.

2-4 CONSTRUCTION AND ACCESSORIES

- ° In oil breakers having a rated interrupting capacity of 10,000 amperes or more at the operating voltage specified, the surfaces of moving or stationary arcing contacts which are exposed directly to the arc shall be faced with suitable arc resisting material (Elkonite or equivalent).
- ° 138 kV circuit breakers shall maintain a minimum live part spacing between phases of 53 inches, 69 kV circuit breakers shall maintain a minimum live part spacing between phases of 27 inches, 34.5 kV circuit breakers shall maintain a minimum live part spacing between phases of 18 inches, and 23 kV circuit breakers shall maintain a minimum live part spacing between phases of 15 inches.
- ° Oil circuit breakers shall be equipped with an oil level sight gauge on each tank.
- ° Two ground pads shall be provided, mounted on diagonally opposite corners of the breaker. They shall be in accordance with ANSI Standard C-57.12.10-1977, paragraph 9.2.8 and C37.12-1981, paragraph 8.1.11.
- ° One maintenance closing type operating device or handle shall be supplied with each circuit breaker.
- ° For purposes of inspection and adjustment, means shall be provided to permit local operation of the circuit breaker. The mechanism and maintenance operating means, for all circuit breaker types, shall be so designed that a person can slowly operate the contacts so that the breaker may be adjusted when it is not in service.
- ° Each circuit breaker shall be supplied with a safety device that will provide a positive means of locking the operating mechanism to prevent any movement of the contacts during inspection and maintenance.

2-4 CONSTRUCTION AND ACCESSORIES (Cont'd)

° Provision shall be made for the use of a Cincinnati Clock and Instrument Co. Circuit Breaker Operation Analyzer to measure the breaker travel-time characteristics. Three tank breakers shall have provision for connection to the moving contact lift rod or cross head on each pole. Single tank breakers shall have provision for direct connection to the moving contact lift rod or cross head on at least one of the three poles. Any alternative connection must be specifically approved by Ohio Edison Co.

° One set of special or unique tools required for maintenance of each breaker shall be supplied for each substation shown on page 1 for which breakers are supplied.

° Breakers shall be provided with a removable plate in the bottom of the mechanism housing for conduit entrances (to be drilled by purchaser). This plate shall have an area of no less than 144 square inches.

° SF<sub>6</sub> circuit breakers rated 138 kV shall be equipped with a temperature compensated SF<sub>6</sub> pressure switch manufactured by the Solon Company monitoring each tank or interrupter chamber. All pressure switches shall have an isolation valve and a vent valve in the supply line from the interrupter in order to permit testing of the pressure switch set points without removing gas from the interrupter. The pressure switch shall have three set points each having electrically separate normally open contact outputs. The function of each set point shall be: 1) Low pressure alarm, 2) Low pressure to initiate breaker trip and reclose block, 3) Loss of Dielectric alarm.

Oilless breakers rated 69 kV and below shall have one pressure switch with two set points each having electrically separate normally open contact outputs. The function of each set point shall be for: 1) Low pressure alarm, 2) Low pressure to initiate breaker trip and reclose block.

The pressure switch set points shall be indicated on the appropriate drawings included in the instruction book and specified on a nameplate attached to the breaker control cabinet.

° Breakers shall be equipped with an externally visible breaker position indicator.

° Floor mounted breakers with rails shall be supplied with steel hold down clips for anchor bolts. Drilled holes in the frame base for anchor bolts are preferred for frame mounted breakers.

° Oil circuit breakers shall be provided with valves for drainage and for filter press connections. A globe type drain valve suitably located for complete drainage shall be provided and mounted so there is no static head of oil against the valve stem with suitable provision for filter press connection and complete with pipe plug. The size of the drain valve shall be 1 inch SPS for frame mounted breakers and 2 inches SPS for floor mounted breakers.

2-4 CONSTRUCTION AND ACCESSORIES (Cont'd)

° Oil circuit breakers shall incorporate an Ohio Brass #5700 sampling device, or Owner approved equal, on the discharge side of the drain valve.

° SPS rigid steel conduit (zinc coated), electrical metallic tubing (zinc coated), or rigid aluminum conduit shall be used for all wiring that is external to the circuit breaker tank. The conduit and fittings shall be in accordance with the latest ANSI Standards C80.1-1983, C80.3-1983, and C80.5-1983. Neither plastic conduit and fittings nor exposed cable are acceptable.

° All circuit breakers shall operate at full interrupting capability to a temperature of  $-30^{\circ}\text{C}$ .

4-18 All exterior housing doors shall latch closed in a weathertight position. Hinged doors are preferred with latches to hold in a fixed open position. The exterior housing doors should be capable of opening  $180^{\circ}$ .

2-5 OPERATING MECHANISM

° The mechanism shall be mechanically and electrically or hydraulically/pneumatically and electrically trip free with unrestrained opening under all conditions. The mechanism and the breaker shall meet the Required Closing-Latching-Carrying-Interrupting Capabilities as specified in ANSI Standard C37.04-1979 paragraph 5.10.2.4.

° The mechanism shall be capable of the above operation for a range of control voltages as specified in Table 10 of ANSI Standard C37.06-1979.

° Breakers covered by this specification shall be capable of an instantaneous reclose operation of no less than 17 cycles. If a timer is provided to adjust the reclose time it shall be adjustable over a range such that the reclose operation may be varied from 17 to 20 cycles.

° The mechanism shall be equipped with an externally mounted, manual pull-to-trip lever which trips the breaker and prevents reclosing by means of a lockout contact in the close circuit. For designs using a push-to-trip lever, a protective cover/shield shall be provided to prevent inadvertant operation. Mechanically trip free mechanisms shall be equipped with a latch checking switch.

° The breaker shall be provided with an operations counter that will register a full step each time the breaker is tripped, with no dial movement when the breaker is closed.

2-5 OPERATING MECHANISM (Cont'd)

° The circuit breaker control scheme shall be in accordance with ANSI Standard C37.11-1979, scheme 3 in figure 5, scheme 4 in figure 6, scheme 2 in figure 7 or scheme 3 in figure 8 as applicable except as modified by Ohio Edison drawing O-GN-ED-116A which has been attached to this specification.

° The "Y" coil in the "X-Y" anti-pump control scheme shall be rated for continuous operation.

° Dual trip coils are required on all 138 kV breakers. Each coil shall be provided with a control circuit and protective device electrically independent from the other as indicated on the attached drawing O-GN-ED-116A.

° Any breaker utilizing a hydraulic or pneumatic operating mechanism to both open and close the breaker shall be equipped with a minimum of one pressure switch with two adjustable and electrically separate output contacts for the purpose of alarming and tripping for low operating pressure. The pressure switch set points should be indicated on the mechanism nameplate.

° All breakers that utilize a hydraulic or pneumatic mechanism shall incorporate a means to block closing in the event of low mechanism pressure.

° Breakers shall be equipped with a rotary type auxiliary switch that will provide a minimum of 5 unused "a" contacts and 5 unused "b" contacts. The auxiliary switches and mechanism control connections to external circuits shall be wired to Marathon Series 1500 STRC stud type terminal blocks.

° When motors are used to restore stored energy, an undervoltage relay shall be provided on the motor circuit for alarm. The undervoltage relay shall be provided with an "a" contact capable of making and carrying currents of 30 amperes momentarily and carrying 6 amperes continuously.

° Mechanism heaters shall be provided suitable for operation at the voltage indicated on page 1.

° The minimum number of stored close-open operations which the breaker shall be capable of providing is 4.

° All control circuits shall be protected by thermal-magnetic breakers with a mechanical anti-shock feature unless manufacturer takes written exception. The continuous current rating of the protective breaker for the trip circuit shall be between 150 and 200% of the required trip circuit current.

2-6 CURRENT TRANSFORMERS

- ° Current transformers supplied with circuit breakers shall be in accordance with ANSI/IEEE Standard C57.13-1978 and the Draft (ANSI C57.xxx-198x) P670/D4, 9/16/80-Requirements for Current Transformers for use with A.C. High-Voltage Circuit Breakers. The current transformer's quantity, ratios and accuracy class ratings are indicated on page 1 of this specification. A separate lead shall be brought out from each CT tap to a single terminal block for each CT in the mechanism housing or CT tank terminal box. This terminal block shall be a Marathon Series 1500 STRC stud type or Owner approved equal.
- ° In those breaker designs that cannot accommodate bushing type CT's, the breaker manufacturer shall supply free standing CT's and CT stands with the breaker.
- ° Approved Free Standing Current Transformers 138 kV and Below - Free Standing Current Transformers 138 kV and below manufactured by Trench Electric, Electromagnetic Industries (Division of Square D), General Electric And Westinghouse are acceptable. European manufacturers of free standing CT's are not acceptable.
- ° CT tank terminals shall be in accordance with paragraph 3-4. Each free standing CT shall be equipped with a power factor test tap and have provisions for mounting a bushing potential device.

2-7 CURRENT TRANSFORMER SWITCHES

Circuit breaker control cabinets shall contain one Superior Technology, Inc. switchboard test switch Cat. No. T-21699-F. The switch shall be 26 pole, front connected, with contact arrangement from left to right as viewed from the front of the block, to be 16-19-19-2-16-19-19-2-16-2-16-2-16-2-16-2-16-2-2-16-2-16-2-16. Note that the last six poles on the switch base are reversed (reference attached drawing number T-21699-0386-A). The switch shall be complete with metal cover Cat. No. 8047-2. All wiring connections to test switch will be made by Ohio Edison Co.

2-8 LINEAR COUPLERS

- ° When indicated on page 1 of this specification, the circuit breaker shall be supplied with linear couplers. These LC's shall be designed to provide an open circuit, secondary induced voltage of 5 volts per 1000 amperes primary current. The impedance of each linear coupler shall not exceed 8 ohms.
- ° The secondary leads from the linear couplers (LC) to their terminal block in the mechanism housing shall be equivalent to No. 12 copper. The leads from each linear coupler shall be twisted together a minimum of 2 or 3 twists per foot. Shorting or grounding facilities for the LC's shall not be provided. The LC's shall be connected to a Marathon Series 1500 STRC stud type terminal block with a nameplate to read "Linear Coupler - Do Not Short or Ground - See Instruction Book" in place of a terminal block cover.

° The linear coupler nameplates shall list the shop order number, specification number and resistance and reactance values, and be mounted adjacent to the LC terminal block.

2-9 INTERNAL CONTROL WIRING

All internal auxiliary wiring shall be Type SIS and shall be No. 14 AWG copper or larger with compression type terminals. All internal control wire connections shall utilize compression type, Burndy "YAV" ring-tongue terminal connectors or Owner approved equal. Terminal connectors shall be installed using a ratchet type crimping tool, Burndy "MR-8" or approved equal. Push-on type connectors are not acceptable.

2-10 TERMINAL BLOCKS

All terminal blocks requiring user's connection shall be Marathon Series 1500STBC stud type or Ohio Edison approved equal. The manufacturer and catalog no. of the terminal blocks shall be shown on the appropriate wiring diagram.

2-11 PAINT

° Color - The tank shall be prime-painted, and finish painted with ANSI #49, Horizon Gray. All components shall be painted with the type and manufacturer of primer and finish coatings specified below.

° Paint Manufacturer and Type - The paints utilized for this breaker shall be Subox Standard Series rust inhibitive primer and finish coatings containing lead-suboxide pigments, or as an alternative, Subox Permanox rust inhibitive primer and finish coatings containing lead-free alkaline earth pigments as follows:

Primer - Subox #11 FD Red Primer (Preferred)  
- Subox Permanox 753 Red Primer (Alternate)

Finish Coat - Subox #10 FD Horizon Gray (Preferred)  
- Subox Permanox #7138 Horizon Gray (Alternate)

° Application - Surfaces to be painted shall be shotblasted or adequately cleaned to remove all mill scale, dirt, oil, and grease. Each coat of paint shall be applied to yield a dry film thickness of 1.5 - 2.5 mils for both the primer and the finish coat, such that the total paint thickness shall be 3.0 - 5.0 mils dry film thickness.

2-12 DIELECTRIC FLUIDS

- ° All necessary dielectric fluids required for placing circuit breakers in service shall be supplied by the manufacturer.
- ° Insulating oil supplied (as an integral part or separately) for the equipment covered by this specification shall be in accordance with Ohio Edison Specification OE-LRS-20, Revised 4/85, "Insulating Oil".
- ° Any SF<sub>6</sub> supplied, either with the breaker or in separate bottles, shall meet the requirements of ASTM standard D2472-81.

2-13 SHIPPING REQUIREMENTS

- ° The manufacturer shall notify the Purchaser's Agent of the breaker ship date. The Agent shall be notified of the ship date a minimum of 48 hours before the breaker is released from the manufacturer's factory.
- ° All circuit breakers shall contain desiccant during shipment unless the breaker is shipped filled with dielectric fluid. In addition, any oil breaker shipped with desiccant shall have an external sign indicating the presence of desiccant and giving instructions to remove all desiccant before filling the breaker with oil.
- ° Any circuit breaker shipped filled with a dielectric fluid shall have an external sign stating the type of dielectric fluid in the breaker.

2-14 TESTS

- ° Design Tests - Tests shall be conducted on each design of circuit breaker and on each significant design change in accordance with ANSI C37.09-1979, Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
- ° Production Tests - All applicable production tests included in ANSI C37.09-1979 shall be made on each circuit breaker.
- ° Test Reports - Six (6) copies of a report of the Production Tests are to be supplied. This report should contain sufficient data to prove compliance with this specification. In addition, the test report shall include Timing Test results according to ANSI C37.09-5.12 and the Bushing Power Factors according to ANSI 76.1-7.4.1.

2-15 PRELIMINARY DATA AND DRAWINGS

The manufacturer shall furnish for approval, three (3) prints and one (1) full sized mylar of the following data and drawings suitable for construction purposes to the Owner.

## a) Outline drawing of circuit breaker showing:

- 1) Base detail illustrating bearing areas.
- 2) Overall width, length, height and tabulation of weights.
- 3) Shipping width, length, height and weight.
- 4) Center lines of gravity in each direction of complete unit. Oil circuit breakers shall show center lines of gravity with and without oil.
- 5) Height required to remove bushings.
- 6) Indication of conduit material type in accordance with Paragraph 4-16.
- 7) Indication that the breaker color is ANSI #49 Horizon Gray.
- 8) Rating of Breakers.
- 9) Location of conduit entrance plate in the mechanism housing in accordance with Paragraph 4-10.
- 10) Location and type of drain valve and sampling device in accordance with paragraphs 4-14 and 4-15.
- 11) Indication that a tank lifter is supplied (Where applicable).
- 12) Indication that the breaker has provisions for the connection of a Cincinnati Clock and Instrument Company Circuit Breaker Operation Analyzer in accordance with Paragraph 4-8.
- 13) Indication that ground pads are provided in accordance with Paragraph 4-4.
- 14) Indication of future equipment such as BPD's shown with dotted lines.
- 15) Value of breaker uplift forces.
- 16) Complete free standing CT outline for those designs requiring free standing CT's.

## b) Outline drawing of bushings showing:

- 1) Manufacturer of bushing.
- 2) Details of breaker terminals in accordance with Paragraph 3-4.
- 3) Indication of strike distance and creep in accordance with Paragraph 3-1.
- 4) Indication that bushing color is ANSI #70 Light Gray.
- 5) Location and detail of power factor test tap in accordance with Paragraph 3-2 if oil bushings are used.
- 6) All bushing dimensional data.

## c) Schematic and detail wiring diagrams for control and accessories showing:

- 1) Tabulation of closing and tripping currents.

- 2) Indication of the rating and type of protective breakers used in the control circuits and heater and motor circuits in accordance with Paragraph 5-15.
  - 3) Indication of catalog numbers and manufacturer of all terminal blocks in accordance with Paragraph 10-0.
  - 4) Indication that the "Y" coil in the "X-Y" anti-pump control scheme shall be rated for continuous operation.
  - 5) Indication of exact location and connections of CT's, CT terminal blocks, LC's and BPD's
  - 6) Wattage of space heaters
- d) Applicable current transformer application data in accordance with ANSI Standard C57.13-1978 showing:
- 1) Connection diagrams where applicable
  - 2) Ratio correction factor curves
  - 3) Excitation curves
  - 4) Ratios available
- e) Linear coupler data (When LC's are required on Page 1)

2-16 FINAL DRAWINGS

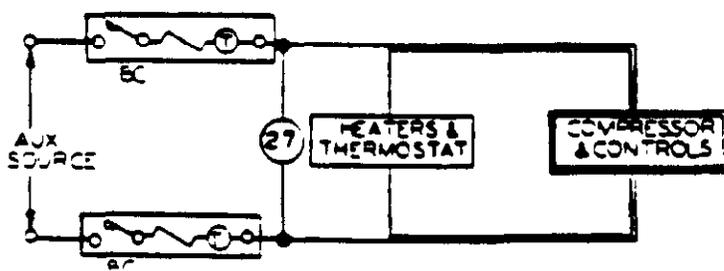
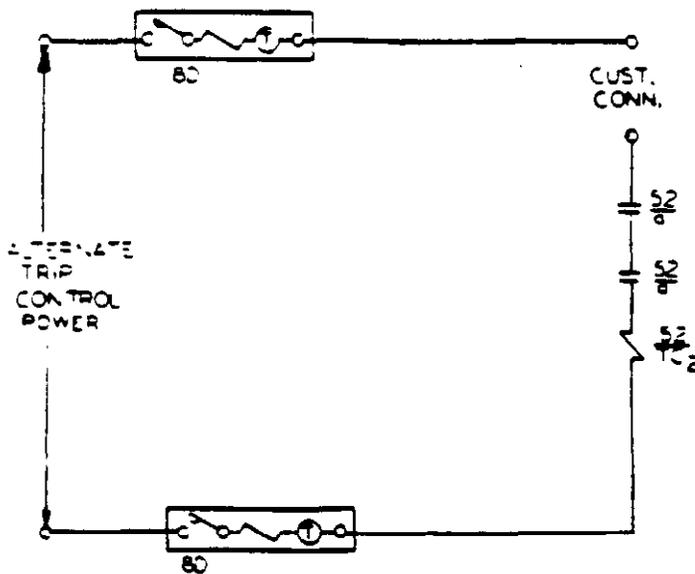
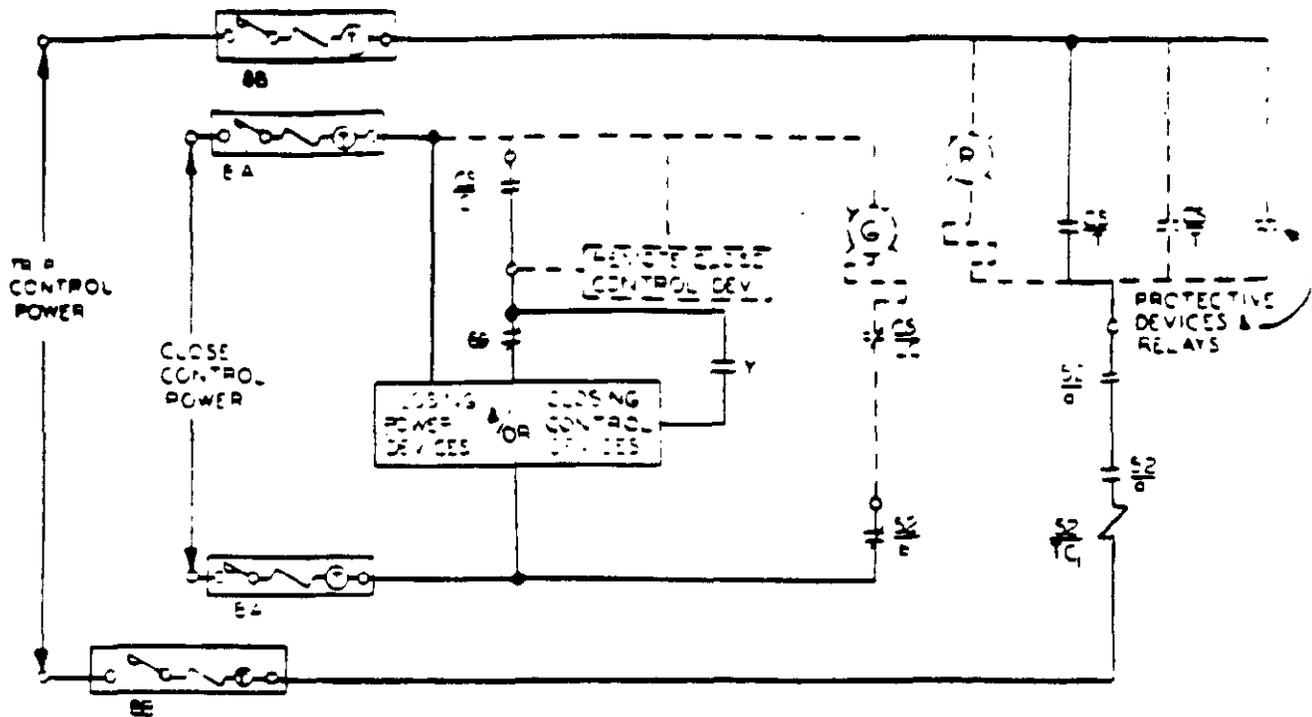
The following shall be supplied for each circuit breaker:

- a) Six (6) instruction books which include a listing of recommended spare parts to be maintained as spares by the purchaser.
- b) Six (6) sets of drawings to adequately facilitate any necessary field assembly.
- c) Six (6) copies of test data.
- d) Six (6) copies of assembly drawings and typical travel recorder chart with test points for this breaker including secondary arcing contact test points.
- e) Six (6) copies of linear coupler instruction books, wiring diagrams, nameplate drawings, and characteristics. This data shall be complete with impedance test values of resistance and reactance. Actual test data on linear couplers must be in the hands of the purchaser before the breaker is shipped.
- f) Six (6) copies of certified test reports on all metering CT's with curves showing Ratio Correction Factor versus Phase Angle.

All documentation to be in English.

- ° In addition, a copy of each drawing shall be furnished on 35 mm standard aperture cards having a film quality that complies with military specification MIL-M-9868D (2) dated September 20, 1982.

The equipment shall be subject to inspection by the Purchaser or Designated Representative during manufacture. The manufacturer shall give advance notice of any inspection points requested by the Purchaser.



LEGEND

8A, 8B, 8C, 8D - WHEE TYPE EB  
250V, 2POLE  
BREAKER OR EQUAL

69 - PERMISSIVE CONTROL DEVICE

27 - UNDERVOLTAGE RELAY

———— SUPPLIED BY MFG.

- - - - SUPPLIED BY OHIO EDISON

———— PNEUMATIC BREAKER ONLY

CIRG 11-6-85	REV'D. DC & AC SCH AND LEGEND	868
BGB 4-10-69	REMVD. CS-T CONT. IN ALTER. CKT.	
AJO 2-14-68	ADDED NOTE TO ITEM 69	

D. GEN OFF      DEPT. GEN ENG

S.                      W.                      OHIO EDISON CO.

DE JO              CH. *SGB* 11/26/67              APPROV. DATE

CONTROL SCHEMATIC  
POWER CIRCUIT BREAKER

Specification No. OE-LRS-20  
Page 1 of 1

SPECIFICATION FOR INSULATING OIL

SCOPE

This specification covers insulating oil purchased with or as part of new equipment as well as oil purchased separately in drums or tank cars for use in all power transformers, distribution transformers, oil circuit breakers, voltage regulators, oil circuit reclosers, and oil switches.

SPECIAL REQUIREMENTS

R4 The manufacturer of equipment who furnishes insulating oil as a component of an equipment order shall be responsible for insuring that the oil supplied is from naphthenic crudes and was refined through a process generally accepted in the utility industry. The oil shall contain less than 1 PPM of Polychlorinated Biphenyls (PCBs).

NEW OIL TEST REQUIREMENTS

Insulating oil must conform to all of the requirements of American Society for Testing and Materials Standard Specification for Mineral Insulating Oil used in Electrical Apparatus, ASTM D-3487 latest revision, except as modified by these specifications.

Type I Mineral Oil shall be used for substation transformers and all oil circuit breakers.

R4 Type II Mineral Oil shall be used for distribution transformers, voltage regulators, oil circuit reclosers and oil switches.

TEST REPORTS

The manufacturer shall provide three (3) certified copies of oil test reports for oil circuit breakers, with a voltage rating of 138 kV or above and power transformers larger than 10,000 kVA, with a voltage rating of 138 kV or above. The test reports shall be sent to the General Equipment Application Engineer, Ohio Edison Company, 76 South Main Street, Akron, Ohio 44308, prior to shipment.

Upon request, three (3) certified copies of oil test reports supplied for equipment rated below 138 kV shall be sent to the following:

- 1) General Equipment Application Engineer for substation equipment.
- 2) General Distribution Engineer for distribution equipment.

Retyped for Revision 2

MEANS/019

APPROVED	DATE
APPROVED	DATE

SPECIFICATIONS

OHIO EDISON CO



Manufacturer \_\_\_\_\_  
Quotation No. \_\_\_\_\_  
Item No. \_\_\_\_\_

3.0 SUMMARY OF DATA  
Power Circuit Breakers

The manufacturer shall complete and return this summary with his proposal.

3-1. VOLTAGE CHARACTERISTICS

- Nominal system voltage (kV) \_\_\_\_\_
- Rated maximum voltage (kV) \_\_\_\_\_
- Rated voltage range factor K \_\_\_\_\_
- Low frequency test voltage (kV rms) \_\_\_\_\_
- Rated BIL (kV Crest) \_\_\_\_\_
- Voltage withstand characteristics for oilless breakers:  
60 Hertz:
  - 1) L-G with 0 psig insulating media, breaker closed (kV) \_\_\_\_\_
  - 2) Across contacts, 0 psig insulating media, breaker open (kV) \_\_\_\_\_
  - 3) Across contacts, normal pressure, breaker open (kV) \_\_\_\_\_
- Full Wave:
  - 1) L-G with 0 psig insulating media, breaker closed (kV) \_\_\_\_\_
  - 2) Across contacts, 0 psig insulating media, breaker open (kV) \_\_\_\_\_
  - 3) Across contacts, normal pressure, breaker open (kV) \_\_\_\_\_
- Maximum capacitor switching capability in amperes \_\_\_\_\_
- Is breaker rated as a general or definite purpose breaker \_\_\_\_\_

3-2. RESISTOR VALUES

- Ohmic value of arc shunting resistor per phase \_\_\_\_\_
- Ohmic value of pre-insertion resistor per phase \_\_\_\_\_
- Are resistors oil filled \_\_\_\_\_
- Type of resistor material (carbon, steel, etc.) \_\_\_\_\_

3-3. CURRENT CHARACTERISTICS

- Rated continuous current at 60 cycles (Amp rms) \_\_\_\_\_
- List maximum symmetrical inter. capabilities for each rating available (kA rms) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
- If maximum symmetrical inter. capabilities can be uprated, show rating (kA) and indicate how it can be accomplished (capacitor, part replacement, etc.) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
- List the respective closing and latching capability for each rating available (kA) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

3-4. INSULATION CHARACTERISTICS

- External creepage distance across live tank breaker (in.) \_\_\_\_\_
- Minimum external creepage distance to ground (in.) \_\_\_\_\_
- External strike distance phase to ground (in.) \_\_\_\_\_
- Minimum internal strike distance to ground (in.) \_\_\_\_\_
- Minimum live part clearance to base line (in.) \_\_\_\_\_
- Bushing impulse withstand 1-1/2 x 40 full wave (kV Crest) \_\_\_\_\_
- Center to center phase spacing (in.) \_\_\_\_\_
- Phase to phase live part spacing (in.) \_\_\_\_\_

3-4. INSULATION CHARACTERISTICS (Cont'd)

- Length of break at main contacts (total inches per break) \_\_\_\_\_
- Number of breaks per phase \_\_\_\_\_

3-5. EMERGENCY OVERLOAD CAPABILITY

- 2 HR/8 HR (Amps) \_\_\_\_\_
- Max. Hot Spot (°C) \_\_\_\_\_

3-6. BREAKER OPERATING TIME FOR RATED CONTROL VOLTAGE & PRESSURE

- Opening time from energization of trip coil to primary contact parting (cycles) \_\_\_\_\_
- Maximum interrupting time (cycles) \_\_\_\_\_
- Additional time for interruption of resistor current (cycles) \_\_\_\_\_
- Closing time (cycles) \_\_\_\_\_
- Rated reclosing time (cycles) \_\_\_\_\_
- Range of adjustment of reclosing time (cycles) \_\_\_\_\_
- Dead time from interruption to re-establishment of sec. arcing contacts (cycles) \_\_\_\_\_
- Rated permissible tripping delay Y = Sec. \_\_\_\_\_
- Maximum time between first and last phase to close, (ele. deg/m. sec) \_\_\_\_\_
- Guaranteed number of oper. at full inter. rating between maintenance inspections \_\_\_\_\_
- Expected number of no load/load current operations between maintenance inspections \_\_\_\_\_
- Type of relay used for 79 X timer \_\_\_\_\_

3-7. PHYSICAL CHARACTERISTICS

- Single or three tank \_\_\_\_\_
- Net weight of complete circuit breaker (lbs.) \_\_\_\_\_
- Number of gallons of oil (where applicable) \_\_\_\_\_

Manufacturer \_\_\_\_\_  
Quotation No. \_\_\_\_\_  
Item No. \_\_\_\_\_

3-7. PHYSICAL CHARACTERISTICS (Cont'd)

- Floor space (length X width) \_\_\_\_\_
- Working space (length X width) \_\_\_\_\_
- Height to top of bushing (in.) \_\_\_\_\_
- Shipping Weight (lbs.) \_\_\_\_\_
- Safe cantilever loading on bushing, installed (lbs.) \_\_\_\_\_
- Type of mounting (frame or floor) \_\_\_\_\_
- Weight of insulating medium (lbs.) \_\_\_\_\_
- Contact Material \_\_\_\_\_
- Live tank or dead tank design \_\_\_\_\_
- Are there internal oil filled capacitors (Yes or No) \_\_\_\_\_

3-8. POWER SUPPLY REQUIREMENTS

- Maximum AC amperage required \_\_\_\_\_
- Maximum DC amperage required \_\_\_\_\_

3-9. GAS SYSTEM CHARACTERISTICS (Where applicable)

- Normal value of Inter. Pressure at 75 F (psig) \_\_\_\_\_
- Range of pressure within which circuit breaker will operate satisfactorily (psig) \_\_\_\_\_
- Total wattage of heaters if used \_\_\_\_\_
- Recommended maximum allowable moisture content of gas \_\_\_\_\_
- List any internal materials which may absorb moisture: \_\_\_\_\_
- Total weight SF-6 gas (lbs) \_\_\_\_\_
- Maximum leakage SF-6 gas, lb per yr. \_\_\_\_\_

3-10. OPERATING MECHANISM

- Type and model number \_\_\_\_\_
- Voltage rating \_\_\_\_\_
- Closing current at rated voltage (Amps) \_\_\_\_\_
- Tripping current at rated voltage (Amps) \_\_\_\_\_
- Pressure range (hydraulic or pneumatic operators) \_\_\_\_\_
- Number of stored C-O operations \_\_\_\_\_
- Time required to recharge stored energy device \_\_\_\_\_

3-11. TEMPERATURE

- Rated temperature rise of circuit breaker \_\_\_\_\_
- Maximum ambient temperature on which rise is based \_\_\_\_\_

3-12. INSTRUMENT TRANSFORMERS

- Can 138 kV circuit breaker accommodate 5 sets of high accuracy devices \_\_\_\_\_ N.A.
- High Accuracy Device =  
2000:5A MR Relay CT with C800 Accuracy @ 1200:5 or  
Linear Coupler with 8 ohm impedance or  
.3B2 Meter Accuracy 2000:5A CT
- Manufacturer of free standing CT \_\_\_\_\_
- Insulating medium of free standing CT \_\_\_\_\_
- BIL of free standing CT \_\_\_\_\_
- Continuous current rating of free standing CT \_\_\_\_\_
- Rated temperature rise of free standing CT \_\_\_\_\_
- Can free standing CT be provided with a p.f. test tap \_\_\_\_\_
- Can BPD be connected to the p.f. test tap to produce an output voltage of 115 volts \_\_\_\_\_

3-13. BUSHINGS

- Manufacturer/Type Designation \_\_\_\_\_
- Insulating medium \_\_\_\_\_
- Current rating (amps) \_\_\_\_\_

3-14. MAXIMUM SOUND LEVEL AT 3 FT. DURING OPERATION (DB) \_\_\_\_\_

3-15. ARE METRIC TOOLS REQUIRED FOR INSTALLATION AND MAINTENANCE \_\_\_\_\_

3-16. EARLIEST DATE THAT PRELIMINARY DATA CAN BE SENT \_\_\_\_\_

3-17. EARLIEST CIRCUIT BREAKER DELIVERY POSSIBLE (WEEKS) \_\_\_\_\_

3-18. DESCRIPTION OF POLICY AND COSTS RELATING TO THE SERVICES OF A QUALIFIED FIELD SERVICE ENGINEER

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

3-19. State that the manufacturer's proposal, as submitted, complies with the Purchaser's Specification and with the latest IEEE or ANSI Standards insofar as is consistent with these specifications.

A) Without exception \_\_\_\_\_

B) With exception \_\_\_\_\_

(List exceptions - printed terms and conditions shall not be considered as exceptions unless specifically noted)

\_\_\_\_\_  
Signature of Bidder

\_\_\_\_\_  
Date

4.0	<u>QUALITY ASSURANCE</u>	1.8
4.1	<u>Quality Assurance Program Requirements</u>	1.11
4.1.1	<u>QA Program</u>	1.12
	The Seller shall have in effect at all times a quality assurance (QA) Program which clearly establishes the authority and responsibility of those responsible for the QA Program. Persons performing quality functions shall have sufficient and well-defined responsibility and authority to enforce quality requirements, to identify, initiate, recommend, and provide solutions to quality problems, and to verify the effectiveness of the solutions. No submittal of this QA Program is required.	1.13 1.14 1.15 1.16 1.17 1.18
4.1.2	<u>Seller's Responsibility for Suppliers</u>	1.20
	The Seller shall identify, in purchase documents to his suppliers, all applicable quality and QA requirements imposed by the Engineers' specification on the Seller and shall ensure compliance thereto.	1.21 1.22
4.2	<u>Tests</u>	1.26
	The circuit breakers, relays, and instrument transformers shall be tested in accordance with ANSI C37.50, ANSI C37.90, and NEMA SE-5.	1.27 1.28
	Written records shall be kept for each test showing date, equipment tested, test method and test results. Test records and certificates of final inspection or approval shall be submitted to the Purchaser for each test within 10 working days after test completion.	1.30 1.31 1.32
	The Seller shall be responsible for compliance with his standard in-production test procedures.	1.33
4.3	<u>Documentation</u>	1.35
4.3.1	<u>Record System</u>	1.36
	A records system shall be established and maintained that provides for the identification and correlation of test and inspection records and certificates.	1.37 1.38
4.3.2	<u>Final Inspection and Check of Records</u>	1.41
	The Seller shall be responsible for inspecting the item(s) and checking the applicable records, prior to shipment, to verify that all specification requirements have been complied with. Two complete sets of all documents required to comply with this specification shall be submitted to the Purchaser. Acceptance of the completed sets of records does not relieve the Seller of responsibility for compliance with specification requirements.	1.42 1.43 1.45 1.46 1.47

4.4 <u>Warranty</u>	1.49
The Seller shall warrant for a period of 12 months from the in-service date or 18 months from the shipment date (whichever occurs first) all equipment supplied is free from defects in design, material, and workmanship. The Seller shall also warrant the equipment supplied is suitable for the intended installation and operation as described in this Specification.	1.50 1.52 1.53 1.54
In the event that the equipment fails to achieve the warranted performance, then, to the extent that the deficiency or failure to achieve the warranted performance is attributable to equipment supplied by the Seller, the Seller shall make such adjustments or modifications to enable the equipment to achieve the warranted performance. The cost of these adjustments or modifications shall be to the Seller's account. After such adjustments or modifications, should the equipment fail to achieve warranted performance, an equitable settlement shall be made, which may without limitation include an adjustment of purchase order price.	1.55 1.57 1.58 2.1 2.2 2.3
4.5 <u>Field Tests</u>	2.5
The Purchaser may conduct field tests at his own expense to verify performance guarantees under the actual working condition. Where the tests reveal deficiencies in the equipment or deviations from the guaranteed performance, the Seller shall be completely responsible for any modifications, repairs, and/or adjustments required to meet the equipment performance guarantees.	2.6 2.8 2.9 2.10
Should additional field testing be required to verify performance guarantees, the cost for the field representative and required materials shall be at the Seller's expense.	2.11 2.12

5.0 <u>PREPARATION FOR SHIPMENT</u>	1.8
Packaging shall be adequate to prevent contamination, mechanical damage, or deterioration of the item supplied. These requirements are applicable immediately after manufacture.	1.11 1.12
The Seller shall identify desiccants and inhibitors used and the required replacement frequency.	1.13
Expendable materials, such as tapes, barriers, plugs, desiccants, desiccant bags, inhibitors, etc., in contact with austenitic stainless steel or nickel alloys shall not contribute to corrosion during the storage period, by, for example, water or condensate leaching deleterious chemicals contained in the expendable materials.	1.14 1.15 1.16
Objectionable chemicals contain lead, mercury, chlorides, fluorides, sulfur, and zinc.	1.17
Items shall be inspected for cleanliness immediately before packaging.	1.18
All openings into items shall be sealed or plugged. Weld-end preparations shall be protected against corrosion and physical damage.	1.20
Entrapped water shall be removed.	1.21
The outermost covering shall be clearly marked with the complete vendor identification which shall include weight.	1.22
The equipment shall be packaged for indoor storage.	1.23
The weight lifting points, indicated on the crate, skid, or package, shall be utilized for all handling procedures.	1.24

6.0	<u>SUPPLEMENTAL PROVISIONS</u>	1.8
6.1	<u>Deviations and Nonconformances</u>	1.11
	No deviation or nonconformance from this specification or applicable federal, state, or local codes and standards invoked by this specification shall be accepted until approved by the Engineers.	1.12
	Deviations are considered departures from any requirement of this specification. Uncorrectable nonconformances are considered to be conditions which cannot be corrected within the specification requirements by rework or replacement.	1.13
		1.14
		1.15
		1.16
	The Seller shall promptly document and notify the Engineers of all deviations and nonconformances from the specification (such as deviations from applicable codes and/or drawings). Further manufacturing after detection of any deviation or nonconformance prior to the Engineers' approval shall be at the Seller's risk. No departure from the specification shall be binding on any party until an addendum or revision to the specification has been issued by the Engineers.	1.17
		1.18
		1.19
		1.20
6.2	<u>Correspondence</u>	1.22
	All correspondence from the Seller shall consist of an original plus two copies and shall contain the following subject heading:	1.23
		1.24
	Purchase Order No. (later)	1.28
	J.O. No. 15164.00	1.29
	28 kV Power Circuit Breaker	1.30
	LIMB Demonstration Project	1.31
	Edgewater Station, Unit No. 4	1.32
	Babcock & Wilcox Company	1.33
	Bid documents and contractual correspondence relative to or affecting prices, terms, conditions, price adjustment, deliveries, return of materials for credit, routing of shipments, or that which changes the price or scope of an order even though also discussing engineering matters shall be addressed to:	1.37
		1.38
	Babcock & Wilcox Company	1.41
	Copy to:	1.46
	Mr. John H. Davies	1.49
	Stone & Webster Engineering Corporation	1.50
	P.O. Box 2325 245/6	1.51
	Boston, Massachusetts 02107	1.52

Correspondence relative to inspection, expediting, technical matters, and transmittal of manufacturer's drawings, spare parts list, and operating instructions shall be addressed to:	1.56
Babcock & Wilcox Company	1.59
with a copy to Mr. Davies of Stone & Webster.	2.5
<u>6.3 Subsuppliers</u>	2.7
Should the Seller propose to purchase from another supplier any of the equipment, material, or services specified herein, he shall, upon request, identify the subsupplier for the specific equipment, material, or services itemized by the Engineers.	2.8 2.9 2.10
To the extent that they apply, the Seller shall impose on each of the subsuppliers the complete requirements of this specification. He shall be directly responsible that the subsuppliers are completely aware of <u>all</u> of these requirements, and that they abide thereby.	2.12 2.14 2.15
<u>6.4 Release for Material Purchase or Fabrication</u>	2.17
Written approval to the Seller to start fabrication of the equipment covered by this specification will be provided by the Purchaser.	2.18 2.19
Fabrication is to be based on drawings and procedures reviewed and approved by the Engineers as required by the specification.	2.21 2.22
<u>6.5 Tools and Spare Parts</u>	2.24
One complete set of all special* tools, fixtures, and appurtenances required for maintenance and operation shall be furnished. (*"Special" is defined as anything not normally and usually available in a power station or readily available thereto.)	2.25 2.28
The Seller shall itemize on the attached Data Sheet the special tools that will be furnished.	2.29
A detailed list of all recommended spare parts shall be provided by the Seller. This list shall include the cost, location, and address of the local supplier, generic description of the part, and the Seller's normal delivery time.	2.30 2.31 2.32
<u>6.6 Installation, Operating, and Maintenance Instructions</u>	2.34
No later than one month before initial shipment, the Seller shall submit to the Engineers' Project Engineer 12 bound copies of a complete installation, operating, and maintenance manual for the equipment furnished, including instructions for individual components. All final	2.35 2.36 2.39

instructions shall be certified by the manufacturer as applicable to the equipment furnished, and shall be specifically identified, such as by serial number. The Seller shall inscribe the following identification on the cover; the words OPERATION AND MAINTENANCE MANUAL, the name and location of the equipment, the name of the manufacturer, and the contract number. The manual shall include the names, addresses, and telephone numbers of other equipment suppliers, and of the local representatives. The manual shall have a table of contents and be assembled to conform to the table of contents with the tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in. The manual shall include: wiring and control diagrams with data to explain detailed operation and control of each item of equipment; description of the function of each principal item of equipment; installation instructions; maintenance instructions; lubrication schedule including type, grade, temperature range, and frequency; safety precautions, diagrams, and illustrations; test procedures; and performance data.

