AmerenUE

# Labadie Plant

## 40th Anniversary

## PLANT GUIDE

## 2010

**Our Vision:**
To be among the low-cost producers in the Midwest; to be among the top ten investor-owned utilities in profitability; to be among the top ten investor-owned utilities in the U.S. in generating capability; and to be an Industry Leader in reduction of Emissions.

**Our Mission:**
To meet our customers' energy needs in a safe, reliable, efficient, and environmentally responsible manner.

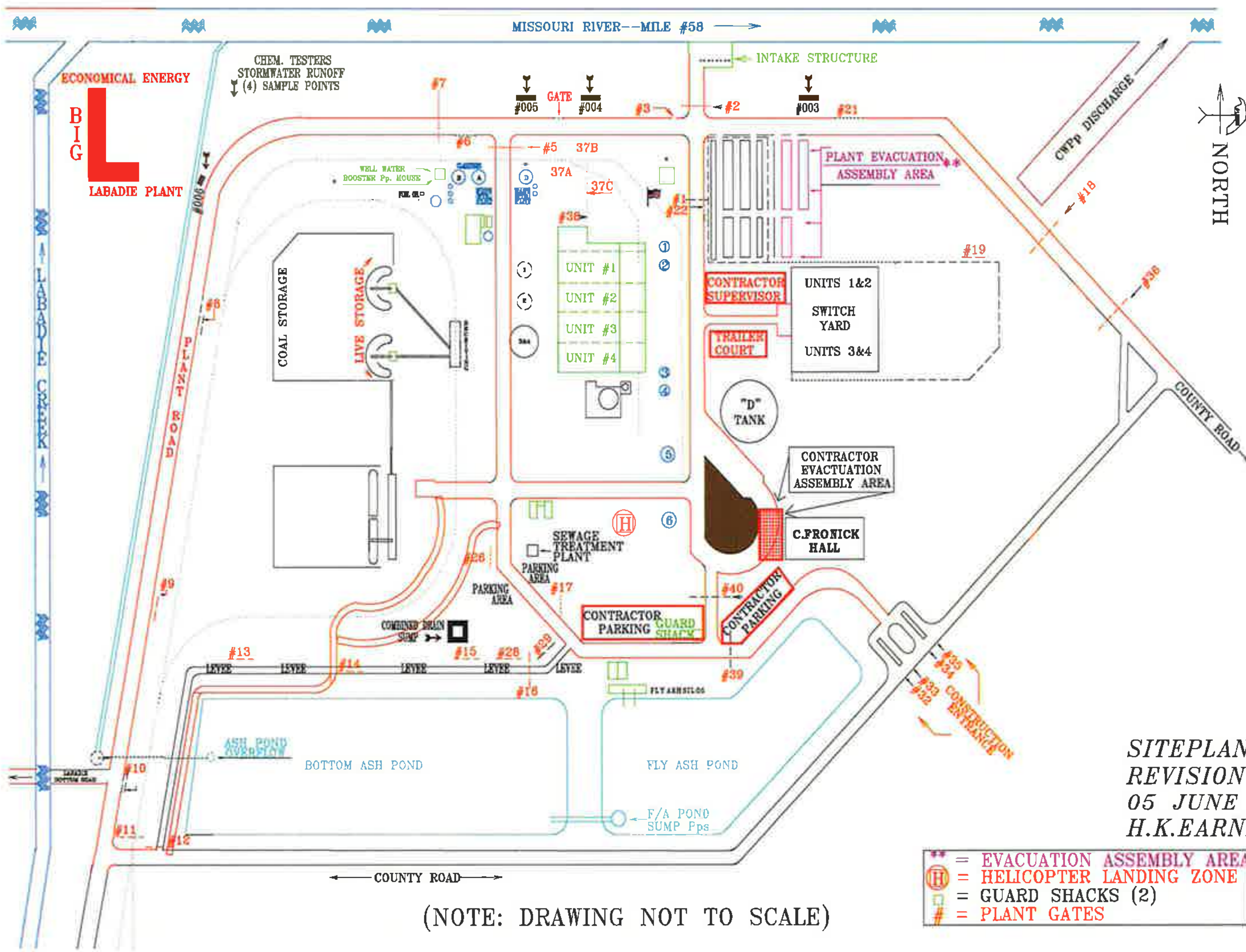
**Our Values:**
Integrity, respect, accountability, stewardship, teamwork and commitment to excellence

# AREA MAP


Pictures by Ernie Black
Drawings by Howard Earney
Guide Constructed by William R. Zengel Jr.

# SITE PLAN

## AMEREN U.E. / LABADIE POWER PLANT




(NOTE: DRAWING NOT TO SCALE)

## *Welcome to Ameren UE Labadie Plant.*

Labadie Plant consists of four low sulfur coal burning steam electric generating Units designed to produce 600,000 kilowatts, (KW), each. Built in early 1970's at a cost of $750,000,000 Labadie Plant is the largest power plant in the Ameren UE system.

**Commercial Operation Dates:**

Unit 1. . . June 30, 1970
Unit 2. . . June 25, 1971
Unit 3. .August 26, 1972
Unit 4. . .August 8, 1973

The plant site is located on the South Bank of the Missouri River approximately 35 miles West of St. Louis. River water is supplied to our on site Water Treatment Facility by three 2,100 Gallon Per Minute, (GPM), Ingersoll-Rand Clarifier Raw Water Pumps which receive their suction from either Unit Two or Unit Three Circulating Water Systems. We have three Well Water Pumps that can supply this water in an emergency.

**Water Treatment System:** (Units 1, 2, 3 & 4)
Missouri River water is softened and coagulated in three 800 gpm Graver Clarifiers, filtered in five 500 gpm Graver Gravity Filters and then stored in two 290,000 gallon treated water tanks and one 225,000 gallon fire service tank. Make-up condensate is prepared in three single train Demineralizers with piping interconnections arranged to serve all four Units. With each train, treated water is passed through a 220 gpm net chemical separation cation exchanger and mixed bed exchanger, and then is stored in each of six condensate storage tanks or is sent directly to Unit Condenser Hotwells. These Condensate Tanks are comprised of four 150,000 gallon, (one associated with each Unit), one 300,000 gallon and one 370,000 gallon tank.

### *Turbine Auxiliaries*

**Circulating Water Pumps:** (Units 1, 2, 3, & 4)
The Circulating Water System is the largest source of water supply to the plant. Two Circulating Water Pumps per Unit, each 107,000 gpm Byron-Jackson vertical wet pit single stage mixed flow 400 Revolutions Per Minute, (RPM), 2,250 hp induction motors are capable of supplying the power plant with 856,000 gallons of strained water per minute with all Circulating Water Pumps running. They supply water for steam condensing, water treatment facility, ash removal and auxiliary equipment cooling.

**Condensers:** (Units 1, 2, 3, & 4)
A Unit Condenser entails a 252,500 square foot Westinghouse horizontal, twin shell, duel pressure, divided water box surface, arranged for circulating water flow in series, serving both the Turbine Generator and the two half-capacity Boiler Feed Pump Turbines. There are 25,168 one inch O.D., stainless steel 36 foot long, per Condenser, per Unit. Steam is exhausted from the low pressure Turbines across the cool Condenser tubes condensing steam back to a liquid state where it is contained in the 20,000 gallon Condenser Hotwell.

**Waterside Vacuum Pumps:** (Units 1, 2, 3, & 4)
There is one single stage water sealed centrifugal displacement pump, 340 cfm at 22 inches of Hg. vacuum, driven by a 25 hp, 1,200 rpm motor for each Unit for evacuation of accumulated non-condensable gases from the Circulating Water System high points.

**Steam Side Vacuum Pumps:** (Units 1, 2, 3, & 4)
Each Unit has two Nash Engineering, first stage air ejector, second stage water sealed centrifugal displacement pumps, designed for hogging and holding mode, rated 24 cfm free dry air at 1.0 inch Hg. Abs, direct driven by a 150 hp, 1,800 rpm motor. The non-condensable gases / air released through Deaerator and air leakage into the Condenser System, is removed by these Vacuum Pumps.

**Turbine-Generator:** (Units 1 & 2)
Original Westinghouse Tandem Compound Turbine Generator sets have been retrofitted with more efficient designs.

Original Westinghouse HP/IP turbine assemblies were replaced entirely with a new Alstom HP/IP turbine assemblies. Original LP turbines (2 each per unit) were retrofitted with new Alstom inner shells and rotors.

Original Westinghouse Generators were replaced with a GE Synchronous Generators, 3 phase, 3600 rpm, 20,000 volt, H2 cooled, water cooled stator. The GE generator is rated at 675 mva at .85 power factor. Excitation is provided by a transformer supplied static exciter rated at 2,950 kw, 515 volts rectifier output. The turbine is directly coupled to the generator.

Turbine valves are positioned by Electronic Systems, ETSI hydraulics.

Guaranteed output of the 4 Flow Tandem Compound Turbine Generator assembly is 645 mw with steam conditions of 4,200,000 lb/hr steam flow, 2400 psig and 1005° Fahrenheit.

**Turbine-Generator:** (Units 3 & 4)
Original GE Tandem Compound Turbine Generator sets have been retrofitted with more efficient designs.

Original GE HP/IP turbine assemblies were replaced with Alstom Inner Shells and Rotors. Original GE LP turbine assemblies (2 per unit) were also retrofitted with new Alstom Inner Shells and Rotors.

The turbines are directly coupled to a GE 3 phase, 3600 rpm, H2 cooled, water cooled stator Synchronous Generator, rated at 690 mva and .90 power factor. Generator field currents are supplied from an Alterrex Exciter. The automatic and manual regulation functions of the excitation systems have been upgraded to the GE EX2000 regulators.

Turbine Valves are positioned by the original GE MHC hydraulic system.

Guaranteed output of the 4 Flow Tandem Compound Turbine Generator assembly is 645 mw with steam conditions of 4,200,000 lb/hr steam flow, 2400 psig and 1005° Fahrenheit.

