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Technical Notes for the Conceptual Design for an Atmospheric Fluidized-Bed Direct Combustion Power Generating Plant

Volume 2

April 1978

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

Under Contract No. EF-77-C-01-2583

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Technical Notes for the Conceptual Design for an Atmospheric Fluidized-Bed Direct Combustion Power Generating Plant

Volume 2

April 1978

Prepared By
Stone & Webster Engineering Corporation

For
U.S. Department of Energy
Assistant Secretary for Energy Technology
Division of Power Systems
Washington, DC 20545

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TECHNICAL NOTES FOR THE
CONCEPTUAL DESIGN FOR AN ATMOSPHERIC FLUIDIZED-BED
DIRECT COMBUSTION POWER GENERATING PLANT

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PART IIIA

**570 Mwe BABCOCK & WILCOX AFB DEFINITION
AND
DESIGN CRITERIA**

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1.0 OBJECTIVE

The objective of this part (Part IIIA) of the Report is to describe the design, arrangement, thermodynamics, and economics of a 592 Mwe (nominal gross) electric power generating plant equipped with a Babcock and Wilcox Company (B&W) Atmospheric Fluidized Bed (AFB) boiler.

This document represents a portion of an overall report describing the conceptual designs of two atmospheric fluidized bed boilers and balance of plants for the generation of electric power and the analysis and comparison of these conceptual designs to a conventional pulverized coal-fired electric power generation plant equipped with a wet limestone flue gas desulfurization system. The reader is cautioned from drawing conclusions from this portion without reviewing the full report. Conclusions regarding the various aspects of this effort are presented in Parts IV and V of this Report.

2.0 INTRODUCTION

The B&W plant duplicates the base plant described in Part I of this Report except where a change has been required due to an AFB unique feature. These changes, as would be expected, are primarily in the boiler area, i.e., from the turbine room side of the silo bay through the stack. Changes required in the turbine-related equipment include the following:

- 13.8 kv electrical system
- Smaller boiler feed pump and drive
- Larger cooling tower
- Larger equipment cooling system
- Larger turbine generator
- New start-up boiler feed pump
- Larger circulating water pumps
- Larger condenser
- Turbine bypass and reheater cooling system

3.0 GENERAL

The B&W AFB Plant is a 592 Mwe (nominal gross) fourth extension to an existing site. Because the plant is an even-numbered extension, auxiliary systems and services are either used or extended rather than installed. The capital cost estimate noted in Table IIIA-1 includes services and/or systems as detailed in Appendix IIIA-A, B&W AFB Plant description of work.

The plant is designed to standard utility central station codes and standards as indicated in the following representative list:

Federal EPA Standard/Regulations
OSHA Regulations
ASME Codes
ANSI Standards
NFPA Codes
National Electrical Code
Uniform Building Code
Local Codes and Standards

The plant is equipped with an AFB boiler and an electrostatic precipitator to meet the 1.2 lb-per-million-Btu EPA SO₂ emission limit and a 0.06 lb-per-million-Btu particulate emission limit.

Like current facilities, the plant has an economic life of 30 yr, starting in 1982, with a planned loading cycle as noted in Table IIIA-2.

4.0 THERMODYNAMIC CYCLE

Diagrams 12919.02A-HBSK-1, 2, 3, and 4 describe the thermodynamic characteristics of the plant at maximum (VWO), 75 percent, 50 percent, and 25 percent load, respectively.

The balanced draft, assisted circulation, drum-type boiler has a heat input of 5,495,500,000 Btu/hr at VWO with a mixed gas outlet temperature of 274 F.

The turbine is a 2,520 psig/1,000 F/1,000 F four-flow tandem compound machine with 30 in. last stage blades. It is rated at approximately 592 Mwe when supplying seven stages of feedwater heating, the boiler feed pump drive, and exhausting into a multipressure condenser with approximately 1/2 percent makeup.

Using the fuel and the economic evaluation factors noted in Table I-2, in Part I of this Report, the following plant design features were optimized as part of the base plant effort and have not been reoptimized as part of the AFB effort.

- Main turbine end size
- Boiler feed pump drive
- Feedwater heater number, terminal difference, and drain cooler approach
- Condenser tube material, length, and diameter
- Cooling tower range approach and flow

TABLE IIIA-1
CAPITAL COST ESTIMATE
FOR A
570 MWE BABCOCK AND WILCOX AFB

<u>Block</u>	<u>Description</u>	<u>Material (000)</u>	<u>Labor (000)</u>	<u>Total (000)</u>	<u>Manhours (000)</u>	<u>\$/Kw (Net)</u>
1	Land and Land Rights		Not Included			-
2	Yardwork	104	158	262	9	0
*3	Main Powerhouse	10,748	10,644	21,392	570	39
4	Administration Building		Not Included			-
*5	Miscellaneous Buildings		Not Included			-
*6	Boiler Equipment by Vendor	34,724	25,214	59,938	1,274	108
*7A	Balance of Boiler Plant Equipment	10,954	7,219	18,173	361	33
*7B	Ash Handling Equipment	7,363	4,095	11,458	202	21
*8	Fuel Handling and Storage Equipment	4,014	2,392	6,406	125	12
*9	Stack	794	1,300	2,094	46	4
*10	Precipitator	9,718	4,331	14,049	224	25
*11	Flue Gas Desulfurization	0	0	0	0	0
*12	Turbine Generator Equipment by Vendor	18,939	868	19,807	44	36
*13	Balance of Turbine Plant Equipment (Excluding Condensing System)	988	2,239	3,227	121	6
*14	Condenser/Circulating Water System	5,533	2,509	8,042	138	14
15	Water Treatment	412	58	470	3	1
*16	Waste Treatment	0	0	0	0	0
*17	Accessory Electrical Equipment	7,623	6,298	13,921	329	25

*Change from Base Plant

TABLE IIIA-1 (Cont'd)

<u>Block</u>	<u>Description</u>	<u>Material (000)</u>	<u>Labor (000)</u>	<u>Total (000)</u>	<u>Manhours (000)</u>	<u>\$/Kw (Net)</u>
18	Miscellaneous Power Plant Equipment	106	276	382	15	1
19	Main Transformers	1,230	107	1,337	6	2
20	Transmission Lines		Not Included			-
	TOTAL DIRECT COST	113,250	67,708	180,958	3,467	327
	Engineering, General, and Administrative	11,294	7,460	18,754	-	34
	Field Distributable Cost	<u>4,557</u>	<u>3,143</u>	<u>7,700</u>	<u>40</u>	<u>14</u>
	DIRECT, INDIRECT, AND DISTRIBUTABLE COST SUBTOTAL	129,101	78,311	207,412	3,507	375
	Allowance for Indeterminates	<u>12,910</u>	<u>7,831</u>	<u>20,741</u>	<u>351</u>	<u>37</u>
	TOTAL 1976 COST	142,011	86,142	228,153	3,858	412
	Escalation to July, 1980	<u>22,012</u>	<u>31,873</u>	<u>53,885</u>	<u>-</u>	<u>97</u>
	TOTAL ESCALATED PLANT COST	164,023	118,015	282,038	3,858	509
	Allowance for Fund Used During Construction	<u>22,963</u>	<u>16,522</u>	<u>39,485</u>	<u>-</u>	<u>71</u>
	TOTAL PLANT CAPITAL COST, APRIL, 1982	186,986	134,537	321,523	3,858	580