One additional set of instructions, certified by the manufacturer, shall be packed and sent with the equipment to the jobsite. A parts identification list shall accompany each set of instructions. This list shall include sectional and/or outline prints or illustrations identifying each numbered part and location in relation to the equipment as a whole. The parts list for equipment shall indicate the source of supply and recommended spare parts.

#### 6.7 Data and Drawings

After the order is placed, the Seller shall submit all drawings in accordance with the agreed-upon schedule. The drawings submitted shall show the following:

1. All physical outlines, as required, to show the overall size and space requirements (including that for dismantling and maintenance) and the interrelationship of the various components
2. Cross sections and details, as required, to satisfy the Engineers and Purchaser that all components are in conformance with the intent of the specification and are satisfactory from the standpoint of design and physical arrangement
3. All information required by the Engineers for the design and location of all connecting Purchaser-furnished structural or electrical items such as steel supports, cables, conduit, etc.
4. Weight of the equipment and distribution of the static and other loads
5. Additional data and Dwgs. listed under section 2-15 & 2-16.

The Engineers' job order number and purchase order number shall be shown on each drawing.	3.23
All drawings submitted shall be in the form of one good quality reproducible and three good, sharp, black and white, direct contact prints of the Seller's original drawing.	3.24
After review by the Engineers, one direct contact print marked APPROVED or APPROVED AS REVISED will be returned to the Seller. If marked APPROVED AS REVISED, the required changes shall be incorporated by the Seller, clearly identified, and be resubmitted to the Engineers. If the Seller elects not to incorporate the revisions, he shall inform the Engineers that the suggested revisions cannot be made without prejudice to the Seller's responsibility under warranty.	3.25 3.26 3.27
Arrangements for production scheduling and the procurement of the necessary materials shall not be deferred pending approval of drawings.	3.28
The Engineers and Purchaser reserve the right to reproduce any drawing or print received from the Seller, as may be required during the design and construction of this project and the preparation of a plant manual, despite any notice prohibiting the same appearing on the drawing or print.	3.29 3.30
<u>6.8 Proposal Requirements</u>	3.32
The bidder shall furnish with his bid a list of all equipment he proposes to use. Deviations from any of the Engineers' requirements must be clearly defined along with the reason(s) for the proposed change(s). All data sheets shall be filled-in. The following data and drawings are required with the bid package:	3.33 3.35 3.38
1. Preliminary Bill of Material	3.40
2. Outline drawings showing the general arrangement and approximate dimensions of the equipment proposed	3.41 3.42

6.9 Schedule 3.45

The following schedule, or a revision of it, as agreed upon by the Seller and the Engineers before the purchase order is placed and included with the purchase order, shall be binding upon the Seller. 3.46  
3.48

<u>Milestone</u>	<u>Date</u>	3.51
1. Bid due date		3.53
2. Award purchase order		3.54
3. Initial drawing submittal		3.55
4. Equipment delivery date		3.56

6.10 Delivery 4.2

Delivery shall be made by enclosed truck. 4.3

Specification for	1.13
5000 kVA, 23 kV-2400/4160 V	1.15
<u>DISTRIBUTION SUBSTATION POWER TRANSFORMER</u>	1.17
Limestone Injection Multistage Burner (LIME)	1.19
Demonstration Project	1.20
Ohio Edison Company's (OE)	1.21
Edgewater Station	1.22
Babcock & Wilcox Company (Owner)	1.24

	<u>APPROVED</u>	1.27	
	<u>Signature</u>	<u>Date</u>	1.29
Preparer	<i>C. H. [Signature]</i>	<u>7/7/87</u>	1.31
Lead Engineer	<i>[Signature]</i>	<u>6/30/87</u>	1.32
Project Engr	<i>[Signature]</i>	<u>7/7/87</u>	1.33

Stone & Webster Engineering Corporation (ENGINEER)  
Boston, Massachusetts

J.O. No. 15164.09  
 Spec. No. 15164-E-006

Bid Specification 1.9  
 Addendum 1 - 09/08/87 1.10

Specification for	1.13
5000 kVA, 23 kV-2400/4160 V	1.15
<u>DISTRIBUTION SUBSTATION POWER TRANSFORMER</u>	1.17
Limestone Injection Multistage Burner (LIMB)	1.19
Demonstration Project	1.20
Ohio Edison Company's (OE)	1.21
Edgewater Station	1.22

Babcock & Wilcox Company (Owner) 1.24

1.0 SCOPE 1.27

This Addendum No. 1 summarizes all changes to the specification to date. 1.30

2.0 CHANGES 1.32

<u>Item</u>	<u>Changes to Specification</u>	
		1.35
1.	Delete: Pages 2-1 and 2-2	1.37
	Add: New pages 2-1 and 2-2 attached	1.38
2.	Specification TD - 46	1.40
	Delete: Pages 1,2,9,10,11, and 12	1.41
	Add: New pages 1,2,9,10,11, and 12 attached	1.42
3.	Delete: Page 5-5	1.44
	Add: New page 5-5 attached	1.45

APPROVED 1.47

	<u>Signature</u>	<u>Date</u>	
Preparer	<i>[Signature]</i>	<u>9/16/87</u>	1.51
Lead Engineer	<i>[Signature]</i>	<u>9/16/87</u>	1.52
Project Engr	<i>[Signature]</i>	<u>9-16-87</u>	1.53

Stone & Webster Engineering Corporation (ENGINEER)  
 Boston, Massachusetts

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DRAWINGS AND SKETCHES		1.41

1.0	<u>GENERAL</u>	1.8
1.1	<u>Scope</u>	1.11
	This specification details the performance, design and manufacturing requirements for furnishing and delivering one 5000 kVA, 23 KV-2400/4160 V distribution substation power transformer for the LIME Demonstration Project being conducted by Babcock & Wilcox at Ohio Edison Company's Edgewater Station, Unit No. 4.	1.12 1.13 1.14 1.16
1.2	<u>Definitions</u>	1.17
	Terms used throughout this specification are defined as follows:	1.18
Seller	- The company accepting the overall responsibility for fulfilling the requirements of this specification	1.20
Engineers	- Stone & Webster Engineering Corporation (SWEC), a Massachusetts corporation, or its duly authorized agencies restricted to the performance of the particular duties entrusted to them by the Purchaser	1.21 1.22 1.23
Purchaser (Owner)	- Babcock & Wilcox Company	1.26 1.27
Approved	- This word, when applied by the Engineers to the Seller's drawings or documents, means that the drawings or documents are satisfactory in that the Engineers have not observed any statement or feature that appears to deviate from the requirements. The Seller shall retain the entire responsibility for complete conformance with all of the requirements.	1.33 1.34 1.36 1.37 1.38
Approved as Revised	- These words, when applied by the Engineers to the Seller's documents, mean that the documents are approved as defined above, except that the changes shown are necessary to be in conformance with the requirements. On the basis that the Seller shall retain the entire responsibility for compliance with all of the requirements, the Seller shall either:	1.41 1.42 1.44 1.46 1.47
	a. Incorporate the changes into his document and resubmit to the Engineers, or	1.50
	b. Inform the Engineers that the changes cannot be made without prejudice to the Seller's responsibility under warranty,	1.51 1.52

and resubmit them with full explanation of the reasons therefor.

1.3 Furnished by Seller 1.54

The Seller shall furnish equipment, material and services as follows: 1.55

<u>Item</u>	<u>Quantity</u>	<u>Description</u>	1.59
1	1	5000 kVA, 23kV-2400/4160 V, distribution substation power transformer in accordance with attached specification	2.2 2.3 2.4 2.5
2	1	Neutral grounding resistor in accordance with attached specification	2.7 2.8 2.9
3		Drawings and documentation	2.11
4		Installation instructions	2.13
5		Operation and maintenance manual	2.15 2.16

1.4 Furnished by Purchaser 2.21

The Purchaser shall furnish: 2.23

1. Handling, unloading, and installation 2.26
2. External control wiring 2.27

1.5 Project Type, Location, and Site Conditions 2.30

The equipment specified will be used in an existing 23 kV switchyard for power supply to other electrical loads. This is part of Babcock & Wilcox's LIME Demonstration Project at Ohio Edison Company's Edgewater Station, Unit No. 4 located in Lorain, Ohio. Edgewater Station is located on the shore of Lake Erie. 2.31  
2.33  
2.34  
2.35

The site is accessible via truck and rail. Maximum and minimum design ambient temperatures are 95°F and 0°F, respectively. 2.37

2.0 TECHNICAL REQUIREMENT		1.8
EDGEWATER PLANT LIMB PROJECT		1.11
5000 kVA, 23 kV delta primary to 4160 V wye secondary three-phase		1.12
oil filled outdoor power transformer with the following		1.13
characteristics:		
1. Number of Phases	Three	1.17
2. Coolant	Oil	1.18
3. Type Cooling	OA with	1.19
	provisions for	1.20
	future FA	1.21
4. Frequency	60 Hz	1.22
5. kVA Rating	5000 OA	1.23
6. High-Voltage Rating	22.9 kV	1.24
7. Low-Voltage Rating	2400/4160 V	1.25
8. High-Voltage BIL	150 kV	1.26
9. Low-Voltage BIL	75 kV	1.27
10. Taps	High Voltage,	1.28
	No-load, $\pm 2-2 \frac{1}{2} \%$	1.29
	above and below	1.30
	normal voltage	1.31
11. Bushing C.T.'s	1200: 5 amp	1.33
H <sub>1</sub> , H <sub>2</sub> , H <sub>3</sub> (23kV)-1 each	Multi-ratio	1.34
	connected on	1.35
	200 amp tap	1.36
Accuracy (Minimum)	C400	1.37
X <sub>1</sub> , X <sub>2</sub> , X <sub>3</sub> (4.16 kV)-1 each	3000: 5 amp	1.39
	Multi-ratio	1.40
Accuracy (Minimum)	C400	1.41
X <sub>1</sub> , X <sub>2</sub> , X <sub>3</sub> (4.16 kV)-1 each	3000: 5 amp	1.43
	single ratio	1.44
Accuracy (Minimum)	C400	1.45
12. Neutral C.T.	150: 5 amp	1.47
(Mounted in Grounding	single -ratio	1.48
Resistor Cage)		1.49
Accuracy (Minimum)	C200	1.50

13. Lightning Arresters		1.53
A. $H_1, H_2, H_3$ (23 kV)		1.55
Rating (kV)	24	1.57
Class	Interm	1.58
Catalogue No.	G.E. 9L12PGA024	2.1
	Ohio Brass VI-218019	2.2
	West. 8046A10A24	2.3
B. $X_1, X_2, X_3$ (4.16 kV)		2.7
Rating	6	2.8
Class	Interm	2.9
Catalogue No.	G. E. 9L12PGA006	2.10
	Ohio Brass VI-218005	2.11
	West. 8046A10A06	2.12
14. Impedance	6 %	2.15
15. Ground Resistor (See Attached Spec. No. R-1)		2.17
Resistance	6 ohms	2.18
Voltage Rating	2400 V (line to ground)	2.19
Current Rating	400 amps	2.20
Time Rating at	10 sec	2.21
above Current		2.22
Type	Outdoor, screened	2.23
Elements	Stainless Steel	2.24
16. <u>Special Requirement</u>		2.28
Bushings - Low Voltage Bushings (4.16 kV) to be side mounted		2.30
for cable termination. Bushings shall be enclosed in a		2.31
weatherproof compartment of sufficient size for proper cable		2.32
termination and arranged for cable entry from the bottom or		2.32
sides of the compartment.		
The following attachments are part of these specifications:		2.33
Specification for Distribution Substation Power		2.35
Transformer No. TD-46		
Specification for Insulating Oil OE-LRS-20		2.36
Specification for Neutral Ground Resistors R-1		2.37

14. Impedance	6 %	2.1
15. Ground Resistor (See Attached Spec. No. R-1)		2.3
Resistance	6 ohms	2.4
Voltage Rating	2400 V (line to ground)	2.5
Current Rating	400 amps	2.6
Time Rating at	10 sec	2.7
above Current		2.8
Type	Outdoor, screened	2.9
Elements	Stainless Steel	2.10
16. <u>Special Requirement</u>		2.14
Bushings - Low Voltage Bushings (4.16 kV) to be side mounted		2.16
for cable termination. Bushings shall be enclosed in a		2.17
weatherproof compartment of sufficient size for proper cable		
termination and arranged for cable entry from the bottom or		2.18
sides of the compartment.		
The following attachments are part of these specifications:		2.19
Specification for Distribution Substation Power		2.21
Transformer No. TD-46		
Specification for Insulating Oil OE-LRS-20		2.22
Specification for Neutral Ground Resistors R-1		2.23

**GENERAL SPECIFICATION FOR  
DISTRIBUTION SUBSTATION POWER TRANSFORMERS**

**2-1 SCOPE**

Transformers covered by this specification shall be two winding, three phase, oil insulated, outdoor power transformers. Transformers shall be designed in accordance with the latest revision of applicable ANSI, IEEE and NEMA Standards insofar as these standards are consistent with this specification. The ratings, voltages, winding connections and type of cooling desired for a particular power transformer ordered under this specification appear on pages 2-1 & 2-2.

**2-2 TRANSFORMER DESIGN REQUIREMENTS**

- ° Temperature Rating - The continuous kVA rating shall be based on a 55°C winding temperature, by resistance, above ambient temperature with a hottest spot winding temperature rise not to exceed 65°C. The transformer shall be designed with a thermally stabilized insulation system so that the transformer shall be capable of delivering 12% additional continuous kVA capacity based on a 65°C winding temperature rise, by resistance, above ambient with a hottest spot winding temperature rise not to exceed 80°C.
- ° Cooling - The transformer shall have self-cooled and forced-air or forced-oil-cooled ratings as noted on 2-1.
- ° Noise Level - Unless otherwise stated on page 2-1 the noise level shall not exceed NEMA Standard TR 1-1980.
- ° Polarity - The transformer shall be subtractive polarity regardless of whether the transformer will be paralleled with a transformer of different polarity.
- ° H-X Angular Displacement
  - ° Delta-Delta Connection: The high voltage shall be in phase with the low voltage with a phase sequence the same as terminal subscripts per ANSI C-57.12.70-1978, figure 19, group 1.
  - ° Delta-Wye Connection: The high voltage shall lead the low voltage by thirty degrees (30°) with a phase sequence the same as terminal subscripts per ANSI C-57.12.70-1978, figure 19, group 2.
- ° Core Ground - The core ground shall be brought to the top of the tank and shall be located within 12 inches of a manhole cover. The core ground connection shall be designed with captive hardware to minimize the hazard of dropping washers, nuts, etc. into the tank while disconnecting the ground. It shall also be

designed so that the lead is not susceptible to becoming immediately disconnected if the fastener becomes loose. Exceptions must be approved by Ohio Edison.

- Winding Connections - All joints shall be welded or brazed except compression type may be used for terminal connections. Bolted connections may be used at bushings and terminal boards provided a suitable locking device is used.
- Short Circuit Strength - The transformer shall be designed to withstand without injury short circuits applied to the terminals as required by ANSI C57.12.00-1980 Section 7 except that the transformer shall withstand without injury a bolted line to ground fault on the secondary terminals for two (2) seconds when connected to a high side source with a capacity as defined by Table 11 of Section 7. Transformers other than autotransformers shall utilize system  $X_0/X_1$  ratios of 2 for all fault cases. The purchaser reserves the right to request a verification test of the transformer's mechanical capability to withstand short circuit stresses by procedures defined in ANSI C57.12.90-1980 at any time prior to delivery for a negotiated price addition.
- Partial Discharge Limits - Transformer maximum partial discharges measured during the Induced Potential Test shall not exceed 100 microvolts.
- Lead Guides - All tubular lead guides within the transformer shall have rounded ends or be provided with smooth rounded inserts.
- Parallel Operation - The transformer shall be suitable for parallel operation on corresponding taps with other transformers when so designated. The information given regarding parallel operation is for the purpose of quotation only and does not relieve the successful bidder from the necessity of obtaining paralleling data from the manufacturer of the existing transformers.
- Impedance Tolerance - ANSI standard tolerance of  $\pm 7.5$  percent (2) on guaranteed impedance values for transformers with two windings shall apply.
- Future Instrument Transformers - The overall transformer design shall provide for the future addition of one externally mounted bushing type instrument transformer on each high voltage bushing.

2-3 DIELECTRIC REQUIREMENTS

The complete transformer shall have impulse insulation strengths, low frequency tests and induced tests as shown below, in accordance with ANSI C57.12.00-1980, Tables 4 and 6 and the latest draft standard, "REVISION OF DIELECTRIC TEST REQUIREMENTS, C57.12.00, C57.12.90" prepared by the 262B Review Task Force of the IEEE Transformers Committee.

Nominal System Voltage (kV) Class	Basic Lightning Impulse Insulation Level BIL (kV Crest)	Cropped Wave Level (kV Crest)	Low Frequency Test Level (kV rms)	CLASS I	Class II	
				Minimum Phase-to-Phase Insulation Test Levels (kV rms)	Induced Voltage Test: (Phase to Ground) One Hour Enhancement Level (kV rms)	Level (kV rms)
High Voltage						
138 II	550	630	230	-	125	145
69 I	350	400	140	115	-	-
34.5 I	200	230	70	57	-	-
25 I	150	175	50	42	-	-
Low Voltage Including Neutral of Eye Winding						
25	150	175	50			
12 to 15	110	130	34			
6 to 9	95	110	26			
5 & below	75	88	19			

NOTES: 1. Transformer classifications are as follows:

- a) Class I Power Transformers shall include power transformers with high voltage windings 69 kV and below.
- b) Class II Power Transformers shall include power transformers with high voltage windings from 115 kV through 765 kV.

2. In the case of multiple windings, the highest line to line voltage of that winding shall be used.

## 2-4 LIVE PART CLEARANCES

All live part clearances shall be as follows:

<u>Nominal System Voltage</u>	<u>138 kV</u>	<u>69 kV</u>	<u>34.5 kV</u>	<u>25 kV &amp; Below</u>
Minimum Live Part Clearance:				
Between Bushings	57"	30"	18"	12"
Between Lightning Arresters	57"	32"	18"	12"
Between Lightning Arrester and Related Bushing	50"	32"	18"	12"
Between Bushings and/or Lightning Arresters of Different Windings (use highest kV involved)	50"	32"	18"	12"
Between Lightning Arresters and tank or other grounded parts	45"	25"	13"	10"

## 2-5 BUSHING REQUIREMENTS

- ° Bushing Construction - The bushings shall be cover mounted and shall be provided in accordance with IEEE Std. Nos. 21-1976 and 24-1984. The bushings shall not be gapped and shall have a power factor test tap. Isolated flange facilities are not acceptable. The bushings shall be suitable for power factor testing without disconnecting from line lead. Bushing porcelain shall be ANSI #70 Gray in color.
- ° Bushing Nameplates - Bushing nameplates shall be marked to comply with the requirements of IEEE Std. No. 21-1976. Nameplate information shall include test power factor referred to 25°C at 10 kV as measured between bushing conductor and potential test tap.
- ° Bushing Electrical Requirements - Bushing electrical characteristics shall be in accordance with IEEE Std. 24-1984, Table 1. These characteristics along with bushing strike requirements are tabulated below.

<u>Nominal Voltage of Winding (kV)</u>	<u>138</u>	<u>69</u>	<u>34.5</u>	<u>25 &amp; Below</u>
Low Freq. Dry 1 Min. rms (kV)	310	160	80	60
Low Freq. Wet 10 Sec. rms (kV)	275	140	75	50
Impulse FW Withstand (kV)	650	350	200	150
Minimum Creep (in.)	92	48	26	17
Minimum Strike (in.)	41	24	13	9

- Bushing Mechanical Requirements - Bushings shall be good for 100 miles per hour actual wind velocity and a cantilever force of 500 lb. applied simultaneously in the direction of the wind.
- Bushing Current Ratings - Bushings shall be sized to meet or exceed the transformer maximum continuous current ratings for their respective windings. In addition, they shall be sized to allow sufficient short time loading and mechanical strength for all calculated fault conditions specified in the short circuit strength section of this specification.

- Approved Bushing -

- Voltage Class

- Above 25 kV: Bushings manufactured by General Electric, McGraw-Edison or Westinghouse are acceptable.

- 25 kV &

- Below:

- Bushings with an insulation class 25 kV and below shall be Westinghouse 25 kV type "O+", General Electric type "U" or approved equal. Bushings for the neutral of Y connected low voltage windings shall be identical to the phase bushings of that winding.

- Bushing Terminals - When the required electrical rating of the transformer can be met, bushings with draw-thru leads and 1- $\frac{1}{2}$ -12 UNF-2A terminal studs shall be furnished. Bushings rated in excess of 1600 amperes shall have 2"-12 UNF-2A studs or larger.

- Bushing Current Transformers

Current transformers supplied and installed on the transformer bushings and in the grounding resistor cage shall be in accordance with ANSI/IEEE Standard C57.13-1978 for Current Transformers. The current transformer's quantity, ratios and accuracy class ratings are indicated on page 2-1 of this specification. A separate lead shall be brought out from each CT tap to a single terminal block for each CT in the mechanism housing or CT tank terminal box. This terminal block shall be a Marathon Series 1500 STRC stud type or Ohio Edison approved equal.

- Terminal Connectors -

- Terminal

- H, X:

- Terminal connectors will be furnished by the purchaser.

- Neutral:

- Manufacturer shall provide terminal for neutral bushing and shall grounded through a neutral grounding resistor as described in the attached Specification R-1.

## 2-6 NAMEPLATE

The nameplate shall be located on the segment 1 side of the transformer and shall have provision whereby tap screws can be attached thereto to show the exact connections and taps being used. The information on the nameplate shall include the rating of each winding at 55°C and 65°C rise as well as all data specified in ANSI Standard C57. For forced-cooled transformers, both the self-cooled and forced-cooled kVA ratings of the various taps shall be included on the nameplate. Also, include the crane lift height (excluding slings) required to untank core and coils. The percent impedance shown on the nameplate shall be identical to the value shown on the test report. It shall also indicate whether the windings have copper or aluminum conductors, and shall give the guaranteed sound level in decibels.

2-7 TANK AND ACCESSORIES

- Vacuum Filling - The transformer tank shall be designed for vacuum filling as required by ANSI C-57.12.10-1977.
- Transformer Base - The transformer will be unloaded by means of skids and cribbing. Wheeled devices shall not be required. The transformer shall have adequate flat base surfaces suitably braced to permit the transformer to be moved on wood rollers in either direction and suitable for mounting on piers. The manufacturer should specify suitable pier spacing necessary to support the transformer. Piers will be parallel to the transformer segments number 2 and 4 tank walls.
- Transformer Tank - The following tank handling facilities shall be provided:
  - a) Lifting eyes for lifting cover only
  - b) Suitable jacking pads
  - c) Pulling eyes for moving transformer in any direction
- Oil Preservation - The transformer oil preservation system shall be an Inert Gas-Pressure System as defined in ANSI C57.12.80-1978, Section 6.5.3. It shall be equipped with an automatically regulated dry nitrogen gas seal system. Ungrounded alarm contacts shall be provided to indicate a low nitrogen level in the gas cylinder and a low and high nitrogen level in the transformer tank. Facilities shall be provided to bypass the gas regulator. The height of the cabinet housing the gas cylinder shall be adjustable from one foot above to two feet below the base of the transformer when measured from the bottom of the cabinet. This cabinet shall be constructed to allow for the addition of a 6" inch adapter between the gas regulator and the cylinder valve.
- Pressure Vacuum Gauge - A pressure vacuum gauge shall be mounted in the manufacturer's standard transformer location to indicate the pressure in the gas space. The gauge shall be located no more than six feet above the base of the transformer. Facilities shall be provided to bypass the gas bleeder or relief valve in order to allow gas to enter the transformer after vacuum filling with oil.
- Sudden Pressure Relay - A Westinghouse Sudden Pressure Relay (with ungrounded alarm contacts) shall be furnished. This relay shall be located on the top cover in accordance with Westinghouse recommendations for mounting the relay. The manufacturer shall supply a 1/4 inch galvanized pipe extending from the relay test plug down to a point 4 to 6 feet above the transformer base for the purpose of testing the relay with the transformer energized. The lower end of the pipe shall have a valve and cap. This relay shall be suitable for operation at 48 volts DC and 125 volts DC.

- ° Pressure Relief Device - A self-resealing top cover pressure relief device with an operation indicator and ungrounded alarm contacts shall be located in the manufacturer's standard location. The calibration of this device shall be clearly marked thereon.
- ° Oil Flow Indicator - If oil pumps are used, one oil flow indicator relay for each pump (with ungrounded alarm contacts) shall be provided.
- ° Oil Level Gauge - An oil level gauge (with ungrounded alarm contacts) shall be provided as specified in ANSI C57.12.10-1977.
- ° Top Oil Temperature Indicator - A dial type top oil temperature indicator thermometer (with adjustable ungrounded alarm contacts) shall be located on the manufacturer's standard side of the transformer. The thermometer shall have a maximum indicating hand with a provision for resetting. The indicator shall be located no more than four feet above the base of the transformer.
- ° Additional Thermometer Well - An additional thermometer well (without thermometer) with a removable protective cap shall be installed for top of oil temperature measurements.
- ° Winding Hot Spot Indicator - A two element or two (2) dial type winding temperature indicators with two adjustable contacts for automatic two-stage control of cooling equipment and one contact for temperature alarm adjusted for 110°C shall be provided. The indicators shall be actuated from hottest spot detector elements located in the line lead of the high and low voltage windings. Each indicator shall be identified indicating winding monitored. The indicator shall be located no more than four feet above the base of the transformer.
- ° Ground Pads - Two ground pads shall be mounted on diagonally opposite corners of the transformer tank base and shall be in accordance with ANSI C-57.12.10-1977, paragraph 19.2.8.
- ° Radiators - Each radiator shall be valved individually or the cooling equipment shall be divided into at least two hydraulically separated groups of approximately equal size. With half of the cooling equipment out of service, the transformer shall be capable of carrying at least 70% of the nameplate rating.
- ° Radiator Valves - The valves shall be mounted so that the static head pressure of the oil in the transformer tank acts to close the valve when the tank is filled with oil and the radiator is drained. The manufacturer shall ensure that the radiator valves on the completed transformer are leak free in the closed position.

- ° CT Manhole - Where BTCT's or future provision for them is specified, a manhole with neoprene or better material gasketing and bolted covers shall be provided. The manhole shall be of sufficient size to permit removal of bushing type current transformers without removing main tank cover.
- ° Alarm Annunciator - The manufacturer shall provide an Edwards 800 series annunciator or Ohio Edison approved equal, with drop targets for each transformer alarm. The annunciator shall have two individual contact outputs for connection to alarm systems, one for a non-critical and one for a critical alarm designation on a station annunciator panel. The low nitrogen cylinder pressure alarm circuit shall be wired to the non-critical signal relay while the remaining alarms shall be wired to the critical signal relay. The available alarm circuit voltage supply is 120 volt AC.
- ° Undervoltage Alarms - The manufacturer shall provide alarm contacts to show loss of voltage in the alarm circuit, the control circuit and the main pump and fan supply circuit. The AC undervoltage relays associated with the pump and fan supply and the control circuit shall have provision for up to a ten-second time delay for dropout. A separate DC auxiliary undervoltage relay shall be provided with its contacts connected in parallel with the critical alarm output. This relay shall have provisions for up to a 10 second time delay for dropout.

## 2-8 WIRING AND CONDUIT

- ° Control Cabinet - All electrical leads including those from all contacts and coils of any alarm, indication, or protective devices required with the transformer and leads from any current transformer or linear coupler secondary taps shall be extended to a common weatherproof (NEMA Type 4) terminal box/control cabinet mounted on the transformer tank wall no higher than six feet above base. The cabinet shall be provided with a removable plate for conduit entrances (to be drilled by purchaser). This plate shall be approximately 12" x 24". Cabinet shall be located on the segment 1 side of the transformer.
- ° Conduit - Rigid steel conduit (zinc coated), electrical metallic tubing (zinc coated), or rigid aluminum conduit shall be used for all wiring that is external to the transformer tank. The conduit and fittings shall be in accordance with ANSI C80.1-1983, C80.3-1983, and C80.5-1983. Neither plastic conduit and fittings nor exposed cable are acceptable.

- ° Internal Control Wiring - All auxiliary wiring shall be Type SIS and shall be No. 14 AWG stranded copper or larger with compression-type terminals. All internal control wire connections shall utilize compression-type, Burndy "YAV" ring tongue terminal connectors or Ohio Edison approved equal. Terminal connectors shall be installed using a ratchet-type crimping tool, Burndy "MR-8" or approved equal. Push-on type connectors are not acceptable.
- ° Terminal Blocks - All terminal blocks requiring users connection shall be Marathon Series 1500STRC stud type or Ohio Edison approved equal. The manufacturer and catalog number of the terminal blocks shall be shown on the appropriate wiring diagrams.
- ° Control Breakers - Westinghouse Type EB or EHB breakers, or approved equal, shall be mounted in the control cabinet for each AC and DC supply. Fuses are not acceptable.
- ° Control Heater - A thermostatically controlled heater sufficient to protect the enclosed equipment from moisture and temperature conditions shall be provided for the control cabinet. The manufacturer shall provide suitable protection of the main control circuit should an electrical problem (short) develop in the heater circuit (fuses are not acceptable). Heater voltage shall be 120 volt AC.
- ° Secondary Terminations of Auxiliary Devices - In accordance with Section 2-7, the following alarm leads shall be extended to the control cabinet:
  - Hot spot winding temperatures
  - Top oil temperature
  - Oil level
  - No Oil Flow (each pump shall be alarmed)
  - Excessive Gas Pressure/Vacuum
  - Sudden pressure relay
  - Pressure relief device
  - AC Undervoltage Alarms
  - DC Undervoltage Alarm
  - Low Nitrogen Cylinder Pressure
- ° Convenience Outlet - An electrical convenience outlet shall be provided in the control cabinet. This outlet shall be suitable for 120 volt equipment requiring grounded three prong connections. The manufacturer shall wire the convenience outlet to unused terminal block points (labelled).

## 2-9 NO LOAD TAP CHANGING EQUIPMENT

A manually operated tap changer (ratio adjuster) for operation only when transformer is de-energized, shall be provided for the high voltage winding. The operating handle shall be brought through the side of the tank and provided with a position indicating plate and provisions for padlocking. Tap changer shall be located for convenience of maintenance and inspection.

## 2-10 AUXILIARY COOLING EQUIPMENT

- ° Power Supply - Any cooling equipment specified shall be suitable for operation from the power supply indicated on page 2-1 or 2-2 of this specification in accordance with ANSI C84.1-1982.
- ° Motor Protection - Individual thermal overload protection shall be provided for each motor.
- ° Controls - Fans and oil circulating pumps shall be arranged for both manual and automatic operation. Automatic control of the cooling equipment shall be provided by using single phase winding temperature equipment specified in Section 2-7. Control of the two-stage cooling arrangement shall be such that first and second cooling group operation can be interchanged by Purchaser. The control circuit shall contain a time delay relay to prevent the starting of all pumps and fans at the same time either by manual or automatic control.
- ° Maintenance - Provision for the lubrication of fan motors shall be either Alemite fittings where ball bearings are furnished or oil cups where sleeve type bearings are furnished.
- ° Fan Rotation - The direction of rotation of fans and pumps shall be clearly indicated on or near those devices by arrows or other suitable means.
- ° Motor Grounding - Fan motor frames and pump motor frames shall be grounded to the control cabinet by means of a ground wire.
- ° Pump & Motor Bearings - All auxiliary cooling oil pumps and oil pump motors shall be provided with sleeve type bearings.

## 2-11 LIGHTNING ARRESTERS AND BRACKETS

- ° Construction - Metal Oxide Lightning arresters shall be supplied for the High Voltage and Low Voltage terminals of the transformer as listed on page 2-1 of this specification. The transformer shall be equipped with mounting brackets for the arresters supplied. Lightning arrester porcelain shall be ANSI #70 Gray in color.

- ° Mounting - It is preferable that the top of the lightning arresters be no higher than the top of the related bushings but in no case shall the top of the lightning arresters be more than 12 inches above the top of the related bushings. The minimum live part and ground clearances of arresters shall be equal to or greater than values indicated in Section 2-4.
- ° Terminals - Lightning arresters shall be furnished complete with clamp type terminals for line and ground connections suitable for 1/0 copper wire.
- ° Line Connections - The lightning arresters are to be connected by hot line taps by the purchaser and therefore shall not be permanently connected to their respective bushings nor shall they be made a part of the termination arrangement.
- ° Ground Connections - The manufacturer shall provide a copper ground bus on the transformer tank. This ground bus shall be connected to the transformer ground pads. This ground bus will be used by the customer to connect the arrester ground leads. The supporting bracket shall not be used for this purpose.

## 2-12 OIL AND OIL PIPING

- ° Oil Requirements - All necessary oil, inert gas or other insulating medium required for placing the transformer in service shall be supplied by the manufacturer. Insulating oil supplied (as an integral part or separately) for equipment covered by this specification shall be in accordance with the Owner Specification OE-LRS-20, Revised 4/85, "Insulating Oil."
- ° Oil Data - At the time the transformer is shipped the following oil data shall be supplied by the manufacturer to the Owner.
  - a) Oil supplier and trade name.
  - b) Refining method.
  - c) Origin of crude oil.
  - d) If inhibitors are used, specify characteristics, quantities, and the point in the refining process at which they are added.
  - e) State mixing compatibility with other insulating oils.
  - f) If oil is not suitable for universal application, state limitation.
  - g) Solubility curve: water in oil.

- ° Drainage/Filter Press Connections - Valves for drainage and for filter press connections shall be provided on the transformer in accordance with ANSI Standard C57 and shall include the following:
  - a) A 2" globe type drain valve suitably located for complete drainage and with suitable provision for filter press connection. The drain valve shall have an Ohio Brass #5700 Sampling Device, or Ohio Edison approved equal, located on the discharge side of the valve.
  - b) A 2" globe type valve for filter press connection located near the top-of-the tank.
- ° Vacuum Pump Connection - One 3" diameter threaded pipe shall be installed in a top-of-tank manhole cover for a vacuum pump connection while filling the transformer with oil. The pipe shall be fillet welded to the manhole cover and supplied with a pipe cap.

## 2-13 PAINT

- ° Color - The tank, radiators, and accessories shall be prime-painted, and finish painted with ANSI #49, Horizon Gray. All components shall be painted with the type and manufacturer of primer and finish coatings specified below.
- ° Paint Manufacturer and Type - The paints utilized for this transformer shall be Subox Standard Series rust inhibitive primer and finish coatings containing lead-suboxide pigments, or as an alternative, Subox Permanox rust inhibitive primer and finish coatings containing lead-free alkaline earth pigments as follows:
  - Primer - Subox #11 FD Red Primer (Preferred)  
- Subox Permanox 753 Red Primer (Alternate)
  - Finish Coat - Subox #10 FD Horizon Gray (Preferred)  
- Subox Permanox #7138 Horizon Gray (Alternate)
- ° Application - Surfaces to be painted shall be shotblasted or adequately cleaned to remove all mill scale, dirt, oil, and grease. Each coat of paint shall be applied to yield a dry film thickness of 1.5 - 2.5 mils for both the primer and the finish coat, such that the total paint thickness shall be 3.0 - 5.0 mils dry film thickness.

## 2-14 TRANSPORTATION AND INSTALLATION

- ° Preparation for Shipment - The method of preparation for shipment shall be such as to protect adequately the case, radiators, core and coils, bushings and all other parts and auxiliary devices or accessories against corrosion, dampness, breakage, or vibration injury that might be encountered in transportation and handling. Manner of packaging shall be such as to prevent tampering or pilfering, and to be acceptable to transportation companies.
- ° Method of Shipment - Transformer shall be shipped dry air filled without oil and with radiators/coolers and all bushings removed. A temporary pressure gauge shall be installed to facilitate monitoring internal gas pressure. Valves shall be sealed and effectively protected to prevent tampering, removal or loss of gas while in transit. Purchaser shall be notified by wire the day shipment is made, indicating carriers, routing, actual shipping height and weight of transformer as listed on freight bill.
- ° Rail Car - All transformers shipped by rail shall be shipped on a cushioned underframe type car. If a delay in delivery will result from scheduling this type of car, the Owner shall be notified in sufficient time to decide whether construction schedules will allow such a delay.
- ° Shipping Clearances - The manufacturer shall assume all responsibility for insuring that his design shall meet all necessary clearances for shipping the transformer(s) to the purchaser's installation site. The preferred maximum shipping height is 144 inches.
- ° Rider - The manufacturer shall provide the services of a rider during shipment to expedite shipping of each transformer. The rider shall provide periodic verbal reports to the purchaser of the transformer's location while in transit.
- ° Impact Recorder - The manufacturer shall mount an impact recorder on the railroad car carrying the transformer. This recorder shall be sensitive to vertical shocks as well as shocks in the direction of travel of the car. The charts of this recorder shall be reviewed jointly by personnel from the Owner, the railroad and the manufacturer upon completion of transit. The Owner reserves the right to be supplied with those portions of these charts that indicate switching speeds greater than 4 M.P.H. and equivalent vertical shocks.
- ° Shipment - The manufacturer shall notify the Purchaser's Receiving Agent identified in the Purchase Requisition of the transformer ship date. The Agent shall be notified of this ship date a minimum of 48 hours before the transformer is released from the Manufacturer's factory.

- ° Installation Engineer - The services of a qualified installation engineer shall be furnished for the purpose of supervising field assembly and providing final adjustment of the equipment purchased under this specification.