**Turbine Oil Conditioning Equipment:** (Units 1, 2, 3, & 4)
Each Oil Conditioning Unit utilizes one Pall vertical stationary type filter / separator rated at 2,040 gpm, installed to recirculate oil from the Turbine Generator Oil Reservoir.

## ***Steam Generating:*** (Units 1, 2, 3, & 4)

**Boiler:**
Each Main Turbine at Labadie Plant is provided with steam from Combustion Engineering controlled circulation steam generators, normally referred to as *Boilers*. These Boilers are capable of delivering 4,284,000 pounds per hour of 2,400 Pounds Per Square Inch, (PSI), steam superheated to 1005° Fahrenheit.

Each Boiler incorporates a *Reheater* designed to heat 3,670,000 pounds per hours of 613 psi steam at 642° Fahrenheit from the high pressure Turbine, returning it to the Turbine at 1005° Fahrenheit.

Feed water from the heat cycle flow path, enters the Boiler at the economizer inlet. As it passes through the various tubes and headers, the feed water is changed to steam and superheated to 1005° Fahrenheit.

The steam exits the top of the Boiler into the *Main Steam Leads,* American Society of Testing and Material, *(ASTM),* A355-P22 alloy steel, hollow forged, Units 1 & 2—20" O.D. x 2.923" min. wall thickness, Units 3 & 4—19" O.D. x 2.777" min. wall thickness. These large pipes deliver the steam to the high pressure section of the Main Turbine.

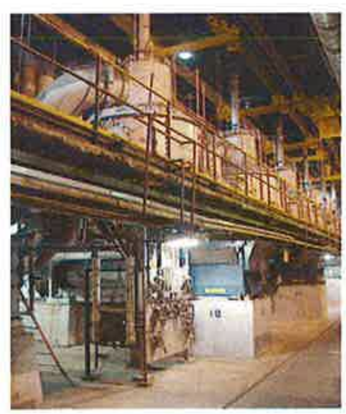
After passing through the high pressure Turbine, the steam is returned to the Boiler through another set of large pipes referred to as the *Cold Reheat Steam Leads, ASTM* 155 grade KC 70 class 1, carbon steel, rolled and welded, 30" O.D. x 0.646" min. wall thickness.

The Cold Reheat steam re-enters the Boiler, passes through yet another group of headers and tubes, and is reheated to 1005° Fahrenheit.

After being reheated, the steam again exits the top of the Boiler into yet another set of large pipes referred to as the *Hot Reheat Steam Leads, ASTM,* A335-P22 alloy steels, hollow forged, 30" O.D. x 1.429" min. wall thickness. These pipes carry the steam to the intermediate pressure section of the Main Turbine. To ensure a positive flow of water to the furnace water walls, four Boiler Circulating Pumps are provided on each Unit.

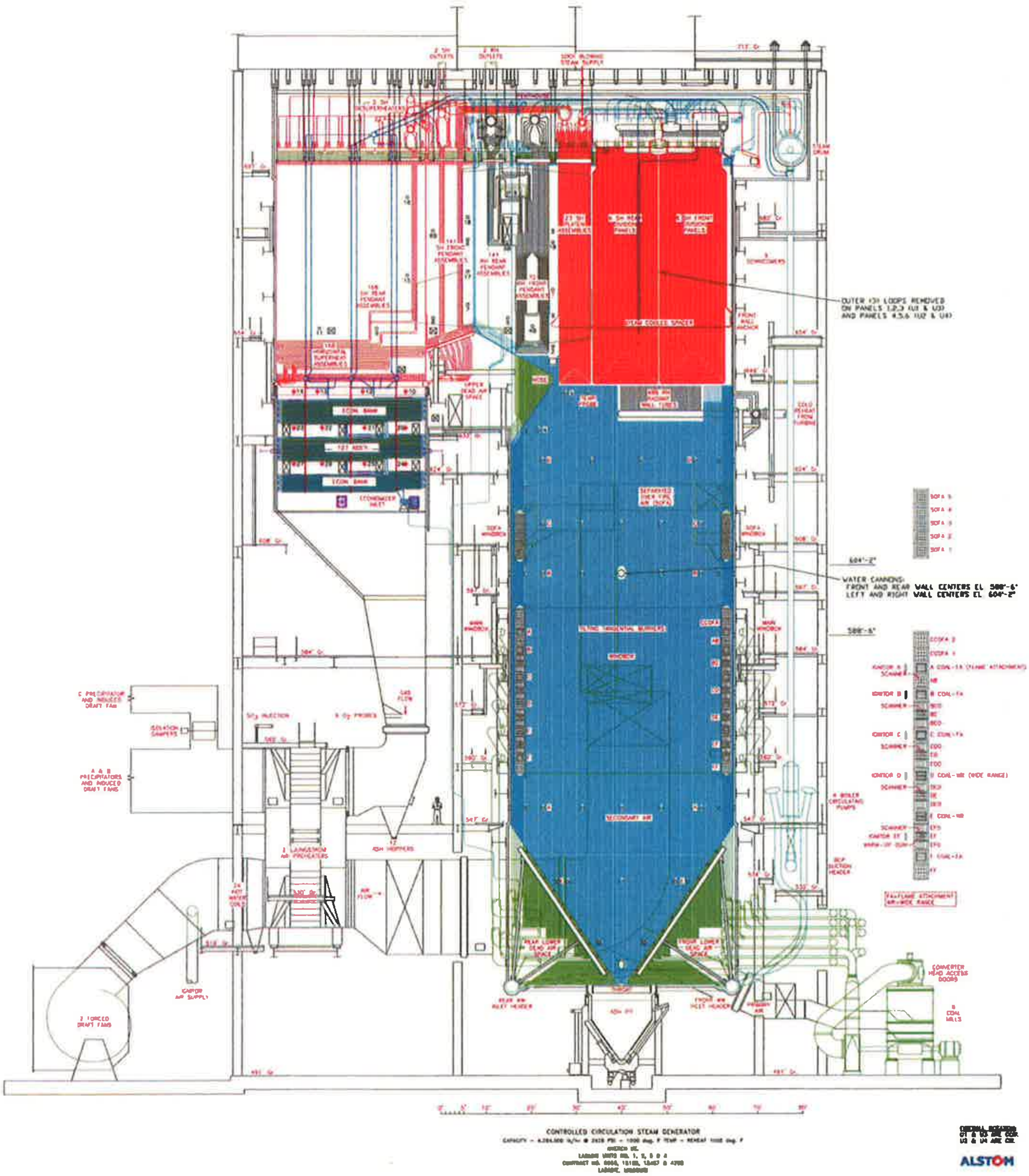
## ***Boiler Auxiliaries***

**Controlled Circulation Pump:**
The Circulating System consists of four Boiler Circulating Pumps taking suction from the Boiler Drum and discharging to the lower water wall inlet headers, to establish positive circulation through the water wall tubes. The pumps, Ingersoll-Rand, (Units 1, 3, & 4), and Hayward-Tyler wet motor, Boiler Circulating Pumps on (Unit 2).



**Coal Pulverizers:** (Units 1, 2, 3, & 4)
Six C-E Raymond Bowl Mill Model 843RS Pulverizers per Unit, each with a capacity of 140,000 lb/hr at 55 grindability, 70% through 200 mesh. Each Pulverizer is powered by a 1,250 HP, 4160 volt motor and serves one level of coal nozzles. All Pulverizers are provided with automatic Inerting Steam Systems which assures the safety of plant personnel and equipment. The Inerting system eliminates the oxygen in the Pulverizer during times when the fuel to air ratio increases the risk of a Pulverizer fire.

**Burners:** (Units 1, 2, 3, & 4)
Low Nox Concentric Firing System, (LNCFS-II), maximizes the NOX reduction capabilities of existing tangential firing systems. This system uses a combination of two techniques to reduce NOX. These techniques are bulk furnace staging using both over fired air and concentric firing. An important design feature incorporated into the LNCFS is the technique of early fuel ignition. Initiating the combustion point very close to the fuel nozzle produces a stable volatile matter flame which is more easily controlled.




CONTROLLED CIRCULATION STEAM GENERATOR

## Condensate / Feed Water Systems

**Hotwell Pumps:** (Units 1, & 2)
Three half capacity Byron-Jackson vertical, three stage, centrifugal pumps per Unit. The pumps are rated at 210 ft. Total Dynamic Head, (TDH), 3,960 gpm and are driven by a 250 hp, 1,200 rpm electric motor. The Hotwell Pumps are the first pumps in the condensate flow path. (Units 3 & 4), Three half capacity Bryron-Jackson vertical, six stage, centrifugal pumps per Unit rated at 500 ft. TDH at 3,720 gpm and is driven by a 600 hp 1,200 rpm motor.

**Condensate Coolers:** (Units 1 & 2), Temperature-controlled condensate is required to maintain temperature of certain Turbine and Generator Auxiliaries. The Circulating Water System removes the heat from the condensate in 4, 1/3 sized, heat exchangers. The heat is lost to the river through the Circulating Water System. These same type coolers are called **Auxiliary Heat Exchangers,**(Units 3 & 4) where Auxiliary cooling water heat is lost to the river through the Circulating Water System.

**Low Pressure Boiler Feed Pumps:** (Units 1 & 2 )
Three half capacity, Worthington, single stage, horizontal centrifugal, split case pumps per Unit. Each driven by a 600 Horse Power, (HP), 1,800 rpm electric motor and is rated at 405 ft. TDH at 3,970 gpm. The L.P. Boiler Feed Pumps are the second group of pumps in the condensate system.

**Low Pressure Feed Water Heaters:** (5a , 5b, 6a, 6b), (Units 1, 2, 3, & 4)
Two twin shell Westinghouse, closed horizontal u-shaped heaters, a total of 4 heaters per Unit. By increasing the temperature of the feed water entering the economizer section of the Boiler, there is less chemical energy in the form of coal required for steam generation.

**Deaerator: Heater NO. 4.** (Units 1, 2, 3, & 4)
One Graver, direct contact, tray type, cross flow Deaerator per Unit designed for 4,801,420 lb. / hr. effluent at .005 cc/liter free oxygen content. Extraction steam from the Main Turbine through a series of piping to the Deaerator, heats feed water on its way to the Boiler. Air and non-condensable gases are withdrawn through air baffles, deaerating the feed water.