*Change from Base Plant

TABLE IIIA-2
ECONOMIC PARAMETERS

Unit life, yr	30	
Plant size, kw (Nominal Gross)	592,000*	
Net unit output, kw	553,636*	
Potential Station Output, kw-hr	1.45×10^{10} *	
Planned Station Output, kw-hr	7.79×10^{10} *	
Levelized Annual, Station Output, kw-hr	3.09×10^{10} *	
Expenditure midpoint	July 1980	
Commercial operation	April 1982	
Annual fixed charge rate, %	15.35	
Present worth discount rate, %	10.5	
Allowance for funds used during construction, %	8.0	
Composite labor escalation, %/yr	7.25	
Composite material escalation, %/yr	3.25	
Fuel escalation, %/yr	7.0	
Limestone escalation, %/yr	5.5	
1982 limestone cost, \$/ton	12.75	
1982 fuel cost, \$/ton ($\$/10^6$ Btu)	21.25 (96.0)	
Replacement capacity cost, \$/kw	399	
Replacement fuel cost, \$/kw (mils/kwhr)	9 (29.05)	
<u>Capitalized Fuel Cost</u>	<u>\$/Kw</u>	<u>\$/Btu/Kw-hr</u>
Constant overload range	708*	34,372*
Directly proportional to load	583*	
Proportional to square of load	498*	
Not proportional to load		
at 94% load	420*	23,047*
at 75% load	175*	7,610*
at 50% load	113*	3,715*

<u>Year</u>	<u>Planned Unit Operation, Percent of Year</u>				
	<u>Unit Load</u>				
	<u>VWO</u>	<u>94</u>	<u>75</u>	<u>50</u>	<u>0</u>
1-5	0.6	50.2	21.3	12.5	15.4
6-10	0.6	45.7	19.0	18.6	16.1
11-15	0.5	43.4	18.7	15.5	21.9
16-20	0.5	40.0	18.9	9.5	31.1
21-25	0.2	28.9	10.0	8.2	52.7
26-30	0.1	20.5	5.0	3.7	70.7

Average Capacity Factor, %	53.53
Capacity Factor Corrected for Present Worth, %	63.74

*Changed from base plant

BOILER DATA
GROSS STATION HEAT RATE 1,172,000 Btu per 1000 KW
NET STATION HEAT RATE 883 1/2 Btu per KW-HR
NET STATION HEAT RATE 883 1/2 Btu per KW-HR

LEAKAGES
FLOW ENTHALPY
A 4144 1458.33
B 886 1456.33
C 35456 1432.20
D 7887 1300.64
E 7482 1308.84
F +276 1391.03
G 844 1347.71
H 2808 1347.71
I 1200 1347.71

THIS HEAT BALANCE DIAGRAM WAS PRODUCED FROM BALANCE NUMBER 128 WHICH WAS GENERATED ON 1 DEC 1977

HEAT BALANCE DIAGRAM
100% WVD, 0-P, 79 F WET BULB
1C4F 3D L5B
BARCOCK & WILCOX CO.
AFB PLANT
DOE AF3 STUDY

STONE & WEBSTER ENGINEERING CORPORATION
BOSTON, MASSACHUSETTS
1 DEC 1977 DRAWING NUMBER 12919.02A-HBSC-81-1

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REVISION 1
401. P001

DATE
12/1/77

RAILER UNIT 2,312,000 GPM 875 FPM WATER
GROSS STEAM HEAT RATE 1335 BTU P. LB. LB.
NET STEAM HEAT RATE 955 BTU LB. LB.

LEAKAGES
LOW ENTHALPY
A 425 1453.70
B 471 1453.70
C 16802 1380.13
D 2851 1276.34
E 2731 1276.34
F 2084 1277.43
G 085 1323.15
H 2800 1323.15
I 200 1323.15

LEGEND
STEAM
WATER
POWER
LB FLOW, POUNDS PER HOUR
H ENTHALPY, BTU PER POUND
F TEMPERATURE, DEGREES F
TO TERMINAL DIFFERENCE, DEGREES F
DC DRAIN COOLER APPROACH, DEGREES F
KW POWER, KILOWATTS
IN HG PRESSURE, IN. OF MERCURY, ABS.
PSIA PRESSURE, LB. PER SQUARE IN. ABS.
PSI THROTTLE OR INTERCEPT VALVE
CONTROL VALVE

THIS HEAT BALANCE DIAGRAM WAS PRODUCED FROM BALANCE NUMBER 129 WHICH WAS GENERATED ON 1 DEC 1977

HEAT BALANCE DIAGRAM
50% WMO, RATED PRESS., 79 F WET BULB
TC 4F 30" LSB
BARCOCK 4 WILCOX CO.
AFB PLANT
ODE AFB STUDY
STONE & WEBSTER ENGINEERING CORPORATION
1 DEC 1977
DRAWING NUMBER 12919-02A-HBSK-83-1

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1 DEC 1977

5.0 PLANT ECONOMICS

5.1 Capital Costs

The present-day (1976) cost to build the B&W AFB plant as noted in Table IIIA-1 is \$228,153,000 (\$412/kw). This cost, when including escalation and 8 percent interest during construction, is equivalent to a total capital investment at the time of commercial operation (1982) of \$321,523,000 (\$580/kw).

A detailed description of the equipment and services included in this cost estimate is presented in Appendix IIIA-A.

The capital cost changes from the base plant are identified in Table IIIA-3.

5.2 Operating Costs

The operating costs for the B&W AFB plant are shown in Table IIIA-4 and are based on an annual fixed charge rate of 15.35 percent and a levelized annual generation of 3.09×10^9 kw-hr.

The planned generation for this plant is 7.79×10^{10} kw-hr. The capital recovery of the \$321,523,000 is equivalent to a 15.97 mil/kw-hr annual operating cost on the levelized annual generation.

The fuel cost was computed using a 1982 cost of \$21.25/ton (\$0.96/ 10^6 Btu) with 7.0 percent/year for escalation.

The limestone cost was computed using a 1982 cost of \$12.75/ton with 5.5 percent/year for escalation.

Ash disposal costs were computed using base plant information and the B&W AFB solid waste flow rate.

Operation and maintenance costs were computed using information from the base plant less the FGD O&M costs noted in Appendix I-D.

5.3 Economic Evaluation Factors

Table IIIA-2 describes the economic evaluation factors used to develop the B&W AFB design. These factors have been used to evaluate annual operating costs for the B&W AFB plant design as shown on Table IIIA-4.

6.0 B&W AFB PLANT PROJECT SCHEDULE

The level I network 12919-BW-CN-1 describes the plan for procurement, fabrication, and erection to place the plant in operation in April, 1982.

7.0 PLANT ARRANGEMENT

7.1 Site

Drawing 12919.02A-EY-602A depicts the B&W AFB plant site. Those features included in the construction of the plant are highlighted with heavier lines.

A new coal/limestone crusher house will be located in the yard. An independent dual set of belt conveyors will tie into the existing conveying system in the yard and the existing belt conveyors will be extended into the new boiler building.