## 2-15 TESTS

- ° Test Reports - Ten (10) copies of a certified report of the tests are required for the transformer supplied. Reports are to be sent to the Owner within 15 days after completion of tests.
- ° Required Tests - The following tests shall be made in accordance with latest IEEE or ANSI Standards and with the transformer assembled in its own case, with bushings, oil, etc., in the same manner as it will be in service. The tests shall include the following but not necessarily in the order listed:
  - a) Polarity
  - b) Ratio on each no load tap.
  - c) Winding resistance in ohms on each no load tap.
  - d) No load loss watts and exciting current at 100% and 110% of rated voltage.
  - e) Load loss watts at the transformer 55°C rise rating and percent positive sequence impedance on each no load tap. Also provide load loss watt values at the 65°C rating.
  - f) Load loss watts and percent zero sequence impedance on each no load tap.
  - g) Temperature rise test. (Unless test data on duplicate or essentially duplicate unit is available.) The test report shall indicate the top oil and winding temperature rise for 55°C and 65°C test runs.
  - h) Manufacturer's Quality Control Impulse Test on all 138 kV (550 BIL) windings with ground current measurement taken on at least the F.W. test.
  - i) Induced voltage test. All 138 kV windings shall be accompanied by partial discharge/corona (PD) monitoring, performed in accordance with Section 9 of IEEE Standard P-262B-1977 and the latest P-262B committee draft standard with the following exceptions and notations:
    - 1) The no load tap changer shall be set on the full winding tap.
    - 2) Enhancement Level. At the start of the test, an enhancement potential specified in Section 3-0 shall be induced in the HV winding and held for 7200 cycles.
    - 3) One Hour Level. At the end of the 7200 cycles, the induced voltage shall be lowered to the one hour level potential specified in Section 3-0 and be maintained for the remainder of the one hour period.

- 4) The results shall be considered acceptable and no further partial discharge tests shall be required if:
  - (i) The magnitude of the PD level does not exceed 100 microvolts.
  - (ii) The increase in PD levels during the One Hour Level does not exceed 30 microvolts.
  - (iii) The PD levels during the One Hour Level do not exhibit any steadily rising trend and there is no sudden, sustained increase in levels during the last 20 minutes of the tests.
- j) Applied voltage test.
- k) Isolated core to tank resistance. The core to tank resistance measured between the isolated core ground strap and the tank shall be a minimum of 20 megohms with the core installed in the tank and under oil, and shall be measured with a 1000 volt megger. The ambient temperature shall also be recorded.
- l) Insulation Power Factor Test. The power factor of the insulation system of the transformer when measured between the high voltage windings and ground (tank), the low voltage windings and ground (tank), or when measured between any two windings shall not exceed 0.5% corrected to 20°C. Any increase above this value, resulting from material composition, will be acceptable only if detailed engineering data relating to the inherent power factor of the material and the anticipated increase in power factor test values of the transformer are supplied to Mr. W. B. Binder, Jr., General Equipment Application Engineer, Ohio Edison Company, 76 South Main Street, Akron, Ohio 44308 at least two months prior to the shipment of the transformer.
- m) Tank oil leak test
- n) Gas-in-Oil Analyses. These tests shall be performed during various phases of the testing process. Dissolved gasses shall be extracted from a known volume of transformer oil and analyzed using gas chromatography in accordance with ANSI C57.104-1978. Measured concentrations (PPM v to v basis) of each gas shall be itemized on the transformer test report for each test run and shall not exceed the absolute limits established below. If during the process of these tests, limits for Test 1, 3 or 4 are exceeded, the manufacturer shall contact the purchaser before proceeding further. The results shall be considered acceptable and no further Gas-in-Oil Tests shall be required if the limits are not exceeded. A minimum of four (4) Gas-in-Oil Tests shall be performed as indicated.

Absolute Limits for  
Gas-in-Oil Analysis

Gas	Concentration PPM (v to v)			
	Test 1	Test 2	Test 3	Test 4
H <sub>2</sub> Hydrogen	3		30	30
CH <sub>4</sub> Methane	1		5	5
CO Carbon Monoxide*			75	75
CO <sub>2</sub> Carbon Dioxide*			400	400
C <sub>2</sub> H <sub>4</sub> Ethylene	1		5	5
C <sub>2</sub> H <sub>6</sub> Ethane	1		5	5
C <sub>2</sub> H <sub>2</sub> Acetylene	None Detectable		None Detectable	None Detectable

\*In addition to limits stated above, the CO<sub>2</sub>/CO ratio shall not exceed a value of 10 for Tests 3 and 4.

Test 1 Before Any Testing. Limits given represent 10% of the values given for Test 3.

Test 2 Before Temperature Rise Test. Limits are not established, but values should be recorded on the test report.

Test 3 After Temperature Rise Test (but before Dielectric Tests).

Test 4 After Corona Test. Numbers given in this column are absolute PPM values and assume no transformer oil change or degassing process.

° Special Notes -

a) The results of the Core to Tank Resistance and Insulation Power Factor Tests shall be recorded on a tag and inserted in the control cabinet of the transformer prior to shipment. The results of both of these tests shall also be recorded on the test report.

b) All neutral mounted devices shall be disconnected during the Impulse and Applied Voltage Tests.

° Problems During Testing - If the transformer fails to pass the dielectric tests or guaranteed limits specified, the Purchaser shall be notified immediately by wire or phone for a decision on

the acceptability of the transformer. If a failure occurs, additional tests shall be made as required to locate the failure. After repair or rebuilding, the required tests shall be repeated.

- ° Test Results - The test report shall include the results of all of the above tests except the impulse test, together with quantity of oil used with the temperature rise test, efficiency, regulation and exciting current at the same points given in the manufacturer's proposal, and the percent impedance between windings, stating the kVA base. The percent impedance (both positive and zero sequence) shall be shown for EACH tap position; the nameplate shall show the impedance for the nominal voltage tap only. A zero sequence impedance diagram may be included with the test report for all taps in lieu of individual zero sequence winding impedances.
- ° Advance Notice - The manufacturer shall give advance notice of all testing, particularly the impulse and induced voltage/corona tests, and the purchaser reserves the right to witness any tests performed. The ANSI Standard impulse test may be required at any time prior to the impulse test, for additional quoted charge.

## 2-16 PRELIMINARY DATA AND DRAWINGS

The manufacturer shall furnish for approval, four (4) prints and one (1) "Full Sized" Reproducible Mylar of the following data and drawings suitable for construction purposes to the Owner.

- a) Transformer Outline Drawing showing:
  - 1) base detail illustrating load bearing areas, recommended pier spacing (where applicable) and tank handling facilities.
  - 2) overall weight, width, length and height.
  - 3) shipping weight, width, length and height.
  - 4) center lines of gravity in each direction of both the complete oil filled unit and the unit without oil in its stripped shipping state.

- 5) summary of all actual live part clearances with minimum values.
- 6) detail of core ground connection.
- 7) indication of conduit material type.
- 8) location and details of control cabinet.
- 9) location and details of the top oil and winding temperature indicators.
- 10) height of bushings and lightning arresters above the tank.
- 11) indication that the tank color is ANSI #49 Horizon Gray.
- 12) indication of future equipment such as BTCT's shown with dotted lines.
- 13) location and details of a pressure vacuum gauge.
- 14) location and details of the Inert Gas-Pressure Oil Preservation System
- 15) verification of the following specified items and details:
  - (a) an oil level gauge with ungrounded alarm contacts.
  - (b) a sudden pressure relay and test valve piping details.
  - (c) a self-resealing pressure relief device with ungrounded alarm contacts.
  - (d) an additional oil thermometer well.
  - (e) a tap changer handle with provisions for padlocking.
  - (f) ground pads.
  - (g) drain and filter press valves.
  - (h) a sampling device, either Ohio Brass #5700 or proposed alternate with detailed drawings and other descriptive data, including manufacturer and catalog number.
  - (i) a vacuum pump connection.
  - (j) radiator valve details with detailed drawings and other descriptive data, including manufacturer and catalog number.

- b) Bushing Outline Drawings showing:
- 1) indication of strike distance and other dimensional data.
  - 2) indication of creep distance if not expressly indicated in readily available catalog information.
  - 3) indication that the color is ANSI #70 Light Gray.
  - 4) Bushing stud diameters and threading details.
  - 5) location and detail of power factor test tap.
  - 6) indication whether the bushing is a draw-thru lead or bottom connected type for this application (may be indicated on TR outline).
  - 7) indication of bushing interchangeability.
  - 8) detail of bushing nameplate
  - 9) All dimensions shown in the applicable Dimensions of Outdoor Power Apparatus Bushing tables from ANSI/IEEE Std. 24-1984 shall be indicated.
- c) Lightning Arrester Outline Drawings showing:
- 1) indication of strike distance.
  - 2) indication that the color is ANSI #70 Light Gray.
  - 3) location and detail of clamp type terminals.
- d) Nameplate Drawing, preferably on standard A size drawing and in no case on any larger drawing than standard B size drawing, showing:
- 1) all data required by ANSI C57.12.00- 1980.
  - 2) polarity of all CTs.
  - 3) indication of provision for meter seal or tap screws.
  - 4) crane lift to untank.
  - 5) provisions for future equipment, for example, CTs.
  - 6) guaranteed sound level in decibels.
  - 7) winding conductor material, either copper or aluminum.

- e) Schematic and detail wiring diagrams for control and accessories showing:
- 1) location of purchaser's connections.
  - 2) indication of supply voltage.
  - 3) ground connections.
  - 4) terminal blocks.
  - 5) indication of special LC terminal block nameplate (when required on page 1C).
  - 6) indication of auxiliary breaker type.

NOTE: All detail wiring diagrams and wiring lists shall clearly indicate the wire physical routing with each wire's origin, destination and size included on these prints.

- f) Current Transformer Application Data in accordance with ANSI C57.13-1978 showing:
- 1) connection diagrams where applicable
  - 2) ratio correction factor curves
  - 3) excitation current data
  - 4) accuracy class
  - 5) indication of lead & secondary winding resistance.
- g) Linear Coupler Data (when LCs are required on page 1A).
- h) Bushing Potential Device Data (when BPD's are required on page 1A).

## 2-17 FINAL DRAWINGS

- ° Required Drawings - Ten (10) fully certified prints and two (2) "Full Sized" Reproducible Mylars of each drawing listed in section 16-0 supplemented by the following shall be supplied and sent to the Owner.
- a) ten (10) installation, operation and maintenance instruction books which include a listing of recommended spare parts to be maintained as spares by the purchaser. The instruction books shall contain instruction leaflets for all transformer accessories such as lightning arresters, sudden pressure/fault pressure relay, pressure relief device, NLTC, cooling equipment, pumps (if supplied), radiator valve instruction leaflet, etc.
  - b) ten (10) sets of drawings adequate to facilitate any necessary field assembly

- c) ten (10) copies of linear coupler instruction books, wiring diagrams, nameplate drawings and characteristics.
- ° Additional Documentation - Not more than fifteen days after shipment the following shall be supplied for each transformer:
  - a) two sets of photographs (8-1/2"x11") or drawings showing the plan and elevation of the interior assembly
  - b) ten (10) copies of the linear coupler test reports with impedance test values of resistance and reactance.
- ° Aperture Cards - In addition, a copy of each of the drawings and test reports for each transformer shall be furnished on 35 mm standard aperture cards having a film quality that complies with U.S. military specification MIL-M-9868D (2) dated September 20, 1982.

## 2-18 INSPECTION

Transformers shall be subject to inspection at any time by the purchaser. In addition, the manufacturer shall give advance notice of the following manufacturing points so that an inspection can be made by the purchaser after the manufacturer's quality control inspection has been completed:

1. completion of the windings immediately prior to "loading"
2. completion of the core and coil assembly immediately prior to tanking.
3. completion of tanking immediately prior to testing (see Section 15).

EA786/001/2

SPECIFICATION FOR INSULATING OIL

SCOPE

This specification covers insulating oil purchased with or as part of new equipment as well as oil purchased separately in drums or tank cars for use in all power transformers, distribution transformers, oil circuit breakers, voltage regulators, oil circuit reclosers, and oil switches.

SPECIAL REQUIREMENTS

24 The manufacturer of equipment who furnishes insulating oil as a component of an equipment order shall be responsible for insuring that the oil supplied is free asphenic crudes and was refined through a process generally accepted in the utility industry. The oil shall contain less than 1 PPM of Polychlorinated Biphenyls (PCBs).

NEW OIL TEST REQUIREMENTS

Insulating oil must conform to all of the requirements of American Society for Testing and Materials Standard Specification for Mineral Insulating Oil used in Electrical Apparatus, ASTM D-3487 latest revision, except as modified by these specifications.

Type I Mineral Oil shall be used for substation transformers and all oil circuit breakers.

24 Type II Mineral Oil shall be used for distribution transformers, voltage regulators, oil circuit reclosers and oil switches.

TEST REPORTS

The manufacturer shall provide three (3) certified copies of oil test reports for oil circuit breakers, with a voltage rating of 138 kV or above and power transformers larger than 10,000 kVA, with a voltage rating of 138 kV or above. The test reports shall be sent to the General Equipment Application Engineer, Ohio Edison Company, 76 South Main Street, Akron, Ohio 44308, prior to shipment.

Upon request, three (3) certified copies of oil test reports supplied for equipment rated below 138 kV shall be sent to the following:

- 1) General Equipment Application Engineer for substation equipment.
- 2) General Distribution Engineer for distribution equipment.

Retyped for Revision 2

ZEAS/019

APPROVED  
DATE

SPECIFICATIONS

OHIO EDISON CO

SPECIFICATION FOR  
NEUTRAL GROUNDING RESISTORS

All resistor(s) shall be designed in accordance with IEEE Standard 32-1972 insofar as is consistent with this specification. The resistor shall consist of stainless steel resistor elements mounted in a grounded louvered safety enclosure.

1-0 RATINGS

Resistance	<u>6</u>	(ohms) Resistance shall not go below 4 ohms.
Voltage Rating	<u>5</u>	(kV line to grd.) Resistor shall be rated for constant voltage.
Current Rating	<u>400</u>	(A)
Time Rating (@ Current Rating Above)	<u>10</u>	(sec)

2-0 APPLICATION

<u>Outdoor</u>	<u>Service</u>
<u>Ground Fault Current Limiting</u>	<u>Use Intended</u>

3-0 DIELECTRIC REQUIREMENTS

The resistor shall have dielectric strength as shown below and in accordance with IEEE Standard 32-1972.

<u>Nominal Insulation Class</u>	<u>Applied Potential Low Frequency Test (kV Rms)</u>
5 kV	13.5

4-0 MOUNTING

Vertical Stack

5-0 TERMINALS

The terminal connectors shall be "NEMA 4 hole drilling" blade type in accordance with ANSI Standards.

6-0 NAMEPLATE

The Neutral Grounding Resistor shall be provided with a corrosion-resistant nameplate with all applicable data specified in IEEE Standard 32-1972.

SPECIFICATION FOR  
NEUTRAL GROUNDING RESISTORS

7-0 SPECIAL REQUIREMENTS

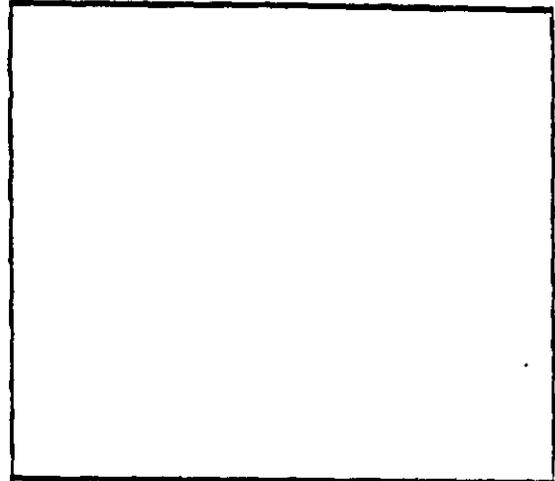
7-1 Terminals shall be located with respect to the base insulator supports as indicated in this drawing.

7-2 Post type insulators are required.

7-3 Terminals are to be electro-tin plated.

7-4 Resistor Element shall be stainless steel

7-5 C.T. Requirements are shown on Page 2-1



8-0

Fourteen (14) copies of certified report of tests are required and shall be sent to the Owner within 15 days after completion of tests. These tests shall be made in accordance with IEEE Standard 32-1972 with the resistor fully assembled for normal service. The report shall include results of the Applied Potential Test and resistance measurements. Temperature test(s) shall be made on an assembled resistor only if no record of a temperature test, made in accordance with IEEE Standard 32-1972, on a duplicate or essentially duplicate design, is available.

9-0 PRELIMINARY DATA AND DRAWINGS

9-1 The manufacturer shall furnish preliminary data suitable for construction plans including overall dimensions, weights, terminal locations, terminal dimensions, terminal current rating, and location of support insulators.

9-2 Three (3) copies of the following drawings shall be sent the Owner.

SPECIFICATION FOR  
NEUTRAL GROUNDING RESISTORS

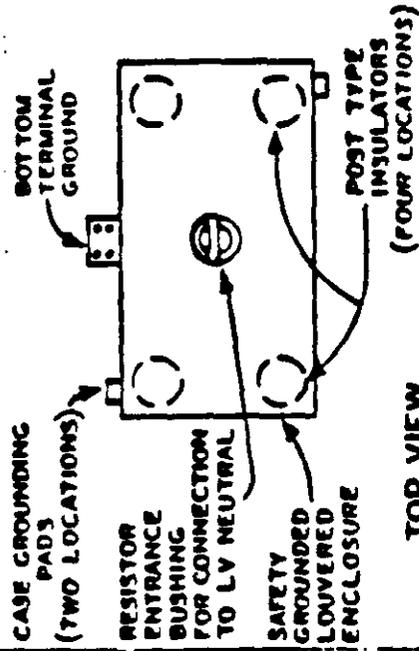
Resistor Outline  
Terminal Connector Outline  
Insulator Outline Including Mounting Details  
Resistor Nameplate Drawing

10-0 FINAL DRAWINGS

Not more than three months after approval, fourteen (14) certified prints and two (2) "Full Sized" Mylars of the above drawings supplemented by the following shall be supplied:

Fourteen (14) Instructions Books with a list of the manufacturer's recommended spare parts.

Fourteen (14) sets of adequate drawings to facilitate any necessary field assembly.



**TOP VIEW**

3.0	<u>QUALITY ASSURANCE</u>	1.8
3.1	<u>Quality Assurance Program Requirements</u>	1.11
3.1.1	<u>QA Program</u>	1.12
	The Seller shall have in effect at all times a quality assurance (QA) Program which clearly establishes the authority and responsibility of those responsible for the QA Program. Persons performing quality functions shall have sufficient and well-defined responsibility and authority to enforce quality requirements, to identify, initiate, recommend, and provide solutions to quality problems, and to verify the effectiveness of the solutions. No submittal of this QA Program is required.	1.13 1.14 1.15 1.16 1.17 1.18
3.1.2	<u>Seller's Responsibility for Suppliers</u>	1.20
	The Seller shall identify, in purchase documents to his suppliers, all applicable quality and QA requirements imposed by the Engineers' specification on the Seller and shall ensure compliance thereto.	1.21 1.22
3.2	<u>Tests</u>	1.26
	The transformers shall be tested in accordance with Specification No. ID-46.	1.27
	Written records shall be kept for each test showing date, equipment tested, test method and test results. Test records and certificates of final inspection or approval shall be submitted to the Purchaser for each test within 10 working days after test completion.	1.29 1.30 1.31
	The Seller shall be responsible for compliance with his standard in-production test procedures.	1.32
3.3	<u>Documentation</u>	1.34
3.3.1	<u>Record System</u>	1.35
	A records system shall be established and maintained that provides for the identification and correlation of test and inspection records and certificates.	1.36 1.37
3.3.2	<u>Final Inspection and Check of Records</u>	1.40
	The Seller shall be responsible for inspecting the item(s) and checking the applicable records, prior to shipment, to verify that all specification requirements have been complied with. Two complete sets of all documents required to comply with this specification shall be submitted to the Purchaser. Acceptance of the completed sets of records does not relieve the Seller of responsibility for compliance with specification requirements.	1.41 1.42 1.44 1.45 1.46

3.4 <u>Warranty</u>	1.48
The Seller shall warrant for a period of 12 months from the in-service date or 18 months from the shipment date (whichever occurs first) all equipment supplied is free from defects in design, material, and workmanship. The Seller shall also warrant the equipment supplied is suitable for the intended installation and operation as described in this Specification.	1.49 1.51 1.52 1.53
In the event that the equipment fails to achieve the warranted performance, then, to the extent that the deficiency or failure to achieve the warranted performance is attributable to equipment supplied by the Seller, the Seller shall make such adjustments or modifications to enable the equipment to achieve the warranted performance. The cost of these adjustments or modifications shall be to the Seller's account. After such adjustments or modifications, should the equipment fail to achieve warranted performance, an equitable settlement shall be made, which may without limitation include an adjustment of purchase order price.	1.54 1.56 1.57 1.59 2.1 2.2
3.5 <u>Field Tests</u>	2.4
The Purchaser may conduct field tests at his own expense to verify performance guarantees under the actual working condition. Where the tests reveal deficiencies in the equipment or deviations from the guaranteed performance, the Seller shall be completely responsible for any modifications, repairs, and/or adjustments required to meet the equipment performance guarantees.	2.5 2.7 2.8 2.9
Should additional field testing be required to verify performance guarantees, the cost for the field representative and required materials shall be at the Seller's expense.	2.10 2.11

4.0 PREPARATION FOR SHIPMENT

1.8

Packaging shall be adequate to prevent contamination, mechanical damage, 1.11  
 or deterioration of the item supplied. These requirements are 1.12  
 applicable immediately after manufacture.

The Seller shall identify desiccants and inhibitors used and the 1.13  
 required replacement frequency.

Expendable materials, such as tapes, barriers, plugs, desiccants, 1.14  
 desiccant bags, inhibitors, etc., in contact with austenitic stainless 1.15  
 steel or nickel alloys shall not contribute to corrosion during the  
 storage period, by, for example, water or condensate leaching 1.16  
 deleterious chemicals contained in the expendable materials.  
 Objectionable chemicals contain lead, mercury, chlorides, fluorides, 1.17  
 sulfur, and zinc.

Items shall be inspected for cleanliness immediately before packaging. 1.18  
 All openings into items shall be sealed or plugged. Weld-end 1.20  
 preparations shall be protected against corrosion and physical damage.  
 Entrapped water shall be removed. 1.21

The outermost covering shall be clearly marked with the complete vendor 1.22  
 identification which shall include weight.

The equipment shall be packaged for indoor storage. 1.23

The weight lifting points, indicated on the crate, skid, or package, 1.24  
 shall be utilized for all handling procedures.

<u>5.0 SUPPLEMENTAL PROVISIONS</u>	1.8
<u>5.1 Deviations and Nonconformances</u>	1.11
No deviation or nonconformance from this specification or applicable federal, state, or local codes and standards invoked by this specification shall be accepted until approved by the Engineers.	1.12
Deviations are considered departures from any requirement of this specification. Uncorrectable nonconformances are considered to be conditions which cannot be corrected within the specification requirements by rework or replacement.	1.13
	1.14
	1.15
	1.16
The Seller shall promptly document and notify the Engineers of all deviations and nonconformances from the specification (such as deviations from applicable codes and/or drawings). Further manufacturing after detection of any deviation or nonconformance prior to the Engineers' approval shall be at the Seller's risk. No departure from the specification shall be binding on any party until an addendum or revision to the specification has been issued by the Engineers.	1.17
	1.18
	1.19
	1.20
<u>5.2 Correspondence</u>	1.22
All correspondence from the Seller shall consist of an original plus two copies and shall contain the following subject heading:	1.23
	1.24
Purchase Order No. (later)	1.28
J.O. No. 15164.00	1.29
5000 kVA, 23kV-2400/4160 V Transformer	1.30
LIMS Demonstration Project	1.31
Edgewater Station, Unit No. 4	1.32
Babcock & Wilcox Company	1.33
Bid documents and contractual correspondence relative to or affecting prices, terms, conditions, price adjustment, deliveries, return of materials for credit, routing of shipments, or that which changes the price or scope of an order even though also discussing engineering matters shall be addressed to:	1.37
	1.38
Babcock & Wilcox Company	1.41
Copy to:	1.46
Mr. John H. Davies	1.49
Stone & Webster Engineering Corporation	1.50
P.O. Box 2325 245/6	1.51
Boston, Massachusetts 02107	1.52

Correspondence relative to inspection, expediting, technical matters, and transmittal of manufacturer's drawings, spare parts list, and operating instructions shall be addressed to:	1.56
Babcock & Wilcox Company	1.59
with a copy to Mr. Davies of Stone & Webster.	2.5
<u>5.3 Subsuppliers</u>	2.7
Should the Seller propose to purchase from another supplier any of the equipment, material, or services specified herein, he shall, upon request, identify the subsupplier for the specific equipment, material, or services itemized by the Engineers.	2.8 2.9 2.10
To the extent that they apply, the Seller shall impose on each of the subsuppliers the complete requirements of this specification. He shall be directly responsible that the subsuppliers are completely aware of all of these requirements, and that they abide thereby.	2.12 2.14 2.15
<u>5.4 Release for Material Purchase or Fabrication</u>	2.17
Written approval to the Seller to start fabrication of the equipment covered by this specification will be provided by the Purchaser. Fabrication is to be based on drawings and procedures reviewed and approved by the Engineers as required by the specification.	2.16 2.19 2.21 2.22
<u>5.5 Tools and Spare Parts</u>	2.24
One complete set of all special* tools, fixtures, and appurtenances required for maintenance and operation shall be furnished. (*"Special" is defined as anything not normally and usually available in a power station or readily available thereto.)	2.25 2.26
The Seller shall itemize on the attached Data Sheet the special tools that will be furnished.	2.29
A detailed list of all recommended spare parts shall be provided by the Seller. This list shall include the cost, location, and address of the local supplier, generic description of the part, and the Seller's normal delivery time.	2.30 2.31 2.32
<u>5.6 Installation, Operating, and Maintenance Instructions</u>	2.34
No later than one month before initial shipment, the Seller shall submit to the Engineers' Project Engineer 12 bound copies of a complete installation, operating, and maintenance manual for the equipment furnished, including instructions for individual components. All final	2.35 2.36 2.39

instructions shall be certified by the manufacturer as applicable to the equipment furnished, and shall be specifically identified, such as by serial number. The Seller shall inscribe the following identification on the cover; the words OPERATION AND MAINTENANCE MANUAL, the name and location of the equipment, the name of the manufacturer, and the contract number. The manual shall include the names, addresses, and telephone numbers of other equipment suppliers, and of the local representatives. The manual shall have a table of contents and be assembled to conform to the table of contents with the tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in. The manual shall include: wiring and control diagrams with data to explain detailed operation and control of each item of equipment; description of the function of each principal item of equipment; installation instructions; maintenance instructions; lubrication schedule including type, grade, temperature range, and frequency; safety precautions, diagrams, and illustrations; test procedures; and performance data.

One additional set of instructions, certified by the manufacturer, shall be packed and sent with the equipment to the jobsite. A parts identification list shall accompany each set of instructions. This list shall include sectional and/or outline prints or illustrations identifying each numbered part and location in relation to the equipment as a whole. The parts list for equipment shall indicate the source of supply and recommended spare parts.

#### 5.7 Data and Drawings

After the order is placed, the Seller shall submit all drawings in accordance with the agreed-upon schedule. The drawings submitted shall show the following:

1. All physical outlines, as required, to show the overall size and space requirements (including that for dismantling and maintenance) and the interrelationship of the various components
2. Cross sections and details, as required, to satisfy the Engineers and Purchaser that all components are in conformance with the intent of the specification and are satisfactory from the standpoint of design and physical arrangement
3. All information required by the Engineers for the design and location of all connecting Purchaser-furnished structural or electrical items such as steel supports, cables, conduit, etc.
4. Weight of the equipment and distribution of the static and other loads

As a minimum, the following data and drawings are required:	3.15
1. Equipment arrangement drawing	3.17
2. Elementary diagrams	3.18
3. Wiring diagrams for circuit breaker and wiring between circuit breakers and external devices	3.19
4. Bill of Materials	3.20
5. One Installation, Operation, and Maintenance Manual for review	3.21
The Engineers' job order number and purchase order number shall be shown on each drawing.	3.23
All drawings submitted shall be in the form of one good quality reproducible and three good, sharp, black and white, direct contact prints of the Seller's original drawing.	3.24
After review by the Engineers, one direct contact print marked APPROVED or APPROVED AS REVISED will be returned to the Seller. If marked APPROVED AS REVISED, the required changes shall be incorporated by the Seller, clearly identified, and be resubmitted to the Engineers. If the Seller elects not to incorporate the revisions, he shall inform the Engineers that the suggested revisions cannot be made without prejudice to the Seller's responsibility under warranty.	3.25 3.26 3.27
Arrangements for production scheduling and the procurement of the necessary materials shall not be deferred pending approval of drawings.	3.28
The Engineers and Purchaser reserve the right to reproduce any drawing or print received from the Seller, as may be required during the design and construction of this project and the preparation of a plant manual, despite any notice prohibiting the same appearing on the drawing or print.	3.29 3.30
<u>5.8 Proposal Requirements</u>	3.32
The bidder shall furnish with his bid a list of all equipment he proposes to use. Deviations from any of the Engineers' requirements must be clearly defined along with the reason(s) for the proposed change(s). All data sheets shall be filled-in. The following data and drawings are required with the bid package:	3.33 3.35 3.36
1. Preliminary Bill of Material	3.40
2. Outline drawings showing the general arrangement and approximate dimensions of the equipment proposed	3.41 3.42

5.9 Schedule 3.45

The following schedule, or a revision of it, as agreed upon by the Seller and the Engineers before the purchase order is placed and included with the purchase order, shall be binding upon the Seller. 3.46  
3.48

<u>Milestone</u>	<u>Date</u>	3.51
1. Bid due date		3.53
2. Award purchase order		3.54
3. Initial drawing submittal		3.55
4. Equipment delivery date		3.56

Specification for	1.13
<u>5 KV METAL-CLAD SWITCHGEAR</u>	1.15
Limestone Injection Multistage Burner (LIMB)	1.17
Demonstration Project	1.18
Ohio Edison Company's	1.19
Edgewater Station	1.20
Babcock & Wilcox Company (Owner)	1.22

	<u>APPROVED</u>	1.25	
	<u>Signature</u>	<u>Date</u>	1.27
Preparer	<i>[Signature]</i>	6/30/87	1.29
Lead Engineer	<i>[Signature]</i>	6/30/87	1.30
Project Engr	<i>[Signature]</i>	7-1-87	1.31

Stone & Webster Engineering Corporation (ENGINEER)  
Boston, Massachusetts

Specification for

5 KV METAL-CLAD SWITCHGEAR

Limestone Injection Multistage Burner (LIMB)  
Demonstration Project  
Ohio Edison Company's  
Edgewater Station

Babcock & Wilcox Company (Owner)

1.0 SCOPE

This addendum No. 1 summarizes all changes to the specification to date.

2.0 CHANGES

<u>ITEM</u>	<u>CHANGES TO SPECIFICATION</u>
1.	Delete: Pages 1,6,7, & 9 of Section 2.0 Technical Requirements Add: Pages 1,6,7, & 9 of Section 2.0 Technical Requirements (Attached)
2.	Delete: Pages 5-1 & 5-4 Add: Pages 5-1 & 5-4 (Attached)
3.	Delete: Drawing No. 15164.09-ESK-002, 4160V-One Line Diagram Add: Drawing No. 15164.09-ESK-002, 4160V-One Line Diagram (Issue 3, dated 9/4/87) (Attached)
4.	Add: Protective Relay List (Attached)

APPROVED

	<u>Signature</u>	<u>Date</u>
Preparer	<u>M. E. Vachon</u>	<u>9-15-87</u>
Lead Engineer	<u>D. G. Donatelli</u>	<u>9-15-87</u>
Project Engineer	<u>J. H. Davis</u>	<u>9-16-87</u>

Stone & Webster Engineering Corporation (ENGINEER)  
Boston, Massachusetts

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DRAWINGS AND SKETCHES		1.41

1.0	<u>GENERAL</u>	1.8
1.1	<u>Scope</u>	1.11
	This specification details the performance, design and manufacturing requirements for furnishing and delivering 5 kV metal-clad switchgear for the LIME Demonstration Project being conducted by Babcock and Wilcox at Ohio Edison Company's Edgewater Station, Unit No. 4.	1.12 1.13 1.14 1.16
1.2	<u>Definitions</u>	1.17
	Terms used throughout this specification are defined as follows:	1.18
	Seller - The company accepting the overall responsibility for fulfilling the requirements of this specification	1.20
	Engineers - Stone & Webster Engineering Corporation (SWEC), a Massachusetts corporation, or its duly authorized agencies restricted to the performance of the particular duties entrusted to them by the Purchaser	1.21 1.22 1.23
	Purchaser - Babcock & Wilcox Company (Owner)	1.25 1.27
	Approved - This word, when applied by the Engineers to the Seller's drawings or documents, means that the drawings or documents are satisfactory in that the Engineers have not observed any statement or feature that appears to deviate from the requirements. The Seller shall retain the entire responsibility for complete conformance with all of the requirements.	1.33 1.34 1.36 1.38
	Approved - These words, when applied by the Engineers to the Seller's documents, mean that the documents are approved as defined above, except that the changes shown are necessary to be in conformance with the requirements. On the basis that the Seller shall retain the entire responsibility for compliance with all of the requirements, the Seller shall either:	1.41 1.42 1.44 1.46 1.47
	a. Incorporate the changes into his document and resubmit to the Engineers, or	1.50
	b. Inform the Engineers that the changes cannot be made without prejudice to the Seller's responsibility under warranty, and resubmit them with full explanation of the reasons therefor.	1.51 1.52
1.3	<u>Furnished by Seller</u>	1.54
	The Seller shall furnish equipment, material and services as follows:	1.55

<u>Item</u>	<u>Quantity</u>	<u>Description</u>	
			1.59
1	1	5 kV metal-clad switchgear bus in accordance with attached specification	2.2 2.3 2.4
2		Drawings and documentation	2.6
3		Installation instructions	2.8
4		Operation and maintenance manual	2.10 2.11
1.4		<u>Furnished by Purchaser</u>	2.15
		The Purchaser shall furnish:	2.17
		1. Handling, unloading and installation	2.20
		2. External wiring	2.21
1.5		<u>Project Type, Location, and Site Conditions</u>	2.24
		The equipment specified will be used for power supply to other electrical loads. This is part of Babcock & Wilcox's LIME Demonstration Project at Ohio Edison Company's Edgewater Station, Unit No. 4 located in Lorain, Ohio. Edgewater Station is located on the shore of Lake Erie.	2.25 2.27 2.28 2.29
		The site is accessible via truck and rail. Maximum and minimum design ambient temperatures are 95°F and 0°F, respectively.	2.31

## 2.0 TECHNICAL REQUIREMENTS

This specification covers the technical and quality requirements for the design, fabrication, testing and delivery of the metal-clad switch-gear shown below.

### Ratings and Quantity

Quantity: 1 Line-Up

Rated Maximum Voltage: 4.76 kV

Rated Interrupting Current at rated Max. kV: 29 kA rms

Rated Voltage range Factor, k: 1.24

Three Second Current Rating: 36 kA rms

Closing and Latching Capability: 58 kA rms

Continuous Current Rating: 1200 A

### Attachments

	<u>Drawing No.</u>	<u>Issue</u>	<u>Description</u>
I.	15164.09-ESK-002	3	4160 V One Line Diagram
II.	Protective Relay List		

Main Bus Requirements

Capacity: 1200 - A

Voltage: 5 kV

Conductor Material: Copper

Joint: Silver-Plated and Bolted Connections

Interior and Exterior Color: ANSI No. 61 Gray

Special Requirements:

None

Identification and Delivery Requirements

Location: \_\_\_\_\_

Delivery Required: \_\_\_\_\_

Prepared by: \_\_\_\_\_

## 2.1 Scope

This specification covers indoor metal-clad switchgear utilizing oilless, three pole, "Air-Magnetic" or "SF<sub>6</sub> Gas" circuit breakers. Equipment to be furnished shall be in accordance with the latest ANSI and NEMA standards, in particular ANSI C37.20-1969/C37.20C-1974, Draft C37.20.2-19XX (D/14, 5/03/85), NEMA SG5-1981 and ANSI C37.06-1979, insofar as is consistent with this specification. The quantity and ratings of the equipment are specified on Page 1. The entire switchgear including circuit breakers, instrument transformers, buses, relay and control panels, and all accessory equipment shall be designed and completely assembled and tested at the factory and ready for operation on delivery. It shall be furnished with all necessary control and auxiliary equipment for satisfactory operation except for that equipment to be supplied by Owner as specifically indicated in this specification.

## 2.2 General Cubicle Requirements

- The metal-clad switchgear structure shall consist of unit type, self-supporting, completely enclosed stationary housings consisting of high tensile strength sheet steel treated with suitable corrosion resistant undercoatings and finishes. Metal thickness shall be no less than No. 11 MSG (Manufacturer's Standard Gauge). Finish shall be phosphatized prior to painting. External and internal surfaces shall receive one coat of corrosion-resisting paint. Color shall be Light Gray No. 61.
- The switchgear structure shall be designed so that additional units may be readily added to either end of the line-up.
- Individual units shall be completely isolated from adjacent units by sheet steel barriers. Where buses penetrate barriers, suitable bushings or other insulation shall be provided to minimize the possibility of communicating faults between primary sections.
- Ventilation louvers shall be designed to prevent the entrance of water and other foreign material. When outdoor switchgear is specified, the enclosure shall also be designed to prevent the entrance of blowing snow.

## 2.2 General Cubicle Requirements (Cont'd)

- ° The front of each unit shall have a full length hinged metal door. All relays, meters, indicating lights, and control switches shall be mounted on the door. They shall be mounted so that they can be viewed from the front while the door is closed. The door shall be designed to prevent the inadvertent operation or damage of relays while the door is being opened or closed. The door shall have a latching mechanism in the full open position and be designed to allow breaker removal without interference with door mounted devices.
- ° A removable panel on the rear of each unit shall be provided for access to the power cable compartment. Power cable interface requirements, if necessary, are specified on attachments.

## 2.3 Breaker Compartment Requirements

- ° Connected, test, and withdrawn positions shall be provided for each breaker unit.
- ° Grounded metal safety shutters or non-metallic shutters made of insulating material which automatically close to cover the stationary primary contacts whenever the breaker is removed from the connected position shall be provided.
- ° A mechanical interlock shall be provided to prevent the breaker from being inserted or withdrawn from the connected position while the breaker is closed.
- ° The racking mechanism shall be designed to prevent overtravel of the breaker when moving it into the connected, test, or withdrawn positions and to latch the breaker in each position. Provisions for padlocking the breaker in the test or withdrawn positions shall be provided. Positive means of indication shall be provided to indicate whether the breaker is in the connected, test, or withdrawn positions.
- ° The breaker mechanism shall be designed so that the stored energy device is discharged when the breaker is withdrawn from or inserted into the breaker compartment.
- ° Circuit breakers of the same rating shall be completely interchangeable.

2.3 Breaker Compartment Requirements (Cont'd)

- ° The stationary primary disconnecting contacts shall be constructed of silver plated copper. All movable contact fingers and springs shall be mounted on the circuit breaker where they may easily be inspected.

2.4 Main Bus and Tap Requirements

- ° Main bus voltage ratings, capacity ratings, conductor material and joint requirements are specified on Page 2. Thermal limits shall be defined by ANSI C37.20C-1974, paragraph 4.4.
- ° Bus bars, connections, joints, taps and supports shall be guaranteed to withstand without damage all electrical, mechanical, and thermal stresses due to short circuits of a magnitude equal to or greater than the interrupting rating of the circuit breaker specified on Page 1.
- ° Removable panels shall be provided for access to the bus compartment.
- ° Bus conductors shall be insulated with flame-retardant, non-hygroscopic insulation and use flame-retardant track resistant polyester glass or porcelain bus insulators.
- ° Taps to breakers shall have a voltage and thermal rating at least equal to the breaker rating. The thermal rating of the tap shall be defined by ANSI C37.20C-1974, paragraph 4.4.5.