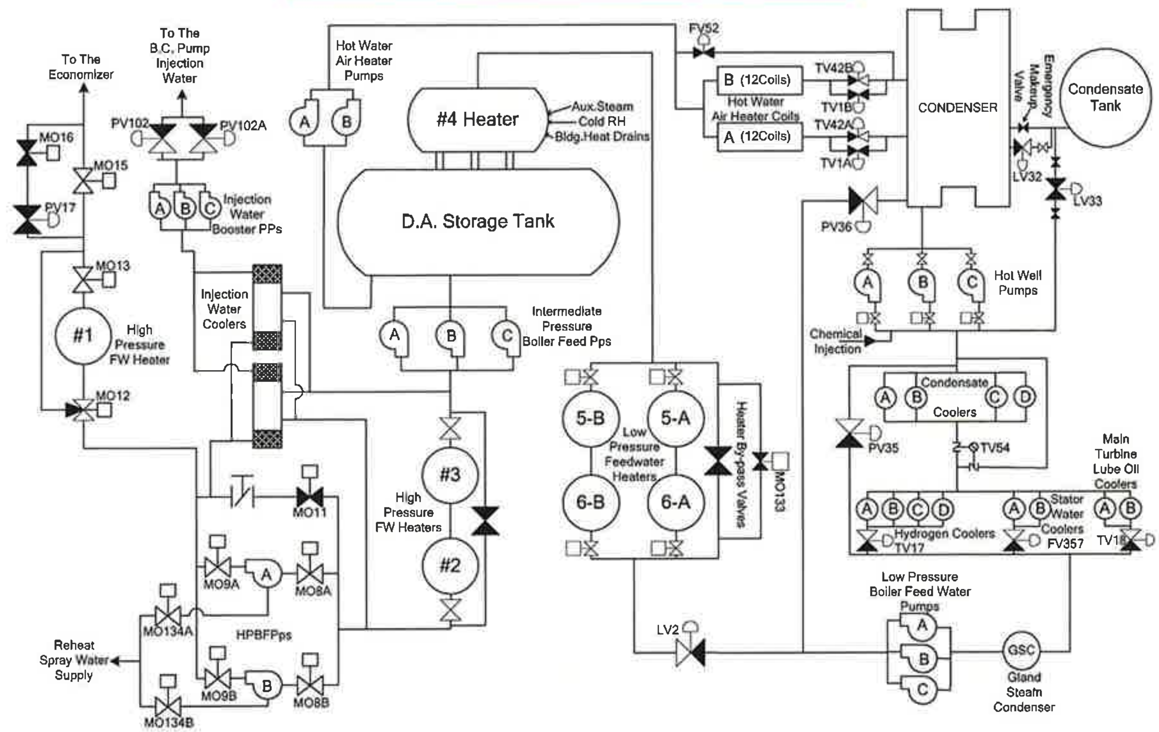
**Intermediate Pressure Boiler Feed Pumps:** (Units 1, 2, 3, & 4)
Three half capacity Pacific pumps supplied for each Unit. Each pump is single stage, centrifugal, and driven by a 1,750 hp electric motor. Each rated at 3,600 rpm, 5,300 gpm 1,180 ft. TDH. The I.P. Boiler Feed Pumps are the first pumps in the upper heat cycle. Feed water at a pressure of 50 psi and 305° Fahrenheit at the pump suction, is increased in pressure to 600 psi at the discharge.

**Intermediate Pressure Feed Water Heaters: NO. 3 & 2.** (Units 1, 2, 3, & 4)
Two single shell, Westinghouse, closed horizontal u-shaped heaters per Unit. Main Turbine extraction steam, routed by way of a series of piping, heats feed water on its way to Boiler.

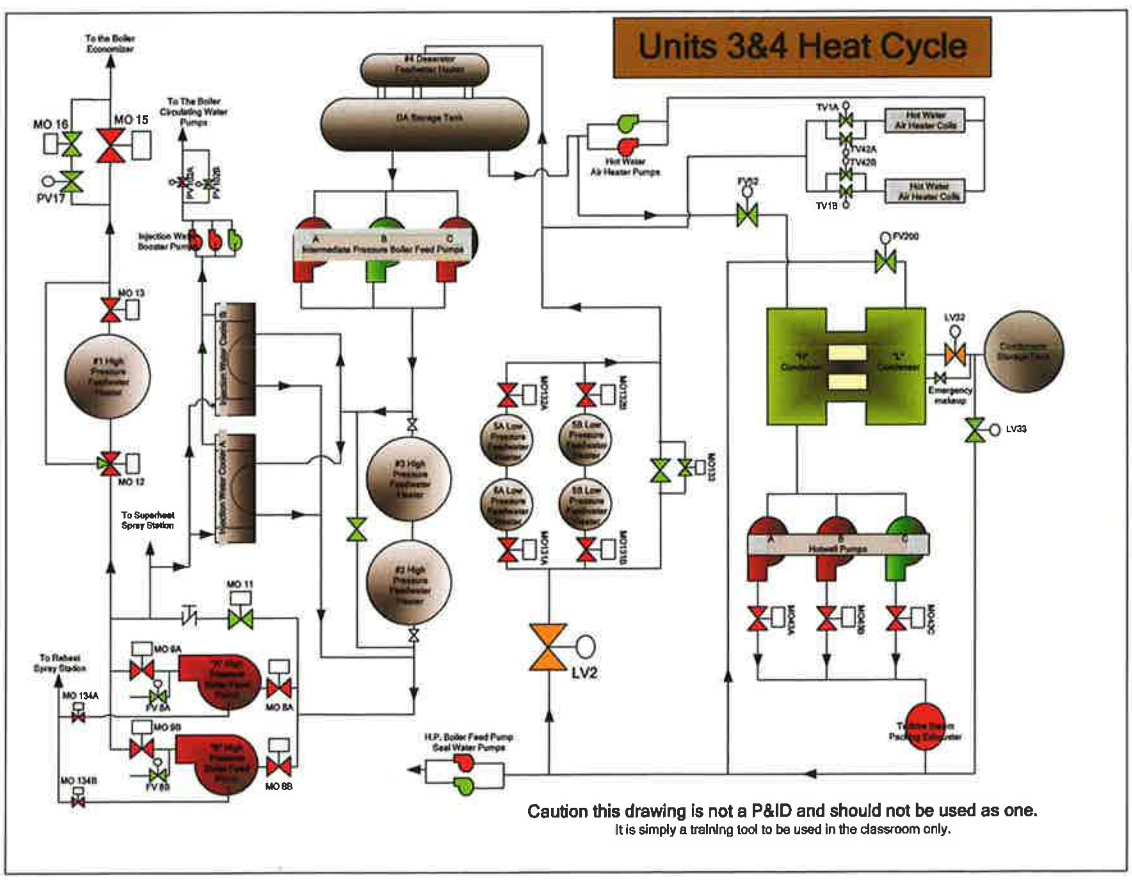
**High Pressure Boiler Feed Water Pump:** (Units 1 & 2)
Two half capacity Pacific Pumps per Unit, 5 stage, centrifugal, each driven by a standard Westinghouse impulse / reaction condensing turbine designed to operate from cold reheat or intermediate pressure Turbine-Generator extraction steam. Pump rating: 5,500 gpm, 7050 ft. TDH. Turbine rating: I.P. extraction steam 9,775 hp / turbine at 5,600 rpm; cold reheat system 11,300 hp / turbine at 5,880 rpm. Both turbine ratings are at 2.5 inch Hg. Abs. exhaust pressure. (Unit 3 & 4), Turbines are General Electric and operated from H.P. Main, I.P. Turbine extraction steam.

**High Pressure Heater: NO. 1.** (Units 1, 2, 3, & 4)
One single shell, Westinghouse closed, horizontal u-tube heater per Unit. Main Turbine extraction steam, routed by way of a series of piping, heats feed water on its way to Boiler.

# Units 1 & 2 Heat Cycle




Graphic Illustration only **Do Not** use this drawing for WPA Purposes
*"Check Your WPA"*



## *Boiler Draft System*

**Forced Draft Fans:** (Units 1, 2, 3, & 4)
Two per Unit, Westinghouse 780,000 cfm each at 15 inches H2O and 100° Fahrenheit, double inlet, airfoil blade type, constant speed, inlet vane volume control, coupled to a 1,750 hp, 514 rpm motor. The combustion process in the furnace requires 1,100 pounds of air for every pound of coal burned. The Forced Draft Fans provide this positive pressure air requirement.

**Hot Water Coils:** (Units 1, 2, 3, & 4)
Twenty-two Aerofin coils, 75° Fahrenheit rise at an air flow of 2,413,000 lb. / hr. water inlet temperature 300° Fahrenheit, 272,500 lb. / hr. to prevent corrosion, the Hot Water Air Heater Coils maintain the proper cold end metal average temperature at the Air Pre-Heaters. Hot water from the feed water system passing through coils exchange heat to the incoming combustion air.

**Air Pre-Heaters:** (Units 1, 2, 3, & 4)
Two per Unit, Ljungstrom Regenerative type, each 293,500 square feet heating surface, one gas pass, one air pass, soot blowing and water washing devices. Ambient air is pre-heated to about 650° Fahrenheit before being supplied to the Boiler. This is accomplished by the Hot Water Air Heater Coils and Air Pre-Heaters. The Air Pre-Heaters exchange heat from the Boiler exit gases to the in-coming combustion air. Each Air Pre-Heater is equipped with a variable frequency drive which automatically varies the 25 HP motor RPM from 900 to 1800, depending on boiler load.