This unit utilizes a twelve-cell mechanically induced draft cooling tower for heat rejection.

7.2 Turbine Room

The turbine room is essentially identical to the base plant except for a start-up boiler feed pump on the ground floor as noted on Drawing 12919.02A-EM-203A.

7.3 Boiler Room

As noted on Drawings 12919.02A-EM-202A and 202B, the boiler room dimensions are approximately 338 ft wide by 157 ft deep by 222 ft high with the ground, operating, and mezzanine floors matching those of the turbine room.

The three coal bunker bays on three sides of the boiler are a total of 512 ft long by 33 ft deep by 131 ft high, with the coal tripper conveyor floor at El. 107 ft and gravimetric feeders at El. 64 ft-0 in.

The forced draft, induced draft, primary air and tempering air fans are located in a closed room for sound attenuation. Because this room will operate at subatmospheric pressure, double door air locks are supplied.

Boiler area composites are shown on Drawings 12919.02A-EP-202A through 202G. Column locations and bracing are as noted on Drawings 12919.02A-ES-601A, 606A, 609A, and 609B.

TABLE IIIA-3

CAPITAL COST CHANGES FOR A B&W AFB PLANT

<u>Block No.</u>	<u>Account</u>	<u>Description</u>
1	All	No Change
2	All	No Change
3	1101.10	Increase Substructure Cost
3	1101.20	Increase Superstructure Cost
4	All	No Change
6	1200.00	Increase Boiler Cost
6	1200.1131	Increase Boiler Steel
6	1200.15	Increase Cost of Coal and Limestone Delivery and Injection Systems
6	1200.261	Add Carbon Reinjection System
6	1200.261	Add Bed Letdown System
6	1200.261	Add CBC Dust Collector
7A	1200.221	Delete Scrubber Duct Work and Dampers
7A	1200.221	Increase Air and Gas Duct Cost
7A	1200.2291	Increase Duct Insulation Cost
7A	1200.231	Increase F.D. Fan and Drive Cost
7A	1200.232	Increase I.D. Fan and Drive Cost
7A	1200.32	Decrease BFP and Drive Cost
7A	1200.321	Add Start-up Boiler Feed Pump
7A	1200.60	Add Turbine Bypass System
7A	1200.60	Add Reheater Cooling and Desuperheater System
7B	1200.50	Delete Existing Bottom and Fly Ash Systems
7B	1200.51	Add New Bed-material Collection and Disposal System

TABLE IIIA-3 (Cont'd)

<u>Block No.</u>	<u>Account</u>	<u>Description</u>
7B	1200.54	Add New Fly Ash Collection and Disposal System
8A	1241.20	Add New Coal and Limestone Crushing and Conveying Equipment
8A	1241.20	Add New Tripper Equipment
8A	1241.41	Increase Inplant Coal and Limestone Storage
8A		Delete Limestone Preparation Equipment
8A	1241.49	Increase Coal and Limestone Chutes, Gates, etc.
8B	1242.00	New Ignition Oil System for the Same Cost
8C	All	No Change
8D	All	Add New Crusher House
9	1200.81	Change Stack Liner to Steel
10	1200.252	Increase Precipitator Cost
10	1200.252	Add New CBC Precipitator
11	1200.27	Delete All Scrubber Costs
12	1400.10	Increase Turbine-Generator Cost
13	1400.85	Increase Component Cooling System Cost
14A	All	Change Included in Block 14E
14B	1400.21	Increase Condenser Cost
14B	1400.281	Increase Circulating Water Pump and Drive Cost
14C	1400.30	No Change
14D	All	No Change
14E	1400.34	Increase Cooling Tower Cost
14E	1400.348	Increase MU Water Pump and Drive Cost

TABLE IIIA-3 (Cont'd)

<u>Block No.</u>	<u>Account</u>	<u>Description</u>
15	1200.34	No Change
16		Eliminate Ash and Scrubber Waste System Cost
17	1500.123	Increase Power Cable Cost
17	1500.211	Increase Unit Station Service Transformer Cost
17	1500.211	Increase Reserve Station Service Transformer Cost
17	1500.2522	Increase Station Service Switchgear Cost
17	1500.253	Increase 480 V Substation Cost
17		Add Nonsegregated Bus Duct
17	1500.71	Increase Main Control Board Cost
17	1500.72	Increase Control System's Cost
18	1600.47	No Change
19		No Change
20		No Change

TABLE IIIA-4

B&W AFB PLANT ANNUAL OPERATING COSTS (MILLS/KW-HR) NET

Capital Recovery	15.97
Fuel Cost	17.76
Limestone Cost	2.18
Operation and Maintenance	
Power Plant	3.28
FGD Plant	0
Sludge Stabilization Plant	0
Ash and Sorbent Disposal	0.11
Particle Emission Control Equipment	<u>0.32</u>
	39.61

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BADCOCK & WILCOX	
ATMOSPHERIC FLUIDIZED BED BOILER	
ERDA CONTRACT EF 77-C-01-2583	
LEVEL 1 CONSTRUCTION NETWORK	
STONE & WEBSTER ENGINEERING CORPORATION BOSTON, MASS.	
DRAWING NUMBER	REV.
SHEET	OF
DWG. NO. 12919-BW-CN-1

- LEGEND**
- PAVED ROAD
 - EXISTING POWER LINE
 - EXIST POWER POLE
 - FENCE
 - RAILROAD TRACKS
 - EXST TRANS TOWER

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THIS DRAWING BASED ON BABCOCK & WILCOX COMPANY AFB DESIGN

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UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
MAJOR FACILITIES PROJECT MANAGEMENT DIVISION
CONCEPTUAL DESIGN ATMOSPHERIC FLUIDIZED BED POWER PLANT
ERDA CONTRACT NO. EF-77-C-48-5885

DRAWING BY: STONE & WEBSTER ENGINEERING CORP.
BOSTON, MASS. 02117
DESIGNED: DATE: 10-3-77
CHECKED: DATE: 10-3-77
APPROVED: DATE: 10-3-77

TITLE: **SITE PLAN**

NOTE:
1. SCALE 1/8" = 1'-0"
2. GENERAL NOTES & REFERENCE DWGS EM-202A

THIS DRAWING BASED ON BABCOCK WILCOX
ENERGY CORPORATION AFB DESIGN

PLAN EL 0'-0'

NOT TO BE USED FOR CONSTRUCTION

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UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
MAJOR FACILITIES PROJECT MANAGEMENT DIVISION

CONCEPTUAL DESIGN ATMOSPHERIC FLUIDIZED BED POWER PLANT
ERDA CONTRACT NO. EF-77-G-91-2583

DRAWN BY: STONE & WEBSTER ENGINEERING CORP.
BOSTON, MASS. 02107

DESIGNED: DATE: 11-9-77
CHECKED: F.W. SCHREIBER DATE: 11-9-77
APPROVED: PF 1, PAB: DATE: 11-9-77

THIS GENERAL ARRT TURBINE BUILDING
PLAN-GROUND FLOOR EL 0'-0'

S&W DWG. NO. 12919.02AEM-203A

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1	DESIGNED	DATE	11-11-77	APPROVED	DATE	11-11-77
2	CHECKED	T. S. BILALD	DATE	11-18-77	APPROVED	DATE
3	APPROVED	P. J. LIPARI	DATE		APPROVED	DATE
4	TITLE: GENERAL ARRANGEMENT BOILER AREA - SH 1					
5	S&W DWG. NO. 12919.02A-EM-202A-1

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NOTES:
1. SCALE: 1" = 1'-0"
2. GENERAL NOTES & REFERENCE DRAWINGS EP-202A

THIS DRAWING BASED ON BABCOCK & WILCOX COMPANY AFB DESIGN

NOT TO BE USED FOR CONSTRUCTION

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UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
MAJOR FACILITIES PROJECT MANAGEMENT DIVISION

CONCEPTUAL DESIGN ATMOSPHERIC FLUIDIZED BED POWER PLANT
EDDA CONTRACT NO. EP-77-2-01-2550

DESIGNED BY: STONE & WEBSTER ENGINEERING CORP.
BOSTON, MASS. 02107

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

DATE: 11-18-77
CHECKED: J. S. BARNALD
APPROVED: J. E. L. P. A. B. I.