2.5 Ground Bus and Control Bus Requirements

- ° The copper ground bus shall be capable of carrying at least 600 amperes continuous capacity and a minimum momentary rating equal to the momentary rating of the circuit breaker for a time duration of 2 seconds. It should extend through the length of the switchgear line-up. Each unit shall be grounded to the bus using solderless cable connections. Standard two-hole NEMA termination (NEMA CCl.4.05-1975) shall be provided at each end of the ground bus for connection to Ohio Edison's ground system.
- ° A 125V DC control bus running the full length of the line-up and isolated from the high voltage compartment shall be provided. Two 2-pole thermal magnetic breakers, Westinghouse type "AB" or Owner approved equal shall be provided at each cell for individual breaker close and trip circuit protection. The source leads for the DC bus shall enter the line-up as specified in the attachments.

## 2.6 Circuit Breaker Requirements

- ° Circuit breakers shall have ratings in accordance with ANSI standard C37.06-1979, Table 2. Interrupting ratings are specified on Page 1. Dielectric requirements are summarized below:

Rated Maximum Voltage (r.m.s.)	<u>4.76 kV</u>	<u>8.25 kV</u>	<u>15 kV</u>
Impulse FW Withstand	60 kV	95 kV	95 kV
Low Frequency Withstand (r.m.s.)	19 kV	36 kV	36 kV

- ° Circuit breakers shall have a maximum rated interrupting time of 5 cycles and a rated permissible tripping delay of 2 seconds.
- ° Circuit breakers shall be electrically and mechanically trip free and shall be equipped with an antipump feature.
- ° Circuit breakers shall be supplied with a manual trip device for emergency operation complete with a lockout contact in the close circuit.

## 2.7 Circuit Breaker Control and Wiring

- ° The circuit breaker close and trip control shall be as follows:
  - a. When the breaker is in the connected position, remote or local closing is permitted.
  - b. When the breaker is in the connected position, remote or local tripping is permitted.
  - c. When the breaker is in the test position, only local closing and tripping is permitted.
- ° Electrically separate and convertible breaker auxiliary switch contacts shall be provided for each breaker. Auxiliary contacts and control contacts shall be operable in the connected or test positions. All connections shall be disconnected in the withdrawn position. A minimum of ten unused convertible contacts (5 N.O. and 5 N.C.) shall be provided for user connections. All auxiliary contacts shall be wired to Marathon Series 1500 STRC (stud-type riveted construction) terminal blocks.
- ° A minimum of ten unused stationary contacts (5 N.O. and 5 N.C.) shall be provided for user connection.

## 2.7 Circuit Breaker Control and Wiring (Cont'd)

- A cell switch (connected or test position indicator switch) that changes state when the breaker is moved from the connected to the test position shall be provided with a minimum of four unused convertible contacts for user connections. One purpose of this switch is to permit the breaker to be opened and closed in the test position.
- Devices in the closing circuit shall operate successfully and without damage for a voltage range of 90 to 140 V.D.C. Devices in the tripping circuit shall operate successfully and without damage for a voltage range of 70 to 140 V.D.C.
- All terminal blocks including those used for instrument transformer secondary leads shall be Marathon Series 1500 STRC stud type or Ohio Edison approved equal. Terminal blocks shall have at least 20 percent spare positions. An additional spare 12-point terminal block for each unit shall be provided for Ohio Edison use. All terminal blocks shall be marked corresponding to the identification on the supplier's wiring diagrams.
- All control wire shall be Type SIS, minimum #14 AWG copper, 7 strand flame-retardant, cross-lined polyethylene insulated rated 600 volts and for 90°C continuous operation in accordance with Ohio Edison Specification No. OE-BSC-41. All instrument transformer secondary wiring shall be #12 AWG copper, 7 strand wire or larger when specified in the bill of materials.
- All control switches shall be Westinghouse Type W.-2
- AMP Special Products PIDG industrial preinsulated, grip-pressure type, ring-tongue lug connectors with copper sleeves and insulated sleeves or Ohio Edison approved equal shall be used for all connections; including relays, switches and terminal blocks. "Equal" terminal connectors shall consist of seamless metal sleeves or brazed seams on the barrel. Soldered terminals or butted seams on terminal connectors shall not be used. The terminal connector manufacturer's recommended crimping tool shall be used and must utilize a ratchet mechanism which requires complete closing of the tool before it can be released. The crimping tool shall not be altered in any way without the recommendation or approval of the manufacturer.
- All control and instrument transformer secondary leads shall be segregated from high voltage sections.

2.7 Circuit Breaker Control and Wiring (Cont'd)

- ° Relays, secondary protective devices including breakers and fuses, meters, and terminal blocks shall be readily accessible by the cubicle door in front of the cabinet without disassembling any part of the cabinet. They shall be located so that they are isolated from any high voltage equipment or ionized gasses and shall be located no higher than 6 ft. from floor level.
- ° The switchgear shall be designed to accommodate top entry or bottom entry control wiring as specified on page 2 in Special Requirements.
- ° If shipping considerations require that a switchgear line-up be separated into sections, terminal strips shall be provided at breaker points to connect all secondary and control wiring. Break points and terminal strips shall be identified on wiring diagrams. All wires and terminal strips shall be marked so that connection can be easily accomplished.

2.8 Accessories

- ° Current transformers shall be supplied in accordance with ANSI standard C57.13 with the ratios and accuracy class as specified. Current transformers shall have short circuit and thermal withstand at least equal to the circuit breaker. A separate lead shall be brought out from each CT tap to a common terminal block. The first current transformer per phase on both the bus and line side of the breaker shall be mounted such that removal and replacement can be accomplished with a live main bus with complete operator safety.
- ° Potential transformers shall be supplied in accordance with ANSI standard C57.13 with ratings as specified. Potential transformers shall be located in a drawout type compartment and shall be disconnected, primary grounded and isolated from high voltage when the access door is opened. The potential transformers shall be protected with current limiting fuses located in the primary circuit.
- ° One set of accessories for the satisfactory operation, testing and maintenance of the equipment shall be provided. This will include at a minimum one each of the following items:
  - a. Closing lever for manually closing the breaker.
  - b. Hand crank for operating the circuit breaker racking mechanism.
  - c. Extension to the hand crank to operate the breaker in the withdrawn position.

2.8 Accessories (Cont'd)

- d. Transfer truck.
- e. Test cabinet.
- f. Any other devices or equipment required for convenient handling, servicing, maintenance or testing of equipment supplied.

2.9 Preliminary Data and Drawings

° The manufacturer shall furnish for approval three copies of the following data and drawings suitable for construction purposes to the Owner.

- a. Outline drawing showing overall dimensions, weight, base details, anchor bolt spacing and connections to the ground bus. This drawing shall be supplied no later than 8 weeks after receipt of order.
- b. Schematic wiring diagram complete with the following:
  - 1. Identification of all electrical and electronic components.
  - 2. Manufacturer and style number of all relays, meters, protective breakers, fuses, switches and terminal blocks.
  - 3. A tabulation of closing and tripping currents for electromechanical relay circuits.
  - 4. Ratings of the protective breakers in the control circuit.
  - 5. Circuit breaker control diagrams
- c. Connection and detail wiring diagram.
- d. Electrical and structural details such as front view, rear view and sections.
- e. Current transformer saturation curves and ratio correction factors.
- f. Bill of Materials for all accessory equipment including CT's, PT's and all devices specified in paragraph 2.8. In the case of CT's and PT's, the Bill of Materials shall provide manufacturer and style number.

## 2.10 Final Drawings

Not more than two months after approval, the following shall be supplied to the Owner.

- a. One non-folded reproducible tracing (sepia not acceptable) of the schematic wiring diagram and the connection and detail wiring diagram.
- b. Six fully certified copies of the items in Section 9.
- c. Six instruction books.
- d. Six sets of adequate drawings to facilitate any necessary field assembly.
- e. Six copies of test data.

## 2.11 Inspection

The switchgear shall be subject to inspection at any time by the Owner. When requested, the supplier will notify the Owner 5 days in advance of the mutually agreed upon witness or observation points to permit inspection by a representative of the Owner at the designated stage of assembly.

3.0	<u>QUALITY ASSURANCE</u>	1.8
3.1	<u>Quality Assurance Program Requirements</u>	1.11
3.1.1	<u>QA Program</u>	1.12
	The Seller shall have in effect at all times a quality assurance (QA) Program which clearly establishes the authority and responsibility of those responsible for the QA Program. Persons performing quality functions shall have sufficient and well-defined responsibility and authority to enforce quality requirements, to identify, initiate, recommend, and provide solutions to quality problems, and to verify the effectiveness of the solutions. No submittal of this QA Program is required.	1.13 1.14 1.15 1.16 1.17 1.18
3.1.2	<u>Seller's Responsibility for Suppliers</u>	1.20
	The Seller shall identify, in purchase documents to his suppliers, all applicable quality and QA requirements imposed by the Engineers' specification on the Seller and shall ensure compliance thereto.	1.21 1.22
3.2	<u>Tests</u>	1.26
	The circuit breakers, relays, and instrument transformers shall be tested in accordance with ANSI C37.50, ANSI C37.90, and NEMA SE-5.	1.27 1.28
	Written records shall be kept for each test showing date, equipment tested, test method and test results. Test records and certificates of final inspection or approval shall be submitted to the Purchaser for each test within 10 working days after test completion.	1.30 1.31 1.32
	The Seller shall be responsible for compliance with his standard in-production test procedures.	1.33
3.3	<u>Documentation</u>	1.35
3.3.1	<u>Record System</u>	1.36
	A records system shall be established and maintained that provides for the identification and correlation of test and inspection records and certificates.	1.37 1.38
3.3.2	<u>Final Inspection and Check of Records</u>	1.41
	The Seller shall be responsible for inspecting the item(s) and checking the applicable records, prior to shipment, to verify that all specification requirements have been complied with. Two complete sets of all documents required to comply with this specification shall be submitted to the Purchaser. Acceptance of the completed sets of records does not relieve the Seller of responsibility for compliance with specification requirements.	1.42 1.43 1.44 1.45 1.46 1.47

3.4 <u>Warranty</u>	1.49
The Seller shall warrant for a period of 12 months from the in-service date or 18 months from the shipment date (whichever occurs first) all equipment supplied is free from defects in design, material, and workmanship. The Seller shall also warrant the equipment supplied is suitable for the intended installation and operation as described in this Specification.	1.50 1.52 1.53 1.54
In the event that the equipment fails to achieve the warranted performance, then, to the extent that the deficiency or failure to achieve the warranted performance is attributable to equipment supplied by the Seller, the Seller shall make such adjustments or modifications to enable the equipment to achieve the warranted performance. The cost of these adjustments or modifications shall be to the Seller's account. After such adjustments or modifications, should the equipment fail to achieve warranted performance, an equitable settlement shall be made, which may without limitation include an adjustment of purchase order price.	1.55 1.57 1.58 2.1 2.2 2.3
3.5 <u>Field Tests</u>	2.5
The Purchaser may conduct field tests at his own expense to verify performance guarantees under the actual working condition. Where the tests reveal deficiencies in the equipment or deviations from the guaranteed performance, the Seller shall be completely responsible for any modifications, repairs, and/or adjustments required to meet the equipment performance guarantees.	2.6 2.8 2.9 2.10
Should additional field testing be required to verify performance guarantees, the cost for the field representative and required materials shall be at the Seller's expense.	2.11 2.12

4.0 PREPARATION FOR SHIPMENT

1.8

Packaging shall be adequate to prevent contamination, mechanical damage, or deterioration of the item supplied. These requirements are applicable immediately after manufacture. 1.11  
1.12

The Seller shall identify desiccants and inhibitors used and the required replacement frequency. 1.13

Expendable materials, such as tapes, barriers, plugs, desiccants, desiccant bags, inhibitors, etc., in contact with austenitic stainless steel or nickel alloys shall not contribute to corrosion during the storage period, by, for example, water or condensate leaching deleterious chemicals contained in the expendable materials. 1.14  
1.15  
1.16  
Objectionable chemicals contain lead, mercury, chlorides, fluorides, sulfur, and zinc. 1.17

Items shall be inspected for cleanliness immediately before packaging. 1.18  
All openings into items shall be sealed or plugged. Weld-end preparations shall be protected against corrosion and physical damage. 1.20  
Entrapped water shall be removed. 1.21

The outermost covering shall be clearly marked with the complete vendor identification which shall include weight. 1.22

The equipment shall be packaged for indoor storage. 1.23

The weight lifting points, indicated on the crate, skid, or package, shall be utilized for all handling procedures. 1.24

5.0	<u>SUPPLEMENTAL PROVISIONS</u>	1.8
5.1	<u>Deviations and Nonconformances</u>	1.11
	No deviation or nonconformance from this specification or applicable federal, state, or local codes and standards invoked by this specification shall be accepted until approved by the Engineers.	1.12
	Deviations are considered departures from any requirement of this specification. Uncorrectable nonconformances are considered to be conditions which cannot be corrected within the specification requirements by rework or replacement.	1.13 1.14 1.15 1.16
	The Seller shall promptly document and notify the Engineers of all deviations and nonconformances from the specification (such as deviations from applicable codes and/or drawings). Further manufacturing after detection of any deviation or nonconformance prior to the Engineers' approval shall be at the Seller's risk. No departure from the specification shall be binding on any party until an addendum or revision to the specification has been issued by the Engineers.	1.17 1.18 1.19 1.20
5.2	<u>Correspondence</u>	1.22
	All correspondence from the Seller shall consist of an original plus two copies and shall contain the following subject heading:	1.23 1.24
	Purchase Order No. (later)	1.28
	J.O. No. 15164.00	1.29
	5 KV Metal Clad Switchgear	1.30
	LIME Demonstration Project	1.31
	Edgewater Station, Unit No. 4	1.32
	Babcock & Wilcox Company	1.33
	Bid documents and contractual correspondence relative to or affecting prices, terms, conditions, price adjustment, deliveries, return of materials for credit, routing of shipments, or that which changes the price or scope of an order even though, also discussing engineering matters shall be addressed to:	1.37 1.38
	Babcock & Wilcox Company	1.41
	Copy to:	1.46
	Mr. John H. Davies	1.49
	Stone & Webster Engineering Corporation	1.50
	P.O. Box 2325 245/6	1.51
	Boston, Massachusetts 02107	1.52

Correspondence relative to inspection, expediting, technical matters, and transmittal of manufacturer's drawings, spare parts list, and operating instructions shall be addressed to:	1.56
Babcock & Wilcox Company	1.59
with a copy to Mr. Davies of Stone & Webster.	2.5
<u>5.3 Subsuppliers</u>	2.7
Should the Seller propose to purchase from another supplier any of the equipment, material, or services specified herein, he shall, upon request, identify the subsupplier for the specific equipment, material, or services itemized by the Engineers.	2.8 2.9 2.10
To the extent that they apply, the Seller shall impose on each of the subsuppliers the complete requirements of this specification. He shall be directly responsible that the subsuppliers are completely aware of <u>all</u> of these requirements, and that they abide thereby.	2.12 2.14 2.15
<u>5.4 Release for Material Purchase or Fabrication</u>	2.17
Written approval to the Seller to start fabrication of the equipment covered by this specification will be provided by the Purchaser. Fabrication is to be based on drawings and procedures reviewed and approved by the Engineers as required by the specification.	2.18 2.19 2.21 2.22
<u>5.5 Tools and Spare Parts</u>	2.24
One complete set of all special* tools, fixtures, and appurtenances required for maintenance and operation shall be furnished. (*"Special" is defined as anything not normally and usually available in a power station or readily available thereto.)	2.25 2.28
The Seller shall itemize on the attached Data Sheet the special tools that will be furnished.	2.29
A detailed list of all recommended spare parts shall be provided by the Seller. This list shall include the cost, location, and address of the local supplier, generic description of the part, and the Seller's normal delivery time.	2.30 2.31 2.32
<u>5.6 Installation, Operating, and Maintenance Instructions</u>	2.34
No later than one month before initial shipment, the Seller shall submit to the Engineers' Project Engineer 12 bound copies of a complete installation, operating, and maintenance manual for the equipment furnished, including instructions for individual components. All final	2.35 2.36 2.39

instructions shall be certified by the manufacturer as applicable to the equipment furnished, and shall be specifically identified, such as by serial number. The Seller shall inscribe the following identification on the cover; the words OPERATION AND MAINTENANCE MANUAL, the name and location of the equipment, the name of the manufacturer, and the contract number. The manual shall include the names, addresses, and telephone numbers of other equipment suppliers, and of the local representatives. The manual shall have a table of contents and be assembled to conform to the table of contents with the tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in. The manual shall include: wiring and control diagrams with data to explain detailed operation and control of each item of equipment; description of the function of each principal item of equipment; installation instructions; maintenance instructions; lubrication schedule including type, grade, temperature range, and frequency; safety precautions, diagrams, and illustrations; test procedures; and performance data.

One additional set of instructions, certified by the manufacturer, shall be packed and sent with the equipment to the jobsite. A parts identification list shall accompany each set of instructions. This list shall include sectional and/or outline prints or illustrations identifying each numbered part and location in relation to the equipment as a whole. The parts list for equipment shall indicate the source of supply and recommended spare parts.

#### 5.7 Data and Drawings

After the order is placed, the Seller shall submit all drawings in accordance with the agreed-upon schedule. The drawings submitted shall show the following:

1. All physical outlines, as required, to show the overall size and space requirements (including that for dismantling and maintenance) and the interrelationship of the various components
2. Cross sections and details, as required, to satisfy the Engineers and Purchaser that all components are in conformance with the intent of the specification and are satisfactory from the standpoint of design and physical arrangement
3. All information required by the Engineers for the design and location of all connecting Purchaser-furnished structural or electrical items such as steel supports, cables, conduit, etc.
4. Weight of the equipment and distribution of the static and other loads
5. All drawings and documentation listed in Section 2.0 Technical Requirements

As a minimum, the following data and drawings are required:	3.16
1. Equipment arrangement drawing	3.18
2. Elementary diagrams (showing protection & controls)	3.19
3. Wiring diagrams for circuit breakers and wiring between circuit breakers and external devices	3.20
4. Bill of Materials	3.21
5. One Installation, Operation, and Maintenance Manual for review	3.22
The Engineers' job order number and purchase order number shall be shown on each drawing.	3.24
All drawings submitted shall be in the form of one good quality reproducible and three good, sharp, black and white, direct contact prints of the Seller's original drawing.	3.25
After review by the Engineers, one direct contact print marked APPROVED or APPROVED AS REVISED will be returned to the Seller. If marked APPROVED AS REVISED, the required changes shall be incorporated by the Seller, clearly identified, and be resubmitted to the Engineers. If the Seller elects not to incorporate the revisions, he shall inform the Engineers that the suggested revisions cannot be made without prejudice to the Seller's responsibility under warranty.	3.26 3.27 3.28
Arrangements for production scheduling and the procurement of the necessary materials shall not be deferred pending approval of drawings.	3.29
The Engineers and Purchaser reserve the right to reproduce any drawing or print received from the Seller, as may be required during the design and construction of this project and the preparation of a plant manual, despite any notice prohibiting the same appearing on the drawing or print.	3.30 3.31
<u>5.8 Proposal Requirements</u>	3.33
The bidder shall furnish with his bid a list of all equipment he proposes to use. Deviations from any of the Engineers' requirements must be clearly defined along with the reason(s) for the proposed change(s). All data sheets shall be filled-in. The following data and drawings are required with the bid package:	3.34 3.36 3.39
1. Preliminary Bill of Material	3.41
2. Outline drawings showing the general arrangement and approximate dimensions of the equipment proposed	3.42 3.43

5.9 Schedule 3.46

The following schedule, or a revision of it, as agreed upon by the Seller and the Engineers before the purchase order is placed and included with the purchase order, shall be binding upon the Seller. 3.47  
3.49

<u>Milestone</u>	<u>Date</u>	
		3.52
1. Bid due date		3.54
2. Award purchase order		3.55
3. Initial drawing submittal		3.56
4. Equipment delivery date		3.57

5.10 Delivery 4.3

Delivery shall be made by enclosed truck. 4.4



ATTACHMENT II

PROTECTIVE RELAY LIST - 4160V SWGR

<u>Item</u>	<u>Office No.</u>	<u>Type</u>	<u>Mfg.</u>	<u>Qty.</u>	<u>Cat. No.</u>	<u>Comments</u>
Incoming Supply						
1	51	IAC	GE	3	12IAC51A802A	2-16A
Atomizing Air Compr Feeder						
2	-	MPR	GE	1	MPR3B1A2N9	No Substitutes
TR345 Feeder						
3	50/51	IAC	GE	3	12IAC51B806A	TOC 2-16A, INST 10-80.
4	50N	PJC	GE	1	12PJC11AV3A	2-8A
AUX CUBICLE						
5	27	IAV	GE	2	12IAC55C1A	115V, 55-140V RANGE

J.O. No. 15164.09  
Spec. No. 15164-E-008

Bid Specification 1.9  
1.10

Specification for	1.13
<u>1500 kVA, 4160-480 V</u>	1.15
<u>PAD-MOUNTED SUBSTATION TRANSFORMER</u>	1.17
Limestone Injection Multistage Burner (LIMB)	1.19
Demonstration Project	1.20
Ohio Edison Company's (OE)	1.21
Edgewater Station	1.22
Babcock & Wilcox Company (Owner)	1.24

APPROVED 1.27

	<u>Signature</u>	<u>Date</u>	
Preparer	<i>C. J. Allington</i>	<u>26 June 87</u>	1.31
Lead Engineer	<i>J. G. [unclear]</i>	<u>6/26/87</u>	1.32
Project Engr	<i>J. H. Davies</i>	<u>6-29-87</u>	1.33

Stone & Webster Engineering Corporation (ENGINEER)  
Boston, Massachusetts

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	1.0 <u>GENERAL</u>	1.8
1.1 <u>Scope</u>	-	1.11
This specification details the performance, design and manufacturing requirements for furnishing and delivering a 1500 kVA, 4160-480 V pad-mounted substation power transformer for the LIMB Demonstration Project being conducted by Babcock & Wilcox at Ohio Edison Company's Edgewater Station, Unit No. 4.		1.12 1.13 1.14 1.16
1.2 <u>Definitions</u>		1.17
Terms used throughout this specification are defined as follows:		1.18
Seller	- The company accepting the overall responsibility for fulfilling the requirements of this specification	1.20
Engineer	- Stone & Webster Engineering Corporation (SWEC), a Massachusetts corporation, or its duly authorized agencies restricted to the performance of the particular duties entrusted to them by the Purchaser	1.21 1.22 1.23
Purchaser (Owner)	- Babcock & Wilcox Company	1.26 1.27
Approved	- This word, when applied by the Engineers to the Seller's drawings or documents, means that the drawings or documents are satisfactory in that the Engineers have not observed any statement or feature that appears to deviate from the requirements. The Seller shall retain the entire responsibility for complete conformance with all of the requirements.	1.33 1.34 1.36 1.37 1.38
Approved as Revised	- These words, when applied by the Engineers to the Seller's documents, mean that the documents are approved as defined above, except that the changes shown are necessary to be in conformance with the requirements. On the basis that the Seller shall retain the entire responsibility for compliance with all of the requirements, the Seller shall either:	1.41 1.42 1.44 1.46 1.47
	a. Incorporate the changes into his document and resubmit to the Engineers, or	1.50
	b. Inform the Engineers that the changes cannot be made without prejudice to the Seller's responsibility under warranty, and resubmit them with full explanation of the reasons therefor.	1.51 1.52

1.3 Furnished by Seller 1.54

The Seller shall furnish equipment, material and services as follows: 1.55

<u>Item</u>	<u>Quantity</u>	<u>Description</u>	1.59
1	1	1500 kVA, 4160-480 V, pad-mounted substation transformer in accordance with attached specification	2.2 2.3 2.4 2.5
2		Drawings and documentation	2.7
3		Installation instructions	2.9
4		Operation and maintenance manual	2.11 2.12

1.4 Furnished by Purchaser 2.17

The Purchaser shall furnish: 2.19

1. Handling, unloading, and installation 2.22
2. External control wiring 2.23

1.5 Project Type, Location, and Site Conditions 2.26

The equipment specified will be used in an existing power plant 2.27  
for power supply to other electrical loads. This is part of 2.29  
Babcock & Wilcox's LIMB Demonstration Project at Ohio Edison  
Company's Edgewater Station, Unit No. 4 located in Lorain, Ohio. 2.30  
Edgewater Station is located on the shore of Lake Erie. 2.31

The site is accessible via truck and rail. Maximum and minimum 2.33  
design ambient temperatures are 95°F and 0°F, respectively.

2.0 TECHNICAL REQUIREMENT		1.8
1500 kVA, 4160-V delta primary to 480 V delta secondary three-phase oil filled outdoor substation transformer with the following characteristics:		1.11 1.13
1. Number of Phases	Three	1.16
2. Coolant	Oil	1.18
3. Type Cooling	Self-cooled (OA)	1.20
4. Frequency	60 Hz	1.22
5. kVA Rating	1500	1.24
6. High-Voltage Rating	4160 V	1.26
7. Low-Voltage Rating	480V	1.28
8. High-Voltage BIL	75 kV	1.30
9. Low-Voltage BIL	30 kV	1.32
10. High-Voltage Insulation Class	5.0 kV	1.34
11. Low-Voltage Insulation Class	1.2 kV	1.36
12. Taps	High Voltage, No-load, $\pm 2-2\frac{1}{2}\%$ above and below rated voltage	1.38 1.39 1.40 1.41
13. Bushing C.T.'s	None	1.42
14. Impedance	5.75%	1.44
15. <u>Special Requirements</u>		1.49
The transformer shall be manufactured in accordance with Ohio Edison Specification DE-RTP-27, Rev. 10, dated 10/86, which is attached as a part of these specifications, except as follows:		1.51 1.52
A. The transformer shall be equipped with 600 amp deadbreak primary bushings manufactured by RTE.		1.54
B. The transformer shall be equipped with 12-hole spades and secondary bus supports.		1.56

Specification No. OE-RTP-27

Page 1 of 11

**PAD-MOUNTED COMPARTMENTAL-TYPE, SELF-COOLED,  
THREE-PHASE TRANSFORMERS WITH SEPARABLE INSULATED CONNECTORS**  
— 12,470 GRD. Y/7,200 V AND BELOW

1. SCOPE

- 1.1 These specifications cover the electrical characteristics and mechanical features of three-phase, 60 Hz, mineral-oil immersed, self-cooled, pad-mounted, compartmental-type distribution transformers rated 2,500 kVA and smaller with separable insulated high voltage connectors; high voltage 12,470 Grd. Y/7,200 volts and below; low voltage 240, 208 Grd. Y/120, 480 and 480 Grd. Y/277 volts.
- 1.2 All requirements shall be in accordance with ANSI Standard C57.12.26 except as modified by these specifications. Any exceptions to these specifications shall be clearly defined and noted with quotation.

2. SUMMARY OF REFERENCED STANDARDS AND SPECIFICATIONS

The standards and specifications listed below are referenced in this specification:

ANSI C57.12.26 - 1975 - Pad-Mounted Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers  
ASTM/ANSI D1535-80 - Standard Method of Specifying Color by the Munsell System  
Draft No. 9, 3/86 - Proposed ANSI Standard for Padmount Equipment Integrity  
NEMA Standards Publication No. TR.1-1980, Section TR 1-0.05 - Audible Sound Levels for Transformers  
NEMA Standards Publication No. 260-1982, Figure 4 "DANGER" (bilingual) - Safety Labels for Padmounted Switchgear and Transformers Sited in Public Areas  
O.E. Specification No. OE-LRS-20, Revision 5, 9/86 - Insulating Oil  
O.E. Specification No. OE-QMP-1, Revision 2, 5/84 - Quality Monitoring Program

3. Ratings

- 3.1 Voltage ratings shall be in accordance with Table I.

4. BASIC IMPULSE INSULATION LEVELS

- 4.1 Basic impulse insulation levels (BIL) shall be as shown in Tables II and III.

APPROVED  
DATE 10/17/85  
DATE 10/17/85

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PAD-MOUNTED COMPARTMENTAL-TYPE, SELF-COOLED,  
THREE-PHASE TRANSFORMERS WITH SEPARABLE INSULATED CONNECTORS  
— 12,470 GRD. Y/7,200 V AND BELOW

5. AUDIBLE SOUND LEVELS

- 5.1 Transformers shall be so designed that the average sound level will not exceed the values given in NEMA Standards Publication No. TR 1, Section TR 1-0.05.

6. ELECTRICAL DATA6.1 GUARANTEED LOSSES

Guaranteed no load losses and percent exciting current values shall be quoted corrected to 20°C core/coil temperature. Guaranteed load losses and percent impedance values shall be corrected to 100% load and temperature rise to stability for 20°C ambient temperature.

6.2 TESTED LOSSES

All transformers manufactured under this specification shall be tested for no load and load losses, percent impedance, and exciting current. Actual loss data shall be prepared in accordance with Table V.

7. INSULATING OIL

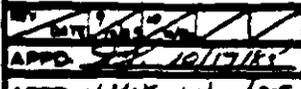
- 7.1 The insulating oil shall be per Ohio Edison Specification OE-LRS-20.

8. CONSTRUCTION

- 8.1 Critical dimensions shall be as shown in Figures 1, 2, and 3.

8.2 BUSHINGS AND TERMINALS

- 8.2.1 High voltage bushings shall be insert type to facilitate connection to the distribution system through loadbreak type separable insulated high voltage connectors and externally clamped universal wells. Approved manufacturers of high voltage bushings shall be Elastimold, General Electric, or RTE rated 8.3/14.4 kV.
- 8.2.2 High voltage bushings shall be arranged, spaced and wired for either radial or loop feed operation in accordance with Figure 2.
- 8.2.3 The low voltage spade type terminals shall be tinned copper and be positioned in a staggered (preferred) or in line (alternate) arrangement with spacing as shown in Figure 3. Secondary spade and bushing design (including clamping band and bolts) shall accommodate current transformers having a maximum depth of 2-1/2" without interfering with cable terminal lug installation.



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PAD-MOUNTED COMPARTMENTAL-TYPE, SELF-COOLED,  
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— 12,470 GRD. Y/Y, 200 V AND BELOW

8. CONSTRUCTION (Cont'd)
- R 8.2.4 The low voltage terminals on transformers rated 75-500 kVA shall be 6 hole type. Transformers rated 750-2500 kVA shall be equipped with 12 hole spades and secondary bus supports.
- 8.2.5 The high voltage neutral shall be internally connected to the low voltage neutral for wye-wye connected transformers.
- 8.2.6 The high voltage neutral shall be internally isolated for wye-delta connected transformers.
- 8.2.7 The low voltage neutral shall be a fully insulated bushing. A removable ground strap sized for the rating of the transformer shall be provided and connected between the neutral bushing and a ground pad provided on the outer surface of the tank.
- R 8.2.8 Low voltage terminals shall be externally clamped and externally replaceable.
- 8.3 HIGH VOLTAGE AND LOW VOLTAGE COMPARTMENTS
- 8.3.1 Terminal compartments shall be full height, air-filled with doors.
- 8.3.2 Unlocking the padlock shall permit access to both the high and low voltage terminations when the compartment doors are removed or opened. There shall not be a barrier between the high voltage and low voltage compartments, however, a vertical member sufficient to latch the doors may be used if centered between the low voltage neutral terminal and the adjacent high voltage bushing.
- 8.3.3 The locking assembly shall be able to accept a lock with a 1" x 1" shackle clearance and a 3/8" diameter shackle.
- 8.3.4 In addition to the regular locking provisions, the access doors shall be secured by a captive 1/2" stainless steel pentahed bolt. The device used to make the bolt captive shall be non-removable. The nut shall incorporate a "blind hole" feature such that, when the bolt and nut are disengaged, no foreign object can be inserted through the hole into the compartment to contact live parts.
- 8.3.5 Stainless steel hinges and pins shall be provided.
- 8.4 CORE AND COIL
- 8.4.1 There shall be three primary and three secondary windings wound on a five-legged or equivalent core design to eliminate unbalance and ferroresonant conditions.

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**PAD-MOUNTED COMPARTMENTAL-TYPE, SELF-COOLED,  
THREE-PHASE TRANSFORMERS WITH SEPARABLE INSULATED CONNECTORS**  
— 12,470 GRD. Y/7,200 V AND BELOW

**8. CONSTRUCTION (Cont'd)**

8.4.2 All insulating paper used as layer insulation in transformer coils shall be coated on both sides with a thermosetting adhesive and properly cured prior to impregnating with oil.

**8.5 TANK**

8.5.1 Grounding provisions, consisting of two or three ground pads with solderless type connectors, shall be provided. The ground pads shall be steel with a 1/2 inch - 13 NC tapped hole, 7/16 inch deep welded on the tank wall in the high voltage compartment as shown in Figure 2. The solderless type grounding connectors shall be sized to accommodate AWG conductor size No. 8 solid to No. 2 stranded.

8.5.2 The finish shall be weather-resistant Bell Telephone green color, Munsell notation 7.0 GY 3.29/1.5 as per ASTM/ANSI D1535.

R 8.5.3 The transformer tank and cabinet shall be designed, manufactured, treated, and tested in accordance with the specifications outlined in Draft No. 9 of the proposed ANSI Standard for Padmount Equipment Integrity.

8.5.4 An oil shield(s) shall be provided on transformers equipped with Bay-O-Net fusing to prevent oil vented from the fuse assemblies from spilling on elbow connectors, bushings or cable.

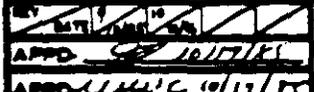
8.5.5 Parking stands for both radial and loop feed transformers shall be constructed in accordance with Figure 5 of ANSI Standard C57.12.26, (Detail of Parking Stand, Nominal Dimensions).

**8.6 MARKINGS**

8.6.1 The transformer kVA, voltage and load sensing and/or fault sensing fuse catalog number(s) and ampere rating(s) for all voltage settings shall be stenciled on the inside of the door so as to be legible with the door in the open position.

8.6.2 A safety label meeting the requirements of NEMA Standards Publication No. 260, Figure 4 "DANGER" (bilingual) shall be mounted internally.

R 8.6.3 A weatherproof NO-PCB decal with a dark blue background and white lettering shall be installed and centered on the inside upper half of the right access door. The decal shall be approximately 3" x 3" with a statement certifying the insulating oil contains less than 1 PPM PCB.



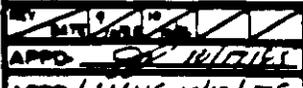
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PAD-MOUNTED COMPARTMENTAL-TYPE, SELF-COOLED,  
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12,470 GRD. Y/7,200 V AND BELOW

8. CONSTRUCTION (Cont'd)
- 8.6.4 All other external markings such as stenciling, decals, safety labels, etc., shall not be applied or furnished.
- 8.7 HIGH VOLTAGE FUSING (NOT APPLICABLE)
- 8.8 PRESSURE RELIEF DEVICE
- 8.8.1 All transformers shall be equipped with one (1) indicating type, automatic pressure relief device with manual pull-ring and white cap with retainer manufactured by TOMCO COUPLER DIVISION, BETA VALVE, Cat. Numbers 1712K-5 or 1712K-6.
- 8.9 NAMEPLATE
- 8.9.1 Nameplates shall be made of stainless steel or approved alternate material.
- R 8.9.2 The nameplate shall be permanently marked with essential operating data and instructions including primary and secondary BIL ratings, fusing, gallons of oil, etc.
- 8.9.3 The nameplate shall be permanently marked with a statement certifying that the INSULATING OIL CONTAINS LESS THAN 1 PPM PCB.



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PAD-MOUNTED COMPARTMENTAL-TYPE, SELF-COOLED,  
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9. QUALITY PROGRAM REQUIREMENTS

9.1 GENERAL REQUIREMENTS

9.1.1 Transformers addressed by this Specification are subject to a quality program in accordance with Ohio Edison Quality Monitoring Program Specification No. OE-QMP-1. This program establishes requirements to assure that the transformers provided by the Vendor will comply with the technical and quality requirements of the purchase order.

REV	BY	DATE	DESCRIPTION
APPRO	11/17/13		
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**PAD-MOUNTED COMPARTMENTAL-TYPE, SELF-COOLED,  
THREE-PHASE TRANSFORMERS WITH SEPARABLE INSULATED CONNECTORS  
12,470 GRD. Y/7,200 V AND BELOW**

**TABLE I**

Range of kVA and Voltage Ratings		
High Voltage Rating (Volts) Grounded Wye	Low Voltage Ratings, Volts	
	208 Y/120, 240	480 Y/277, 480
4,160	75 - 1,000 kVA	75 - 1,000 kVA
8,320	75 - 1,000 kVA	75 - 2,000 kVA
12,470	75 - 1,000 kVA	75 - 2,500 kVA

**TABLE II**

High Voltage Insulation Characteristics		
Rated High Voltage (Volts)	BIL kV	Insulation Class kV
4,160 Grd. Y/2,400	60	5
8,320 Grd. Y/4,800	75	8.7
12,470 Grd. Y/7,200	95	15
4,160 Grd. Y/2,400 x 12,470 Grd. Y/7,200	95*	15
8,320 Grd. Y/4,800 x 12,470 Grd. Y/7,200	95*	15

**TABLE III**

Low Voltage Insulation Characteristics		
Rated Voltage (Volts)	BIL (kV)	Insulation Class (kV)
208 Y/120	30	1.2
240	30	1.2
480 Y/277	30	1.2
480	30	1.2

\* Also applies to BIL rating of the primary winding when operated at the lower HV setting.

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12,470 GRD. Y/7,200 V AND BELOW

TABLE V

The format contained in this table shall be utilized to accumulate actual tested loss data to be transmitted to the owner.

(Manufacturer's Name)  
Certified Test Data  
Ohio Edison Company  
(Month and Year)

Catalog No. (or Style No.) \_\_\_\_\_ kVA \_\_\_\_\_ kV \_\_\_\_\_

Purchase  
Order

<u>M/C No.</u>	<u>Serial No.</u>	<u>% IX*</u>	<u>% Z **</u>	<u>No Load* (Watts)</u>	<u>Load** (Watts)</u>	<u>Total (Watts)</u>
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
		_____	_____	_____	_____	_____

Summation

Total Units \_\_\_\_\_

Average  
Values

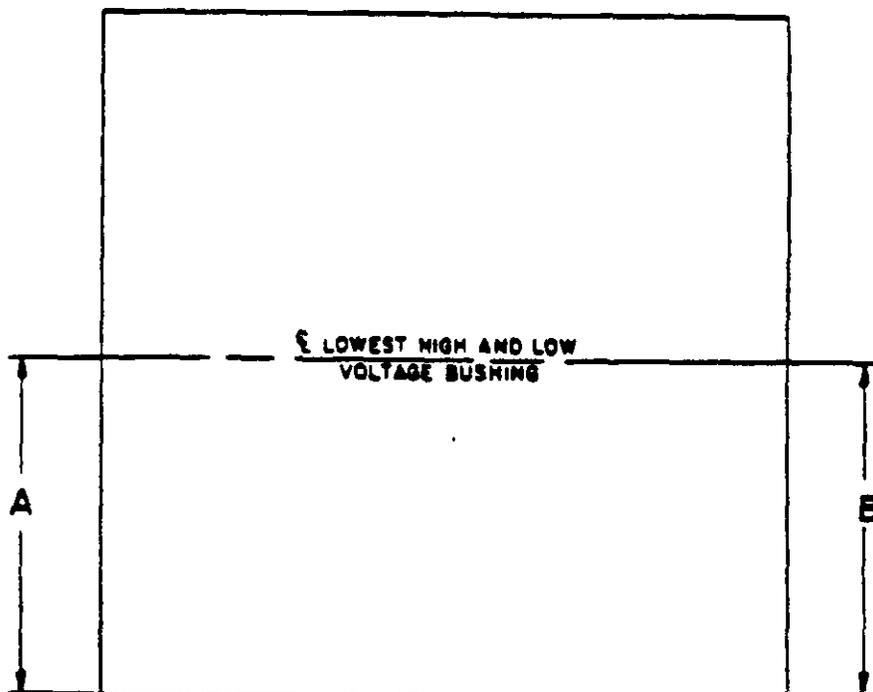
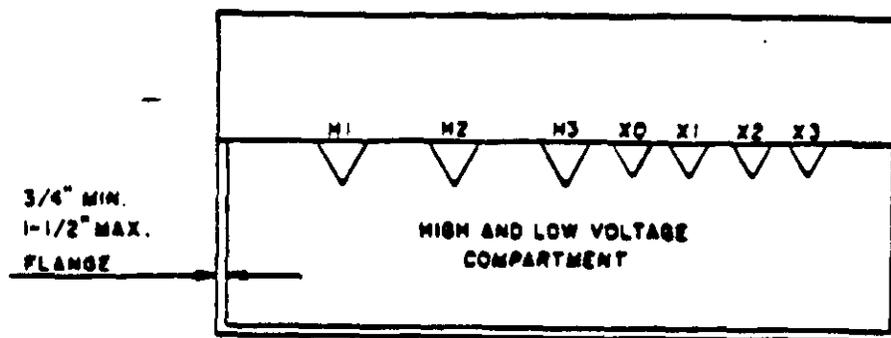
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\*Report Value for 100% voltage and corrected to 20°C.  
\*\*Value corrected to 85°C.