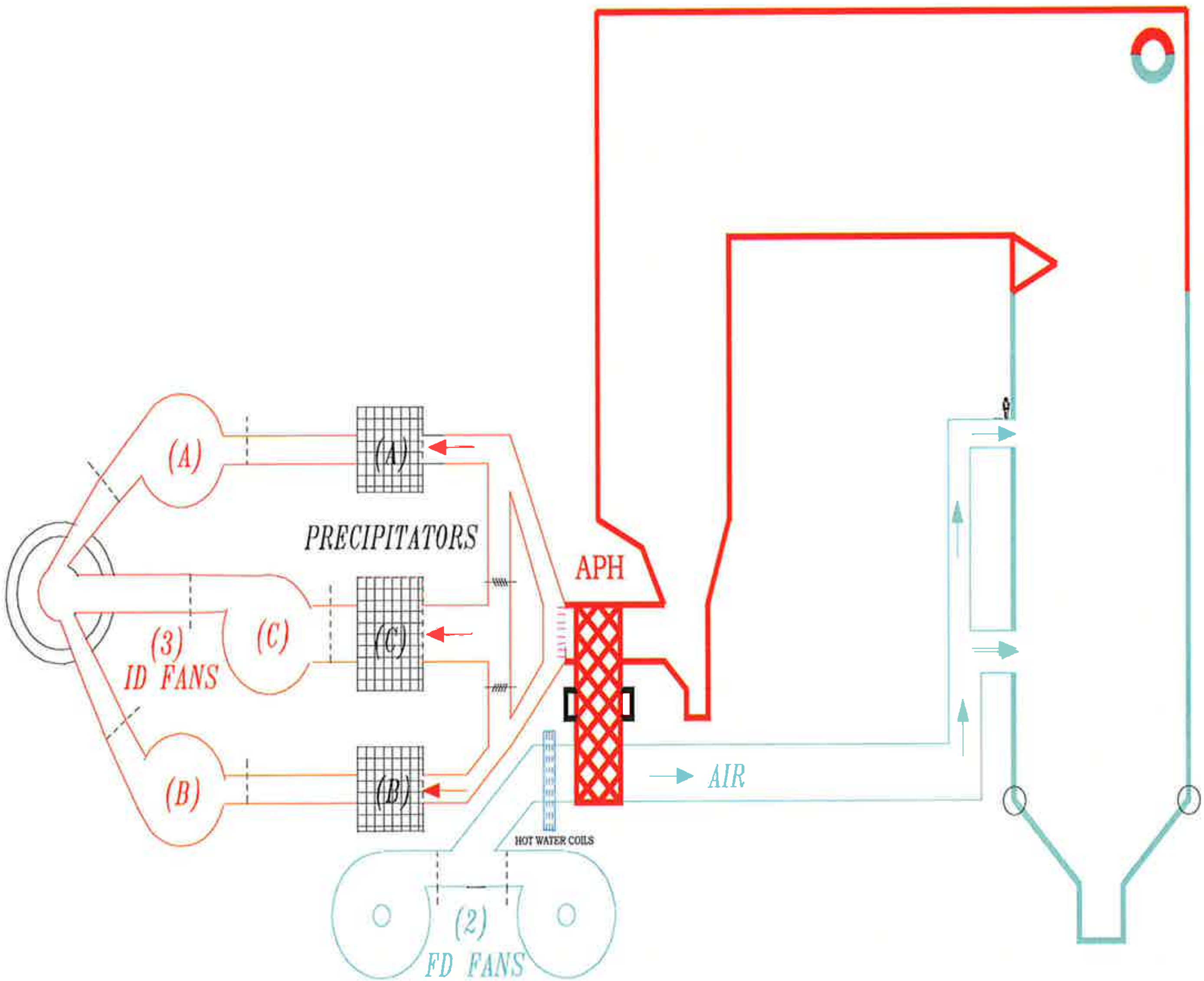
**Precipitators:** (Units 1, 2, 3, & 4)
Three per Unit operate in parallel. The "A & B" Precipitators are Research-Cottrell, 99.0% Efficient, 362,880 square feet total collection of ash area, 1,320,000 cfm total gas flow, 1,120 KVA (Unit 1) and 1,330 KVA (Units 2, 3 & 4) total maximum operating power requirement. These Precipitators each handle 30% of the total flue gas. Ash is stored in hoppers below these Precipitators and removed by way of an ash handling system.
The "C" Precipitator is a Flakt INC., 99.7% efficient, 353,430 square feet total collection area, 880,000 cfm total gas flow, 1,440 KiloVolt Amps, (KVA), total maximum operating power requirement removing 40% of the ash in the flue gas. Hopper ash is removed by way of an ash handling system.

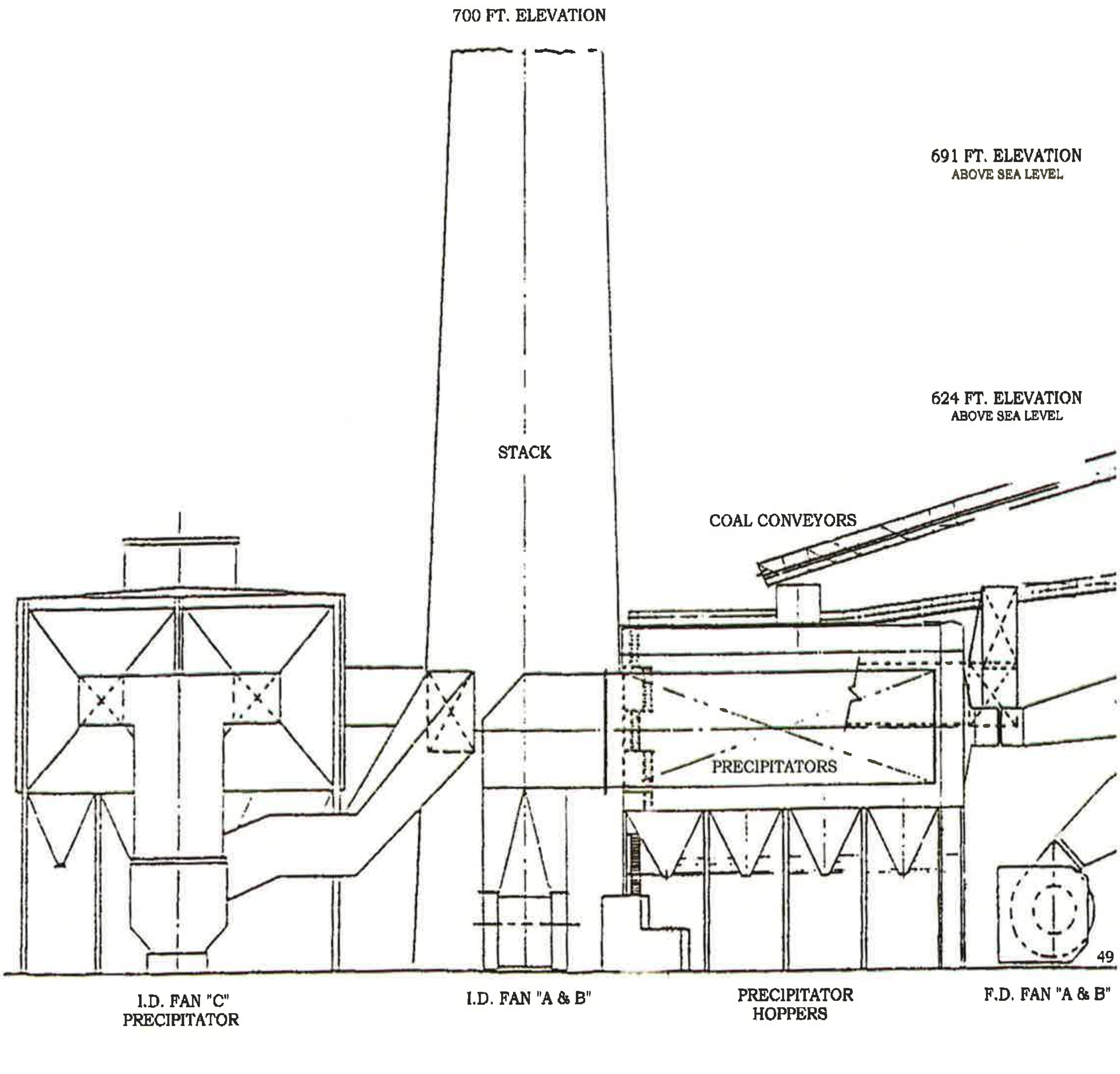
All Four Units have **Forry Control So3 Systems** designed to increase Precipitator efficiency by injecting sulfur trioxide into the flue gas to treat fly ash particles discharged from the Boiler.

**Induced Draft Fans:** (Units 1, 2, 3, & 4)
Three per Unit, Westinghouse manufactured. The "A & B" I.D. Fans are rated for 760,000 cfm Units 1 & 2, (1,088,000 cfm Units 3 & 4, Bigger Rotor) each at 22.2" of $H_2O$ Units 1 & 2, (19.8 inches of $H_2O$ Units 3 & 4), double inlet airfoil blade type, constant speed, inlet vane control, coupled to a 4,000 hp, 720 rpm motor. The "C" I.D. Fan is rated for 860,000 / 1,036,000 cfm at 21.7 / 31.6 inches of $H_2O$ (low speed / high speed), double inlet, airfoil blade type, two speed, inlet vane control, coupled to a 4,200 / 6,000 hp, 720 rpm motor. Hot gases, drawn from the Boiler through Electrostatic Precipitators, enters each fan through variable pitched inlet vanes, through the fan, and out to the Stack.

**Stack:** (Units 1 & 2)
Each Unit has a 700' reinforced concrete Stack varying in outside diameter from 54'6" at the base to 22'-8" at the top. The Stacks are lined with an insulated Corten steel liner having an inside diameter of 20'-6" for the top 580' and then a 60' transition section to a diameter of 30'-0" from the bottom 60'.
(Units 3 & 4)
One 700' reinforced concrete Stack, varying in outside diameter from 65"-6" at the base to 42'-2" at the top, serves both Units. The Stack has two independent insulated Corten steel liners. The liners are elliptical for the top 150' and then a 10'-0" transition section changes the liners to a circular shape with inside diameter of 20'-6".