TITLE: COMPOSITE-BOILER AREA
PLAN-EL 55'-0" SHEET 2

S&W DWG. NO. 1291902A-EP-202B-1

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- NOTES
- SCALE: 1" = 1'-0"
 - GENERAL NOTES AND REFERENCE DRAWINGS EP-2C2A
 - W INDICATE BY BOILER WFR

THIS DRAWING BASED ON BARCOCK & WILCOX COMPANY AFB DESIGN

(EP-202F G-40)

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UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
MAJOR FACILITIES PROJECT MANAGEMENT DIVISION
CONCEPTUAL DESIGN ATMOSPHERIC FLUIDIZED BED POWER PLANT
ERDA CONTRACT NO. EF-77-C-01-2885

DRAWN BY: STOKES & WEBSTER ENGINEERING CORP.
BOSTON, MASS. 02107
DESIGNED BY: STOKES & WEBSTER ENGINEERING CORP.
DATE: 11-18-77
DRAWN BY: STOKES & WEBSTER ENGINEERING CORP.
DATE: 11-18-77
CHECKED BY: STOKES & WEBSTER ENGINEERING CORP.
DATE: 11-29-77
APPROVED BY: STOKES & WEBSTER ENGINEERING CORP.
DATE: 12-1-77

TITLE: COMPOSITE - BOILER AREA
PLAN - EL. 112'-0" SHEET 3
S&W DWG. NO. 1291902A-EP-202C-1

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THIS DRAWING BASED ON BABCOCK &
WILCOX COMPANY AFB DESIGN

NOT TO BE USED FOR CONSTRUCTION

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UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
MAJOR FACILITIES PROJECT MANAGEMENT DIVISION

CONCEPTUAL DESIGN ATMOSPHERIC FLUIDIZED BED POWER PLANT
ERDA CONTRACT NO. EF-77-C-01-2583

DRAWING BY: STONE & WEBSTER ENGINEERING CORP. BOSTON, MASS. 02107	UNITED STATES ENERGY RESEARCH
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DESIGNED RW PERKINS DATE 11-18-77
DRAWN RW PERKINS DATE 11-18-77

CHECKED T. SIBBALD DATE 11-29-77
APPROVED P. F. LIPARI DATE _____

COMPOSITE-BOILER AREA
PLAN EL 145'-0" SHEET 4

S&W DWG. NO. J291902A-EP-2020-1

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NOTES
 1. SCALE: 1/8" = 1'-0"
 2. GENERAL NOTES & REFERENCE DRAWINGS: EP-202A
 3. A. INDICATE BY BLR MFR

THIS DRAWING BASED ON BARCOCK &
 WILCOX COMPANY AFB DESIGN

NOT TO BE USED FOR CONSTRUCTION

UNITED STATES ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION MAJOR FACILITIES PROJECT MANAGEMENT DIVISION	
CONCEPTUAL DESIGN ATMOSPHERIC FLUIDIZED BED POWER PLANT ERDA CONTRACT NO. EP-77-C-01-2583	
DRAWN BY: STONE & WEBSTER ENGINEERING CORP. BOSTON, MASS. 02107	UNITED STATES ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
DESIGNED BY: R. W. PERKINS DATE: 11-18-72	CHECKED BY: T. SIBBALD DATE: 11-29-72
APPROVED BY: J. J. LIPARI DATE:	
TITLE: COMPOSITE-BOILER AREA PLAN-EL178-0 SHEET 5	
S&W DWG. NO. 1291902A-EP-202E-1	

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CONCEPTUAL DESIGN ATMOSPHERIC FLUIDIZED BED POWER PLANT ERDA CONTRACT NO. EF-77-C-1-2563			
DRAWING BY: BYRON E. WEBSTER ENGINEERING CORP. BOSTON, MASS. 02107		UNITED STATES ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION MAJOR FACILITIES PROJECT MANAGEMENT DIVISION	
DESIGNED BY: W. PERKINS		DATE 11-16-77	
DRAWN BY: W. PERKINS		DATE 11-16-77	
CHECKED: T. SIBBALD		DATE 11-29-77	
APPROVED: P.F. LIPARI		DATE	
TITLE:		COMPOSITE - ROLLER ARE A SECTION 1-1 SHEET 1	
S&W DWG. NO. 100-204-FP-202-F

NOTES:
1. SCALE $\frac{1}{8}'' = 1'-0''$
2. GENERAL NOTES & REFERENCE DRAWINGS EP 202A

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<p>DRAWN BY STONE & WEBSTER ENGINEERING CORP. BOSTON, MASS. 02107</p>			<p style="text-align: center;">UNITED STATES ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION</p>		
<p>DESIGNED R.W. PERKINS</p>			<p>DATE 11-18-77</p>		
<p>DRAWN S.F. CILICIAN</p>			<p>DATE 11-18-77</p>		
<p>CHECKED T. SIBBALD</p>			<p>DATE 11-29-77</p>		
<p>APPROVED R.F. LIPARI</p>			<p>DATE</p>		
<p>TITLE:</p>			<p>CONCEPT - BOILER AREA SECTION 2-2 SHEET 2</p>		
<p> S&W DWG. NO. 291902A-EP-2026</p>			<p>DATE</p>		

14206162

NOTES
1. SCALE 1/8" = 1' 0"

REFERENCE DWGS
PLANS-DRAWING LEVELS
ELEVATIONS VERTICAL BRACING SH 1 & SH 2
GENERAL ARRANGEMENT BOILER AREA
ES 600A
ES 600A 4 B
FM 202 SERIES

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DRAWING BY: STONE & WEBSTER ENGINEERING CORP. BOSTON, MASS. 02107		UNITED STATES ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION	
DESIGNED: J.H. (JSA) DATE 10-31-77		CHECKED: J.H. (JSA) DATE 10-31-77	
DRAWN: J.H. (JSA) DATE 10-31-77		APPROVED: P.T. (JSA) DATE 11-17-77	

COLUMN LOCATION PLAN

S&W DWG. NO. 1291902A-ES-601A-1

PLAN EL 123'-0"

PLAN EL 55'-0"

PLAN EL 178'-0"