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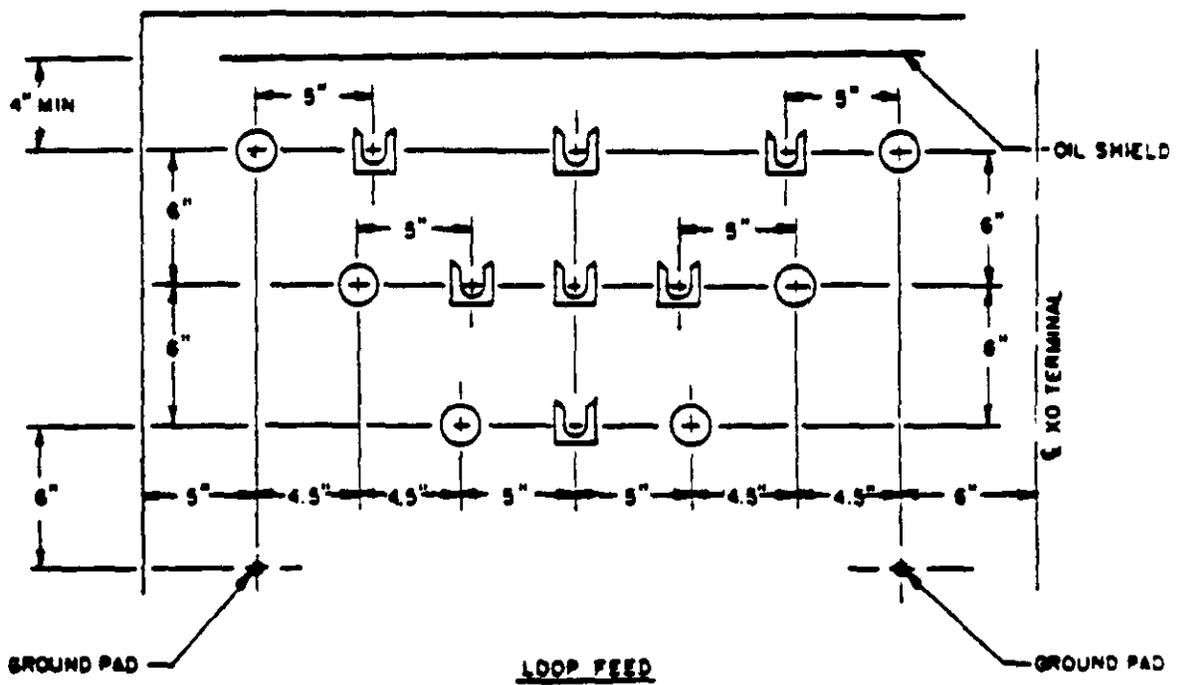
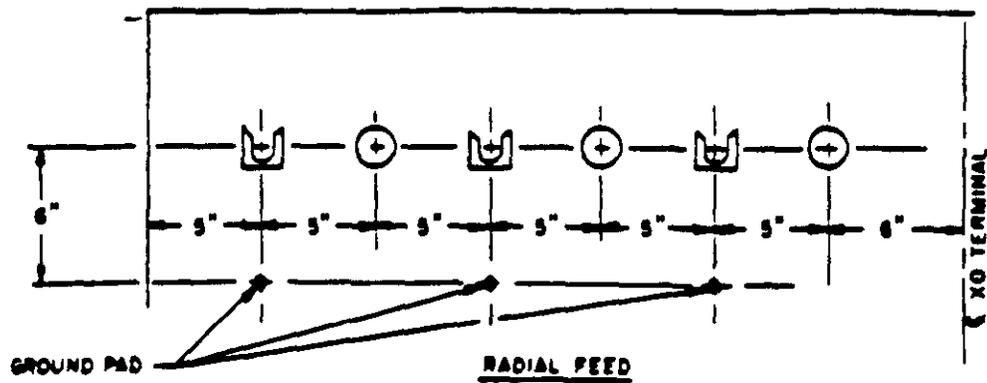
KVA RATINGS	LOWEST BUSHING HEIGHT	
	A	B
75-150	27"	27"
225-500	27"	31"
750-2500	27"	46"

(FIG. 1) HIGH AND LOW VOLTAGE COMPARTMENT

APPD. *[Signature]* 10/17/21  
 APPD. *[Signature]* 4/17/22

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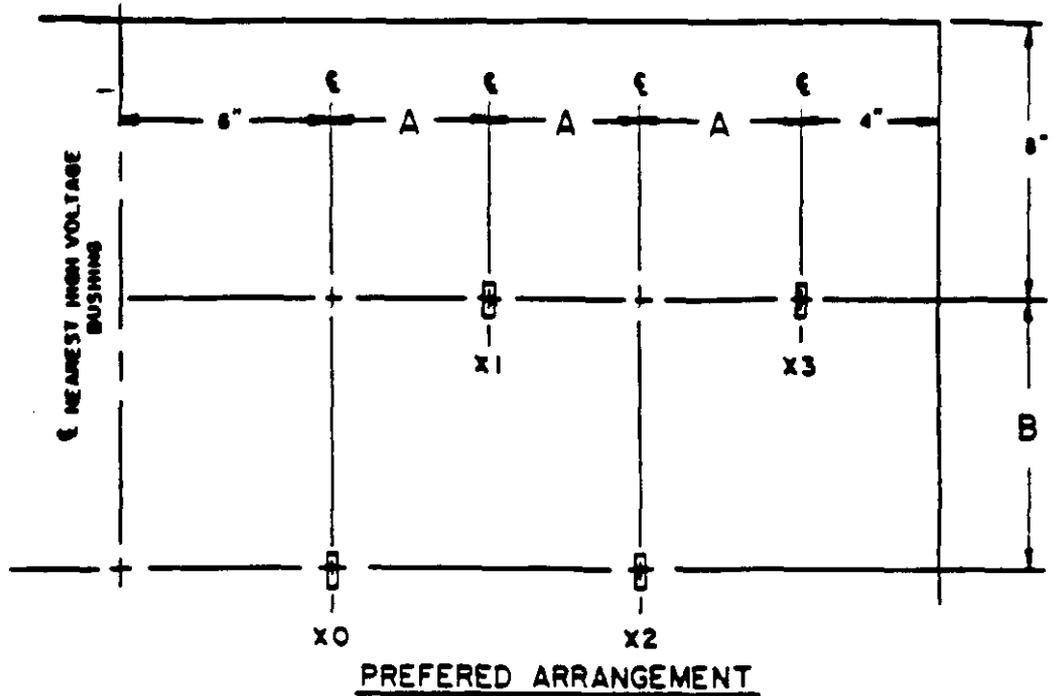
HIGH VOLTAGE BUSHING ARRANGEMENT - MINIMUM DIMENSIONS

(FIG. 2)

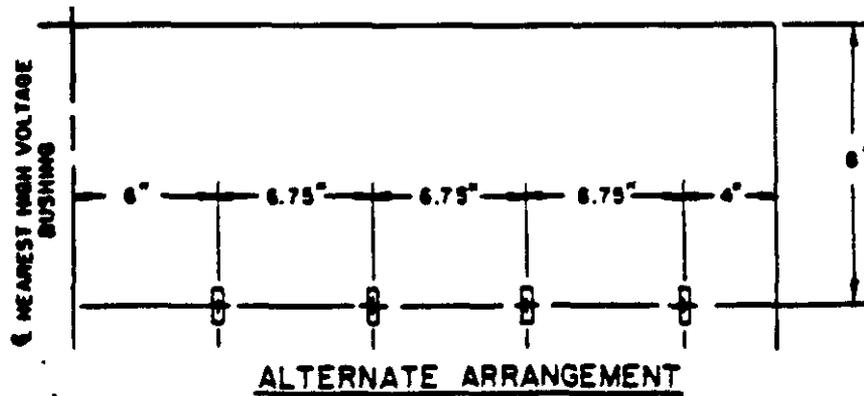
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 DATE 11/12/50

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KVA RATINGS	LV TERMINAL SPACING	
	A	B
75-150	5"	6"
225-2500	6"	6"



**LOW VOLTAGE TERMINAL ARRANGEMENT-MINIMUM DIMENSIONS**

(FIG.3)

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SPECIFICATIONS

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SPECIFICATION FOR INSULATING OIL

SCOPE

This specification covers insulating oil purchased with or as part of new equipment as well as oil purchased separately in drums or tank cars for use in all power transformers, distribution transformers, oil circuit breakers, voltage regulators, oil circuit reclosers, and oil switches.

SPECIAL REQUIREMENTS

R4 The manufacturer of equipment who furnishes insulating oil as a component of an equipment order shall be responsible for insuring that the oil supplied is from naphthenic crudes and was refined through a process generally accepted in the utility industry. The oil shall contain less than 1 PPM of Polychlorinated Biphenyls (PCBs).

NEW OIL TEST REQUIREMENTS

Insulating oil must conform to all of the requirements of American Society for Testing and Materials Standard Specification for Mineral Insulating Oil used in Electrical Apparatus, ASTM D-3487 latest revision, except as modified by these specifications.

Type I Mineral Oil shall be used for substation transformers and all oil circuit breakers.

R4 Type II Mineral Oil shall be used for distribution transformers, voltage regulators, oil circuit reclosers and oil switches.

TEST REPORTS

The manufacturer shall provide three (3) certified copies of oil test reports for oil circuit breakers, with a voltage rating of 138 kV or above and power transformers larger than 10,000 kVA, with a voltage rating of 138 kV or above. The test reports shall be sent to the General Equipment Application Engineer, Ohio Edison Company, 76 South Main Street, Akron, Ohio 44308, prior to shipment.

Upon request, three (3) certified copies of oil test reports supplied for equipment rated below 138 kV shall be sent to the following:

- 1) General Equipment Application Engineer for substation equipment.
- 2) General Distribution Engineer for distribution equipment.

Retyped for Revision 2

EEA85/019

APPROVED	DATE
APPROVED	DATE

SPECIFICATIONS

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3.0	<u>QUALITY ASSURANCE</u>	1.8
3.1	<u>Quality Assurance Program Requirements</u>	1.11
3.1.1	<u>QA Program</u>	1.12
	The Seller shall have in effect at all times a quality assurance (QA) Program which clearly establishes the authority and responsibility of those responsible for the QA Program. Persons performing quality functions shall have sufficient and well-defined responsibility and authority to enforce quality requirements, to identify, initiate, recommend, and provide solutions to quality problems, and to verify the effectiveness of the solutions. No submittal of this QA Program is required.	1.13 1.14 1.15 1.16 1.17 1.18
3.1.2	<u>Seller's Responsibility for Suppliers</u>	1.20
	The Seller shall identify, in purchase documents to his suppliers, all applicable quality and QA requirements imposed by the Engineers' specification on the Seller and shall ensure compliance thereto.	1.21 1.22
3.2	<u>Tests</u>	1.26
	The transformer shall be tested in accordance with Ohio Edison Specification OE-RTP-27.	1.27
	Written records shall be kept for each test showing date, equipment tested, test method and test results. Test records and certificates of final inspection or approval shall be submitted to the Purchaser for each test within 10 working days after test completion.	1.29 1.30 1.31
	The Seller shall be responsible for compliance with his standard in-production test procedures.	1.32
3.3	<u>Documentation</u>	1.34
3.3.1	<u>Record System</u>	1.35
	A records system shall be established and maintained that provides for the identification and correlation of test and inspection records and certificates.	1.36 1.37
3.3.2	<u>Final Inspection and Check of Records</u>	1.40
	The Seller shall be responsible for inspecting the item(s) and checking the applicable records, prior to shipment, to verify that all specification requirements have been complied with. Two complete sets of all documents required to comply with this specification shall be submitted to the Purchaser. Acceptance of the completed sets of records does not relieve the Seller of responsibility for compliance with specification requirements.	1.41 1.42 1.44 1.45 1.46

3.4 <u>Warranty</u>	1.48
The Seller shall warrant for a period of 12 months from the in-service date or 18 months from the shipment date (whichever occurs first) all equipment supplied is free from defects in design, material, and workmanship. The Seller shall also warrant the equipment supplied is suitable for the intended installation and operation as described in this Specification.	1.49 1.51 1.52 1.53
In the event that the equipment fails to achieve the warranted performance, then, to the extent that the deficiency or failure to achieve the warranted performance is attributable to equipment supplied by the Seller, the Seller shall make such adjustments or modifications to enable the equipment to achieve the warranted performance. The cost of these adjustments or modifications shall be to the Seller's account. After such adjustments or modifications, should the equipment fail to achieve warranted performance, an equitable settlement shall be made, which may without limitation include an adjustment of purchase order price.	1.54 1.56 1.57 1.59 2.1 2.2
3.5 <u>Field Tests</u>	2.4
The Purchaser may conduct field tests at his own expense to verify performance guarantees under the actual working condition. Where the tests reveal deficiencies in the equipment or deviations from the guaranteed performance, the Seller shall be completely responsible for any modifications, repairs, and/or adjustments required to meet the equipment performance guarantees.	2.5 2.7 2.8 2.9
Should additional field testing be required to verify performance guarantees, the cost for the field representative and required materials shall be at the Seller's expense.	2.10 2.11

4.0 <u>PREPARATION FOR SHIPMENT</u>	1.8
Packaging shall be adequate to prevent contamination, mechanical damage, or deterioration of the item supplied. These requirements are applicable immediately after manufacture.	1.11 1.12
The Seller shall identify desiccants and inhibitors used and the required replacement frequency.	1.13
Expendable materials, such as tapes, barriers, plugs, desiccants, desiccant bags, inhibitors, etc., in contact with austenitic stainless steel or nickel alloys shall not contribute to corrosion during the storage period, by, for example, water or condensate leaching deleterious chemicals contained in the expendable materials. Objectionable chemicals contain lead, mercury, chlorides, fluorides, sulfur, and zinc.	1.14 1.15 1.16 1.17
Items shall be inspected for cleanliness immediately before packaging. All openings into items shall be sealed or plugged. Weld-end preparations shall be protected against corrosion and physical damage. Entrapped water shall be removed.	1.18 1.20 1.21
The outermost covering shall be clearly marked with the complete vendor identification which shall include weight.	1.22
The equipment shall be packaged for indoor storage.	1.23
The weight lifting points, indicated on the crate, skid, or package, shall be utilized for all handling procedures.	1.24

5.0 <u>SUPPLEMENTAL PROVISIONS</u>	1.8
5.1 <u>Deviations and Nonconformances</u>	1.11
No deviation or nonconformance from this specification or applicable federal, state, or local codes and standards invoked by this specification shall be accepted until approved by the Engineers.	1.12
Deviations are considered departures from any requirement of this specification. Uncorrectable nonconformances are considered to be conditions which cannot be corrected within the specification requirements by rework or replacement.	1.13 1.14 1.15 1.16
The Seller shall promptly document and notify the Engineers of all deviations and nonconformances from the specification (such as deviations from applicable codes and/or drawings). Further manufacturing after detection of any deviation or nonconformance prior to the Engineers' approval shall be at the Seller's risk. No departure from the specification shall be binding on any party until an addendum or revision to the specification has been issued by the Engineers.	1.17 1.18 1.19 1.20
5.2 <u>Correspondence</u>	1.22
All correspondence from the Seller shall consist of an original plus two copies and shall contain the following subject heading:	1.23 1.24
Purchase Order No. (later)	1.28
J.O. No. 15164.00	1.29
1500kVA, 4160-480 V Transformer	1.30
LIMS Demonstration Project	1.31
Edgewater Station, Unit No. 4	1.32
Babcock & Wilcox Company	1.33
Bid documents and contractual correspondence relative to or affecting prices, terms, conditions, price adjustment, deliveries, return of materials for credit, routing of shipments, or that which changes the price or scope of an order even though also discussing engineering matters shall be addressed to:	1.37 1.38
Babcock & Wilcox Company	1.41
Copy to:	1.46
Mr. John H. Davies	1.49
Stone & Webster Engineering Corporation	1.50
P.O. Box 2325 245/6	1.51
Boston, Massachusetts 02107	1.52

Correspondence relative to inspection, expediting, technical matters, and transmittal of manufacturer's drawings, spare parts list, and operating instructions shall be addressed to:	1.56
Babcock & Wilcox Company	1.59
with a copy to Mr. Davies of Stone & Webster.	2.5
<u>5.3 Subsuppliers</u>	2.7
Should the Seller propose to purchase from another supplier any of the equipment, material, or services specified herein, he shall, upon request, identify the subsupplier for the specific equipment, material, or services itemized by the Engineers.	2.8 2.9 2.10
To the extent that they apply, the Seller shall impose on each of the subsuppliers the complete requirements of this specification. He shall be directly responsible that the subsuppliers are completely aware of <u>all</u> of these requirements, and that they abide thereby.	2.12 2.14 2.15
<u>5.4 Release for Material Purchase or Fabrication</u>	2.17
Written approval to the Seller to start fabrication of the equipment covered by this specification will be provided by the Purchaser.	2.18 2.19
Fabrication is to be based on drawings and procedures reviewed and approved by the Engineers as required by the specification.	2.21 2.22
<u>5.5 Tools and Spare Parts</u>	2.24
One complete set of all special* tools, fixtures, and appurtenances required for maintenance and operation shall be furnished. (*"Special" is defined as anything not normally and usually available in a power station or readily available thereto.)	2.25 2.28
The Seller shall itemize on the attached Data Sheet the special tools that will be furnished.	2.29
A detailed list of all recommended spare parts shall be provided by the Seller. This list shall include the cost, location, and address of the local supplier, generic description of the part, and the Seller's normal delivery time.	2.30 2.31 2.32
<u>5.6 Installation, Operating, and Maintenance Instructions</u>	2.34
No later than one month before initial shipment, the Seller shall submit to the Engineers' Project Engineer 12 bound copies of a complete installation, operating, and maintenance manual for the equipment furnished, including instructions for individual components. All final	2.35 2.36 2.39

instructions shall be certified by the manufacturer as applicable to the equipment furnished, and shall be specifically identified, such as by serial number.— The Seller shall inscribe the following identification on the cover; the words OPERATION AND MAINTENANCE MANUAL, the name and location of the equipment, the name of the manufacturer, and the contract number. The manual shall include the names, addresses, and telephone numbers of other equipment suppliers, and of the local representatives. The manual shall have a table of contents and be assembled to conform to the table of contents with the tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in. The manual shall include: wiring and control diagrams with data to explain detailed operation and control of each item of equipment; description of the function of each principal item of equipment; installation instructions; maintenance instructions; lubrication schedule including type, grade, temperature range, and frequency; safety precautions, diagrams, and illustrations; test procedures; and performance data.

One additional set of instructions, certified by the manufacturer, shall be packed and sent with the equipment to the jobsite. A parts identification list shall accompany each set of instructions. This list shall include sectional and/or outline prints or illustrations identifying each numbered part and location in relation to the equipment as a whole. The parts list for equipment shall indicate the source of supply and recommended spare parts.

#### 5.7 Data and Drawings

- After the order is placed, the Seller shall submit all drawings in accordance with the agreed-upon schedule. The drawings submitted shall show the following:
1. All physical outlines, as required, to show the overall size and space requirements (including that for dismantling and maintenance) and the interrelationship of the various components
  2. Cross sections and details, as required, to satisfy the Engineers and Purchaser that all components are in conformance with the intent of the specification and are satisfactory from the standpoint of design and physical arrangement
  3. All information required by the Engineers for the design and location of all connecting Purchaser-furnished structural or electrical items such as steel supports, cables, conduit, etc.
  4. Weight of the equipment and distribution of the static and other loads

As a minimum, the following data and drawings are required:	3.15
1. Equipment arrangement drawing	3.17
2. Elementary diagrams	3.18
3. Wiring diagrams	3.19
4. Bill of Materials	3.20
5. One Installation, Operation, and Maintenance Manual for review	3.21
The Engineers' job order number and purchase order number shall be shown on each drawing.	3.23
All drawings submitted shall be in the form of one good quality reproducible and three good, sharp, black and white, direct contact prints of the Seller's original drawing.	3.24
After review by the Engineers, one direct contact print marked APPROVED or APPROVED AS REVISED will be returned to the Seller. If marked APPROVED AS REVISED, the required changes shall be incorporated by the Seller, clearly identified, and be resubmitted to the Engineers. If the Seller elects not to incorporate the revisions, he shall inform the Engineers that the suggested revisions cannot be made without prejudice to the Seller's responsibility under warranty.	3.25 3.26 3.27
Arrangements for production scheduling and the procurement of the necessary materials shall not be deferred pending approval of drawings.	3.28
The Engineers and Purchaser reserve the right to reproduce any drawing or print received from the Seller, as may be required during the design and construction of this project and the preparation of a plant manual, despite any notice prohibiting the same appearing on the drawing or print.	3.29 3.30
<u>5.8 Proposal Requirements</u>	3.32
The bidder shall furnish with his bid a list of all equipment he proposes to use. Deviations from any of the Engineers' requirements must be clearly defined along with the reason(s) for the proposed change(s). All data sheets shall be filled-in. The following data and drawings are required with the bid package:	3.33 3.35 3.38
1. Preliminary Bill of Material	3.40
2. Outline drawings showing the general arrangement and approximate dimensions of the equipment proposed	3.41 3.42

5.9 Schedule 3.45

The following schedule, or a revision of it, as agreed upon by the Seller and the Engineers before the purchase order is placed and included with the purchase order, shall be binding upon the Seller. 3.46  
3.48

<u>Milestone</u>	<u>Date</u>	3.51
1. Bid due date		3.53
2. Award purchase order		3.54
3. Initial drawing submittal		3.55
4. Equipment delivery date		3.56

5.10 Delivery 4.2

Delivery shall be made by enclosed truck. 4.3

J.O. No. 15164.09  
Spec. No. 15164-E-009

Bid Specification 1.10  
1.11

Specification for	1.14
<u>480 VOLT SWITCHGEAR</u>	1.16
Limestone Injection Multistage Burner (LIMB)	1.18
Demonstration Project	1.19
Ohio Edison Company's	1.20
Edgewater Station	1.21
Babcock & Wilcox Company (Owner)	1.23

	<u>APPROVED</u>	1.26	
	<u>Signature</u>	<u>Date</u>	1.28
Preparer	<i>[Signature]</i>	9/14/87	1.30
Lead Engineer	<i>[Signature]</i>	9/15/87	1.31
Project Engr.	<i>[Signature]</i>	9-16-87	1.32

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Boston, Massachusetts

Specification for	1.14
<u>480 VOLT SWITCHGEAR</u>	1.16
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Demonstration Project	1.19
Ohio Edison Company's	1.20
Edgewater Station	1.21
Babcock & Wilcox Company (Owner)	1.23

<u>1.0 SCOPE</u>	1.26
This Addendum No. 1 summarizes all changes to the specification to date.	1.27

<u>2.0 CHANGES</u>	1.28
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<u>Item</u>	<u>Changes to Specification</u>	
1.	Delete: Pages 2-3, 2-4, and 2-5	1.32
	Add: New pages 2-3, 2-4, 2-5, 2-6, and 2-7 (attached)	1.33 1.34
2.	Delete: Attachment III - Protective Relay List	1.36
	Add: New Attachment III - Protective Relay List	1.37
3.	Delete: Attachment I - Sketch 15164-ESK-003	1.39
	Add: New Attachment I - Sketch 15164-ESK-003 (Issue 2, Dated 11/3/87)	1.40 1.41

APPROVED 1.43

	<u>Signature</u>	<u>Date</u>	
Preparer	<i>[Signature]</i>	11/17/87	1.47
Lead Engineer	<i>[Signature]</i>	11/17/87	1.48
Project Engr.	<i>[Signature]</i>	11/17/87	1.49

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DRAWINGS AND SKETCHES		1.47

1.0	<u>GENERAL</u>	1.8
1.1	<u>Scope</u>	1.11
	This specification details the performance, design and manufacturing requirements for furnishing and delivering a 480 volt switchgear for the LIMB Demonstration Project being conducted by Babcock and Wilcox at Ohio Edison Company's Edgewater Station, Unit No. 4.	1.12 1.13 1.15
1.2	<u>Definitions</u>	1.16
	Terms used throughout this specification are defined as follows:	1.17
	Seller - The company accepting the overall responsibility for fulfilling the requirements of this specification	1.19
	Engineers - Stone & Webster Engineering Corporation (SWEC), a Massachusetts corporation, or its duly authorized agencies restricted to the performance of the particular duties entrusted to them by the Purchaser	1.20 1.21 1.22
	Purchaser - Babcock & Wilcox Company	1.25
	(Owner)	1.26
	Approved - This word, when applied by the Engineers to the Seller's drawings or documents, means that the drawings or documents are satisfactory in that the Engineers have not observed any statement or feature that appears to deviate from the requirements. The Seller shall retain the entire responsibility for complete conformance with all of the requirements.	1.32 1.33 1.35 1.37
	Approved - These words, when applied by the Engineers to the Seller's documents, mean that the documents are approved as defined above, except that the changes shown are necessary to be in conformance with the requirements. On the basis that the Seller shall retain the entire responsibility for compliance with all of the requirements, the Seller shall either:	1.40 1.41 1.43 1.45 1.46
	a. Incorporate the changes into his document and resubmit to the Engineers, or	1.49
	b. Inform the Engineers that the changes cannot be made without prejudice to the Seller's responsibility under warranty, and resubmit them with full explanation of the reasons therefor.	1.50 1.51
1.3	<u>Furnished by Seller</u>	1.53
	The Seller shall furnish equipment, material and services as follows:	1.54

<u>Item</u>	<u>Quantity</u>	<u>Description</u>	
			1.58
1	1	480 volt switchgear in accordance with the attached specification and documentation	2.1 2.2 2.3
2		Drawings and documentation	2.5
3		Installation instructions	2.7
4		Operation and maintenance manual	2.9 2.10
1.4 <u>Furnished by Purchaser</u>			2.14
The Purchaser shall furnish:			2.16
1.		Handling, unloading and installation	2.19
2.		External wiring	2.20
1.5 <u>Project Type, Location, and Site Conditions</u>			2.23
The equipment specified will be used in an existing power plant for power supply to other electrical loads. This is part of Babcock & Wilcox's LIMB Demonstration Project at Ohio Edison Company's Edgewater Station, Unit No. 4 located in Lorain, Ohio. Edgewater Station is located on the shore of Lake Erie.			2.24 2.26 2.28
The site is accessible via truck and rail. Maximum and minimum design ambient temperatures are 95°F and 0°F, respectively.			2.30

2.0	<u>TECHNICAL SPECIFICATION</u>	1.8
2.1	<u>Items and Services to be Supplied by the Vendor</u>	1.11
	The switchgear assembly including air circuit breakers, relays, etc,	1.12
	shall be completely factory assembled and tested and ready for operation	1.13
	on delivery. It shall be furnished complete with all control and	1.14
	auxiliary equipment necessary for satisfactory operation, except for	1.15
	that equipment to be supplied by Owner as specifically stated in this	
	specification.	
	The Vendor shall furnish details of sills required such as channel size,	1.16
	spacings, and drillings.	
2.2	<u>Items and Services to be Supplied by Others</u>	1.17
	The switchgear will be mounted on channel sills supplied by others.	1.18
	Receiving and unloading will be by others.	1.19
2.3	<u>Supplemental Specifications and Information</u>	1.20
Attachment I	- One Line Diagram - 480 V Switchgear - Sketch No. 15164-	1.22
	ESK-003	1.23
Attachment II	- Specification NO. OE-BCC-35	1.24
Attachment III	- Protective Relay List	1.25
2.4	<u>Definitions</u>	1.28
	INSPECTOR	1.29
	"Inspector" is the authorized representative of the Owner.	1.30
	QUALITY RECORDS	1.31
	"Quality Records" are those documents listed in Paragraph 5.7 of this	1.32
	specification, to be furnished by the Vendor.	
2.5	<u>Applicable Codes, Standards, and Regulations</u>	1.33
	The switchgear equipment covered in this specification shall be	1.34
	designed, tested, and assembled in accordance with the following	1.35
	standards:	
	<u>National Electrical Manufacturers Association (NEMA)</u>	1.38
NEMA SG5	1981 Power Switchgear Assemblies	1.41
NEMA ICS-6	1983 Enclosures for Industrial Controls	1.44
	and Systems	1.45

	<u>American National Standards Institute (ANSI)</u>	1.49
ANSI C.37.13	1981 Low Voltage AC Power Breakers Used in Enclosures	1.52 1.53
ANSI C.37-16	1980 Preferred Ratings for Low Voltage Power Circuit Breakers	1.56 1.57
ANSI C.37.20	1969 Switchgear Assemblies Including Metal-Enclosed Bus	1.59 2.1
ANSI C.57.13	1968 Instrument Transformers	2.3
ANSI C.37.50	1981 Test Procedures for Low Voltage AC Power Circuit Breakers Used in Enclosures	2.5 2.6 2.7
ANSI C.37.90	1978 Relays and Relay Systems Associated with Electric Power Apparatus	2.9 2.10
ANSI Z55.1.70	1967 Light Grey Enamels	2.12
Williams-Steiger Occupational Safety and Health Act: 1970 Chapter XVII of Title 29 of the Federal Register Vol. 37, No. 202, 1974 (OSHA).		2.15 2.16
In case of a conflict between this specification and the Codes or Standards the matter shall be brought to the attention of the Owner's Engineer for resolution.		2.17 2.18
<u>2.6 Design Requirements</u>		2.19
<u>2.6.1 General</u>		2.20
The indoor low voltage metal-enclosed switchgear shall consist of a stationary structure assembly and draw-out type air circuit breakers rated 600 volt for use on a nominal 480 volt, 3 phase, 3 wire Hz ungrounded system. The switchgear will be located in an electrical equipment room where the temperature will not exceed 40°C.		2.21 2.22 2.23
Each compartment shall be designed to house one breaker. The primary disconnecting contacts shall be silver-plated copper. All moveable contact fingers and springs shall be mounted on the circuit breaker where they may be easily inspected.		2.25 2.26
The circuit breakers with the necessary disconnecting contacts and interlocks shall permit closing the compartment doors with the breakers in the "connected-test-disconnect and withdrawn" positions.		2.27 2.28
The stationary switchgear housing shall consist of a rigid frame, free standing structure completely enclosed by sheet steel which shall be approximately 1/8 in. thick or U.S. Standard Gage 10 and free from flaws. The enclosure shall be NEMA Type 1 gasketed per NEMA ICS6-1983.		2.29 2.30 2.31

The completed units shall have ample strength to withstand 1.9  
without damage, all stresses incidental to shipping, 1.10  
installation, and short circuit forces during operation. 1.11  
Suitable lifting lugs shall be provided.

All parts of the metal structure shall be grounded to the ground 1.12  
bus herein specified.

The arrangement of the equipment shall in no case prevent 1.13  
satisfactory performance, and shall have sufficient space for 1.14  
performing maintenance within the structure. The structure, 1.15  
buses and control wiring troughs shall be arranged so as to make  
switchgear extension readily feasible.

The switchgear structure shall be provided with hinged doors for 1.16  
access to the circuit breaker compartments on the front of the 1.17  
structure and removable panels at the rear of each vertical  
section.

Control panels shall be reinforced against distortion by suitable 1.18  
flanges and stiffening members.

Doors shall be supported by strong hinges of the concealed type 1.19  
and shall be braced in such a manner as to assure freedom from 1.20  
sagging, binding, or general distortion of doors or hinge parts.

Handle operated latches shall be provided for holding the doors 1.21  
securely in the closed position unless other means, such as 1.22  
bolting, is specified. Suitable latching devices shall also be 1.23  
provided to hold the doors in a full open position.

Grounded metal barriers shall provide separate compartments for 1.24  
circuit breakers and instruments, buses and current transformers. 1.25  
All compartments shall be sufficiently gas tight to ensure 1.26  
complete deionization of any gases that pass from one compartment 1.27  
to another. Adequate provision shall be made for venting of 1.28  
gases from the switchgear. All cubicle venting, connections, and 1.29  
raceways should be designed to minimize fire propagation from one  
cubicle to another. 1.30

Louvers or other ventilating openings shall be arranged and 1.31  
located to prevent damage to or malfunction of the switchgear, 1.32  
circuit breakers, control circuits, and other components which  
could be caused by water dripping from above or splashing from 1.33  
the floor.

#### 2.6.2 Circuit Breakers 1.35

Each circuit breaker compartment shall be designed to house a 1.36  
drawout air circuit breaker. Access to the breaker shall be 1.38  
through a hinged front door. The breakers shall be mechanically 1.39  
interlocked so that they cannot be inserted or withdrawn when

they are in the closed position. The stored energy mechanism shall be discharged before the breaker can be removed or inserted. Provisions for padlocking breakers in the "Test" or "Disconnect" positions shall be included. The padlock shall not interfere with the stored energy mechanism, circuit breaker operation or testing. All circuit breakers of the same type, voltage and current rating shall be electrically and mechanically interchangeable. A mechanical "Close-Trip" indicator shall be provided with each breaker. Each breaker shall have an operation counter.

All breakers shall be indoor drawout type, 3 pole, single throw, 600 volt for use on a nominal 480 volt system. The circuit breakers shall have short-circuit ratings in accordance with ANSI C37.13 and ANSI C37.16 as follows:

Breaker Frame Amps	Short Circuit Amps	1.51
800	42,000 Sym	1.53
2000	55,000 Sym	1.54

The 2000A main breaker shall be electrically operated and shall be equipped with 120 volt ac trip and closing coils. The trip coils shall operate over a range of 60 to 127 volts and closing coils shall operate over a range of 104 to 127 volts. The manually operated 800A feed breakers shall be provided with a shunt trip. The feeder breakers shall be furnished with protective relays as specified in Attachment III to this specification.

All breakers shall have stored energy operating mechanisms. Electrically operated breakers shall have electrically charged mechanism. Electrical close shall be initiated by means of a release solenoid to provide fast close for automatic transfer. When operating manually, only one stroke of the operating handle will be necessary to charge the stored energy spring. The release of the energy to close the breaker manually shall be by means of a mechanical pushbutton which ensures positive control for the closing operation. A manual trip button shall be provided for each breaker.

The circuit breaker shall be equipped with silver-plated secondary disconnecting contacts which shall automatically engage in the operating and test position to complete control circuits as required.

All controls, coils, contacts, etc, operating from the 120 volt system shall be suitable for normal operation and shall have sufficient suppression devices to allow them to operate satisfactorily under the transient voltage spike conditions normally associated with stations.