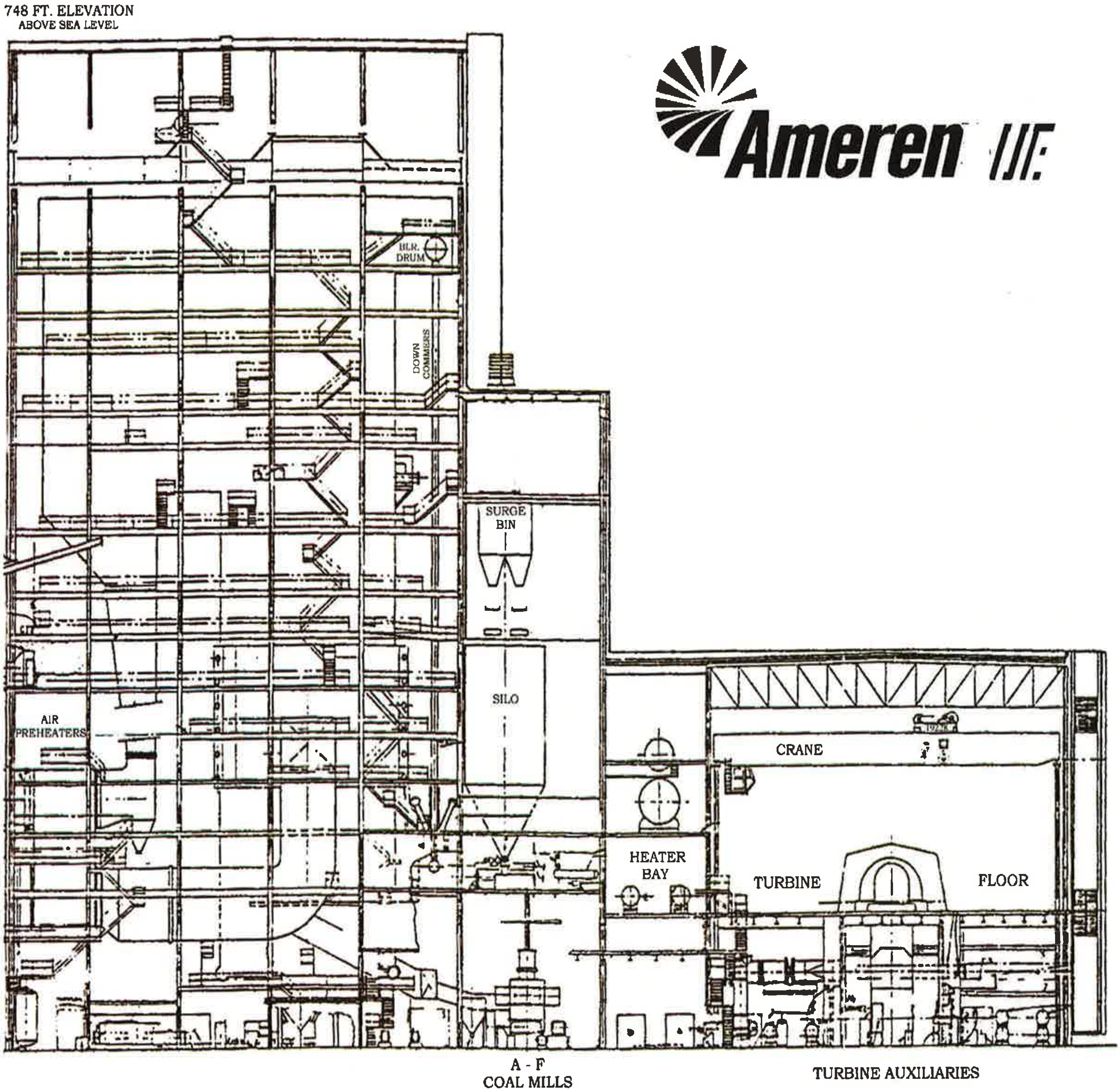
# BOILER DRAFT






# LABADIE PLANT CROSS-SECTION

Ameren UE


748 FT. ELEVATION
ABOVE SEA LEVEL
BLR. DRUM
DOWN COMMERS
SURGE BIN
SILO
AIR PREHEATERS
CRANE
HEATER BAY
TURBINE
FLOOR
A - F
COAL MILLS
TURBINE AUXILIARIES

## *Major Electrical Equipment*

**Starting Transformer #1 & 138 KV Switchyard Equipment, 2H:**
The 138 KV primary windings of Starting Transformer #1 is connected to the Labadie Gray Summit transmission line through a load interrupter switch, one, S & C type G, motor operated, 1,200 ampere circuit switcher. The 4.16 KV secondary winding, is connected to the 4.16 KV Common Auxiliary Bus A through a parallel set of 3,000 amp, air blast, circuit breakers. This power is normally used to operate equipment common to Units 1 & 2. It is also the normal source of power to the 4.16 KV Unit Bus 1A or 2A during startup operation. When sufficient power output is available from the Generator, circuit breakers are operated to transfer the power supply for the 4.16 KV Unit Busses to the Unit Transformer.

*Grounding Switch:*
One Southern States type HRR-PB0138, high speed, motor operated, single pole, 70,000 amperes momentary.

(Units 2, 3, & 4)
**Starting Transformers & 345 KV Switchyard Equipment 14H, 16H, 26H:**
Primary windings are connected to the 345 KV Buses in the Switchyard.

Unit 1: One Pennsylvania, 15/20/25 MVA OA/FA/FA, 138-4.16 KV.
Unit 2: One General Electric, 15/20/25 MVA OA/FA/FOA 354.16 KV.
Units 3 & 4: One, (Each) Westinghouse, 15/20/25 MVA OA/FOA/FOA 345.16 KV.

**Generator Transformers:** (Units 1, & 3)
This large, outdoor type, newer power transformer, is used to step up Generator output voltage from 20 KV to 345 KV for transmission over high voltage power lines in the Switchyard. Nitrogen Gas system maintains a positive pressure above the oil to prevent contaminants from entering the tank and allows for expansion and contraction of the transformer oil.
(Units 2, & 4) Same as above. These Transformers use the Constant Oil Pressure System, (COPS).

*Main Generator Leads:*
The Low Voltage Windings are connected by the Isophase Bus to the Generator terminals. General Electric, forced air cooled isolated phase bus duct, single insulator, zero force design of 22,200 amperes with a tap of 1,200 amperes.

*High Voltage Transformer Leads:*
The High Voltage Windings are connected through manually operated ground and transformer disconnects to the generator 1,600 amp air blast circuit breaker. One conductor per phase of 2,500 Mega Circular Mils, (MCM), all aluminum conductor.

**Unit Transformer:** (Units 1, 2, 3, & 4)

One per Unit, Moloney Electric, 24/32/40 MVA OA/FA/FA. 19-4.16 KV. The Unit Transformer is an outdoor type, power transformer, used to step down the Generator output voltage from 20 KV to 4.16 KV. The high voltage primary windings are connected to the Isophase Bus. There are two, (2), sets of low voltage secondary windings. One is connected to the 4.16 KV Unit Bus A, the other to 4.16 KV Unit Bus B. A 3,000 amp, air blast, circuit breaker is located in the feed to each bus. The connecting buses are enclosed in steel ducts from the transformer to the auxiliary buses.

## *Switchyard*

The Switchyard equipment is arranged in a single bus, single breaker scheme, with Bus sectionalizing breakers. The Bus is designed for continuous operation at 3,000 amperes.

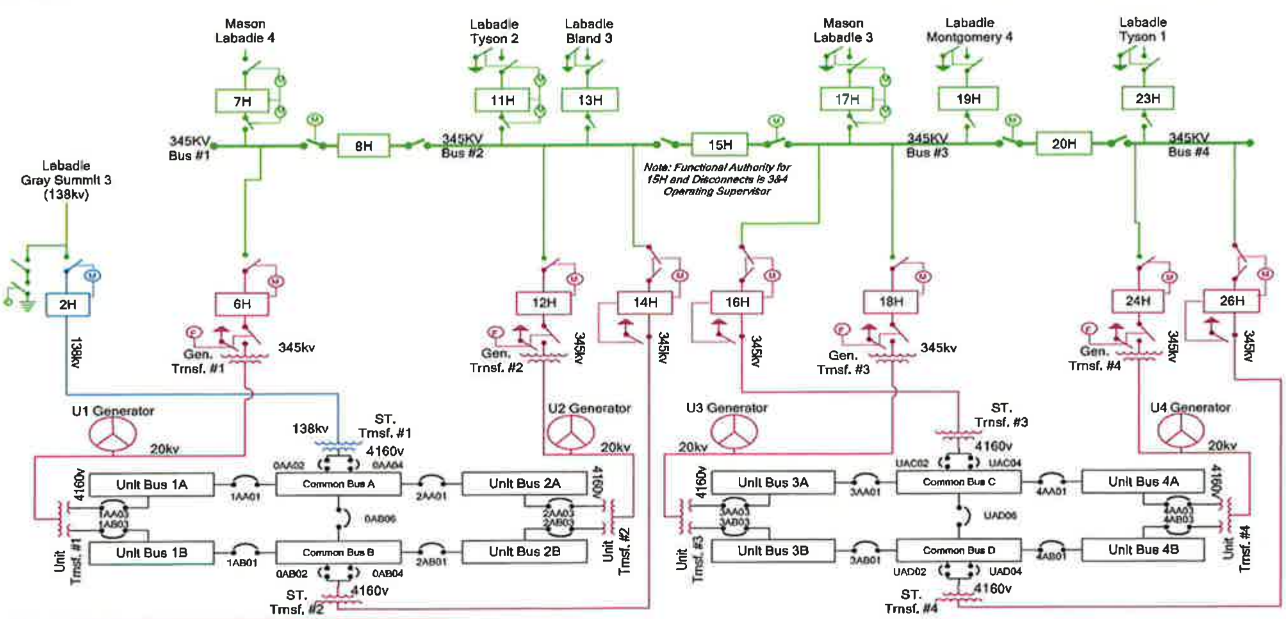
**125 Volt DC Power System:**
Direct Current Power (DC) is used as control power for the air blast circuit breakers and circuit switchers, relaying and metering devices. Two Battery Units consisting of 60 cells of lead antimony construction.
*Relaying:*
General Electric static primary relaying with directional comparison carrier blocking scheme. Westinghouse electro-mechanical secondary relaying with RFL static audio tone.