NOTES
1. SCALE 1/8"=1'-0"
2. REFERENCE DWGS ES-60A

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DRAWING BY: STONE & WEBSTER ENGINEERING CORP. BOSTON, MASS. 02107		UNITED STATES ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION	
DESIGNED BY: <u>Z. HAJOSZ</u> DATE: <u>10-31-77</u> DRAWN BY: <u>Z. HAJOSZ</u> DATE: <u>10-31-77</u> CHECKED BY: <u>Z. HAJOSZ</u> DATE: <u>11-7-77</u> APPROVED BY: <u>J.F. LIPARI</u> DATE: _____		TITLE: PLANS - BRACED LEVELS S&W DWG. NO. 129902A-ES-606A-1	

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NOTES
1 SCALE 1/4" = 1'-0"
2 REFERENCE DWGS ES-604

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MAJOR FACILITIES PROJECT MANAGEMENT DIVISION
CONCEPTUAL DESIGN ATMOSPHERIC FLUIDIZED BED POWER PLANT
ERDA CONTRACT NO. E7-77-G-01-2503

DRAWING BY:
STONE & WEBSTER ENGINEERING CORP.
BOSTON, MASS. 02107

DESIGNED BY: H.A. JONES, JR. DATE 11-7-77

DRAWN BY: J. DODDNER DATE 11-7-77

CHECKED BY: H.A. JONES, JR. DATE 11-14-77

APPROVED BY: J. L. BROWN DATE

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DATE

ELEVATIONS-VERTICAL BRACING SH-1

S&W DWG. NO. 129G02A-ES-609A-1

NOTES
1 SCALE 1/4"=1'-0"
2 REFERENCE DWGS ES-60A

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DESIGNED BY: J. HALL (E.A.) DATE 11-1-77		DRAWN BY: J. HALL (E.A.) DATE 11-1-77	
CHECKED BY: J. HALL (E.A.) DATE 11-15-77		APPROVED BY: P. F. LEBLANC DATE 11-15-77	

ELEVATIONS-VERTICAL BRACING SH-2

8.0 PROCESS SYSTEMS

8.1 General

The flow diagrams indicated hereinafter utilize the notation "Pipe Cl YYYYX," "Insul Cl X" and "VXX-YYYY," where X denotes an alpha character and Y denotes a numeric character.

"Pipe Cl YYYYX" is a denoter of pipe material, pressure rating, schedule, etc., as described in Appendix I-2.

"Insul Cl X" is a denoter of pipe insulation material and thickness as described in Appendix I-3.

"VXX-YYYY" is a denoter of valve type, pressure rating, construction, end preparation, etc. These details are identified in the "Pipe Cl" indicated on the flow diagram. A general explanation of the notation system is shown on Drawing STD-MM-1002-1-2. (See Part I of this Report.)

8.2 Steam Systems

8.2.1 Main Steam, Hot and Cold Reheat

Refer to Flow Diagram 12919.02A-EM-102A.

Main Steam

The main steam system is identical to the base plant described in Section 8.2.1 except that a high pressure turbine bypass system is supplied to assure minimum flow through the superheater. The pressures, temperatures, and flows vary slightly as noted on heat balances 12919.02A-HBSK-1, 2, 3, and 4 as a result of permitting the base plant stack gas reheating steam to expand through the turbine.

Cold Reheat

The cold reheat system is identical to the base plant described in Section 8.2.1 except for the addition of a safety valve and a nonreturn valve. The pressures, temperatures, and flows vary slightly as noted on heat balances 12919.02A-HBSK-1, 2, 3, and 4 as a result of permitting the base plant stack gas reheating steam to expand through the turbine.

Hot Reheat

The hot reheat system is identical to the base plant described in Section 8.2.1 except that two electromatic relief valves were installed. The pressures, temperatures, and flows vary slightly as noted on heat balances 12919.02B-HBSK-1, 2, 3, and 4 as a

result of permitting the base plant stack gas reheating steam to expand through the turbine.

Reheater Cooling

A reheater cooling system has been imposed on B&W to assure minimum flow through the reheater following a turbine trip.

8.2.2 Extraction

Refer to Flow Diagram 12919.01-EM-103A.

The extraction steam system is identical to the base plant system described in Section 8.2.2 of Part I of this Report except that the extraction stage pressures, temperatures, and flows vary slightly as noted on the heat balances 12919.02A-HBSK-1,2,3, and 4.

8.2.3 Auxiliary Steam

The auxiliary steam system is identical to the base plant system described in Section 8.2.3 of Part I of this Report except that there is no requirement for stack gas reheating.

8.3 Water Systems

8.3.1 Circulating and Makeup Water and Condenser Air Removal

Refer to Flow Diagram 12919.01-EM-110A.

The circulating and makeup water and the condenser air removal systems are identical to the base plant systems described in Section 8.3.1 of Part I of this Report except that the component cooling water system (Section 8.3.5.1) duty has increased due to the addition of bed material letdown coolers. The condenser duty has increased by approximately 5 percent as a result of permitting the base plant stack gas reheating steam to expand through the turbine. Table IIIA-5 identifies these changes.

8.3.2 Condensate

Refer to Flow Diagram 12919.01-EM-104A.

The condensate system is identical to the base plant system described in Section 8.3.2 of Part I of this Report.

8.3.3 Feedwater and Desuperheating Water

Refer to Flow Diagram 12919.02A-EM-105A.

1291902A-EM-102A-1

TABLE IIIA-5

HEAT REJECTION SYSTEM PARAMETERS

Design wet bulb, F	79	
Design dry bulb, F	96	
Dry air density, lb/cu ft	0.0705 @ 96 F	
Heat rejected by cooling tower, Btu/hr	2.945 x 10 ⁹ *	
Heat rejected by condenser, Btu/hr	2.692 x 10 ⁹ *	
<u>Parameter</u>	<u>Tower</u>	<u>Condenser</u>
Flow, gpm	202,700*	185,500*
Range, F	27.7	29.36
Cells/zones	12	2
Type	Wood fill wet mechanical	Multipressure
Surface, ft ²	-	316,359*
Approach, F	12.87	5.3
Tube diameter, in.	-	7/8
Tube length, ft	-	48
Tube gage, BWG	-	22
Tube material	-	304 SS

*Change from base plant

- LEGEND
- GATE VALVE - VG
□ GLOBE VALVE - VQ
○ STOP VALVE - VS
□ STOP CHECK - VK
○ SAFETY VALVE - SV
○ MOTOR OPERATED VALVE - MOV
○ CONTROL VALVE, AIR TO CLOSE
○ CONTROL VALVE, AIR TO OPEN
- NORMALLY CLOSED VALVE
— BREAKDOWN ORANGE-RED
FIT FLOW INDICATING TRANSMITTER
— DISTURBING TEMPERATURE DETECTOR
L1 LEVEL INDICATOR
LIP LEVEL INDICATING RECEIVER
L1 TEMPERATURE TRANSMITTER
P1 PRESSURE INDICATOR
PM1 PRESSURE INDICATING TRANSMITTER
— POINT ON LOGICAL
TW TEST WELL
T1 TEMPERATURE
T2 TEMPERATURE
T3 TEMPERATURE TRANSMITTER
SP SAMPLE POINT
— SAMPLE SAMPLE CONNECTION
LC GAGE GLASS
V CONTROL VALVE
PVC PRESSURE CONTROL VALVE
R RECORDER
— FURNISHED BY EQUIPMENT MANUFACTURER
— FLOW METER
— FLOW ORANGE-RED
D DRAIN
D1 CUMUL DRAIN
L1 LOCKED OPEN
G GATE OPERATED
T TEST
V VELOCITY