2.6.3	<u>Main Bus Compartment and Buses</u>	2.16
	Removable panels shall be provided for access to the bus compartment. All bus bars shall be copper, silver-plated at connection points, with at least two bolts with belleville or split-type washers for each connection point.	2.17 2.19 2.20
	Each circuit will include the necessary 3 phase bus and connections (capacity equal to breaker rating) between the main bus and the bus side circuit breaker studs. Solderless type terminals on silver-plated copper extensions for the outgoing cables shall be provided on the load side of the circuit breaker studs.	2.21 2.22 2.23 2.24
	The main bus shall have a minimum continuous rating of 2000 amps.	2.25
	A 1/4 in. x 2 in. copper ground bus shall be installed for grounding. This ground bus shall be secured to each unit frame and shall extend the full length of the structure.	2.26 2.27
	The manufacturer shall provide a control bus running the full length of the structure. Two suitably rated two pole thermal magnetic breakers Westinghouse Type AB or equal shall be provided at each cell, for electrically operated breakers only, one for close circuit protection and one for trip circuit protection. Manually operated breakers shall have one thermal magnetic breaker for shunt trip protection.	2.28 2.29 2.30 2.31
2.6.4	<u>Controls and Wiring</u>	2.33
	The control of 480 volt circuit breakers shall be as follows:	2.34
	a. The main breakers shall have provisions for remote close and tripping. When the breakers are in the test position, remote control shall be deactivated.	2.37 2.38
	b. The motor feeder breakers shall have provisions for remote close and tripping. When the breakers are in the test position, remote control shall be deactivated.	2.39 2.40
	c. The MCC feeder breakers shall have only local closing and tripping.	2.41
	The Vendor shall furnish a cell switch on each breaker to perform the function as described above, complete with two extra auxiliary contacts which are open when the breaker is in the connected position and closed in all other positions.	2.43 2.44 2.45
2.6.5	All terminal blocks including those used for instrument transformer secondary leads shall be Marathon Series 1500 STRC stud type or OWNER approved equal. Terminal blocks shall have at least 20 percent spare positions. An additional spare 12-point	2.47 2.48 2.50 2.51

terminal block for each unit shall be provided for Ohio Edison use. All terminal blocks shall be marked corresponding to the identification on the supplier's wiring diagrams.	2.52
2.6.6 All control wire shall be Type SIS, No. 14 AWG copper, 7 strand flame-retardant, cross-linked polyethylene insulated rated 600 volts and for 90C continuous operation. All instrument transformer secondary wiring shall be No. 12 AWG copper, 7 strand wire or larger.	2.54 2.56 2.58
2.6.7 All control switches shall be Westinghouse Type W-2.	3.1
2.6.8 AMP Special Products PIDG industrial preinsulated, grip-pressure type, ring-tongue lug connectors with copper sleeves and insulated sleeves or Ohio Edison Engineer approved equal shall be used for all connections; including relays, switches, and terminal blocks. "Equal" terminal connectors shall consist of seamless metal sleeves or brazed seams on the barrel. Soldered terminals or butted seams on terminal connectors shall be not be used. The terminal connector manufacturer's recommended crimping tool shall be used and must utilize a ratchet mechanism which requires complete closing of the tool before it can be released. The crimping tool shall not be altered in any way without the recommendation or approval of the manufacturer.	3.3 3.4 3.5 3.7 3.8 3.9 3.10 3.11
2.6.9 All control and instrument transformer secondary leads shall be segregated from high voltage sections. Terminal connectors shall be provided for all cables entering and leaving the switchgear cubicles. Power cable terminals shall be compression type lugs with a minimum of two bolts in the contact tongue. Terminals shall be Burndy Type YA and shall be sized to accommodate cables as shown in Attachment 1.	3.13 3.15 3.16 3.17
2.6.10 Relays, secondary protective devices including breakers, meters, and terminal blocks shall be readily accessible by the cubicle door in front of the cabinet without disassembling any part of the cabinet. They shall be located so that they are isolated from any high voltage equipment or ionized gasses and shall be located no higher than 6 ft from floor level.	3.19 3.20 3.22 3.23
2.6.11 The switchgear shall be designed to accommodate top entry control wiring.	3.24
2.6.12 If shipping considerations require that a switchgear line-up be separated into sections, terminal strips shall be provided at break points to connect all secondary and control wiring. Break points and terminal strips shall be identified on wiring diagrams. All wires and terminal strips shall be marked so that connection can be easily accomplished.	3.26 3.27 3.29 3.30

2.6.13 Current transformers shall be supplied in accordance with ANSI standard C57.13 with the ratios as specified in Attachment I and an accuracy class of at least C-200. Current transformers shall have short circuit and thermal withstand at least equal to the circuit breaker. The first current transformer per phase on both the bus and line side of the breaker shall mounted such that removal and replacement can be accomplished with a live main bus with complete operator safety.	3.32 3.33 3.35 3.36 3.37
2.6.14 Potential transformers shall be supplied in accordance with ANSI C57.13 with a burden capability of 200 volt amperes minimum. Potential transformers shall be located in a drawout type compartment and shall be disconnected, primary grounded, and isolated from high voltage when the access door is opened.	3.39 3.40 3.42 3.43
2.6.15 All components shall function in a satisfactory manner within and at their rated capacity under the specified service conditions, regardless of whether all necessary specific performances are set herein or in applicable standards.	3.45 3.46 3.47
2.6.16 The use of PVC, teflon or asbestos is forbidden.	3.49
2.6.17 The equipment covered by this specification shall be completely assembled in the factory and thoroughly tested in accordance with the latest applicable standards of ANSI and NEMA listed in this specification.	3.51 3.52

<u>3.0 QUALITY ASSURANCE</u>	1.8
<u>3.1 Quality Assurance Program Requirements</u>	1.11
3.1.1 <u>QA Program</u>	1.12
The Seller shall have in effect at all times a quality assurance (QA) Program which clearly establishes the authority and responsibility of those responsible for the QA Program. Persons performing quality functions shall have sufficient and well-defined responsibility and authority to enforce quality requirements, to identify, initiate, recommend, and provide solutions to quality problems, and to verify the effectiveness of the solutions. No submittal of this QA Program is required.	1.13 1.14 1.15 1.16 1.17 1.18
3.1.2 <u>Seller's Responsibility for Suppliers</u>	1.20
The Seller shall identify, in purchase documents to his suppliers, all applicable quality and QA requirements imposed by the Engineers' specification on the Seller and shall ensure compliance thereto.	1.21 1.22
3.2 <u>Tests</u>	1.26
The circuit breakers, relays, and instrument transformers shall be tested in accordance with ANSI C37.50, ANSI C37.90, and NEMA SE-5.	1.27 1.28
Written records shall be kept for each test showing date, equipment tested, test method and test results. Test records and certificates of final inspection or approval shall be submitted to the Purchaser for each test within 10 working days after test completion.	1.30 1.31 1.32
The Seller shall be responsible for compliance with his standard in-production test procedures.	1.33
3.3 <u>Documentation</u>	1.35
3.3.1 <u>Record System</u>	1.36
A records system shall be established and maintained that provides for the identification and correlation of test and inspection records and certificates.	1.37 1.38
3.3.2 <u>Final Inspection and Check of Records</u>	1.41
The Seller shall be responsible for inspecting the item(s) and checking the applicable records, prior to shipment, to verify that all specification requirements have been complied with. Two complete sets of all documents required to comply with this specification shall be submitted to the Purchaser. Acceptance of the completed sets of records does not relieve the Seller of responsibility for compliance with specification requirements.	1.42 1.43 1.45 1.46 1.47

3.4 <u>Warranty</u>	1.49
The Seller shall warrant for a period of 12 months from the in-service date or 18 months from the shipment date (whichever occurs first) all equipment supplied is free from defects in design, material, and workmanship. The Seller shall also warrant the equipment supplied is suitable for the intended installation and operation as described in this Specification.	1.50 1.52 1.53 1.54
In the event that the equipment fails to achieve the warranted performance, then, to the extent that the deficiency or failure to achieve the warranted performance is attributable to equipment supplied by the Seller, the Seller shall make such adjustments or modifications to enable the equipment to achieve the warranted performance. The cost of these adjustments or modifications shall be to the Seller's account. After such adjustments or modifications, should the equipment fail to achieve warranted performance, an equitable settlement shall be made, which may without limitation include an adjustment of purchase order price.	1.55 1.57 1.58 2.1 2.2 2.3
3.5 <u>Field Tests</u>	2.5
The Purchaser may conduct field tests at his own expense to verify performance guarantees under the actual working condition. Where the tests reveal deficiencies in the equipment or deviations from the guaranteed performance, the Seller shall be completely responsible for any modifications, repairs, and/or adjustments required to meet the equipment performance guarantees.	2.6 2.8 2.9 2.10
Should additional field testing be required to verify performance guarantees, the cost for the field representative and required materials shall be at the Seller's expense.	2.11 2.12

4.0 PREPARATION FOR SHIPMENT

- Packaging shall be adequate to prevent contamination, mechanical damage, or deterioration of the item supplied. These requirements are applicable immediately after manufacture. 1.11
- The Seller shall identify desiccants and inhibitors used and the required replacement frequency. 1.14
- Expendable materials, such as tapes, barriers, plugs, desiccants, desiccant bags, inhibitors, etc, in contact with austenitic stainless steel or nickel alloys shall not contribute to corrosion during the storage period, by, for example, water or condensate leaching deleterious chemicals contained in the expendable materials. 1.15 1.16
- Objectionable chemicals contain lead, mercury, chlorides, fluorides, sulfur, and zinc. 1.17 1.18
- Items shall be inspected for cleanliness immediately before packaging. 1.19
- All openings into items shall be sealed or plugged. Weld-end preparations shall be protected against corrosion and physical damage. 1.21
- Entrapped water shall be removed. 1.22
- The outermost covering shall be clearly marked with the complete vendor identification which shall include weight. 1.23
- The equipment shall be packaged for indoor storage. 1.24
- The weight lifting points, indicated on the crate, skid, or package, shall be utilized for all handling procedures. 1.25

5.0	<u>SUPPLEMENTAL PROVISIONS</u>	1.8
5.1	<u>Deviations and Nonconformances</u>	1.11
	No deviation or nonconformance from this specification or applicable federal, state, or local codes and standards invoked by this specification shall be accepted until approved by the Engineers.	1.12
	Deviations are considered departures from any requirement of this specification. Uncorrectable nonconformances are considered to be conditions which cannot be corrected within the specification requirements by rework or replacement.	1.13 1.14 1.15 1.16
	The Seller shall promptly document and notify the Engineers of all deviations and nonconformances from the specification (such as deviations from applicable codes and/or drawings). Further manufacturing after detection of any deviation or nonconformance prior to the Engineers' approval shall be at the Seller's risk. No departure from the specification shall be binding on any party until an addendum or revision to the specification has been issued by the Engineers.	1.17 1.18 1.19 1.20
5.2	<u>Correspondence</u>	1.22
	All correspondence from the Seller shall consist of an original plus two copies and shall contain the following subject heading:	1.23 1.24
	Purchase Order No. (later)	1.28
	J.O. No. 15164.00	1.29
	48 Volt Switchgear	1.30
	LIMB Demonstration Project	1.31
	Edgewater Station, Unit No. 4	1.32
	Babcock & Wilcox Company	1.33
	Bid documents and contractual correspondence relative to or affecting prices, terms, conditions, price adjustment, deliveries, return of materials for credit, routing of shipments, or that which changes the price or scope of an order even though also discussing engineering matters shall be addressed to:	1.37 1.38
	Babcock & Wilcox Company	1.41
	Copy to:	1.46
	Mr. John H. Davies	1.49
	Stone & Webster Engineering Corporation	1.50
	P.O. Box 2325 245/6	1.51
	Boston, Massachusetts 02107	1.52

Correspondence relative to inspection, expediting, technical matters, and transmittal of manufacturer's drawings, spare parts list, and operating instructions shall be addressed to:	1.56
Babcock & Wilcox Company	1.59
with a copy to Mr. Davies of Stone & Webster.	2.5
<u>5.3 Subsuppliers</u>	2.7
Should the Seller propose to purchase from another supplier any of the equipment, material, or services specified herein, he shall, upon request, identify the subsupplier for the specific equipment, material, or services itemized by the Engineers.	2.8 2.9 2.10
To the extent that they apply, the Seller shall impose on each of the subsuppliers the complete requirements of this specification. He shall be directly responsible that the subsuppliers are completely aware of <u>all</u> of these requirements, and that they abide thereby.	2.12 2.14 2.15
<u>5.4 Release for Material Purchase or Fabrication</u>	2.17
Written approval to the Seller to start fabrication of the equipment covered by this specification will be provided by the Purchaser.	2.18 2.19
Fabrication is to be based on drawings and procedures reviewed and approved by the Engineers as required by the specification.	2.21 2.22
<u>5.5 Tools and Spare Parts</u>	2.24
One complete set of all special* tools, fixtures, and appurtenances required for maintenance and operation shall be furnished. (*"Special" is defined as anything not normally and usually available in a power station or readily available thereto.)	2.25 2.28
The Seller shall itemize on the attached Data Sheet the special tools that will be furnished.	2.29
A detailed list of all recommended spare parts shall be provided by the Seller. This list shall include the cost, location, and address of the local supplier, generic description of the part, and the Seller's normal delivery time.	2.30 2.31 2.32
<u>5.6 Installation, Operating, and Maintenance Instructions</u>	2.34
No later than one month before initial shipment, the Seller shall submit to the Engineers' Project Engineer 12 bound copies of a complete installation, operating, and maintenance manual for the equipment furnished, including instructions for individual components. All final	2.35 2.36 2.39

instructions shall be certified by the manufacturer as applicable to the equipment furnished, and shall be specifically identified, such as by serial number. The Seller shall inscribe the following identification on the cover; the words OPERATION AND MAINTENANCE MANUAL, the name and location of the equipment, the name of the manufacturer, and the contract number. The manual shall include the names, addresses, and telephone numbers of other equipment suppliers, and of the local representatives. The manual shall have a table of contents and be assembled to conform to the table of contents with the tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in. The manual shall include: wiring and control diagrams with data to explain detailed operation and control of each item of equipment; description of the function of each principal item of equipment; installation instructions; maintenance instructions; lubrication schedule including type, grade, temperature range, and frequency; safety precautions, diagrams, and illustrations; test procedures; and performance data.

One additional set of instructions, certified by the manufacturer, shall be packed and sent with the equipment to the jobsite. A parts identification list shall accompany each set of instructions. This list shall include sectional and/or outline prints or illustrations identifying each numbered part and location in relation to the equipment as a whole. The parts list for equipment shall indicate the source of supply and recommended spare parts.

#### 5.7 Data and Drawings

After the order is placed, the Seller shall submit all drawings in accordance with the agreed-upon schedule. The drawings submitted shall show the following:

1. All physical outlines, as required, to show the overall size and space requirements (including that for dismantling and maintenance) and the interrelationship of the various components
2. Cross sections and details, as required, to satisfy the Engineers and Purchaser that all components are in conformance with the intent of the specification and are satisfactory from the standpoint of design and physical arrangement
3. All information required by the Engineers for the design and location of all connecting Purchaser-furnished structural or electrical items such as steel supports, cables, conduit, etc.
4. Weight of the equipment and distribution of the static and other loads

As a minimum, the following data and drawings are required:	3.15
1. Equipment arrangement drawing	3.17
2. Elementary diagrams	3.18
3. Wiring diagrams for circuit breaker and wiring between circuit breakers and external devices	3.19
4. Bill of Materials	3.20
5. One Installation, Operation, and Maintenance Manual for review	3.21
The Engineers' job order number and purchase order number shall be shown on each drawing.	3.23
All drawings submitted shall be in the form of one good quality reproducible and three good, sharp, black and white, direct contact prints of the Seller's original drawing.	3.24
After review by the Engineers, one direct contact print marked APPROVED or APPROVED AS REVISED will be returned to the Seller. If marked APPROVED AS REVISED, the required changes shall be incorporated by the Seller, clearly identified, and be resubmitted to the Engineers.	3.25 3.26
If the Seller elects not to incorporate the revisions, he shall inform the Engineers that the suggested revisions cannot be made without prejudice to the Seller's responsibility under warranty.	3.27
Arrangements for production scheduling and the procurement of the necessary materials shall not be deferred pending approval of drawings.	3.28
The Engineers and Purchaser reserve the right to reproduce any drawing or print received from the Seller, as may be required during the design and construction of this project and the preparation of a plant manual, despite any notice prohibiting the same appearing on the drawing or print.	3.29 3.30
<u>5.8 Proposal Requirements</u>	3.32
The bidder shall furnish with his bid a list of all equipment he proposes to use. Deviations from any of the Engineers' requirements must be clearly defined along with the reason(s) for the proposed change(s). All data sheets shall be filled-in. The following data and drawings are required with the bid package:	3.33 3.35 3.38
1. Preliminary Bill of Material	3.40
2. Outline drawings showing the general arrangement and approximate dimensions of the equipment proposed	3.41 3.42

5.9 Schedule 3.45

The following schedule, or a revision of it, as agreed upon by the Seller and the Engineers before the purchase order is placed and included with the purchase order, shall be binding upon the Seller. 3.46  
3.48

<u>Milestone</u>	<u>Date</u>	
1. Bid due date		3.53
2. Award purchase order		3.54
3. Initial drawing submittal		3.55
4. Equipment delivery date		3.56

5.10 Delivery 4.2

Delivery shall be made by enclosed truck. 4.3

SPECIFICATIONS FOR 600 VOLT ETHYLENE PROPYLENE  
RUBBER OR CROSS-LINKED POLYETHYLENE INSULATED CONTROL CABLE  
FOR SUBSTATION & GENERATING PLANT USE

1. SCOPE

This specification covers flame retardant ethylene propylene rubber or cross-linked polyethylene insulated, heavy-duty neoprene or heavy-duty chlorosulfonated polyethylene jacketed cable for use as control cable in electric substations and electric generating stations. The cable shall be rated 600 volts and certified for continuous operation at 90°C in wet or dry locations, for installation in trays, conduits or ducts.

2. APPLICABLE CODES, STANDARDS AND REGULATIONS

2.1 The cable covered by this Specification shall be manufactured and tested in accordance with the Specifications as listed herein and the following standards:

Insulated Cable Engineers Association: (ICEA)

ICEA S-66-524, latest revision	Cross-linked-thermosetting-polyethylene-insulated Wire and Cable for the Transmission and Distribution of Electric Energy
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ICEA S-68-516, latest revision	Ethylene-propylene-rubber-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
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Institute of Electrical and Electronics Engineers: (IEEE)

IEEE 383, latest revision	IEEE Standard for Type Test of Class 1E Electrical Cables, Field Splices and Connections for Nuclear Power Generating Stations.
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2.2 In case of conflict between this Specification and the Codes or Standards, the matter shall be brought to the attention of the Ohio Edison Transmission and Distribution Engineering Department.

REV	DATE	BY	AS
APPRO	JUN	AEK	
APPRO	EM	WJC	

SPECIFICATIONS

OHIO EDISON CO.

SPECIFICATIONS FOR 600 VOLT ETHYLENE PROPYLENE  
RUBBER OR CROSS-LINKED POLYETHYLENE INSULATED CONTROL CABLE  
FOR SUBSTATION & GENERATING PLANT USE

3. BASIC CABLE CONSTRUCTION

Cable is to consist of stranded annealed coated copper conductor, ethylene propylene rubber or cross-linked polyethylene insulation with a heavy-duty neoprene or heavy-duty chlorosulfonated polyethylene jacket over the single conductor when required. Fillers, when necessary, in multiple conductor cables are to be flame and moisture resistant. The conductor assembly shall be covered with a flame retardant binder tape, a coated copper shielding tape (when specified) and a heavy-duty neoprene or heavy-duty chlorosulfonated polyethylene jacket overall. Two conductor cables shall be of round construction. The use of asbestos in any form in the makeup of the cable is not acceptable.

4. DETAILS OF CABLE CONSTRUCTION

4.1 CONDUCTOR

The conductors shall be Class B concentric stranded annealed coated copper in accordance with ASTM B33 for tin coated conductors or B189 for lead or lead-alloy coated conductors per Section 2.1.1 of ICEA Pub. No. S-68-516 or S-66-524.

4.2 INSULATION

The individual conductors shall be insulated with ozone-resistant Type I or Type II ethylene propylene rubber whose thickness is in accordance with Section 7.5.3 and Table 7.5-1 of ICEA Pub. No. S-68-516, or cross-linked polyethylene whose thickness is in accordance with Section 7.7.3 and Table 7-32 of ICEA Pub. No. S-66-524.

4.3 JACKET OVER INDIVIDUAL CONDUCTORS

The individual conductors insulated with Type I ethylene propylene rubber shall be covered with a minimum 15 mil heavy-duty neoprene or heavy-duty chlorosulfonated polyethylene jacket in accordance with Section 7.5.4 of ICEA Pub. No. S-68-516. The individual conductors insulated with Type II ethylene propylene rubber or cross-linked polyethylene shall have no individual outer jacket.

4.4 MULTIPLE CONDUCTOR ASSEMBLY

Cable shall be assembled in accordance with Section 5 of ICEA Pub. No. S-68-516 or S-66-524.

REV	DATE	BY
APPD	J. G. W.	GER
APPD	W. W. C.	

SPECIFICATIONS

OHIO EDISON CO.

SPECIFICATIONS FOR 600 VOLT ETHYLENE PROPYLENE  
RUBBER OR CROSS-LINKED POLYETHYLENE INSULATED CONTROL CABLE  
FOR SUBSTATION & GENERATING PLANT USE

4.4.1 Shielded Cable

The conductor assembly shall be covered with a flame retardant binder tape, a 5 mil coated copper shielding tape helically wrapped to provide a 20% overlap, and a heavy-duty neoprene or heavy-duty chlorosulfonated polyethylene jacket overall in accordance with Section 7.5.7 and Table 7.5-2 of ICEA Pub. No. S-68-516 (EP insulation) or Section 7.7.7 and Table 7-33 of ICEA Pub. No. S-66-524 (XLP insulation).

4.4.2 Unshielded Cable

The conductor assembly shall be covered with a flame retardant binder tape and a heavy-duty neoprene or heavy-duty chlorosulfonated polyethylene jacket overall in accordance with Section 7.5.7 and Table 7.5-2 of ICEA Pub. No. S-68-516 (EP insulation) or Sections 7.7.7 and Table 7-33 of ICEA Pub. No. S-66-524 (XLP insulation).

4.5 CONDUCTOR IDENTIFICATION

Conductor identification of multi-conductor cables shall be in accordance with Section 5.3.2.1.1, Method 1 (Colored Compounds with Tracers) of ICEA Pub. No. S-68-516 (EP insulation) or Appendix L, Section L.3.1, Method 1, Table L-1 (Colored Compounds with Tracers) of ICEA Pub. No. S-66-524 (XLP insulation).

R9

Cables shall have sequential footage markers durably printed on the outer surface of the cable, spaced not more than ten feet apart, throughout its entire length. The number of the last sequential footage marker at the core of the reel shall be clearly and permanently marked on the reel.

All identification markings on the reel, such as manufacturer, reel number, etc., shall be permanent. Stenciling on paper or cardboard stapled or otherwise fastened to the reel is not acceptable.

REV	DATE	BY
APPD	J. W.	DEB
APPD	W. W.	W. W.

SPECIFICATIONS

OHIO EDISON CO.

## TECHNICAL REQUIREMENTS

- ° The motor control centers shall conform to the requirements of NEMA ICS 1, NEFM ICS 2, NEMA ICS 4, NEMA ICS 5, and the MCC data sheets.
  - ° Horizontal bus shall be per MCC data sheet. Vertical bus shall be 300 Amp copper, braced for 42,000 amp rms symmetrical.
  - ° Starters shall be provided with manufacturers standard overload relays, with two normally closed and two normally open contracts for control circuits.
  - ° A space designated as "Equiped Space" shall be furnished completed with doors and all other hardware required to permit completion by the addition of the drawout starters unit or feeder or tap unit.
  - ° A space designated as "Future" shall be complete with vertical bus and removal covers in the front and rear, but shall not include stab-ins, framework, etc.
  - ° Control wire shall be type SIS, minimum #14AWG.
  - ° The motor control centers shall be designed to accomodate expansion from either side.
  - ° Vertical wireway shall have hinged doors
  - ° AC holding coil shall have a minimum pick-up voltage of 70% of rated voltage.
  - ° Control transformers shall be rated 150VA for size 1 starters and 200 VA for size 2 starters, with one leg fused and one leg grounded.
  - ° Circuit breakers shall have provisions for padlocking.
  - ° One red and one green indicating, oil-tight, transformer indicating light shall be provided for each unit.
- All buses shall be copper. Ground bus shall be ½" x 2".
- ° Marathon series 1500 STRC stud type terminal blocks shall be provided for all control connections with 20% spare positions.
  - ° AMP Special industries self insulated ring tongue terminal connectors shall be used for all control wiring.
  - ° MCC shall be designed to operate in 35% to 100% humidity.

The following tests are required:

1. Dielectric tests listed in NEMA ICS 1.
2. Factory Tests - operation and mechanical adjustment.

The manufacturer shall furnish the following certified drawings and data.

- a. Dimensioned outline drawings showing equipment layouts and front view
- b. Wiring and internal connection diagrams
- c. Bill of Materials
- d. Spare parts list
- e. Tabulation of settings for all adjustable protection devices.
- f. Elementary Diagrams.

The following documents form part of this specification.

- Data Sheet-MCC HBA-1 (Sheets I, II, III, IV)
- Sketch No. 15164-SK-MCC-HBA-1
- Data Sheet-MCC-HBA-1 (Sheets I, II, III, IV)
- Sketch No. -15164-SK-MCC-HBA-2

<b>STONE &amp; WEBSTER ENGINEERING CORPORATION</b>		D. NO. <b>15164.04</b>	SPEC. NO. <b>15164-E-011</b>
<b>MOTOR CONTROL CENTER DATA SHEET</b>		DATA SHEET NO. <b>MCC-HBA-1</b>	
PROJECT <b>B &amp; W</b>		PAGE <b>I</b> OF <b>IV</b>	
SPECIFICS		MOTOR CONTROL CENTER NO. <b>HUMIDIFICATION MCC-1</b>	
SERVICE:	- VOLTS <b>480</b>	- PHASE <b>3</b>	- WIRE <b>3</b>
	<input checked="" type="checkbox"/> DELTA	<input type="checkbox"/> WYE	- AMBIENT
	<input checked="" type="checkbox"/> INDOOR	<input type="checkbox"/> OUTDOOR	<input type="checkbox"/> GROUNDED
NEMA CLASS AND TYPE WIRING:	<input checked="" type="checkbox"/> CLASS I	<input type="checkbox"/> CLASS II	<input type="checkbox"/> GROUNDED
	<input type="checkbox"/> TYPE A	<input checked="" type="checkbox"/> TYPE B	<input type="checkbox"/> TYPE C
ENCLOSURE:	<input type="checkbox"/> NEMA 1	<input type="checkbox"/> NEMA 3	<input checked="" type="checkbox"/> NEMA 12
COMPARTMENT CONSTRUCTION:	<input type="checkbox"/> BACK TO BACK	<input checked="" type="checkbox"/> FRONT ONLY	<input type="checkbox"/> OTHER
CONTROL VOLTAGE:	<b>INDIVIDUAL CPT 480-120</b> - VOLTS		
INCOMING MAIN CABLE:	SIZE - <b>LTR.</b>		
	<input type="checkbox"/> BOTTOM ENTRANCE	<input checked="" type="checkbox"/> TOP ENTRANCE	ENTRY BOX <input type="checkbox"/> REQUIRED <input checked="" type="checkbox"/> NOT REQUIRED
MAIN PROTECTIVE DEVICE:	<input type="checkbox"/> CIRCUIT BREAKER <input type="checkbox"/> FUSED SWITCH <input checked="" type="checkbox"/> NONE - LUGS ONLY		
HORIZONTAL BUS:	CONTINUOUS RATING - <b>600</b> AMPERES 750°C RISE		
	SHORT CIRCUIT RATING -	<input checked="" type="checkbox"/> 42,000	<input type="checkbox"/> 65,000 <input type="checkbox"/> 100,000 RMS SYMMETRICAL AMP.
BRANCH CIRCUIT PROTECTIVE DEVICES:	<input checked="" type="checkbox"/> CIRCUIT BREAKER <input type="checkbox"/> MOTOR CIRCUIT PROTECTOR <input type="checkbox"/> FUSED SWITCH <input type="checkbox"/> U.L. FUSE TYPE -		
	SHORT CIRCUIT RATING - <b>42,000</b> RMS SYMMETRICAL AMP.		
BRANCH FEEDER CABLE ENTRANCE:	<input checked="" type="checkbox"/> TOP <input type="checkbox"/> BOTTOM <input type="checkbox"/> TOP AND BOTTOM		
	ENTRY BOX <input type="checkbox"/> REQUIRED <input checked="" type="checkbox"/> NOT REQUIRED		
GROUND CABLE SIZE:	MAIN <b>4/0 AWG</b>		
<b>ACCESSORIES</b>			
SPACE HEATERS:	<b>120V</b> <input checked="" type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED		
<b>SKETCH</b>			
<b>SEE FRONT VIEW SKETCH 15164-SK-MCC-HBA-1</b>			



STONE & WEBSTER ENGINEERING CORPORATION

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MCC REAR ACCESSIBLE:

LOOP FEEDER PROVISION:

PER PHASE

MCM.

CABLE DATA

▲ 9038 1 INCOMING LINE

ITEM NO.	EQUIPMENT NAME PLATE SERVICE DESIGNATION	MOTOR HP	NEMA SIZE	TYPE	STARTER		COIL VOLTS	MTR. SIZE AMP.	BRANCH FDR. ACB TRIP AMP.	PILOT DEVICES			ESK NO.	OTHER
					AUX. CONT. NO.	CONT. TRANS.				PB	SEL. SW.	IND. LT.		
2JL	LOUVER DAMPER	2							15					L.R. (LATER)
2JR	HEAT TRACE	10KW							30					
2L	OIL COOLER FAN	3	1	FVNR	2	2	120							
3B	CHAMBER VIBRATOR													EQUIPPED SPACE FOR SIZE 1 FVNR *
3D	PUFF PACK BLR-1	5	1	FVNR	2	2	120							
3E	LUMP BREAKER	10	1	FVR	2	2	120							EQUIPPED SPACE FOR SIZE 3 FVNR *
3F	ATOMIZING WTR PP	40	3	FVNR	2	2	120							EQUIPPED SPACE FOR SIZE 1 FVNR *
3L	VACUUM BLR "A"													
4B	CHAMBER VIBRATOR													
4D	PUFF PACK BLR-3	5	1	FVNR	2	2	120							
4F	LUMP BREAKER	10	1	FVR	2	2	120							
4H	PUFF PACK BLR-5	5	1	FVNR	2	2	120							

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MOTOR CONTROL CENTER DATA SHEET  
 MCC NO. IDENTIFICATION MAR-1

LEGEND: \* PROVIDE NAMEPLATE ON DOOR AS SHOWN  
 PB - PUSH BUTTON - NUMBER INDICATES QUANTITY  
 IND. LT. - NUMBER INDICATES QUANTITY X - YES, OR REQUIRED





STONE & WEBSTER ENGINEERING CORPORATION	ORDER NO. <b>15164.09</b>	SPEC. NO. <b>15164-E-011</b>
MOTOR CONTROL CENTER DATA SHEET		DATA SHEET NO. <b>MCC-HBA-2</b>

CLIENT <b>B &amp; W</b>	PROJECT <b>LIMB/HUMIDIFICATION</b>	PAGE <b>I</b> OF <b>IV</b>
SPECIFICS		MOTOR CONTROL CENTER NO. <b>HUMIDIFICATION MCC</b>

SERVICE:	- VOLTS <b>480</b>	- PHASE <b>3</b>	- WIRE <b>3</b>	- HERTZ <b>60</b>
	<input checked="" type="checkbox"/> DELTA	<input type="checkbox"/> WYE	<input type="checkbox"/> AMBIENT	
	<input checked="" type="checkbox"/> INDOOR	<input type="checkbox"/> OUTDOOR	<input type="checkbox"/> GROUNDING	<input type="checkbox"/> UNGROUNDING
NEMA CLASS AND TYPE WIRING:	<input checked="" type="checkbox"/> CLASS I		<input type="checkbox"/> CLASS II	
	<input type="checkbox"/> TYPE A		<input checked="" type="checkbox"/> TYPE B	<input type="checkbox"/> TYPE C
ENCLOSURE:	<input type="checkbox"/> NEMA 1	<input type="checkbox"/> NEMA 3	<input checked="" type="checkbox"/> NEMA 12	<input type="checkbox"/> OTHER
COMPARTMENT CONSTRUCTION:	<input type="checkbox"/> BACK TO BACK		<input checked="" type="checkbox"/> FRONT ONLY	
CONTROL VOLTAGE:	<b>INDIVIDUAL CPT 480-120</b>		- VOLTS	
INCOMING MAIN CABLE:	SIZE - <b>LTR</b>			
	<input type="checkbox"/> BOTTOM ENTRANCE	<input checked="" type="checkbox"/> TOP ENTRANCE	ENTRY BOX	<input type="checkbox"/> REQUIRED <input checked="" type="checkbox"/> NOT REQUIRED
MAIN PROTECTIVE DEVICE:	<input type="checkbox"/> CIRCUIT BREAKER <input type="checkbox"/> FUSED SWITCH <input checked="" type="checkbox"/> NONE - LUGS ONLY			
HORIZONTAL BUS:	CONTINUOUS RATING - <b>600</b>		AMPERES 300C RISE	
	SHORT CIRCUIT RATING -	<input checked="" type="checkbox"/> 42,000	<input type="checkbox"/> 65,000	<input type="checkbox"/> 100,000 RMS SYMMETRICAL AMP.
BRANCH CIRCUIT PROTECTIVE DEVICES:	<input checked="" type="checkbox"/> CIRCUIT BREAKER <input type="checkbox"/> MOTOR CIRCUIT PROTECTOR <input type="checkbox"/> FUSED SWITCH <input type="checkbox"/> U.L. FUSE TYPE -			
	SHORT CIRCUIT RATING - <b>42,000</b>		RMS SYMMETRICAL AMP.	
BRANCH FEEDER CABLE ENTRANCE:	<input checked="" type="checkbox"/> TOP <input type="checkbox"/> BOTTOM <input type="checkbox"/> TOP AND BOTTOM			
	ENTRY BOX	<input type="checkbox"/> REQUIRED	<input checked="" type="checkbox"/> NOT REQUIRED	
GROUND CABLE SIZE:	MAIN <b>4/0 AWG</b>			

ACCESSORIES

SPACE HEATERS:	<b>120V</b>	<input checked="" type="checkbox"/> REQUIRED	<input type="checkbox"/> NOT REQUIRED
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SKETCH

**SEE FRONT VIEW SKETCH 15164-SK-MCC-HBA-2**

STONE & WEBSTER ENGINEERING CORPORATION

PAGE 9

A 5028 1

INCOMING LINE: CABLE DATA MCM. PER PHASE LOOP FEEDER PROVISION: MCC REAR ACCESSIBLE.

ITEM NO.	EQUIPMENT NAME PLATE SERVICE DESIGNATION	MOTOR HP	NFMA SIZE	TYPE	STARTER			COIL VOLTS	OIL MTR SIZE AMP	BRANCH FOR ACB TRIP SW AMP	FUSED SW AMP	PILOT DEVICES			FSK NO	OTHER
					AUX. AGO L	CONT	NO					NC	CONT TRANS	PB		
IB	INCOMING LINE															
ID	No. 2 HOIST															EQUIPPED SPACE FOR SIZE 1 FVR *
IF	Hopper Vibrator															EQUIPPED SPACE FOR SIZE 1 FVHR *
IHL	ELECT RM HEATER	10KW								30						
IHR	ELECT. RM HEATER	10KW								30						
IJL	GUILLotine DAMPER	15								50						
IJR	GUILLotine DAMPER	6.6								25						
IL	ELECT RM VENT FAN	10														L.R. 61 AMPS L.R. 26 AMPS
2BL	HEATER - NORTH SPRAY DECK	15KW								30						
2BR	HEATER - NORTH SPRAY DECK	20KW								40						
2DL	HEATER - SOUTH SPRAY DECK	20KW								40						
2DR	HEATER - SOUTH SPRAY DECK	20KW								40						
2F	Hopper Vibrator									15						EQUIPPED SPACE FOR SIZE 1 FVHR *
2HL	Hopper Heaters									15						SPARE *
2HR	Hopper Heaters									15						SPARE *

REV 12/17/87

LEGEND: \* PROVIDE NAMEPLATE ON DOOR AS SHOWN  
 PB - PUSH BUTTON - NUMBER INDICATES QUANTITY  
 IND. LT. - INDICATOR LIGHT - NUMBER INDICATES QUANTITY  
 X - YES, OR REQUIRED  
 MOTOR CONTROL CENTER DATA SHEET  
 MCC NO. IDENTIFICATION MARK-7  
 J.O. NO. 15164.09  
 ISSUE #  
 DATE 1/1/87





STONE & WEBSTER ENGINEERING CORPORATION  
 CALCULATION SHEET

▲ 5010 65

CALCULATION IDENTIFICATION NUMBER				PAGE ____
J.O. OR W.O. NO. 15164-OR	DIVISION & GROUP 3902-200	CALCULATION NO. 1112-77	OPTIONAL TASK CODE	

REV. 12/7/87

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A -	INC SECT. 1B	100A ACE 2BL	100A ACB 2BR	EQUIP. SP SIZE 1 FVNR 3B	EQUIP. SP SIZE 1 FVNR 4B
B -	EQUIP. SP SIZE 1 FVR 1D	100A ACE 2BL	100A ACB 2BR	SIZE 1 FVNR 3D	SIZE 1 FVNR 4D
C -	EQUIP. SP SIZE 1 FVNR 1E	EQUIP. SP SIZE 1 FVNR 2E		SIZE 1 FVR 3E	SIZE 1 FVR 4E
D -	100A ACE 1BL	100A ACE 2BL	100A ACE 2BR	SIZE 1 FVNR 3F	SIZE 1 FVNR 4F
E -	100A ACE 1BL	100A ACE 2BL	100A ACE 2BR	SIZE 1 FVNR 3G	SIZE 1 FVNR 4G
F -	100A ACE 1BL	100A ACE 2BL	100A ACE 2BR	SIZE 1 FVNR 3H	SIZE 1 FVNR 4H
G -	100A ACE 1BL	100A ACE 2BL	100A ACE 2BR	SIZE 1 FVNR 3I	SIZE 1 FVNR 4I
H -	100A ACE 1BL	100A ACE 2BL	100A ACE 2BR	SIZE 1 FVNR 3J	SIZE 1 FVNR 4J
I -	100A ACE 1BL	100A ACE 2BL	100A ACE 2BR	SIZE 1 FVNR 3K	SIZE 1 FVNR 4K
J -	100A ACE 1BL	100A ACE 2BL	100A ACE 2BR	SIZE 1 FVNR 3L	SIZE 1 FVNR 4L

HUMIDIFICATION MCC2 - BOILER AREA

SKETCH NO. 15164-OR-MCC-HEA-2

SWEC J.O. NO. 15164.09  
SPEC. NO. 15164-M-017

February 19, 1988

MEMORANDUM OF TECHNICAL REQUIREMENTS

FOR

TRANSFORMER FIRE PROTECTION  
SYSTEM EXTENSION

Limestone Injection Multistage Burner (LIMB)  
Demonstration Project  
Ohio Edison Company's  
Edgewater Station

Babcock & Wilcox Company \_ (Owner)

SELLER: AUTOMATIC SPRINKLER CORPORATION OF AMERICA

	<u>Signature</u>	<u>Date</u>
Preparer:	<u><i>Amos K. Hallmark</i></u>	<u>2/22/88</u>
Lead Engineer:	<u><i>S. L. Fyke</i></u>	<u>2-22-88</u>
Project Engineer:	<u><i>J. L. [unclear]</i></u>	<u>2-26-88</u>

Stone & Webster Engineering Corporation  
Boston, Massachusetts

J.O. No. 15164.09

ITEM NO. 1: Transformer Fire Protection System Extension

APPLICATION: To provide fire protection water to new transformer by extending the existing fire protection system header, shown on Ohio Edison's Dwg. No. 0-401-G1070 Sh. 12 of 12.

To also provide fire detection/actuation for the transformer fire protection system extension.

LOCATION: • For transformer location, see SWEC Dwg. No. 15164.09-ES-2C-1  
 • For transformer dimensions, see Westinghouse Electric Corporation's Dwg. No. 2D60288

NUMBER OF SYSTEMS: One complete system

EQUIPMENT AND MISCELLANEOUS TECHNICAL REQUIREMENTS:EQUIPMENT:

Pipe Length and Fittings See Vendor's drawings attached.

Piping Material Specification: Galvanized Carbon Steel for Fire Protection Service (SWEC's Piping Class 47F)

<u>PIPE</u>	<u>2" and Smaller</u>	<u>2 1/2" and Larger</u>
ASTM Spec.	A120	A120
Type	Welded or Seamless	Welded or seamless
Schedule	40	STD
Ends	Threaded or grooved	Threaded or grooved
Finish	Galvanized to ASTM A153	Galvanized

<u>FITTINGS</u>	<u>6" and Smaller</u>
Conditions	All
Type	(b) Malleable iron, screwed, or Grooved ends banded
ASTM Spec	A197 or A47
Class	-
Rating	(a) 150 lb or 300 lb
ANSI Std	B16.3
Finish	Galvanized
Approval	UL or FM

<u>COUPLINGS</u>		<u>6" and Smaller</u>	
Type	(b)Malleable iron, screwed, ribbed and banded or companion flanges		or Grooved end, malleable or ductile iron, victaulic style 75 or 77 or "Zero Flex" or equal with EPDM gaskets
ANSI Std.	B16.3		-
Pressure Class	150 lb or 300 lb		-
Finish	Galvanized		Galvanized
Approval	UL or FM		UL or FM

<u>PLUGS</u>			
Size Range	<u>2" and Smaller</u>		<u>2 1/2" through 6"</u>
Type	Malleable iron, solid, square head		Use blind flanges
ANSI Std	B16.14		
Finish	Galvanized		

(a) Straight runs of 200 ft or more shall have 300 lb elbows at the downstream end to absorb the water impact

(b) Ductile iron to ASTM A395 may be substituted for malleable iron.

<u>UNIONS</u>		<u>2" and Smaller</u>	<u>2 1/2" through 6"</u>
Type	Malleable iron, screwed female		Use flanges
ASTM Spec	A197		
Pressure Rating	300 lb WOG		
Seat	Brass to iron		
Finish	Galvanized		
Approval	UL or FM		

<u>FLANGES</u>		
Size Range	<u>12" and Smaller</u>	
Type	Ductile or malleable iron, screwed	
ASTM Spec	A395 or A197	
ANSI Std.	B16.1	
Rating	150 lb flat faced	
Finish	Galvanized	

GASKETS

Condition	Not exposed to possible fire	Where exposed to possible fire
Type	Full face, 1/16" thick	Flat ring 1/8" thick
Material	Rubber J-M Style 107, or equal	Type 304 SS with Flexicarb filler, spiral wound Flexitallic Style CG or equal with 1/8 in. thick ring
ANSI Std.	B-16.21, 125 lb	B16.5, Annex E, Fig. E3, Class 150

BOLTING

Type	Bolts, each with one nut
Material	Carbon steel A307, Gr. B galvanized or plated with heavy hex nuts

TECHNICAL REQUIREMENTS

## GENERAL

All materials, supplies, and hardware furnished and incorporated in the permanent work shall be of recent manufacture, and unused. Substitution of materials must be submitted to S&W.

All devices and materials shall be designed for the service they will encounter and shall not be readily rendered inoperative or susceptible to accidental operation.

## CODES &amp; STANDARDS:

The design and installation of the fire protection and detection system extension shall conform to the following NFPA standards:

No. 15 Water Spray Fixed Systems

## DRAWINGS AND COMPUTATIONS:

Approval of working drawings, computations, and system design of the fire protection system extension by the authority having jurisdiction is required, and preliminary approval of drawings and computations shall be secured before submittal to S&W and the Owner.

Any substantial changes from the approved plans must be resubmitted for further review and corrected if necessary. As-installed plans shall be submitted to the Owner and the authority having jurisdiction.

INSTALLATION AND TESTS:

The installation shall be coordinated with and approved by the Owner. In general, installation and tests shall be in accordance with NFPA No. 15.