**Circuit Breakers:**
*Transmission Line:* Six General Electric type ATB-7, 25,000 MVA, 3,000 ampere, air blast with pre-inserting resistors.
*Bus Ties*: Three General Electric type ATB-7, 25,000 MVA, 3,000 ampere, air blast with pre-insertion resistors.
*Generators:* Four General Electric type ATB-7, 25,000 MVA, 1,600 ampere, air blast with pre-insertion resistors.

**Disconnecting Switches:**

*Transmission Line:* Twelve H.K. Porter type MK-40A, 2,000 ampere, 70,000 ampere momentary. Six with ground attachments, six without.
*Bus Ties:* Six H.K. Porter type MIL-40A, 2,000 ampere, 70,000 ampere momentary.
*Generators:* Eight H.K. Porter type MK-40A, 2,000 ampere, 70,000 ampere momentary. Four are motorized and without ground disconnects. Four are not motorized and with ground disconnects.

*Jurisdictional Authority:* This Operating Authority is in charge of, and responsible for directing and coordinating operation of system equipment.
*Functional Authority:* This Operating Authority specifically performs or directs someone else to perform detailed switching operations, directs valving, etc. as ordered by the Jurisdictional Authority.




| LEGEND | Jurisdictional Authority | Functional Authority |
|---|---|---|
| (green) | Transmission Dispatcher | Transmission Dispatcher |
| (maroon) | Power Dispatcher | Operating Supervisor |
| (black) | Operating Supervisor | Operating Supervisor |
| (blue) | Transmission Dispatcher | Operating Supervisor |

**Switchyard and Auxiliary Busses**
**Labadie Plant Units 1,2,3 & 4**

Rev. 8/18/08 TS

## *Coal Handling System*

Labadie Plant Boilers have consumed over 270 million tons of coal since 1970.

The Coal Handling System is divided into three sections:
A. ***Receiving***; B. ***Reclaim***; C. ***Silo-Filling.***

The Receiving and Reclaim Systems are interdependent and serve all four Units. Each Unit has an independent Silo-Fill System.

Coal arrives at Labadie by Unitrain, consisting of 143 hopper cars. Each car carries 117 tons of coal, which is 16,700 tons per train. A Unitrain unloads without uncoupling. Low sulfur coal for the Plant is supplied from the Powder River Basin area of Wyoming and is delivered by the Union Pacific Railroad.

When Labadie Plant is at full load, 2,580 MW's, approximately 23 tons of coal is burned each minute. (A train car lasts approximately five minutes). A typical daily burn is 33,000 tons.

Coal is dumped from the slowly moving Unitrain into ***Receiving*** hoppers under the tracks and is fed by vibrating feeders and a 3,000 ton/hr conveyor belt system to a movable stacker boom which deposits the coal on a kidney shaped pile. Two identical coal ***Reclaim*** Systems,each with a maximum capacity of 850 Tons Per Hour, (TPH), move the coal through hoppers, vibrating feeders and inclined belt conveyors to a 100 ton capacity surge bin. A Benetech Dust Suppression System is used to spray foam on the coal stream to reduce dust.

The ***Silo Fill*** System for each Unit consists of six cascading conveyors which move the coal from the Surge Bin to six silos, each feeding one Coal Mill. The filling system maintains a level in the silos automatically by having the last two silos mounted on load cells which govern the feed rate of the vibrating feeders under the surge bin. The feed rate to the six Coal Mills from the silos is controlled by individual Gravimetric Feeders which receive feedrate signals from the Boiler Control System.

**Labadie Plant Coal Statistics:**
2009

| | |
|---|---|
| Coal Received: | 9,906,994 Tons |
| Coal Burned: | 10,123,723 Tons |
| Trains Unloaded: | 596 |
| Avg. Unloading time: | 6.65 hours |
| Gross Generation | 18,120,095 MWH |

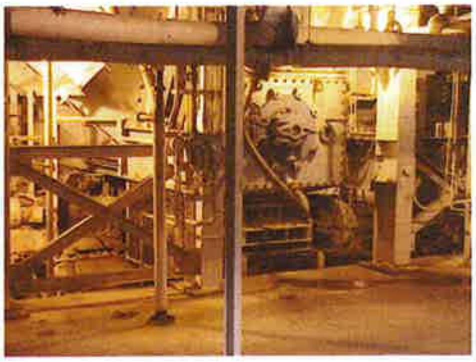
## *Raw Water Systems*

**Low Pressure System:** (Units 1, 2, 3, & 4)
Six Ingersoll-Rand, Centrifugal pumps take suction from the circulating water header, then route raw water through a network of headers, valves and strainers to supply water through common headers to the Sootblowing Compressor Intercoolers, Condenser Vacuum Pump Coolers, and Jacket Water Coolers. Each pump rated 4,500 gpm at 65 ft. TDH and driven by a 100 hp, 1,175 rpm motor.

**High Pressure System:** (Units 1, 2, 3, & 4)
Six Ingersoll-Rand, centrifugal pumps take suction from the circulating water header, then route raw water through a network of headers, valves and strainers to supply raw water through common headers to the Ash Removal System.

## *Ash Handling Systems*

**Coal Mill Pyrites:** (Units 1, 2, 3, & 4)
Coal Mill rejects, such as iron pyrite, are deposited in open-top collection hoppers positioned next to each of the Coal Mills to catch material being discharged from the reject chute for each Coal Mill. A screen type grating prevents objects from entering the hopper that are too large to pass through the transport line. The waste material is then sluiced to the bottom ash hoppers by the Pyrite Removal system.



**Bottom Ash:** (Units 1, 2, 3, & 4)
The Bottom Ash system includes all equipment necessary to transport the Bottom Ash from the Boiler Ash Pit hoppers to the Ash Pond. Ash is sluiced from the Boiler Ash Pit through the sluice door to the motor driven clinker grinder. Ash is ground up by the grinder and pumped by the jet pulsion pump through the 12 inch diameter basalt lined ash discharge pipes to the Ash Pond.

**Bottom Ash Marketing:**
In September, 2006, AmerenUE's Labadie Power Plant opened a concrete packaging facility on its property. This was the first of its kind to operate in the United States on power plant property, closest to the source of the ash. The facility is the result of a unique partnership between AmerenUE, Charah, QUIKRETE® and The Home Depot, annually recycling 70,000 tons of fly and bottom ash into two million bags of high-quality QUIKRETE® concrete mix. At this facility, the mix is processed and packaged for sale in fully recyclable, two-handled plastic bags from Charah which is then sold at 24 area Home Depot stores. Approximately 20% of the QUIKRETE® concrete mix produced by Charah comes from recycled ash.

**Economizer Ash:** (Units 1, 2, 3, & 4)
Ash carried in the flue gas through the Economizer section of the Boiler, but too heavy to remain in suspension, is collected in twelve Economizer Ash Hoppers. The ash is removed from the hoppers by vacuum created by a hydrovactor. High pressure raw water is required to supply the hydrovactor. Ash is pulled, one hopper at a time and deposited in the Bottom Ash hopper.

**Fly Ash:** (Units 1, 2, 3, & 4)
As coal is burned in the Boiler, approximately 5% of the total ends up in some form of ash. Approximately 75% of the total is Fly Ash. The Fly Ash is collected by Electrostatic Precipitators and deposited in forty storage hoppers located below the Precipitators. The Fly Ash is then transported by means of one of three Vacuum Pumps and deposited in Transfer Tanks. There are two Transfer Tanks per Unit. Each tank is a steel, cylindrical, flat bottomed storage chamber having two discharge openings. Collected material is discharged into Air Locks. There are four Air Locks per Transfer Tank. There are two Fly Ash Blowers per Unit that blow the ash from the Air Locks to the Fly Ash Silos. There are two Labadie Plant Fly Ash Pond Silos. They are located at the Fly Ash Pond South of unit Four. Each Silo is a 30' diameter cylinder with 6,667 cubic feet of usable storage capacity. Each steel tank consists of a flat bottom storage chamber with three discharge openings, two for discharge into wetting heads below and one for a telescopic chute for unloading.

**Fly Ash Marketing:**
One of the by-products of burning coal is Fly Ash. This by-product has become a valuable resource to the Concrete and Construction Industry. Ash is stored in silos then is trucked out of the Plant by a Fly Ash Marketer.

Labadie Plant produced 400,000 tons of fly ash in 2009. Mineral Resource Technology (MRT) shipped 161,000 tons of fly ash in 2009 via trucks and rail cars. Trucks average approximately 26 tons each and railcars average 100 tons each.

## *Instruments and Control*

**Controls Upgrade:**
Labadie Plant Unit Control Upgrades, at a total cost of $40,000,000 were as follows:

Unit 2.....September, 1998
Unit 4.......February, 1999
Unit 3.....September, 1999
Unit 1.......February, 2000

Upgrade was needed to:
*Improve Operation* and *Information Access*, provide *More Flexibility* and *Position Labadie Plant for the Future.* An increase in difficulty finding replacement parts for the old system, also contributed.

Labadie Plant upgraded our old Bailey 721 controls to new Bailey INFI 90 DCS, Digital Control Systems.

New **Bailey INFI 90 DCS** controls provide:

- Redundant Control Systems.
- Reliability.
- Full featured interface for enterprise management and control.
- Flexibility in Control Changes, Keyboard, instead of wires.
- Advanced display system supporting up to 8 windows per CRT.

New **ID/FD Fan Damper Drive** controls:

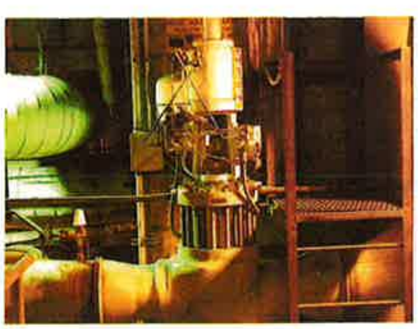
New *BECK* drives replace the *EIM* Drives to:
- Provide more reliability airflow control.
- Provide accurate position feedback toDCS.