- NOTES
- 1 ALL PRESSURE CONNECTIONS ARE 1/2" N.W.
 - 2 PROMOTER 10' GRAVITY, 8" RUB CLAMP & ELIM HUB FOR PERMANENT INSTALLATION. SUB (1-11-74) FOR TEMPORARY.
 - 3 1/2" DIA. 10' PERFOR. 1/2" CYCLE DRIVING
 - 4 THERMATED SUMPS PROVIDED ON ALL DRAIN, VENT AND TEST CONNECTIONS.
 - 5 ALL PIPING (1.750) UNLESS NOTED OTHERWISE
 - 6 ALL GLOBE VALVES 1/2" & SMALLER OF 1.750 LINE SIZE UNLESS NOTED OTHERWISE
 - 7 TEMP. RATING 150-750°F
 - 8 TEMPERATURE CONNECTIONS 1/2" UNLESS OTHERWISE NOTED
 - 9 ALL GATE OPERATED VALVES TO BE OPERABLE BY REMOTE AIR SWITCH
 - 10 14" 2.407" MIN WALL FOR STRAIGHT PIPE
 - 11 12" 1.885" MIN WALL 10" STRAIGHT P.I.P.E
 - 12 6" 10.731" MIN WALL FOR STRAIGHT PIPE

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MAJOR FACILITIES PROJECT MANAGEMENT DIVISION

CONCEPTUAL DESIGN ATMOSPHERIC FLAMMABLE BED POWER PLANT
ERDA CONTRACT NO. DE-FW-CA-2385

DESIGNED BY
STONE & WEBSTER ENGINEERING CORP.
BOSTON, MASS. 02167

DRAWN: T. NASHALD DATE: 10/22/71

CHECKED: J. S. BARNES DATE: 12/14/71

APPROVED: P. J. RYAN

CLIENTS OFFICE
GENERAL INVESTIGATION
AND
DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C.

REVISED: _____
REASON: _____
DATE: _____

TITLE: **FLOW DIAGRAM BOILER FEED**

⚠️ S&W DWG. NO. 12919Q2A EM105A

Feedwater

The feedwater system is identical to the base plant system described in Section 8.3.3 of Part I of this Report except that at low boiler pressures during start-up, the 5,860 gpm, 7,556 ft TDH (68 percent load) start-up feed pump will be used to supply boiler feedwater.

Main Steam Desuperheating Water

Water from the boiler feed pump discharge is injected into the primary superheater outlet to maintain a secondary superheater outlet temperature of 1,000 F.

Reheat-Desuperheater

Water from an intermediate stage of the boiler feed pump is supplied to the reheater inlet to maintain a hot reheat steam temperature of 1,000 F. Water is also supplied to the Turbine Bypass and Reheater Cooling System for steam desuperheating during a start-up, shutdown, or turbine trip.

8.3.4 Heater Drains

Refer to 12919.01-EM-106A.

The heater drain system is identical to the base plant system described in Section 8.3.4 of Part I of this Report except that the pressures, temperatures, and flows vary slightly as noted on heat balances 12919.02A-HBSK-1,2,3, and 4.

8.3.5 Cooling Water Systems

8.3.5.1 Component Cooling Water

The component cooling water system is identical to the base plant system described in Section 8.3.5.1 of Part I of this Report except that the duty and flow have been increased by one-third as a result of cooling the bed material leaving the AFB boiler.

8.3.5.2 Bearing Cooling Water

The bearing cooling water system is identical to the base plant system described in Section 8.3.5.2 of Part I of this Report.

8.3.6 Other Water Systems

8.3.6.1 Condensate Polishing

Refer to Flow Diagram 12919.01-EM-128A.

The condensate polishing system is identical to the base plant system described in Section 8.3.6.1 of Part I of this Report.

8.3.6.2 Chemical Feed

Refer to flow Diagram 12919.01-EM-119A.

The chemical feed system is identical to the base plant system described in Section 8.3.6.2 of Part I of this Report.

8.4 Material Handling Systems

8.4.1 Coal and Limestone Handling System

Refer to Flow Diagrams 12919.02A-EM-170A, EM-170B, EM-170C, and General Arrangement Drawings 12919.02A-EM-211A, EM-211B, and EM-211C.

The coal and limestone parameters for this study are shown in Tables I-6 and I-7 in Part I of this Report.

The coal/limestone handling system consists of the yard and station subsystem and the distribution and injection subsystem.

8.4.1.1 Delivery Subsystem

Sections 8.4.1.1.1 Delivery to Site, 8.4.1.1.2 Transfer to Storage, 8.4.1.1.1 Transfer to Station remain as described in Part I of this Report for the existing Units 1-3.

In order to transfer coal and limestone to the station from the as-delivered state, or from storage, new conveyors to and from the new crushers were required.

The preparation of the coal and limestone to the specific size requirements for use in the fluidized bed required new coal and limestone crushers for this unit.

The transfer of coal and limestone to the AFB unit can be accomplished by using two paths from either source: As Delivered or Storage.

As Delivered

The coal and limestone are delivered from the railroad unloading hoppers onto existing conveyors C-2B, C-3B bypassing the existing crushers 1B and 2B onto conveyor C-5B which is used normally as the stackout conveyor to yard storage Location 1. A new fixed tripper will transfer coal or limestone from the existing conveyor C-5B onto new conveyors C-15 to C-17 to the surge hopper through the new coal or limestone crushers via flop gate. From the crushers, the coal or limestone is transferred by either one

12919-02A

REFERENCE DWG
FLOW DIAGRAM SH 2 - COAL & SORBENT HANDLING EM-1708

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COMPANY AFF DESIGN

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REFERENCE DWG
FLOW DIAGRAM SH-1 - COAL & SORBENT HANDLING EM-170A

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COMPANY AFB DESIGN

UNITED STATES ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION MAJOR FACILITIES PROJECT MANAGEMENT DIVISION CONCEPTUAL DESIGN ATMOSPHERIC FURNACED BED POWER PLANT ERDA CONTRACT NO. EP-77-C-01-383	
DESIGNED BY: STONE & WEBSTER ENGINEERING CORP. BOSTON, MASS. 02107	UNITED STATES ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
DESIGNED: _____ DATE: _____	CHECKED: _____ DATE: _____
DRAWN: J. W. S. DATE: 11-19-77	APPROVED: P. E. L. DATE: _____
TITLE: FLOW DIAGRAM SH 2 COAL AND SORBENT HANDLING S&W DWG. NO. 1291902A-EM-170B-1	

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NOTES:
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UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
MAJOR FACILITIES PROJECT MANAGEMENT DIVISION
CONCEPTUAL DESIGN ATMOSPHERIC FLUIDIZED BED POWER PLANT
ERDA CONTRACT NO. EF-77-C-01-2503