Specification for	1.13
<u>ROOFING AND SIDING</u>	1.15
for	1.17
LIMESTONE INJECTION MULTISTAGE BURNER (LIMB)	1.19
DEMONSTRATION PROJECT	1.20
BY-PASS/COOLSIDE MODIFICATION	1.21
OHIO EDISON COMPANY'S	1.22
EDGEWATER STATION	1.23
<u>BABCOCK &amp; WILCOX COMPANY</u>	1.25
(OWNER)	1.27

REVIEW REQUIRED	REVIEWED BY	DATE
PREPARER	R.J. Donnell	9-30-87
LEAD ENGR	R.J. Donnell	9-30-87
PROJ. ENGR	J.H. [Signature]	9-30-87

Stone & Webster Engineering Corporation  
 Boston, Massachusetts

## SECTION I - DETAILED SPECIFICATIONS 1.11

## CONTENTS 1.13

<u>Article</u>	<u>Description</u>	<u>Page</u>	
			1.16
1.1	Scope of Work	I-1	1.18
1.2	Furnished by the Contractor	I-1	1.20
1.3	Furnished by the Owner	I-1	1.22
1.4	Applicable Documents	I-2	1.24
1.5	Extent of the Work	I-3	1.26
1.6	Submittals	I-4	1.28
1.6.1	Data and Drawings	I-4	1.29
1.7	Product Handling	I-5	1.31
1.7.1	Product Delivery, Storage, and Handling	I-5	1.32
1.8	Design and Materials	I-6	1.34
1.8.1	Precast Concrete Roof Deck	I-6	1.35
1.8.2	Asphalt and Gravel Roofing	I-7	1.36
1.8.3	Metal Siding	I-9	1.37
1.8.4	Metal Roofing	I-13	1.38
1.9	Erection Requirements	I-14	1.40
1.9.1	Precast Concrete Roof Deck	I-14	1.41
1.9.2	Asphalt and Gravel Roofing	I-15	1.42
1.9.3	Metal Siding	I-19	1.43
1.9.4	Metal Roofing	I-21	1.44

## SECTION I - DETAILED SPECIFICATIONS 1.14

1.1 Scope of Work 1.17

This section of the specification details the technical requirements for the completion of the roofing and siding work as detailed below. 1.18  
1.19

1.2 Furnished by the Contractor 1.20

Design, shop detail, furnish, deliver, unload, haul, and erect all precast concrete roof deck, grouting and accessories. 1.21  
1.22

Furnish and install the built-up asphalt and gravel roofing system and accessories including all necessary modifications at the interface of the existing roofing, and flashing of all penetrations. 1.23  
1.24

Furnish and install rigid board insulation, including tapered insulation, over decking with mechanical fasteners, and any incidental work necessitated by these operations and such other related work as may be called for on the Engineers' drawings. 1.25  
1.26  
1.27

Furnish and install insulated metal siding for exterior enclosure, including flashing, trim closures and accessories, fixed stormproof louvers, and hollow metal doors. 1.28  
1.30

Furnish and install all shop coated insulated metal roofing and accessories including gutters and downspouts to nearest roof system. 1.31  
1.32

1.3 Furnished by the Owner 1.34

The Owner will furnish the following items and associated work: 1.35

1. The site, with existing topography and grading. 1.37
2. Plumbing and drainage lines, except as shown on drawings. 1.39
3. Furnish and erect the structural steel framing and bracing including stairways and grating. 1.40
4. miscellaneous concrete deck supports as required. 1.41
5. Furnish and install metal rain hoods on pipes and ducts through roof. 1.43

1.4	<u>Applicable Documents</u>		1.47
	<u>American Iron and Steel Institute</u>		1.50
AISI Speci- fication	1980	Specification for the Design of Cold- Formed Steel Structural Members	1.53 1.54
AISI Type 305	1974	Steel Products Manual Stainless and Heat- Resistant Steel	1.58 1.59
	<u>American Society for Testing and Materials</u>		2.5
ASTM A167	1977	Specification for Stainless and Heat-Resisting Chromium - Nickel Steel Plate, Sheet, and Strip	2.9
ASTM A366	1979	Standard Specification for Steel, Carbon, Cold-Rolled Sheet, Commercial Quality	2.11
ASTM A416	1980	Standard Specification for Uncoated Seven-Wire Stress Relieved Steel Strand for Prestressed Concrete	2.14
ASTM A446	1983	Specification for Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process, Physical (Structural) Quality	2.17 2.18
ASTM A525	1983	Specification for Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process, General Requirements	2.21 2.22 2.23
ASTM B32	1976	Specification for Solder Metal	2.25
ASTM C33	1982	Standard Specification for Concrete Aggregates	2.26
ASTM C39	1981	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens	2.27
ASTM C150	1981	Standard Specification for Portland Cement	2.28
ASTM C236	1980	Standard Test Method for Steady State Thermal Performance of Building Assem- blies by Means of a Guarded Hot Box	2.30 2.31
ASTM D41	1973	Specification for Primer for Use with Asphalt in Dampproofing and Waterproofing	2.33

ASTM D226	1977	Specification for Asphalt-Saturated Roofing Felt for Use in Waterproofing and in Constructing Built-Up Roofs	2.34 2.35
ASTM D250	1977	Specification for Asphalt-Saturated Asbestos Felts for Use in Waterproofing and in Constructing Built-Up Roofs	2.36 2.37
ASTM D312	1971	Specification for Asphalt for Use in Constructing Built-Up Roof Coverings	2.38
ASTM D1863	1977	Specification for Mineral Aggregate for Use on Built-Up Roofs	2.39
ASTM E84	1981	Standard Test Method for Surface Burning Characteristics of Building Materials	2.41
ASTM E119	1973	Standard Test Method for Fire Tests of Building Construction and Materials	2.44
		<u>American Concrete Institute</u>	2.49
ACI 318 and 1986 Supplement	1983	Building Code Requirements for Reinforced Concrete	2.52 2.53 2.54
ACI 711	1958	Minimum Standard Requirements for Precast Concrete Floors and Roof Units (ACI Journal - July 1958 pgs 83 to 94)	2.58 2.59
		<u>American Welding Society</u>	3.3
AWS D1.1	1983	Structural Welding Code - Steel	3.6
AWS D1.3	1981	Specification for Welding Sheet Steel in Structures	3.8
		<u>U.S. Federal Specification</u>	3.12
HH-I-521-E	1977	Insulation Blanket, Thermal (Mineral Fiber, for Ambient Temperatures)	3.15
1.5		<u>Extent of the Work</u>	3.22
The extent of the work is shown on the Engineers' drawings included with the bid documents and on such other drawings as may hereafter be furnished or approved by the Engineers to explain the work in greater detail. Standard details and reference drawings are also included.			3.23 3.25 3.26

Drawings of all adjacent existing structures are available at the jobsite. Prints will be provided to the successful contractor, as required, to complete the work.	3.27 3.28
1.6 <u>Submittals</u>	3.30
1.6.1 <u>Data and Drawings</u>	3.31
1.6.1.1 <u>Precast Concrete Roof Deck</u>	3.32
Prepare and submit shop detail and erection drawings.	3.33
1.6.1.2 <u>Built-Up Roofing</u>	3.36
Prepare and submit the following:	3.37
1. Furnish the manufacturer and brand of the following materials:	3.39
Felt	3.41
Asphalt	3.42
Elastic cement	3.43
Insulation	3.44
Insulation fasteners	3.45
Vapor barrier	3.46
2. Proposed manufacturer's standard specification	3.49
3. List all contemplated departures from the above specification	3.50
1.6.1.3 <u>Metal Siding</u>	3.53
Prepare and submit the following:	3.54
1. Shop detail and erection drawings for Siding, Louvers, and Doors	3.56
2. Catalog Data for Louvers and Doors	3.58
3. Color charts for Finish Color Selection	3.59
4. Complete sets of the manufacturer's erection instructions shall be submitted in sufficient time to arrive at least one month prior to shipment of the metal siding materials.	4.1 4.2 4.3
1.6.1.4 <u>Metal Roofing</u>	4.5
Prepare and submit shop detail and erection drawings.	4.6

1.7 <u>Product Handling</u>	4.8
1.7.1 <u>Product Delivery, Storage, and Handling</u>	4.9
1.7.1.1 <u>Precast Concrete Roof Deck</u>	4.10
At the jobsite, concrete deck shall be stored outdoors, on	4.11
cribbing, with one end elevated at an angle to prevent standing	4.12
water.	
Any special storage requirements specified by the manufacturer	4.14
shall be forwarded to the jobsite with each shipment to which	4.15
they are applicable.	
Concrete deck shall be tagged in accordance with the area in	4.16
which it is to be located.	
1.7.1.2 <u>Built-Up Roofing</u>	4.19
Deliver materials in original unopened containers.	4.20
Containers shall be labeled with manufacturer's name, brand name,	4.22
installation instructions, and identification of various items.	4.23
All materials shall be stored between 60°F and 80°F, in a dry	4.24
area and protected from water and direct sunlight. If exposed to	4.26
a lower temperature, they shall be restored to the proper	
temperature before using. Damaged materials shall be replaced at	4.27
the Contractor's expense.	
1.7.1.3 <u>Metal Siding</u>	4.30
All materials and equipment shall be carefully boxed, crated, or	4.31
otherwise protected for shipment. Coated material shall be	4.34
covered with a strippable plastic protective covering which shall	
retain its strippable properties for no less than six months or	4.35
shall be shipped with an interlaced plastic sheet between layers.	
As a minimum, material covered by this specification shall be	4.36
stored at the jobsite in an unheated building, or outdoors with	4.37
equivalent protection. Tarpaulin covers are considered suitable	4.39
protection for outdoor storage. Any special storage requirements	4.40
requested by the siding manufacturer shall be forwarded to the	
jobsite with each shipment to which they are applicable. Special	4.42
storage requirements shall be implemented by the Contractor.	
1.7.1.4 <u>Metal Roofing</u>	4.43
See Section 1.7.1.3 above	4.44

1.8	<u>Design and Materials</u>	4.46
1.8.1	<u>Precast Concrete Roof Deck</u>	4.47
	<u>General</u>	4.49
	Design procedure, computations, and section properties shall be determined in strict accordance with the ACI Standard Building Code requirements for reinforced concrete (ACI-318.83). Deck shall be designed to conform to the steel framing layout as shown on the Engineers' drawings.	4.51 4.52 4.53
	Wind loads on the roof shall be as follows:	4.54
	<u>Wind Pressures</u>	4.57
	Uplift load on main roof area: 38 psf	4.59
	Uplift load within 10 ft of edges or corners of the roof: 60 psf	5.2 5.3
	As construction loading may govern, the conc. deck shall also be designed for dead load, plus the more severe of a temporary 250 lb concentrated load located at midspan of the panel or a temporary uniform load of 100 psf. Normal snow load is 20 psf.	5.7 5.8 5.9
	<u>Type of Slab:</u>	5.12
	The units shall be Flexicore floor and/or roof slabs, with voids running lengthwise as fabricated by a licensee of the Flexicore Co., Inc., Dayton, Ohio.	5.14 5.15
	<u>Material and Fabrication:</u>	5.18
	All concrete materials shall be clean and properly graded and the resulting concrete shall have a minimum compressive strength of 3500 psi at time of initial prestress and 5000 psi at 28 days.	5.20 5.21
	Prestressing steel shall be uncoated seven-wire, stress-relieved strand equivalent of ASTM A416.	5.22
	Portland Cement shall be the equivalent of ASTM C150.	5.23
	Concrete aggregates shall be the equivalent of ASTM C33 or C330.	5.24
	Admixtures containing calcium chloride shall not be used.	5.25
	The manufacturer shall cure the slabs by the steam or other suitable methods to secure 3500 psi minimum compressive strength at time of initial prestress and 5000 psi minimum at 28 days, as indicated by 6" x 12" compression cylinder tests (ASTM C39).	5.26 5.27 5.28

Slab length shall be furnished only in one inch increments.	5.29	
<u>Roof Openings</u>	5.32	
Openings wider than 24 in. will be framed and shown on the Engineers' drawings.	5.34	
Where framed openings are shown on the Engineers' drawings, the deck panels shall be shop fabricated to fit the openings.	5.36	
	5.37	
1.8.2 <u>Asphalt and Gravel Roofing</u>	5.39	
<u>General</u>	5.41	
All roofing materials shall bear manufacturers' and Underwriters' Laboratories, Inc., Class "A" labels when delivered to the job.	5.43	
	5.44	
The following materials shall be in accordance with requirements of the ASTM specification noted:	5.46	
Asphalt primer	D41	5.48
Roofing asphalts	D312	5.49
Asphalt-saturated roofing felt	D226	5.50
Asphalt-saturated asbestos felt	D250	5.51
Metal flashings		5.52
Stainless steel	A167, Type 302	5.53
Solder - 1/2 pig lead and 1/2 block tin	B32	5.54
Gravel or slag	D1863	5.55
		5.56
<u>Felts</u>	6.2	
Base and finishing felts shall be as required by the applicable roofing specification of either Johns-Manville Sales Corporation or the Celotex Corporation.	6.4	
	6.5	
<u>Elastic Cement</u>	6.8	
Elastic cement shall be Elastigum Roofer's Cement, as manufactured by The Celotex Corporation, or equal, as approved by the Engineer.	6.10	
	6.11	
<u>Base Flashing</u>	6.14	
Base flashing shall be Asbestos Base Flashing (Specification No. AB-20) by The Celotex Corporation or equal as approved by the Engineer.	6.16	
	6.17	
<u>Metal Flashing</u>	6.20	
Metal flashings such as gravel stops and counterflashings shall be 0.018 in. stainless steel.	6.22	

Insulation 6.25

Insulation shall be Celotherm by The Celotex Corporation, or equal, as approved by the Engineer, used in locations shown on Engineer's drawings. It shall be of thicknesses shown on drawings, except that, where thicknesses are designated "nominal," actual thickness may vary from nominal as long as the following maximum conductances are not exceeded:

<u>Nominal Insulation Thickness - In.</u>	<u>Maximum Conductance -</u>		6.33
	<u>Btu Per Hr, Per Sq Ft,</u>		6.34
	<u>Per Deg F</u>		6.35
1	0.36		6.37
1 1/2	0.24		6.38
2	0.19		6.39
2 1/2	0.15		6.40
3	0.12		6.41

Insulation shall be delivered and stored in a dry place in unbroken cartons and shall be free from all defects or loose materials. Damaged pieces shall not be used.

Priming Paint on Metal and Concrete 6.49

Priming paint on metal and concrete surfaces shall be Asphalt Primer, as manufactured by The Celotex Corporation, or equal, as approved by the Engineer.

Nails, Screws, Bolts, and Washers 6.55

All nails through flashing into wood shall be not less than No. 12 gage, barbed flatheaded, stainless steel roofing nails, to match the flashing, or approved equal, extending at least 7/8 in. into sound wood nailers. All nails into wood decking shall extend at least 1 in. into sound wood. All nails into mortar joints shall be special hard steel nails manufactured for this purpose. All nails through insulation into steel deck shall be Lexsuco clips, Rivnail, or equal, as approved by the Engineer.

All bolts shall have flat heads and be hot-dip galvanized. Bolts through steel plate flanges shall have countersunk heads.

Drive screws shall be hardened steel.

All drive screws, nails, and bolts through roofing or flashing shall have flat caps, or approved equal, not less than 1 in. in diam. Bell or cup shaped caps shall not be used.

<u>Expansion Joint Covers</u>	7.12
Expansion joint covers, when required shall be E-Z-Flash, as manufactured by E-Z-Flash, Inc., or butyl rubber bellows with stainless steel flanges as manufactured by Grefco Inc., or equal, as approved by the Engineer.	7.14 7.15
<u>Wood Nailers and Cants</u>	7.19
All rough lumber such as insulation stops, nailing pieces, etc., shall be Douglas Fir No. 1 common or better, and shall be treated with one generous brush coat of wood preservative such as Cuprinol #20 as manufactured by Darnworth Inc., or equal, as approved by the Engineer.	7.21 7.22 7.23
<u>Painting</u>	7.26
All metal parts used for anchors, supports, stiffeners, sleeves, and other metal furnished under this specification and exposed after roofing is completed, except copper, aluminum, stainless steel, asbestos covered or other protected metal, shall be painted with one coat of asphalt primer, or equal, as approved by the Engineer, and one coat of an approved metal protective paint. Where dissimilar materials are in contact, stainless steel shall be isolated by painting with an approved zinc chromate primer followed by two coats of compatible paint or other acceptable material approved by the Engineer.	7.28 7.29 7.30 7.32 7.33 7.34
<u>Asphalt Pockets</u>	7.37
When required, install asphalt pockets around all steel columns, posts, pipes, conduit, etc, which extend through the roof or concrete pads and foundations projecting above the roof, in accordance with details on the Engineers' drawings. The asphalt pockets shall have flanges fastened to wood mailers.	7.39 7.40 7.42
1.8.3 <u>Metal Siding</u>	7.44
<u>Steel Sheet</u>	7.46
Metal siding shall be formed from steel sheets conforming to ASTM A446, Grade A or ASTM A366. The sheets shall be galvanized with commercial quality zinc coating conforming to ASTM A525 coating designation G90, or equal as approved by the Engineers. The exterior sheets of insulated and uninsulated steel panels shall be no less than 20 U.S.S. gauge steel. The interior sheet (liner panel) of insulated steel panels shall be no less than 22 U.S.S. gauge steel.	7.48 7.50 7.51 7.52 7.53

<u>Insulation</u>	7.56
Insulation shall be of the glass fiber type complying with Federal Specification HH-I-521E, Type 1. The resulting completely assembled wall system including side joints shall have a thermal transmittance value (U) including through metal conductance of no more than $U = .14$ Btu/hr/sq ft/°F when tested in accordance with ASTM C236.	7.58 8.2 8.3 8.4
<u>Flashing and Closure Strips</u>	8.7
All flashing and closure strips shall be formed from the same type and texture material as, and at least the same gauge as, the siding to which they are attached.	8.9 8.10
Closure filler strips shall be preformed to match sheet configurations.	8.12
<u>Fasteners and Concealed Clips</u>	8.15
All fasteners shall be made from stainless steel alloy conforming to American Iron and Steel Institute Type 305. Fasteners shall be installed with a neoprene washer under the head.	8.17 8.20 8.21
Exposed fasteners shall be provided with nylon heads or oven baked painted heads colored to match the siding.	8.22
Concealed fastening shall be achieved by a proven and tested system of concealed clips.	8.23
<u>Caulking Compounds and Sealing</u>	8.26
Caulking compounds shall be elastic compounds of recognized manufacturers of such products.	8.28
Sealing shall be by caulking, factory-applied vinyl, or neoprene gasket material, or a combination thereof.	8.30
<u>Subgirts</u>	8.33
Subgirts, where required, shall be 18 U.S.S. gauge steel or heavier. Subgirts shall be galvanized with a commercial coating conforming to ASTM A525, coating designation G90.	8.35 8.37 8.38
<u>Noncombustibility</u>	8.41
The siding panels shall be approved by Underwriters Laboratories, Inc., as noncombustible. Fuel contribution, smoke, and flame spread classifications shall be no more than those given below when tested in accordance with ASTM E84 with the fire on the interior side of the wall panel.	8.43 8.45 8.46 8.47

<u>Test</u>	<u>Rating</u>	
		8.51
	<u>Fluoropolymer Coating</u>	8.53
Flame Spread	25	8.55
Fuel Contributed	10	8.56
Smoke Developed	50	8.57
 <u>Louvers</u>		 9.4
Louvers shall be of the frame fixed type and sizes and details shall be as shown on the drawings.		9.6
Louvers shall be 6 in. deep, have stormproof blades set at an angle of not less than 45 degrees from horizontal, and provide a minimum free opening percentage of 38 percent.		9.8 9.10
Louvers shall be of the channel frame type. Typically, frames shall have flat surfaces at the inside and outside faces at the head, jamb, and sill, unless special details are shown on the drawings. Where louvers abut at jambs, a batten flashing shall be furnished to provide weathertight joints.		9.13 9.14 9.15
Louvers shall be constructed of galvanized steel or aluminum.		9.16
Steel louvers shall have 18 gauge U.S.S. frames and blades and be coated in the same manner as the siding. Aluminum louvers shall have .10 in. frames and .081 in. blades and shall be color coated to match the siding.		9.17 9.18
All louvers shall be furnished with the manufacturer's standard bird screen mounted on the interior side of the louver.		9.19 9.20
 <u>Steel Swing Doors</u>		 9.23
Steel swing doors shall be heavy duty designed and manufactured in accordance with standards established by the Steel Door Institute, SDI-100 and SDI-107. Coatings shall be as specified for structural steel.		9.25 9.27 9.28
Clear wire glass for exterior doors were shown on the drawings, shall be 1/4 in. thick, and shall conform to Federal Specification DD-G-451D. Glazing shall be in strict accordance with the glass manufacturer's instructions and FGMA-GM, Glazing Manual. Door hardware shall match the Owner's existing hardware.		9.29 9.31 9.32
Gutters and downspouts shall be 24 gauge (minimum) zinc-coated steel coated with a baked-on enamel.		9.33
 <u>Design</u>		 9.36
All siding panels and fastening to the building girts shall be designed for the wind pressures given below, applied as either		9.38 9.40

inward or outward pressures in a direction normal to the plane of the wall with the siding spanning between the girts shown on the Engineers' drawings. When subjected to the wind pressures given below, the siding shall not exceed the allowable stress for the material, a deflection limit of L/180 and shall not produce vibration noises. The length (L) is the center-to-center distance between supporting members.

<u>WIND PRESSURES</u>				9.48
<u>Height Above Ground, ft</u>	<u>Normal Pressure, psf</u>		<u>Corner Pressure, psf</u>	9.52
	<u>Positive</u>	<u>Negative</u>	<u>Negative</u>	9.53
125 to 225	+38.0	-38.0	-60	9.55
Corner strips only shall be designed for both the normal wind pressure and the larger negative corner pressure. The width of the corner strip shall be considered 6 ft wide.				10.2 10.3
Panels shall be arranged generally so that, wherever possible, each panel shall span continuously over three or more girts. All end joints shall occur at girts. The upper sheet shall lap the lower sheet by at least 2 in. for exterior sheets. Adjacent panels shall be lap spliced at the same elevation, to produce a neat straight line appearance.				10.5 10.6 10.7 10.9 10.10
<u>Surface Finish</u>				10.13
The exposed surface of exterior sheets shall have a polyvinylidene fluoride coating with at least a 70 percent base of Kynar 500 as produced and licensed by the Pennwalt Corporation or fluoropolymer finish Du-Lite as produced and registered by DuPont.				10.15 10.17 10.18
The coating shall be coil coated to the galvanized steel which has been pretreated and primed according to the specification of the licensed formulator. The prime coat shall be oven cured and result in a minimum coat of 0.2 mil dry film thickness. The finish coat shall be oven cured and result in a minimum coat of 1.0 mil dry film thickness. The entire coating system shall be applied in the factory and result in a total thickness of at least 1.2 mil dry film thickness.				10.19 10.20 10.21 10.23 10.24 10.25 10.26
The interior surface of the exterior sheet of insulated siding panels shall receive the manufacturer's standard prime coat of paint over the galvanized steel.				10.28 10.29
The unexposed surface of the liner sheets for insulated wall panels shall have no treatment other than the specified galvanizing.				10.31

The exposed surface of the liner sheets, for insulated wall panels shall have an off-white baked enamel coating (0.5 mil minimum) over a (.2 mil) prime coat. 10.32  
10.33

Final choice of colors for exposed surface of exterior sheets will be by the Owner, to match the existing structures. 10.34

Profile 10.37

The profile of the exterior sheet of the siding shall be a 1 1/2 in. deep high-rib profile similar to H.H. Roberson HR5-36 or steelite Hi-Rib-35, and shall be approved by the Engineers. 10.39  
10.40

1.8.4 Metal Roofing 10.42

Materials and Workmanship 10.44

The exposed metal roof covering shall be 24 gauge (minimum) coated galvanized steel panels conforming to the requirements of ASTM A446, Grade A. Panels shall be of such configuration to provide the load carrying capability specified herein and meet the deflection requirements specified by AISC or AISI as applicable. Roof panels shall be of "standing-seam interlocking" design and shall be secured to the roof purlins with a concealed structural fastening system. The roofing and fastening system shall be designed to accommodate all thermal movements. The concealed system shall provide minimal through penetration of the roof surface and allow the roof covering to move independently of any differential thermal movement by the structural framing system. The standing seams shall have factory-applied, nonhardening sealant, and the seams shall be continuously locked or crimped together by mechanical means during erection. Through penetration of the roofing surface by exposed fasteners shall occur only at terminal locations of the roof panels. All roof covering shall be properly designed with flashing provided and caulking indicated at all eaves and opening with necessary fascia and trim to provide complete weathertightness. 10.46  
10.47  
10.49  
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10.51  
10.53  
10.54  
10.55  
10.56  
10.58  
11.1  
11.2

All fasteners shall be made from stainless steel alloy conforming to the American Iron and Steel Institute Type 305. Fasteners shall be installed with a neoprene washer under the head, or equal, as approved by the Engineer. Exposed fasteners shall be provided with oven baked painted heads colored to match the roofing and shall be approved by the Engineer. 11.3  
11.4  
11.5  
11.6

Material Finishes 11.9

The roof panel sheets shall be finished on both sides as specified under metal siding herein. 11.11

Flashings, trim, and miscellaneous exposed galvanized steel accessories shall be finished with a two coat system consisting 11.13  
11.14

of an epoxy primer and a silicone polyester topcoat to a total dry film thickness of 0.5 mil.

Galvanizing for metal flashings, closures, trim, cover panels, and other miscellaneous uses shall conform to ASTM A525 commercial coating class (G90). Cadmium plating for all miscellaneous, light guage flashing, trim, and cover panel fasteners shall conform to ASTM A165, type S, with a minimum thickness of 0.3 mils.

Downspouts and Gutters 11.21

All downspouts and gutters, where shown on the Engineer's drawings, shall be furnished and installed by this Contractor. 11.23  
11.24

Gutters shall be 24 gage galvanized steel finished in accordance with Section 1.8.3 herein. 11.26

Downspouts shall be 3 in. by 4 in., 26 gage galvanized steel. 11.27

1.9 Erection Requirements 11.29

1.9.1 Precast Concrete Roof Deck 11.30

Erection and Installation 11.32

Installation of the precast units is to be made by leveling the floor and/or roof slabs in a workmanlike manner keeping the units tight and at right angles to the bearing system. 11.34  
11.36

Slabs shall be aligned and leveled by the method approved by the flexicore manufacturer using equipment recommended or supplied by the Manufacturer. 11.37  
11.38

Slabs shall be grouted by a mixture of not less than one part cement to three parts fine sand, care being taken to see that the joints are filled. Any grout that may have seeped through to the ceiling below shall be removed before it hardens. 11.39  
11.40  
11.41

Cooperation shall be extended other trades in permitting insertion of anchors, hangers, electrical outlets, etc. Holes, not requiring cutting of prestress strand, for plumbing and heating pipes, ducts, electric conduits, outlet boxes, vents, etc, shall be cut in the field by the Contractor in hollow sections of slabs in accordance with the manufacturer's standard recommendations. Holes requiring cutting of prestress strand shall be planned for in advance of installation as dictated by structural considerations. No prestress strand shall be cut without approval of manufacturer and the Engineer. All openings larger than a slab width shall be framed with concrete headers or structural steel hangers in accordance with the design limitations of ACI 711-58. 11.42  
11.43  
11.44  
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11.46  
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11.50

All work shall be neatly and fully finished and all surplus materials and rubbish attributed to this contractor's work shall be removed from the premises.	11.51 11.52
No erection of any materials shall be performed until any conditions in the supporting steel which would be in any way detrimental to the proper erection and satisfactory appearance of these materials have been remedied.	11.53 11.54
<u>1.9.2 Asphalt and Gravel Roofing</u>	11.56
<u>General</u>	11.58
Roofing systems in accordance with the approved Roofing System Manufacturer's specifications shall be applied by a roofing contractor approved by the Roofing System Manufacturer.	12.1 12.2
The instructions, cautions, and warnings in the manufacturer's literature shall be followed.	12.4
<u>Installation Requirements</u>	12.9
<u>Cant Strips</u>	12.10
Cant strips fabricated of insulation materials shall be set in hot asphalt and may be set on top of insulation.	12.12
<u>Flashing</u>	12.16
<u>At Parapets, Vertical, Walls, and Curb Walls Around Large Openings</u>	12.17
Vertical surfaces at parapets, vertical walls, and curb walls around large openings, shall be flashed over all plies of roofing with built-up flashing similar to The Celotex Corporation Specification No. AB-20 and as indicated on the drawings. Built-up roofing shall be carried to top of cant strip.	12.19 12.20 12.23
Vertical surfaces of riser wall curbs and curbs around large openings shall be insulated, if roof is insulated. Insulation shall be applied at steel curb plates for walls, or around duct, stack, and other large openings through roofs.	12.24 12.25 12.26
<u>At Pipe Penetrations</u>	12.29
Steel pipe sleeves 3/16 in. thick with 3 in. by 1/8 in. welded flashing flanges shall be provided and set at roof openings. They shall project a minimum of 12 in. above roof slab or top of insulation and shall extend through to underside of roof, with close fit. Sleeves shall be painted with one coat of asphalt primer and one coat of an approved metal protective paint.	12.31 12.32 12.34 12.35 12.36

Sleeve flange shall be set in elastic cement on top of roof plies, nailed to wood roof or nailing strips with a pair of large head galvanized nails at each quarter point, or bolted to steel decks with a single countersunk 3/16 in. diam galvanized bolt at each quarter point. All metal flanges shall be covered with two strips of 15 lb asbestos finishing felt set into and trowelled over with elastic cement. Strips shall be 8 in. and 10 in. wide.

#### Metal Flashings

Metal flashings, such as gravel stops and counterflashings, shall be furnished and installed. They shall be securely nailed to nailing strips provided for this purpose, or bolted to structural members, where required. All joints shall be made weathertight by lapping and setting in elastic cement of proper type for this purpose.

All unprotected metal flashing surfaces to be in contact with roofing materials shall be given one coat of asphalt primer.

#### Downspouts and Gutters

All sheet metal downspouts, gutters, and similar work, if required by drawings, shall be installed in strict accordance with Engineer's drawings, complete with all necessary anchors, hangers, and other supports.

#### Roof Boxes

Roof drains, where required, will be basic Series No. 4110 as manufactured by Josam Manufacturing Co.; Product Z-100 as manufactured by Zurn Industries, Inc., or equal, as approved by the Engineer, unless otherwise required to suit clearance conditions below the roof and shall be furnished and set by the Building Service Contractor. Roof boxes shall be flashed weathertight by this Contractor.

#### Roofing Installation

##### General

Roofing shall be 20-year bondable roofing, in accordance with the following Celotex Corporation specifications, or equal, as approved by the Engineer.

##### Celotex Specification No. O.A-4-C-G (MIA)

A fiberglass based felt system in accordance with Johns-Manville Sales Corp., Specification 4GIA or equal as approved by the Engineer and meeting all the requirements herein may be submitted as an alternate system.

Roofing or insulation shall not be applied on any surface which is wet, or which contains frost. 13.25

Before proceeding with his work, the Contractor shall inspect roof surface and report immediately to the Engineer any existing conditions which, in his opinion, might prove detrimental to finished roofing and flashing. Failure to so report shall not relieve the Contractor of responsibility for furnishing a roofing and flashing installation first class, in every respect. Failure to report adverse conditions shall be considered as acceptance of all liability for correcting any damage or failure in the roofing and flashing which may result from such acceptance. 13.26  
13.27  
13.28  
13.30  
13.31

The Contractor shall make provisions to seal all openings to the extent necessary to prevent hot bitumen from dripping down into the interior of the building during the installation. 13.32  
13.33

The asphalt kettle shall be equipped with an accurate and easily read thermometer, and the asphalt shall be heated to the mop and kettle temperatures specified by the manufacturers. Overheating of asphalt shall be carefully avoided and shall be cause for rejection of the melt. Asphalt shall be stirred during and after melting to prevent burning. Cutting back or adding materials to the asphalt shall not be permitted. 13.34  
13.35  
13.36  
13.37  
13.38

Sufficient asphalt shall be used to flow ahead of felt roll in an unbroken line, so that in no place shall felt touch felt. Each ply shall be thoroughly broomed to ensure complete and continuous embedment. 13.39  
13.41

No insulation or roofing shall be applied when temperatures are below 40°F without the prior approval of the Owner's Senior Construction Site Representative. When work is performed at temperatures below 40°F, special precautions shall be taken to ensure satisfactory performance of the finished roof. 13.42  
13.43  
13.44  
13.45

#### Insulation 13.48

Insulation shall be installed in strick accordance with the manufacturer's instructions. 13.50

Insulation shall not be left exposed to weather. 13.52

When applying insulation board, joints in adjoining courses shall be broken and all adjoining edges and joints at stops, walls, and around roof projections shall be in contact, but not forced. All end joints shall be staggered. 13.53  
13.54  
13.55

The runs of roofing felt shall be set perpendicular to the slope of the roof. Temporary water cutoffs consisting of path strippings of oneply of asphalt-saturated felt mopped with asphalt shall be installed at all exposed edges of insulation at 13.56  
13.57  
13.58

end of each day's operations. They shall be removed when operations are resumed. No more insulation shall be applied than can be covered immediately by roofing. 13.59 14.1

Insulation up to 1 in. thickness shall be applied in one layer. 14.2  
 Insulation over 1 in. thickness shall be applied in two layers 14.3  
 with joints broken at least 6 in. in both directions with an 14.4  
 additional mopping of at least 30 lb 190°F steep asphalt between layers.

Built-Up Roof Pads 14.7

Where called for on the drawings, walkways pads shall be 1/2 in. thick "Carey-Tred," as manufactured by The Celotex Corporation, or equal, as approved by the Engineer. Panels shall be installed in accordance with the manufacturer's recommendations. 14.9 14.10 14.12

Vapor Barrier 14.15

For other than steel deck, vapor barrier shall consist of one ply of Celotex Vented Vaporbar base sheet (organic) embedded in 190°F steep asphalt using a minimum of 23 lb per square. Poured concrete decks shall be primed. 14.17 14.18 14.20

Tests and Inspection 14.23

Inspection cuts of roofing for laboratory examination by the Owner's Field Inspector may be required at such locations as the Field Inspector may select. One test cut may be made for each 10,000 sq ft of roofing. Strips 4 in. wide and 3 ft long, extending at right angles to direction of felts, shall be cut through all plies of roofing and then replaced to full number of layers used in main roofing. 14.25 14.26 14.28 14.29 14.30

The Owner's Field Inspector shall have laboratory tests performed on any inspection cuts of roofing to determine that the amounts of asphalt and gravel conform to the specification. 14.31 14.32

The cutout area shall be repaired by placing a filler piece of felts into hot asphalt. The filler piece shall be composed of the same number of plies and asphalt moppings as the section which was removed. The area shall be covered with 3 plies of felt, hot mopped in place. The first ply shall overlap the cutout area on all sides by 6 in. on all sides. The flood coat of asphalt and the gravel shall be applied in the normal manner. The Contractor shall quote a unit price for cutting out test strips and repairing the area as required above. 14.33 14.34 14.35 14.36 14.37 14.38

The Contractor shall be responsible for inspecting the material and checking the applicable records, prior to shipment, to verify that all specification requirements have been complied with. Two 14.39 14.41 14.42

copies of all documents required to comply with this specification shall be submitted to the Owner's Field Inspector.

<u>Guarantees</u>	14.45
<u>Installation Guarantee</u>	14.46
The Contractor shall guarantee in writing the complete installation of roofing and flashing to be weathertight for a period of five years after its completion and acceptance, and shall agree to make all repairs necessary during that period without cost to the Owner.	14.48 14.49 14.50
<u>Manufacturer's Guarantee or Bond</u>	14.54
The manufacturer of roofing materials used on this work shall guarantee or bond complete installation of roofing and flashing, other than metal flashing and other metal work attached to roof, to be weathertight for a period of 20 years after its completion and acceptance, and shall agree to make all necessary repairs covered under the terms of the guarantee/bond during that period without cost to the Owner.	14.56 14.58 14.59 15.1
<u>Installation Instructions</u>	15.3
The Contractor shall furnish three complete sets of his proposed installation instructions to the Owner's Senior Construction Site Representative. These shall be submitted at least one month prior to the start of roofing installation.	15.5 15.6 15.8
<u>Daily Seal</u>	15.10
Care should be exercised to ensure that the water does not flow beneath any completed sections of roof. Temporarily seal loose edge of membrane with an approved Nite Seal as necessary to prevent damage.	15.12 15.13
1.9.3 <u>Metal Siding</u>	15.16
<u>Inspection</u>	15.18
Before starting erection of the siding, verify that the governing dimensions of the buildings are correct; that all girts and door heads are level and all jambs plumb; and that all supporting steel, concrete, and masonry are in satisfactory condition for fastening the material thereto.	15.20 15.22
Any conditions in the supporting system that would be in any way detrimental to the proper erection and satisfactory appearance of the erected siding shall be reported to the Engineers.	15.23 15.24 15.25

No material shall be erected on such steel until these conditions have been remedied.	15.26 15.27
<u>Erection</u>	15.30
All material shall be erected in accordance with approved manufacturers' drawings and requirements of this Section.	15.32
Defective material, such as bent, buckled, or scarred panels, shall not be erected. If such panels are erected, they shall be removed and replaced.	15.34 15.35
All siding shall be securely fastened to each structural steel supporting member directly or by use of subgirts.	15.36 15.37
All siding shall be made weathertight around all openings and at the roof line. Fluted sections shall be fitted with metal closures at the top and bottom of all vertical runs and at wall openings.	15.38 15.39 15.40
The siding, corners, closures, and flashings shall be installed without wrinkles, buckles, or dimples.	15.41 15.42
All cutting, drilling, and tapping required for the erection of the siding shall be performed by the Contractor. All steel cuttings caused by drilling of holes shall be removed from the siding sheets to prevent staining.	15.43 15.45
For insulated siding, the liner panel shall be fastened tightly against each girt. The interlocking lips of the flat sheets shall be fastened together on not over 3 ft centers. Subgirts shall be spaced not to exceed the safe carrying capacity of the exterior sheets. A subgirt shall be placed at each main girt. The exterior sheets shall be fastened to the subgirts.	15.46 15.47 15.48 15.50 15.51
Side lap joints of both interior and exterior sheets shall be sealed in a manner to produce a weathertight joint. Sealing shall consist of a caulking compound, factory-applied gasket material, or a combination thereof. The interior sheet shall serve as a vapor barrier.	15.53 15.54 15.56
Laps of exterior sheets, including covers, shall be caulked. Insulation at the top and bottom of all runs and at wall openings shall be adequately protected against dampness and displacement. Insulation which gets wet during erection shall be dried or replaced at the Contractor's expense.	15.57 15.58 15.59 16.1
After the work has been completed, the surface of the sheeting shall be inspected for integrity of the coating. Where the coating is scratched or scraped off, the Contractor shall touch up such places with a coating of identical color compatible with the shop finish. Sheeting scratched, dented, or otherwise	16.2 16.3 16.4 16.5

damaged which, after repair and touch-up, does not present a uniform appearance from the closest ground or public approach shall be replaced.

Door Erection 16.10

All staging, shoring, and bracing, necessary for the installation of the doors, shall be furnished, placed, and removed by the Contractor. 16.12 16.13

The Contractor shall make all connections to materials erected by others, including all drilling, tapping, and other necessary work including cutting channel frames. 16.15 16.16

Doors shall be erected plumb, rigid, and in true alignment with all hardware left in proper working order. Erection shall be done by a competent door erector and in accordance with door manufacturer's instructions. 16.17 16.18

1.9.4 Metal Roofing 16.19

Refer to Section 1.8.4 and all applicable portions of 1.9.3. herein. 16.20

NaOH PURCHASE SPECIFICATION

Instructions to Bidders

The Babcock & Wilcox Company, acting as a participant and prime contractor in the LIMB Demonstration Project Extension is inviting Proposals for the supply, transport and unloading of a 50% solution of NaOH into the Owners holding tank at the Ohio Edison Company's, Edgewater Plant in Lorain, Ohio.