New **Feedwater Heater** controls:

The New *Magnetrol* system replaces *Masoneilan* to:
- Provide accurate level indication to Control Room on DCS.
- Have better Operation and Engineering awareness.
- Better Operation means longer life expectancy.
- Control of valve's via DCS through Net 90.

New **Burner Tilt Drive** controls:

New *BECK* drives replace the *REXA / Bailey* drives to:
- Improves heat rate and controls Nox.
- Better control or Superheat/Reheat temperatures.
- Exact positioning of dampers, more reliable.
- Inputs to DCS system through Net 90.



Installation of new **Process Control Valves:**

- Replacement of key control valves:
  (Units 1, 2, 3, & 4) LV-2, by Valtek, PV-17, Fisher, PV-19 A & B, Masoneilan, TV-22A & B, Control Components.
  (Units 1& 2) Gland Turbine Steam valves PV-30, 31, 32, and PV-117, Masoneilan.
- Replacement of 83 process transmitters, by Yokogawa.

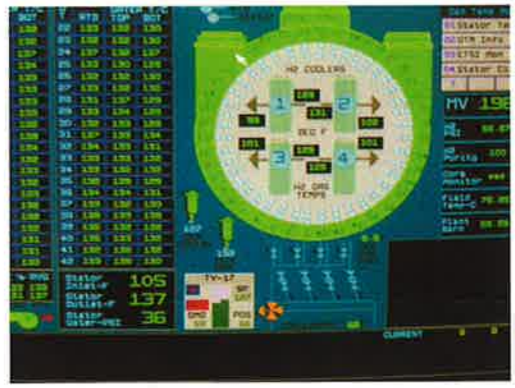
New **Turbine Controls:** (Units 1 & 2)

New *Electronic Technology Systems, Inc.* (ETSI) provides high pressure hydraulics used to position the Turbine steam valves.

*New system provides:*

- Less chance of fire.
- Tighter control of valves.
- Much more reliable operation.
- Turn around from unit trips much easier.

New **Generator Temperature Monitor** control:



New *RTD's and TC's* fed into Bailey:

- Reads temperature accurately. Old controls, unreliable.
- Provides appropriate alarming and graphic interface.
- Incorporates "ON LINE" help displays.

New **Uninterruptible Power Supply** control:

An Uninterruptible Power Supply, (UPS) protects critical loads from the effects of power outages, low line voltage, line fluctuations, fast transients caused by switching and power line faults. The UPS rectifies the power to Direct Current, (DC), and is connected to a battery, this DC is then inverted back to Alternating Current, (AC), to supply the critical loads.

*New system provides:*

- Each Unit with Two UPS Units, A & B.
- More reliable.

Installation of **Pegasus:**


NeuSight, the optimizing program which is the brains of Pegasus, builds a combustion process model of our Boiler using over 250 inputs from the DCS system.

*New system provides:*

- Optimizes the combustion process to improve heat rate.
- Inputs are error checked to ensure safe operating conditions.
- Computer adjusts set points / biases to optimize.
- Provides 20 to 25% reduction in Nox.

New **PI, Plant Information**, System:

PI is a Windows-based user interface designed to support data collection and analysis. Displays, reports, and analysis are organized via an easy-to-use workbook format. Data may be displayed in a variety of formats, including process graphics, trends, statistical plots, tables, and charts. Displays are easy to configure and may be created in advance or built as desired. *New system provides:*

- Tool to gather and analyze system data.
- Plant information is collected from 40,000 Bailey tags.
- PI interfaces with Bailey DCS.
- Everyone at Labadie Plant has this information available.
- PI is very impressive when analyzing problems.

## *Instruments and Control*

**Control Room** Remodeling:
(Units 1, 2, 3, & 4)

- Reduce Maintenance Costs, (No recorders or switches).
- Fewer distractions for Unit Operators.
- More secure area in which to work.
- Modernization to accommodate DCS.

**Training Simulators,** (Two):
(One in each Control Room)

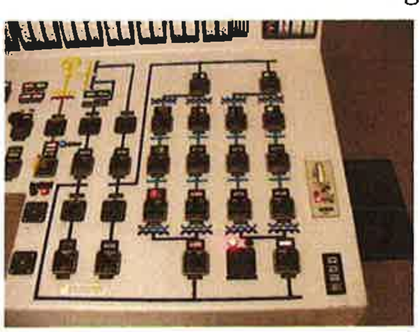
- Built from Generic TRAX models.
- Simulators allow trainees to practice real life scenarios and operate Units identical to "On Line" Units.
- Operators can practice Operational techniques without affecting live Units.
- Used for Startup / Shutdown / Checkout.


New **Control Display / Configuration** systems:

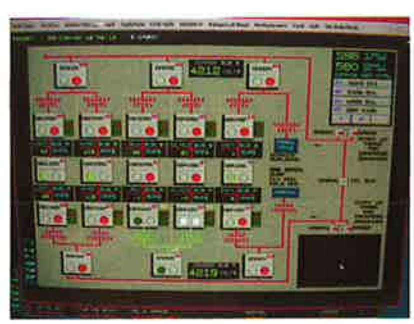
- New graphic control screens built totally "In House".
- New Alarm Prioritization.
- Operator friendly, more information available.
- Configured by SEGA Inc. out of Kansas City.
- Number of displays available, approximately 210.
- Configured from the 721 Control concept .
- Enhances previous Burner Management Screens.

Common Equipment and **Electrical Buss** controls**:**
Labadie Plant is *ONLY* Plant in Ameren System thus far to place *All* electrical controls into Digital Control System.

From This:

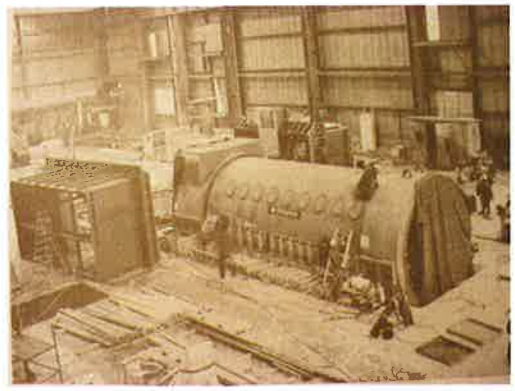


**To This:**

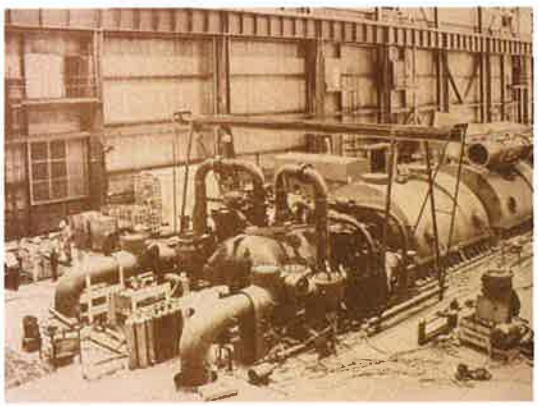


# Labadie Plant

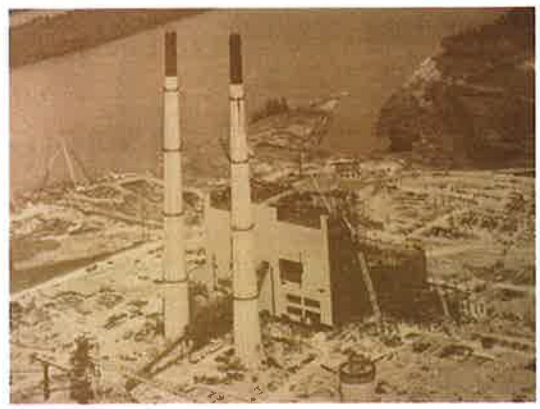
**May 1968** Structural Steel Construction.



**December 1968** Unit One Turbine.



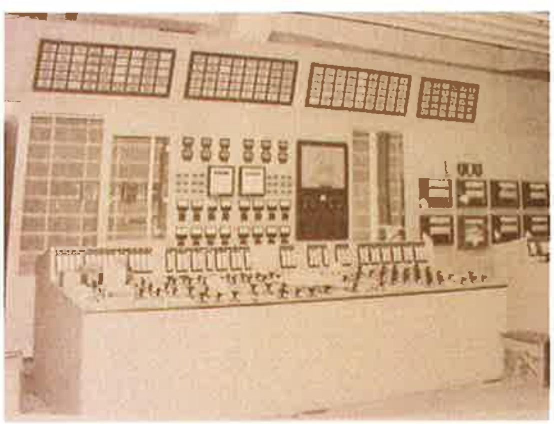
**August 1969** Unit One Turbine.



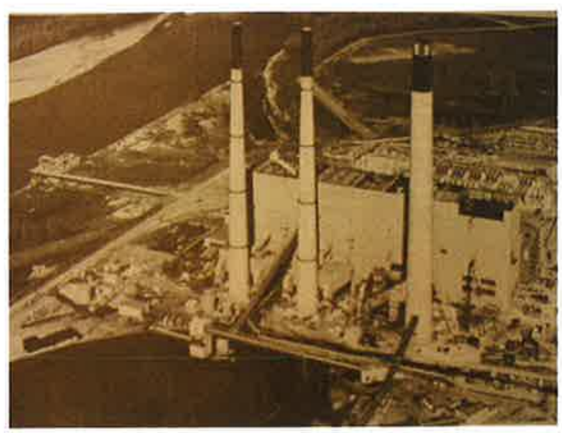
**September 1969** looking Northeast.