DRAWN BY: STONE & WEBSTER ENGINEERING CORP.
BOSTON, MASS 02107

DESIGNED: DATE: 11-18-77
CHECKED: J. SUBALD. DATE: 11-18-77
APPROVED: P. L. DARR. DATE: 11-18-77

TITLE: FLOW DIAGRAM
COAL AND SORBENT HANDLING
S&W DWG. NO. 12919.02A-EM-170C-1

1-1 (E-3, E-5)
SCALE 1/8"=1'-0" 2-2 (E-3, E-5)
SCALE 1/8"=1'-0"NOTES:
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CONCEPTUAL DESIGN ATMOSPHERIC FLUIDIZED BED POWER PLANT
ENRDA CONTRACT NO. EF-77-G-01-2583

DRAWING BY: STONE & WEBSTER ENGINEERING CORP.
BOSTON, MASS. 02107

DESIGNED BY: A.H. LABRECQUE, JR. DATE: 11-17-77

DRAWN BY: J. G. LASSMAN DATE: 11-29-77

CHECKED BY: J. G. LASSMAN DATE: 11-29-77

APPROVED BY: J. G. LASSMAN DATE: 11-29-77

TITLE: GEN. ARRGT COAL/LIMESTONE HANDLING IN PLANT-PLAN SHEET 1

S&W DWG. NO. 12919.02A-EM211A-1

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of two parallel paths via conveyors C-20 to C-22 onto the existing conveyors C-8A and C-9A and onto the tripper conveyors C-9A extended C-24, and C-25 and into the bunkers, or via C-21 to C-23 onto existing conveyors C-8B and C-9B and onto tripper conveyors C-9B extended, C-24, and C-25 and into the bunkers. C-24 and C-25 are tripper conveyors that feed the bunkers on the left and right side of the boiler, respectively.

From Yard Storage Location 2

Coal or limestone from coal pile 2 is reclaimed using the existing stacker reclaimer conveyor C-7B. A new fixed tripper will transfer coal or limestone from C-7B onto new conveyors C-16 and to C-18 into surge hopper and into the crusher house and the coal or limestone bunkers as described above.

8.4.1.1.4 Tramp Iron Protection

The inlet chute of both the new coal and limestone crushers will be equipped with magnets to remove tramp iron; otherwise, the section remains as described in Part I of this Report.

8.4.1.1.5 Mass Transfer Measurement

This remains as described in Part I of this Report.

8.4.1.1.6 Crushers

Remains as in the base plant report for Units 1-3. For Unit 4, the new coal crushers discharge - 1/4 in. coal with - 2 1/2 in. ROM input. The new limestone crushers discharge - 1/8 in. limestone with - 3/4 in. input. Each crusher is rated at 900 TPH.

8.4.1.1.7 Sampling

An "as fired" sampling system is included in the discharge chute of each set of new crushers for the AFB unit; otherwise, the section remains as described in Part I of this Report.

8.4.1.1.8 System Included With This Unit

The coal/limestone handling system included in the scope of this unit is as follows:

1. The installation of fixed trippers on existing conveyors C-5B and C-7B.
2. The installation of a new crusher house which would include two limestone crushers and two coal crushers and associated equipment such as ductwork, samplers, grizzlies, etc.

3. The installation of 10 complete new conveyors. The two existing tripper conveyors will be extended.
4. The installation of a total of 25 coal bunkers and 25 limestone bunkers including vibrators, slide gates, and piping.
5. The installation of 25 pairs of gravimetric feeders, 25 mixing bustles, and 25 feed pipes to the boiler material feed distributors.

8.4.1.2 Distribution and Injection Subsystem

Refer to Flow Diagram 12919.02A-EM-115B.

Coal supplied to the 25 bunkers and the limestone supplied to the 25 bunkers is discharged onto gravimetric feeders to 25 mixing bustles where the coal/limestone mixture is dried and pneumatically transported by primary air to the boiler material feed distributors. These distributors transport the coal/limestone mixture underneath the main bed and CBB grid.

8.4.2 Ash Handling System

Refer to Flow Diagram 12919.02A-EM-120A, B, C, and General Arrangement 12919.02A-EM-212A.

The ash analysis for this study is shown on Table I-8 in Part I of this Report.

The ash handling system consists of the bed material letdown transfer and disposal, the fly ash collection and disposal, and the carbon collection and reinjection.

8.4.2.1 Fly Ash Collection and Disposal Subsystem

Refer to Flow Diagram 12919.02A-EM-120C.

Fly ash collected in the CBB dust collector, CBB hot precipitator, regenerative air heater, and stack fly ash hoppers is transported, using a vacuum-pressure pneumatic system, to the fly ash silos in the ash waste treatment area. Periodically, the ash is discharged to trucks and hauled to the on-site disposal area.

8.4.2.2 Bed Letdown Cooling

Bed letdown material is cooled by the use of a screw conveyer cooler. Letdown material is drawn off from each of the twenty-five (25) compartments of the main beds and is cooled by twenty-five (25) water cooled screws. Main bed letdown material will be cooled from 1550 F to 215 F.

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UNITED STATES
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MAJOR FACILITIES PROJECT MANAGEMENT DIVISION
CONCEPTUAL DESIGN ATMOSPHERIC FLUIDIZED BED POWER PLANT
ERDA CONTRACT NO. EF-77-C-01-2583

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CHECKED: T. SIBBALD DATE 11-16-77	DESIGNER: _____
APPROVED: P. LIPARI DATE _____	DATE: _____

TITLE: COAL & LIMESTONE
DISTRIBUTION & INJECTION
S&W DWG. NO. 1291902A-EM-1158-1

COOLER INLET/OUTLET SIZES†

SERVICE	INLET (IN)	OUTLET (IN)
MAIN BEDS	10" x 43"	12" x 28"
STARTUP BEDS	29" x 20"	12" x 21"
CBB BEDS	12" x 13"	6" x 9"

† DIMENSIONS DO NOT INCLUDE 2 1/2" WIDE FLANGE

NOTES:

1. * SUPPLIED BY ASH HANDLING MFG.
2. 2" CYLINDER OPERATED VALVE
3. 3" GATE VALVE
4. 4" CHECK VALVE
5. 5" BACK PRESSURE REGULATOR
6. 6" ORIFICE
7. 7" RELIEF VALVE
8. 8" VACUUM BREAKER
9. 9" GLOBE VALVE
10. 10" SOLENOID OPERATED CONTROL VALVE
11. 11" BUTTERFLY VALVE

REFERENCE DRAWINGS
 FLOW DIAGRAM-CARBON COLLECTION & REINJECTION EM-120B
 FLOW DIAGRAM-FLY ASH COLLECTION & DISPOSAL EM-120C

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DRAWN: M.S. JOHNSON DATE: 10-21-77	APPROVED: P.E. LEBLANC DATE: _____
CHECKED: J. SIBBALD DATE: 11-11-77	
TITLE: FLOW DIAGRAM BED LETDOWN, TRANSFER & DISPOSAL SYSTEM	
S&W DWG. NO. 129102A-EM-120A-1	

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NOTES
1. GENERAL NOTES, LEGEND & REFERENCE DWGS EN-120A

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CHECKED BY: J. L. B. (J. L. B.)	DATE: 11-30-77
APPROVED BY: J. L. B. (J. L. B.)	DATE: 11-30-77
TITLE: FLOW DIAGRAM CARBON COLLECTION & REINJECTION S&W DWG. NO. 12919-02A-EMH208

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DESIGNED DATE	DATE
CHECKED DATE	DATE
APPROVED DATE	DATE
TITLE: FLOW DIAGRAM FLY ASH COLLECTION & DISPOSAL	
S&W DWG. NO. 12919.02A-EM-120C-1	

Similarly, bed material from the CBB is drawn off from each of the eight (8) compartments and is cooled by eight (8) water-cooled screws. CBB letdown material will be cooled from 2000 F to 215 F.