Proposal submittal information

All questions concerning this inquiry shall be directed and the Proposal submitted to:

S.C. Essy  
General Purchasing  
The Babcock & Wilcox Company  
20 South Van Buren Avenue  
Barberton, Ohio 44203-0351  
(216) 860-6171

Definitions

Contractor - The bidding company awarded the contract pursuant to this inquiry.  
Owner - The Ohio Edison Company (OEC)  
Purchaser - The Babcock & Wilcox Company (B&W)  
Site - All of the area within the boundaries of the OEC Edgewater Plant at Lorain, Ohio.  
Site Manager - B&W's authorized representative on the Site.  
LIMB - Lime Injection through Multiple Burners.

Scope of Work

The supply, transportation and unloading of a quantity of liquid caustic into the Owners holding tank located in the Caustic and Acid Building. This building is located against the North wall of the Unit No. 4 Boiler Room at the Site.

Caustic:

The bid should include two possible grades, a Base and an Alternate. The specifications for these appear on Attachment Number 1.

Quantities:

The expected requirement is approximately 3000 gallons (or one full truck load) a day. Bidding is to be based on a continuous delivery over a period of eight (8) weeks, starting March 1, 1989. Actual deliveries will vary to maintain the holding tank level within operating limits or due to upsets in the program. All deliveries will be initiated or approved by the Site Manager.

Unloading Facilities:

For unloading the connection from the truck shall be bolted to the existing 3" - 125 lb. flanged fill-pipe for the holding tank. This is located just outside the North wall of the Caustic and Acid Building. The truck must have its own transfer pump capable of discharging against a 25 ft. head of caustic solution.

Truck Access and Parking:

The truck after entering the gate will move directly to its allocated parking area for unloading. While on the site it will be subject to all of the Owners traffic rules, restraints and directions. All questions will be directed to the Site Manager for resolution.

Additional Items:

Contractor to include in his scope:

- o Material Safety Data Sheet per form OSHA-174.
- o Set of safety placards and tape for restricting access to area when unloading is in progress.
- o Keep accurate records of shipments including quantities date and time of deliveries. A statement showing this information must be issued monthly with invoices.
- o Strict adherence to all federal, state and local regulations governing the supply and transport of this chemical.
- o Certificates of insurance coverage and workers compensation such that risk of loss for each shipment will reside with the Contractor until the caustic is completely unloaded into the Owner's holding tank.

Intended Use:

The caustic is to be used as an additive to Humidification Atomization Water in a LIMB Demonstration Project Extension test program and provide for the Owner's normal water treatment requirements.

Delivery Address:

Babcock & Wilcox Company, Site Manager  
c/o Ohio Edison Company  
Edgewater Plant  
2000 Oberlin Avenue  
Lorain, Ohio

F.O.B. Point

All pricing to be on a "Delivered" basis meaning caustic has been unloaded from Contractors truck into Owners holding tank.

Cancellations

Cancellations may be made by the Site Manager at any time prior to the loading of the delivery truck without penalty.

NaOH SPECIFICATION

ATTACHMENT NUMBER 1

Base: Rayon Grade - Mercury Cell

NaOH, %	49.5 - 51.0
Na <sub>2</sub> CO <sub>3</sub> , %	0.02 maximum
NaClO <sub>3</sub> , %	0.05 maximum
Fe, PPM	4.0 maximum
NaCl, PPM	50.0 maximum

Alternate: Diaphragm Grade (Standard 50% wt.)

NaOH, wt. % As is	49.5 - 51.0
Actual Na <sub>2</sub> O, wt. % As is	38.5 - 39.65
Na <sub>2</sub> CO <sub>3</sub> , wt. % AB	0.40 maximum
NaCl, wt. % AB	2.20 maximum
Na <sub>2</sub> SO <sub>4</sub> , wt. % AB	0.05 maximum

Ranges are minimum to maximum AB = 100% wt. % NaOH basis.

CONTRACTOR'S DATA SHEET

ATTACHMENT NUMBER 2

Name of Company. \_\_\_\_\_

Commercial Address and Phone Number. \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Contact for arranging shipments (with phone Number). \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Estimated maximum weight of fully loaded truck. \_\_\_\_\_

Estimated average delivered gallons of caustic by truck-load. \_\_\_\_\_

\_\_\_\_\_

Estimated time of truck on Site for unloading. \_\_\_\_\_

Rated capacity and discharge head (pressure) of transfer pump on truck. \_\_\_\_\_

What is maximum available supply per day, if any, for: \_\_\_\_\_

Base Grade: \_\_\_\_\_

Alternate grade: \_\_\_\_\_

Lead time to delivery from: \_\_\_\_\_

Receiving formal contract: \_\_\_\_\_

Orders from site manager, thereafter: \_\_\_\_\_

Exceptions and/or comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

892-1171-A  
Rev. 11-4-88

SPECIFICATION

FOR

REMOVAL OF ASH

AT THE

OHIO EDISON COMPANY  
EDGEWATER PLANT

FOR THE

LIMESTONE INJECTION MULTISTAGE BURNER DEMONSTRATION  
PROJECT EXTENSION  
AND  
COOLSIDE PROCESSES TESTING

SEPTEMBER 19, 1988

SPECIFICATION

FOR

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LIMESTONE INJECTION MULTISTAGE BURNER DEMONSTRATION  
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SEPTEMBER 19, 1988

SECTION 1

INSTRUCTIONS TO BIDDERS

SECTION 1  
INSTRUCTIONS TO BIDDERS

1. GENERAL

The Babcock & Wilcox Company, as a participant and General Contractor in this DOE Clean Coal Technology Project is inviting Proposals for the removal, assumption of ownership and disposition of ash collected in the Unit Number 4, Ash Storage Silo at the Plant during the LIMB Demonstration Project Extension and Coolside testing portions of the program.

Questions and responses shall be directed to:

S. C. Essy  
The Babcock & Wilcox Company  
20 S. Van Buren Avenue  
Barberton, Ohio 44203-0351  
(216) 860-6171

2. PROPOSAL SUBMITTAL INFORMATION

One original and three copies of the Proposal shall be submitted to:

S. C. Essy  
The Babcock & Wilcox Company  
20 S. Van Buren Avenue  
Barberton, Ohio 44203-0351  
(216) 860-6171

All bid Proposals must be in the Company's possession no later than 5:00 p.m. on October 11, 1988.

3. DEFINITIONS

The following terms when used herein with initial capitalization shall have the meanings given below unless in any particular instance the context expressly indicates otherwise.

"Ash" shall mean the material produced by LIMB and Coolside SO<sub>2</sub> control processes testing, as described in Attachment B.

"Site Manager" shall be the person or persons designated by the Company to arrange for and generally oversee the Work in accordance with the terms and conditions stated herein.

"Contract" shall mean this Inquiry, any related purchase orders, and only those exceptions to the Inquiry listed in Attachment A accepted by the Company.

"Contractor" shall mean the bidding company awarded the Contract for performance of the Disposal Work and/or Utilization Work under the terms and conditions stated herein.

"Company" shall mean the Babcock & Wilcox Company

"Plant" shall mean the Ohio Edison Company, Edgewater Plant, 200 Oberlin Avenue, Lorain, Ohio 44308.

"Disposal Site" shall mean the facility selected by the Contractor and accepted by the Company for the permanent disposal of the Ash. The facility shall be licensed for the disposal of Solid Waste by and operating in good standing with the Ohio Environmental Protection Agency.

"Disposal Work" shall mean the removal of Ash from the Plant, transportation to and placement in the Disposal Site.

"Inquiry" shall mean Specification Sections 1, 2, and 3 and Attachments A, and B and including any addenda and/or letters of clarification and the formal Company inquiry document.

"Proposal" shall mean the offer of the Contractor to do the Work at the price or prices set forth in the Contract.

"Utilization Work" shall mean the removal of Ash from the Plant and its utilization or sale to others for use in construction, manufacturing, treatment, waste stabilization or other useful purpose.

"Work" when used singly shall mean both Disposal Work and Utilization Work.

#### 4. SCOPE OF WORK

The scope of Work hereunder involves the removal and disposition of Ash produced by Plant Unit 4 resulting from the LIMB Demonstration Project Extension and Coolside processes testing in accordance with the terms and conditions herein. Ash removal shall be by truck and the disposition may involve the following options:

- A. Utilization Work which should provide an income to the Company
- B. Disposal Work at a cost to the Company
- C. A combination of options (A) and (B) above.

#### 5. TERM

The term of this Contract shall be March 1, 1989 through February 28, 1990 with an option for extension to February 28, 1991.

#### 6. QUANTITY

The total amount of Ash, on dry basis, for which Work is required is generally expected to be from 3,000 to 6,000 tons per month. The quantity will vary according to system load requirements and unit outages both scheduled and forced.

7. PRICE

The Company prefers a fixed price per ton for the Work during the term of the Contract. Individual prices are requested for the different components of the Work described below. The prices are requested on a per ton basis but other pricing methods shall be considered if advantageous to the Company.

A. Utilization Work

If this Ash has a utility value that will provide a revenue this should be addressed in the proposal quoting quantities utilized and price adjustment.

B. Disposal Work

Provide a price per ton for hauling the Ash in a damp or dry condition. Also provide information about the types of trucks, any other equipment to be utilized, the round trip mileage from the Plant to the Disposal Site and the estimated round-trip driving time.

The Ash shall be disposed of in a manner fully in keeping with Ohio Environmental Protection Agency regulations, also the Disposal Site must have all necessary permits from the Ohio EPA to accept this material.

Contractor shall also provide the name, address and telephone number of the Disposal Site and the name of the facility manager.

Alternate pricing for disposal work shall be submitted as follows:

Base Price for non-segregated dumping at the Disposal Site.

Alternate Price for segregating the Ash at the Disposal Site from the main part of the fill and the two types of Ash described in Attachment B from each other, (to allow for long-term observation and testing).

The Company encourages the bidder to be innovative and to offer alternate proposals in addition to those requested if in its judgement the alternates better or more economically serve the Company's requirements.

8. INVOICE AND PAYMENT

Following the end of each calendar month the Contractor shall invoice the Company for any Disposal Work including any Utilization Work credit. The invoice shall show the applicable tonnage, purchase order number, the price per ton and the total amount due. The weights for such invoices shall be determined by the Plant on the truck scale at the Plant in accordance with the Plant's practice which is described in Section 2 paragraph 1.2 of this Inquiry. The weights shall be determined by multiplying the arithmetic

average weight of the loads actually weighed that day by the total number of loads hauled that day. No payment shall be made to the Contractor except for Work that complies with these Instructions to Bidders, Technical Specifications and General Conditions.

Billing Address for the Company:

The Babcock & Wilcox Company  
P. O. Box 111  
Barberton, Ohio 44203-0111

9. TITLE

Title to the Ash and risk of loss shall pass to the Contractor when the Ash is loaded into Contractor's trucks.

10. EXCEPTIONS

The Contractor shall state in its Proposal that its Proposal complies with all terms and conditions of this Inquiry. If exceptions are taken, they shall be listed on Attachment 'A', entitled "Exceptions to Inquiry". This form shall be completed and signed by an authorized representative of the Contractor and shall be submitted with the Proposal.

11. PROPOSAL REJECTION

The Company reserves the right to reject in whole, or in part, any or all Proposals.

12. LIMITATION ON ADVERTISING COPY

The Contractor shall not use the performance of Work under this Contract in any advertising copy without the Company's prior expressed approval of that specific advertising copy.

13. ACCESS TO INFORMATION

For any Utilization Work Contractor agrees to keep the Company fully advised of all Ash uses. The Contractor also agrees to share all technical information obtained and to allow the Company and other LIMS participants to visit, observe and participate in any or all such Utilization Work.

14. INFORMATION REQUIRED WITH PROPOSAL

- A. Instructions to Bidders - Paragraphs 7, Price (Base and Alternate); and 8, Invoice and Payment in this section.
- B. General Conditions - Paragraph 7, Notices. The Contractor's address for providing notices hereunder.
- C. General Conditions - Certificates of insurance coverage and worker's compensation in accordance with paragraphs 15.1 and 15.2.
- D. Attachment 'A' - Exceptions to Inquiry

- E. The Proposal shall include any pertinent experience of the Contractor related to Disposal Work and/or Utilization Work.

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SEPTEMBER 19, 1988

SECTION 2

TECHNICAL SPECIFICATIONS

SECTION 2  
TECHNICAL SPECIFICATIONS

1. Contractor's Operations on Plant Property

- 1.1 All trucks shall enter the truck gate and as directed by the Plant either proceed directly to the truck scales to be weighed-in or to the #4 Ash storage silo.
- 1.2 The Contractor shall, as directed by the Plant, have selective trucks weighed daily, normally not less than 20% of the loads hauled, both empty and loaded, on Plant truck scales.
- 1.3 If after damp loading visible steaming occurs, the truck shall be parked in the designated holding area following loading, until visible steaming subsides to the point where the Plant approves movement of the truck. This waiting time prior to truck movement is generally expected to be about 15 minutes. Any Ash on the exterior of the truck shall be washed off by the truck driver. Open bed trucks shall then be tarp covered. Then the truck shall return to the truck scales if to be weighed, or exit the Plant at the truck gate.
- 1.4 If dry loaded the truck shall be sealed immediately after loading. Any Ash on the exterior of the truck shall be washed off by the truck driver. The truck shall then proceed directly to the truck scales if to be weighed, or exit the Plant at the truck gate.
- 1.5 All Plant regulations shall be obeyed at all times, including traffic and security regulations.
- 1.6 The Contractor shall comply with all Plant fugitive dust control procedures.
- 1.7 The Contractor shall provide its employees involved with the Work with appropriate safety equipment. Since quicklime is a major constituent of LIMB Ash, and could occur in Coolside Ash, Attachment C provides some general guidelines for handling quicklime, (see Calcium Oxide).
- 1.8 Ash truck loading at the plant shall be done between the hours of 7:30 a.m. and 3:00 p.m. Monday through Friday. The Contractor shall also have trucks available for hauling on weekends if requested by the Site Manager.

2. Ash Hauling

- 2.1 Contractor shall, during transport of the Ash, comply with all applicable local, state and federal environmental regulations including tarp covering all open bed trucks to and from the Plant to prevent the emission of fugitive dust particles.
- 2.2 Contractor shall comply with all applicable city, state and federal highway regulations during transport.

- 2.3 Contractor shall properly equip its trucks to prevent leakage of Ash which shall include the installation and maintenance of tailgate seals or other seals as appropriate.
- 2.4 Contractor shall provide personnel and equipment, if necessary, to clean up Ash spills from its trucks while on public roads.
- 2.5 For damp ash hauling, open bed trucks are recommended by the Company. Steam generated by the Ash may cause excessive pressure to build up inside closed trucks which could cause the rupture of doors or hatches thereby allowing Ash to escape.
- 2.6 Damp Ash has a tendency to stick in the bottom of truck beds. The Contractor may need physical or mechanical means to remove all Ash from the trucks. Disposable heat resistant plastic liners, a Gradall or a back hoe may be useful for this purpose. Truck bed vibrators may only be partially successful and will probably require additional means.

### 3. Disposal Site

- 3.1 The Disposal Site used by the Contractor shall be licensed by the Ohio Environmental Protection Agency for Solid Waste disposal and operating in good standing.
- 3.2 The Ash shall be disposed of in accordance with all applicable environmental regulations.
- 3.3 Contractor shall promptly dispose of the Ash in a safe and lawful manner and shall not in any manner salvage, reclaim, re-use, sell or distribute the Ash or any part thereof without prior written approval of the Company.

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AND  
COOLSIDE PROCESSES TESTING

SEPTEMBER 19, 1988

SECTION 3

GENERAL CONDITIONS

SECTION 3  
GENERAL CONDITIONS

1. PERFORMANCE OF WORK

All Work under the Contract shall be performed and completed in a good, substantial, and workmanlike manner in strict conformity with the terms and conditions, all applicable environmental regulations and also in strict accordance with the requirements of all municipal, state, or federal authorities having jurisdiction over the Work. The Contractor shall perform the Work, under the Contract, in such a way as not to cause any interruption or interference of any work of the Company, the Ohio Edison Company, or others at the Plant.

2. DISCONTINUANCE OF WORK

The Company's Site Manager shall have the right to require the discontinuance of the Work, in whole or in part, for such time as may be necessary, should the condition of the weather or other contingencies make it desirable to do so, in order that the Work shall be well and properly executed.

3. INSPECTION

All Work performed shall be subject to the inspection and final acceptance of the Company's Site Manager but such inspection and acceptance shall not relieve the Contractor of any of its responsibilities under the Contract including any loss or damage resulting from the performance of the Work.

4. WAIVING OF OBLIGATIONS

Only the Company's Site Manager shall have the power to waive any obligation of the Contractor. Each waiver must be in writing.

5. COMPANY'S RIGHT TO EXPEDITE WORK

If at any time the Contractor's methods, materials, or equipment appear to the Company's Site Manager to be unsafe, inefficient, or inadequate for securing the safety of the workers, the public or the environment, the performance of the Work or the rate of progress required, the Company's Site Manager may order the Contractor to increase its safety, efficiency, and adequacy and the Contractor shall comply as soon as possible with such orders at no additional expense to the Company. If at any time the Contractor's working force and equipment, in the opinion of the Company's Site Manager shall be inadequate for securing the necessary rate of progress, as herein stipulated, the Contractor shall, if so directed, at no additional expense to the Company, increase the working force and equipment to such an extent as to give reasonable assurance of compliance with the schedule of Work. The failure of the Company's Site Manager to make such demands shall not relieve the Contractor of its obligation to secure the quality, the safe conducting of the Work and the rate of progress required by

the Contract; and the Contractor alone shall be and remain liable and responsible for the safety, efficiency, and adequacy of its methods, materials, working force, and equipment, irrespective of whether or not it receives any order or makes any change as a result of any order or orders received from the Company's Site Manager.

6. TO DEFINE TERMS AND EXPLAIN PLANS

The various parts of the Contract are intended to be complimentary to each other, but should any discrepancy appear, or any misunderstanding arise to the meaning of anything contained therein, the explanation of the Company's Site Manager shall be final and binding. Such explanation shall be in writing and provided to the parties in accordance with paragraph 7, Notices.

7. NOTICES

All notices provided for herein shall be in writing to the other party and shall be deemed to have been duly given when delivered in person to the other party or when actually received (as evidenced by return receipt requested), with postage prepaid addressed to the parties as follows:

(a) To Company:

S. C. Essy  
The Babcock & Wilcox Company  
20 South Van Buren Avenue  
Barberton, Ohio 44203-0351

(b) To Contractor:

(Bidder to fill-in)

8. REPRESENTATION OF CONTRACTOR

Contractor represents that it is financially responsible and competent to perform the Work described hereunder.

9. SUBCONTRACTS

No subcontract shall be added or changed from the Proposal without the written approval of the Company's Site Manager of both the subcontract and the subcontractor. Such approval shall not affect the provisions of the Proposal. If such approval has been obtained and Contractor shall cause any part or all of the Work to be performed by a subcontractor the provisions of this Contract shall apply to such subcontractor and it or its officers, agents, or employees in all respects as if it and they were employees of the Contractor, and the Contractor shall not in any manner thereby, be discharged from its obligations and liability hereunder, and the Contractor shall be liable hereunder for all acts and negligence of the subcontractor, it or its officers, agents, and employees as if they were employees of the Contractor. Copies of all subcontracts shall be furnished to the Company's Site Manager upon request.

#### 10. WORK PERFORMED AT CONTRACTOR'S RISK

The Contractor shall take all precautions necessary and shall be responsible for the safety of the Work and shall maintain all lights, guards, signs, temporary passages, or other protection necessary for the purpose. All Work shall be done at the Contractor's risk. The Contractor shall be responsible for any loss or damage to material, tools, or other articles used or held for use in connection with the Work, whether incorporated in the Work or not. If any loss or damage to property, material, tools or other articles occurs as a result of fire or other cause, the Contractor shall be liable for such loss or damage free from all expense to Ohio Edison Company and the Company or any of its subcontractors. The Contractor shall promptly repay the Company for any costs incurred by the Company in repairing or replacing such loss or damage. The Work shall be carried on to completion without damage to any work or property of the Company or of others and without interference with the operation of existing machinery or equipment.

#### 11. INFRINGEMENT OF PATENTS

The Contractor shall assume all liability for and fully indemnify and save harmless the Company, its successors or assigns, from and against, all claims, suits, proceedings, damages, losses, expenses, fees, and royalties, arising from any infringement, real or claimed, of any patent or any article, machine, manufacture, structure, composition, arrangement, improvement, design, device, methods or process embodied or used in the performance of the Contract. The Company and its successors and assigns shall give written notice of all such claims and patent infringement suits or proceedings instituted against it to the Contractor, who shall defend same, and the Company shall give the Contractor authority, and all available information to enable it so to do.

#### 12. ASSIGNMENT OF CONTRACT

The Contract shall bind the heirs, executors, administrators, successors and assigns of the parties, but the Contractor agrees that it shall not assign the Contract or any portion thereof to any person, persons, partnership, company, or corporation not satisfactory to the Company, and it shall not make such an assignment until it has received the written permission of the Company. No such assignment, even though thus consented to, shall relieve the Contractor from its liability under the Contract for the performance and completion of the Work by the time and in the manner herein contracted for.

#### 13. SUSPENSION OR TERMINATION OF WORK IF CONTRACT IS VIOLATED

Upon any violation by Contractor of any of the provisions of the Contract, or if the Company determines that a threat to health or the environment may exist because of Contractor's performance of any Work the Company may forthwith temporarily suspend the Work until such violation or threat is remedied to the satisfaction of the Company or terminate the Contract, in addition to any other rights it may have and make such other arrangements as it may see fit for the completion of the Work without incurring any liability to Contractor except to pay to the latter for Work already performed less whatever the Contractor owes the Company under any other provisions of the Contract.

14. INDEBTEDNESS AND LIENS

It is distinctly understood and agreed that no lien shall at any time be filed against the Work or any property of the Ohio Edison Company, the Company or any of its subcontractors by the Contractor or any subcontractor, mechanic, materialman, or other person employed by Contractor. The Contractor agrees to enter into a stipulation against liens when requested by Company.

15. INSURANCE AND INDEMNITY REQUIREMENTS15.1 Insurance

- A. The Contractor agrees to secure and maintain in force Insurance of the types listed below and shall furnish to the Company, prior to starting work and throughout the duration of the Work, Certificates of Insurance evidencing current coverage listed below. These certificates shall be endorsed with substantially the following language:

"This policy will not be canceled or allowed to lapse or any changes made herein which changes, restricts or reduces the insurance provided or changes the name of the insured without first giving at least thirty (30) days' notice in writing to The Babcock & Wilcox Company, at its office in Barberton, Ohio, and Ohio Edison Company, 76 South Main Street Akron, Ohio 44308, as evidenced by receipt of registered letters."

1. Comprehensive General Liability insurance including Contractual Liability, and if any work is to be performed by subcontractor, Contractor's Protective Liability with minimum limits of \$1,000,000 per occurrence, combined single limit, for bodily injury and property damage naming the Company and the Ohio Edison Company as additional named insured parties.
  2. Comprehensive Automobile Liability insurance including nonownership and hired car endorsement with minimum limits of \$1,000,000 per occurrence, combined single limit, for bodily injury and property damage.
  3. Employer's Liability with a minimum limit of \$500,000.
- B. The Company and Ohio Edison Company shall be included as an additional insured, and the policies shall be endorsed with a Cross Liability Clause acceptable to the Company, its being understood that said policies shall provide primary insurance to the Ohio Edison Company, the Company and any of its subcontractors.
- C. In the event of cancellation or lapse of or prohibited change in any policy for which a certificate is required to be furnished under the provisions of paragraph 15.1A above, the Company shall have the right to suspend the work of the Contractor until the policy and certificate in evidence thereof are reinstated or acceptable arrangements are made pending issuance of new policies and certificates.

If any policy of insurance shall be about to terminate, lapse, or be canceled, the Contractor shall, at least thirty (30) days before coverage thereunder ceases, obtain a new policy with like coverage, and in default thereof, the Company may obtain insurance protecting it from the hazards covered by such policy, and all premiums and expenses therefor shall be charged against the Contractor, and be a legitimate deduction from any sum due it from the Company.

- D. Statutory Worker's Compensation - The Contractor and its subcontractors shall furnish, prior to starting work and throughout the duration of the Work, Certificate(s) of Premium Payment (or written evidence thereof) or a Certificate of Employer's Right to Pay Compensation Direct.

#### 15.2 Indemnity

Contractor, for itself, its successors and assigns, agrees to indemnify and save harmless the Ohio Edison Company, the Company and any of its subcontractors or project participants, its successors and assigns, from and against any and all claims, demands, damages, actions or causes of action, together with any and all losses, costs or expenses including legal fees in connection therewith or related thereto, asserted by any person or persons for bodily injuries, death or property damage arising or in any manner growing out of the Work performed or to be performed under this Contract, by Contractor its employees, agents or subcontractors specifically including but not limited to fugitive dust, Ash leakage or spills, and the proper and safe handling and disposal of the Ash. Contractor, for itself and its subcontractors, hereby waives any provision of the Ohio Worker's Compensation Act, whereby Contractor could preclude its joinder as an additional defendant, or avoid liability for damages, contribution or indemnity in an action brought by one of its employees or an employee of any of its subcontractors against the Ohio Edison Company, the Company or any of its subcontractors. Contractor, for itself, its successors and assigns, holds harmless and agrees to indemnify the Ohio Edison Company, the Company and its subcontractor against all fines, penalties or losses incurred for or by reason of the violation by Contractor or his subcontractor in the performance of the Contract, of any ordinance, regulation, rule or law of any political subdivision or duly constituted public authority.

#### 16. CHARACTER OF EMPLOYEES

The Contractor shall immediately remove from the Work, whenever requested to do so by the Company, any person considered by the Company to be incompetent or disposed to be disorderly, or for any other reason the person is deemed to be unsatisfactory or undesirable to the Company, and such person shall not again be employed in performance of the Work without the consent of the Company.

17. INDEPENDENT CONTRACTOR

The Contractor is and shall always remain an independent contractor in the performance of the Contract and shall not be construed to be a subcontractor, agent, or employee of the Company.

18. LAW GOVERNING CONTRACT

This Contract shall be, and is deemed to be, one made under the law of the State of Ohio only and shall be construed and given effect in accordance with the law of Ohio and not otherwise.

19. NO OTHER UNDERSTANDINGS

There is no other understanding between the parties other than as set forth in the Contract. All communications, either verbal or written, made prior to the date of the Contract are hereby abrogated and withdrawn.

20. HANDLING OF ASH

Contractor expressly acknowledges that it shall have responsibility and control of the safe disposal and handling of the Ash and part of the consideration paid by the Company is for Contractor's expertise and safe and proper performance of these responsibilities. The Contractor, having been advised of the chemical characteristics of the ash in Attachment B, knows and understands the need to adhere to the normal recommended safety and handling precautions. Contractor shall advise and inform its employees, (prior to each individual's employment), agents, representatives and subcontractors of the nature of the Ash and the care required in its handling. Contractor shall see that all appropriate safety and handling precautions are followed to ensure the safety and well-being of persons, property and the environment in the performance of the Work. Contractor agrees to inform the Company in writing of any toxic or otherwise harmful property relating to the Ash which becomes known to Contractor subsequent to the date of this Contract.

21. GOVERNMENTAL EMPLOYMENT REGULATIONS

A. During the performance of this Contract, Contractor agrees as follows:

- (1) Contractor shall not discriminate against any employee or applicant because of race, color, religion, sex, or national origin. Contractor shall take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, or national origin. Such action shall include, but not be limited to the following: employment, upgrading, demotion, or transfer,

recruitment or recruitment advertising; layoff or termination; rates of pay of other forms of compensation; and selection for training, including apprenticeship. Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the U.S. Department of Labor setting forth the provisions of this non-discrimination clause.

- (2) Contractor shall, in all solicitations or advertisements for employees placed by or on behalf of Contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, or national origin.
- (3) Contractor shall send to each labor union or representative of workers with which it has a collective bargaining agreement or other contract or understanding, a notice to be provided by the U.S. Department of Labor, advising the labor union or workers' representative of Contractor's commitments under section 202 of Executive Order 11246 of September 24, 1965, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.
- (4) Contractor shall comply with all provisions of Executive Order 11246 of September 24, 1965, and of the rules, regulations, and relevant orders of the Secretary of Labor.
- (5) Contractor shall furnish all information and reports required by Executive Order 11246 of September 24, 1965, and by the rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to its books, records, and accounts by the U.S. Department of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.
- (6) In the event of Contractor's non-compliance with the non-discrimination clauses of this Contract or with any of such rules, regulations, or orders, this Contract may be canceled, terminated or suspended in whole or in part.
- (7) Contractor shall include the provisions of paragraphs (1) through (7) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to section 204 of Executive Order 11246 of September 24, 1965, so that such provisions shall be binding upon each subcontractor. Contractor shall take such action with respect to any subcontract or purchase order as the U.S. Department of Labor may direct as a means of enforcing such provisions including sanctions for non-compliance: provided, however, that in the event Contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the U.S. Department of Labor, Contractor may request the United States to enter into such litigation to protect the interests of the United States.

- B. Contractor shall comply with all Federal, State and Local laws and regulations governing labor or employee relations, including but not limited to Sections 6, 7, 12, and 14 of the Fair Labor Standards Act, as amended. During the performance of this Contract, Contractor agrees to the following affirmative action clauses which are incorporated herein by reference: the handicapped clause in 48 C.F.R. 52-222-36, the disabled veterans and veterans of the Vietnam era in 48 C.F.R. 52-222-35, and the utilization of Small and Disadvantaged Business in 48 C.F.R. 52-219-5. Contractor shall include the provisions of this section in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor.

22. NOTIFICATION OF CITATIONS AND CLAIMS

Contractor agrees that it shall promptly notify the Company of any of the following which is connected with the performance of the Work under this Contract: (i) any warning, citation, indictment, claim, lawsuit or proceeding issued or instituted by any federal, state or local governmental entity or agency, (ii) the revocation of any license, permit or other document issued to Contractor by any such entity or agency, or (iii) any other claim (including, without limitation, claims for Worker's Compensation) or lawsuit against Contractor for personal injury, death or property damage or any violation of highway laws such as weight limits, speeding, reckless operation etc. by hauling vehicles.

23. DISCLAIMER OF WARRANTY

The parties recognize that the physical properties and chemical composition of Ash will vary over time depending on many factors including but not limited to the nature of the fuel being burned in the Ohio Edison Company's equipment. Contractor agrees to select appropriate samples and obtain such test information as is needed to assure that the Ash is, and continues to be suitable for the purposes for which it will be used. THEREFORE, THERE ARE NO WARRANTIES, EXPRESS OR IMPLIED, BY OPERATION OF LAW OR OTHERWISE, OF PRODUCTS OR SERVICES FURNISHED HEREUNDER OR IN CONNECTION HERewith. THE COMPANY DISCLAIMS ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PURPOSE. NO REPRESENTATION OR OTHER AFFIRMATION OF FACT, INCLUDING BUT NOT LIMITED TO, STATEMENTS REGARDING SUITABILITY FOR USE OR PERFORMANCE WHETHER MADE BY COMPANY EMPLOYEES OR OTHERWISE, WHICH IS NOT CONTAINED IN THIS AGREEMENT, SHALL BE DEEMED TO BE A WARRANTY BY THE COMPANY FOR ANY PURPOSE, OR GIVE TO ANY LIABILITY OF THE COMPANY WHATSOEVER.

24. DOE GENERAL PROVISIONS

It is understood that this Contract is a subcontract under the Company's Cooperative Agreement DE-FC22-87PC79798 with the United States Department of Energy (DOE). As the prime contractor the Company has agreed to be bound by the DOE General Provisions, included in the Cooperative Agreement as Attachment B. Said General Provisions are incorporated herein by reference and Contractor agrees to be bound by said provisions which are available to the Contractor.

ATTACHMENT 'A'

EXCEPTIONS TO INQUIRY

SPECIFICATION

FOR

REMOVAL OF ASH

OHIO EDISON COMPANY  
EDGEWATER PLANT

FOR THE

LIMESTONE INJECTION MULTISTAGE BURNER DEMONSTRATION  
PROJECT EXTENSION

AND

COOLSIDE PROCESSES TESTING

The bidder shall list below all exceptions taken to any part of the Inquiry. Any exceptions taken elsewhere in the Proposal, including standard printed forms, shall not be considered unless listed below. Listed exceptions shall be evaluated and shall not become part of the Contract unless accepted by the Company.

The above are the only exceptions taken to any part of this Inquiry.

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Bidder Name

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Authorized Signature

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Date

ATTACHMENT B

ASH CHARACTERISTICS

SPECIFICATIONS

FOR

REMOVAL OF ASH

AT THE

OHIO EDISON COMPANY  
EDGEWATER PLANT

FOR THE

LIMESTONE INJECTION MULTISTAGE BURNER DEMONSTRATION  
PROJECT EXTENSION  
AND  
COOLSIDE PROCESSES TESTING

SEPTEMBER 19, 1988

## LIMB ASH CHARACTERISTICS

### 1. GENERAL

LIMB is a commercial scale demonstration project. Ash, as defined herein, has never been produced by the Plant. The chemical and physical characteristics provided herein, are primarily derived from a laboratory test combustion facility approximating the Plant's operating parameters. Therefore, the actual chemical and physical characteristics of the Ash may be different than stated herein.

### 2. CHEMICAL ANALYSIS OF ASH

The following information is a composite of the results of laboratory Ash samples taken at the test combustion facility when injecting calcitic and dolomitic sorbents.

<u>Component</u>	Range of Values (% By Weight)	
	<u>Dolomitic (b)</u>	<u>Calcitic</u>
LOI	0-5	2.0 - 4.2
Li <sub>2</sub> O	0 - 0.01	0.01
Na <sub>2</sub> O	0 - 0.15	0.11 - 0.15
K <sub>2</sub> O	0 - 0.6	0.38 - 0.78
MgO	15 - 40	0.70 - 0.77
CaO	20 - 45	36.7 - 51.1 (a)
Fe <sub>2</sub> O <sub>3</sub>	2 - 10	3.8 - 12.1
Al <sub>2</sub> O <sub>3</sub>	3 - 8	5.5 - 10.4
SiO <sub>2</sub>	5 - 18	9.3 - 21.7
TiO <sub>2</sub>	0 - 0.5	0.4 - 0.7
P <sub>2</sub> O <sub>5</sub>	0 - 0.04	0.03 - 0.05
SO <sub>3</sub>	10 - 24	15.5 - 26.8 (a)

(a) When calcitic sorbents are used it should be noted that the three major components of Ash are fly ash, CaSO<sub>4</sub> and CaO. The SO<sub>3</sub> analysis reflects the SO<sub>3</sub> combined with a portion of the reported CaO forming CaSO<sub>4</sub> (the ratio of SO<sub>3</sub> to CaSO<sub>4</sub> is 1 to 1.70). For example, 15.5% SO<sub>3</sub> corresponds to 26.4% CaSO<sub>4</sub>, the balance being 10.9% CaO and if the sample analysis reported 36.7% CaO, the CaO component would be 25.8%.

(b) When dolomitic sorbents (dolomitic have a 1:1 molar ratio of calcium to magnesium components) are used, composition ranges will generally come down somewhat - except for MgO which will go up substantially. Estimated ranges are shown above. The SO<sub>3</sub> component is still expected to be bound only to part of the CaO component.

3. LEACHATE ANALYSIS OF ASH (b)

The results below are derived from an EP Toxicity Test.

	<u>Concentrations in Leachate, mg/l</u>	
	<u>Sample A</u>	<u>Sample B</u>
Arsenic	0.0145	0.0210
Barium	4.11	4.24
Cadmium	0.00095	0.0005
Chromium	0.0394	0.0240
Lead	0.0030	0.0045
Mercury	0.0003	0.0003
Selenium		
Silver	0.0005	0.0005
pH	12.4/12.2 pH units (a)	12.4/12.2 pH Units (a)

4. PERMEABILITY DATA (b)

The following results were obtained using a falling head test method.

<u>Curing Time</u>	<u>Permeability in CM/Sec</u>	
	<u>Sample C</u>	<u>Sample D</u>
1 day	$3.70 \times 10^{-4}$	$2.75 \times 10^{-4}$
4 days	$1.75 \times 10^{-4}$	$1.90 \times 10^{-4}$
11 days	$6.30 \times 10^{-5}$	$4.34 \times 10^{-5}$
28 days	$7.35 \times 10^{-6}$	$5.80 \times 10^{-6}$

(a) Before/after acid addition

(b) Whether dolomitic or calcitic sorbents are used, this data is still considered representative. In the case of the dolomitic material, the magnesium component is effectively inert and insoluble.

## COOLSIDE ASH CHARACTERISTICS

### 1. GENERAL

The DOE LIMB Extension and Coolside Process Demonstration Project is a commercial scale demonstration. Ash, as defined herein, has never been produced by the Plant. The chemical and physical characteristics provided herein are primarily derived from a Coolside pilot-scale facility and should be representative for the Plant's operating parameters. Therefore, the actual chemical and physical characteristics of the Ash may be somewhat different than stated herein, and the Company assumes no liability for any changes therein.

### 2. CHEMICAL ANALYSIS OF ASH

The following information is a typical analysis of Coolside Ash from the pilot scale testing facility.

<u>Component</u>	<u>Coolside Ash (a) (wt. %)</u>
Moisture	1.7
LOI at 925° (b)	16.5
Na <sub>2</sub> O	4.0
K <sub>2</sub> O	.6
CaO	36.4
MgO	.5
Fe <sub>2</sub> O <sub>3</sub>	2.9
TiO <sub>2</sub>	.2
P <sub>2</sub> O <sub>5</sub>	.1
SiO <sub>2</sub>	11.5
Al <sub>2</sub> O <sub>3</sub>	4.8
SO <sub>3</sub>	19.1
Unaccounted	1.7

- (a) It should be noted that the major components are fly ash; SO<sub>3</sub> which reflects the SO<sub>3</sub> combined with a portion of the reported CaO and Na<sub>2</sub>O forming CaSO<sub>4</sub>, CaSO<sub>3</sub>, Na<sub>2</sub>SO<sub>4</sub>, and Na<sub>2</sub>SO<sub>3</sub>; and CaO which reflects CaO combined with SO<sub>3</sub> and H<sub>2</sub>O forming Ca(OH)<sub>2</sub> and CaSO<sub>3</sub>. The weight percentage of Ca(OH)<sub>2</sub>, CaSO<sub>3</sub>, CaSO<sub>4</sub>, and CaCO<sub>3</sub> are 24.4%, 17.0%, 9.3%, and 12.7%, respectively. Na<sub>2</sub>SO<sub>3</sub> and Na<sub>2</sub>SO<sub>4</sub> account for 8.4 weight percent of the sample. The weight percents are calculated based on sulfate, sulfite, and carbonate analysis of the Coolside Ash and the assumption that sodium salts are sodium sulfite.
- (b) LOI reflects the dehydration of Ca(OH)<sub>2</sub>, calcination of CaCO<sub>3</sub>, and unburnt carbon.

### 3. LEACHATE ANALYSIS OF COOLSIDE ASH

The results below are derived from an EP toxicity test:

	<u>Concentrations in Leachate, mg/l</u>
Arsenic	0.03
Barium	0.4
Cadmium	0.0006
Chromium	0.13
Lead	0.0031
Mercury	0.0001
Selenium	0.03
Silver	0.025
pH	12.6/12.3 ph units (a)

(a) Before/after acetic acid addition (after 24 hours)

### 4. PERMEABILITY DATA

The following results were obtained using a falling head test method (Earth Method 1110-02-1906) and samples were prepared by the Standard Procter Method (ASTM Method D-698) and cured by ASTM D-559.

<u>Curing Time, days</u>	<u>Permeability in cm/sec</u>
0	$1.2 \times 10^{-5}$
7	$1.4 \times 10^{-6}$
28	$2.2 \times 10^{-6}$
32	$1.8 \times 10^{-6}$