**January 1970.**

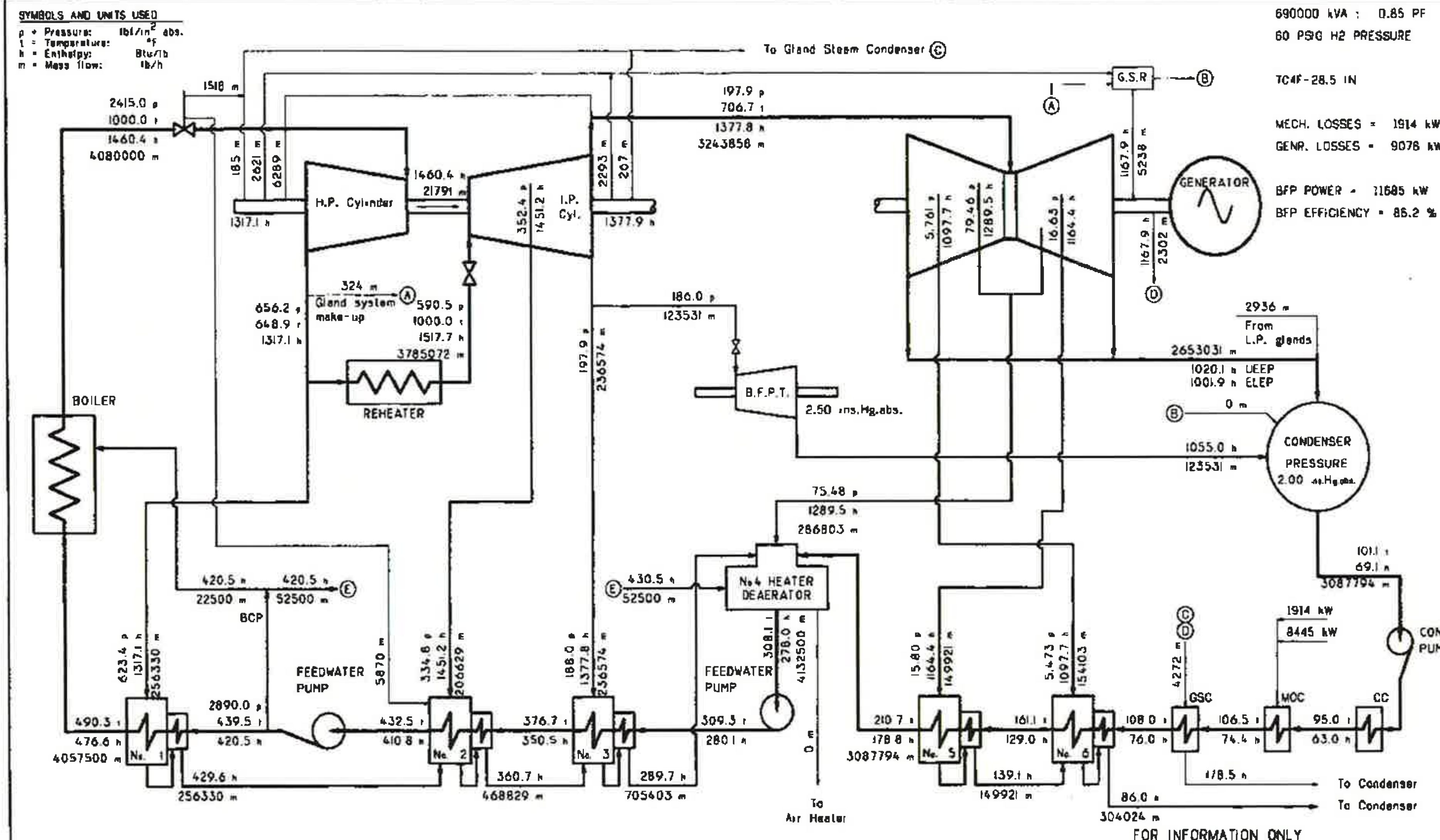
**January 1971.**



**July 1971** Unit 3 Control Room.



**February 1972.**




The Feedheating Plant performance is as follows:

| Heater Number: | 1 | 2 | 3 | Drain | 5 | 6 |
|---|---|---|---|---|---|---|
| Outlet Terminal Temperature Difference: °F | 0 | -5.0 | 0 | 0 | 5.0 | 5.0 |
| Inlet Terminal Temperature Difference: °F | 10.0 | 10.0 | 10.0 | - | 10.0 | 10.0 |
| Bled Steam Pipe Pressure Drop: % | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |



OUTPUT AT GENERATOR TERMINALS = 617769 kW

HEAT RATE =

$$\frac{4080000 \times 1460.4 - 4057500 \times 476.6 \quad 75000 \times 420.5 + 3785072 \times (1517.7 - 1317.1) + 52500 \times 430.5}{617769}$$

= 7729 Btu/kWh

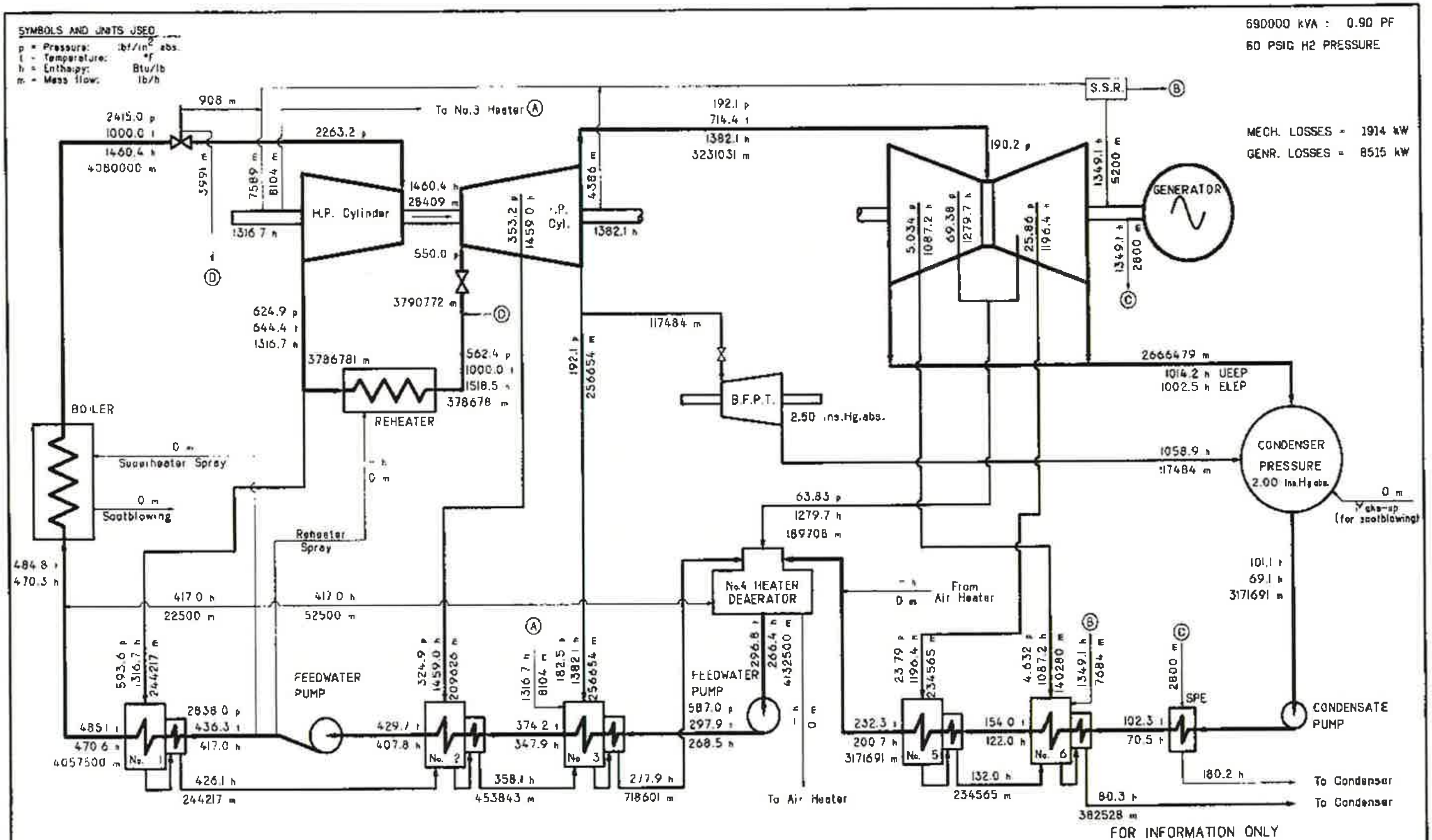


| Drawn: | A.E. | Chckd: | | Apprvd: | [illegible] |
|---|---|---|---|---|---|

**ALSTOM Power**

DIAGRAM OF OPERATING CONDITIONS
AMEREN UE
**LABADIE STEAM STATION UNITS 1 & 2**
REPLACEMENT H.P./I.P. CYLINDER MODULE
4080000 lb/h at 2415 psia

| M.B. Ref: | Quotation No: | Issue: | Drawing Number: |
|---|---|---|---|
| AE3227/2 | T11230/1 | A | TS29112 |

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|---|---|---|---|---|---|---|---|
| Outlet Terminal Temperature Difference: | °F | 0 | -5.0 | 0 | 0 | 5.0 | 5.0 |
| Inlet Terminal Temperature Difference: | °F | 10.0 | 10.0 | 10.0 | – | 10.0 | 10.0 |
| Bled Steam Pipe Pressure Drop: | % | 5.0 | 8.0 | 5.0 | 8.0 | 8.0 | 8.0 |

OUTPUT AT GENERATOR TERMINALS = 625428 kW

HEAT RATE =

$$\frac{4080000 \times (1460.4-470.3) + 3786781 \times (1518.5-1316.7)}{625428}$$

= 7681 Btu/kWh



Drawn: A.E. Chckd: Apprvd: ADG

**ALSTOM Power**

DIAGRAM OF OPERATING CONDITIONS
AMEREN UE
**LABADIE STEAM STATION UNITS 3 & 4**
REPLACEMENT H.P./I.P./L.P.
4080000 lb/h at 2415 psia

| H.B. Ref: | Quotation No: | Issue: | Drawing Number: |
|---|---|---|---|
| AE5562/2 | T11251 | A | TS29479 |

ECONOMICAL ENERGY
LEADING THE WAY INTO THE FUTURE

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OUR HEALTHY, SAFETY-MINDED
EMPLOYEES"

AMEREN UE
LABADIE POWER PLANT
226 LABADIE POWER PLANT ROAD
LABADIE, MISSOURI 63055

Rev. OCTOBER 2010