Cooling water is supplied by the component cooling water portion of the circulating water system. Cooling water is continually fed through the screw conveyor hollow shaft and flites while the material is conveyed in the opposite direction. The cooling water is then returned to the condenser return side of the circulating water system.

8.4.2.3 Carbon Collection and Reinjection Subsystem

Refer to Flow Diagram 12919.02A-EM-120B.

Fly ash collected by the main bed hot precipitators is vacuum transported to the carbon reinjection tank, and from there it is pneumatically transported to the carbon burnup bed by either the primary or tempering air system, or both. Ash flow from the reinjection tank is controlled by rotary feeders located at the bottom of each of the eight hoppers. A single feed line to a 30:1 distributor will constitute one of eight underbed feeds at the CBB.

8.4.2.4 Bed Material Letdown Transfer and Disposal Subsystem

Refer to Flow Diagram 12919.02A-EM-120A.

Bed letdown material is transported to silos in the ash waste treatment area by a pressurized pneumatic system. Periodically, the ash is discharged to a truck and hauled to the on-site disposal area. Bed material, when required, will be used as a supplement to maintain bed level in the carbon burnup bed and main bed feedback should any one of the five beds be dumped during shutdown.

8.5 Wet Limestone Flue Gas Desulfurization System (FGD)

There is no requirement for a FGD System on the B&W AFB boiler.

8.6 Air and Gas Systems

Refer to Flow Diagram 12919.02A-EM-115A.

The air and gas systems consist of the following subsystems:

- Combustion air

- Primary air

- Flue gas (excluding flue gas desulfurization)

- Ignition air

8.6.1 Combustion Air

Each of two half-capacity, forced draft (F.D.) fans takes suction from the fan room and discharges air to the boiler undergrid plenum via a half size steam/air heater and one part of a two section, half size, regenerative air heater (APH).

Air pressure is maintained by adjusting the inlet (suction) vanes on the F.D. fans.

The steam/air heater is used to maintain the average cold end temperature of the APH to minimize corrosion. F.D. fans also supply air to the suction of the primary and tempering air fans.

8.6.2 Primary Air (Including Tempering Air)

The main function of the primary air (PA) fans is to evaporate surface moisture and transport the coal from the mixing bustles to the furnace.

Each of the half-capacity PA fans takes suction from the F.D. fan discharge downstream of the APH and discharges through the mixing bustles to the furnace.

Each of the half-capacity tempering air (TA) fans takes suction from the F.D. fan discharge upstream of the APH and discharges to the mixing bustles to control the temperature of the primary air.

PA and TA flow is held constant by varying the position of the inlet (suction) vanes on the fans.

8.6.3 Flue Gas

Flue gas (combustion products) is drawn from the furnace through the convection pass (heat recovery area), through the electrostatic precipitator, and through one section of the two section APHs by two half-capacity axial-type induced draft (I.D.) fans. The I.D. fans discharge to the stack.

Freeboard pressure is maintained at approximately 0 in. H₂O by varying the blade angle of the I.D. fans.

8.7 Other Systems

8.7.1 Ignition Oil and Air

Refer to Flow Diagram 12919.02A-EM-116A.

The ignition oil and air system consists of ignition oil and ignition air subsystems.

- NOTES
1. FLOW VENTURI
 2. DAMPER
 3. FLOW INDICATOR

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COMPANY AFB DESIGN

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TITLE: FLOW DIAGRAM COMBUSTION AIR AND FLUE GAS	
S&W DWG. NO. 12919.02A EM 115A	

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CONCEPTUAL DESIGN ATMOSPHERIC FLUIDIZED BED POWER PLANT
EXDA CONTRACT NO. E7-77-0-5-882

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TITLE: **FLOW DIAGRAM
IGNITION OIL AIR**

SAW DWG. NO. 12919.02A-EM15

8.7.1.1 Ignition Oil

Two ignition oil pumps take suction from the existing light oil storage tank through an extension to the existing suction header. The ignition oil pumps discharge to 5 ignitors located at the five main bed levels. One ignition burner is also located at the CBB.

8.7.1.2 Ignition Air

Ignition air is supplied to each ignition burner for combustion. Atomizing and operation (retract) air is supplied from the existing compressed air system.

8.7.2 Combustion Air Heating and Air Preheater Wash

Refer to Flow Diagram 12919.01-EM-117A.

The Combustion Air Heating and Air Preheater Wash is identical to the system described in Section 8.7.2 of Part I of this Report.

9.0 ELECTRICAL SYSTEMS

The B&W AFB plant electrical system is shown on Drawing 12919.02A-EW-1A. Refer to Table IIIA-6 Large Motor Loads. The bases for the plant auxiliary requirements as shown on the heat balances are defined in Table IIIA-7, Running Auxiliary Power.

The electrical system for the B&W AFB is considerably different than that of the base plant. Due to the large F.D. and I.D. fan loads and the addition of a start-up boiler feed pump, it was necessary to use 13.8 kv switchgear to avoid exceeding the short circuit rating of the 4 kv bus and ensure sufficiently high starting voltages.

In the base plant, the 4 kv station service loads were divided among six buses primarily because of short circuit considerations. This is not practical in the AFB because the six largest motors account for approximately 70 percent of the station auxiliary load. To ensure satisfactory operation of the system, all large motors 4,500 hp and larger are supplied from two 13.8 kv buses. Voltages for smaller motors follow the same criteria as in the base plant. The number of 4 kv buses has been reduced to two in the AFB, with consequent simplification of the system and elimination of some tie breakers no longer required. However, it is necessary to use 350 mva class breakers for the incoming line and bus tie positions in the 4.16 kv switchgear, since a 3,000 amp rating is not available in the 250 mva class. All feeder breakers are 250 mva class, with high momentary rating, as in the base plant.

One full size unit station service transformer is provided rather than the two half-size transformers used in the base plant. However, two auxiliary station service transformers are required to supply the 4 kv system from the 13.8 kv switchgear.

The rest of the auxiliary station service system for the B&W AFB is designed to the same criteria as the base plant. General arrangements are as noted on Drawings 12919.02A-EE-612A, 612B, 612C, 251A, and 251B.

9.1 Lighting Design Criteria

9.1.1 System Requirements

The lighting system criteria for the B&W AFB plant are identical to the base plant criteria noted in Section 9.1 of Part I of this Report.

9.2 Raceways Design Criteria

The raceway design criteria for the B&W AFB plant are identical to the base plant criteria noted in Section 9.2 of Part I of this Report.

9.3 Wire and Cable Design Criteria

The wire and cable design criteria for the B&W AFB plant are identical to the base plant criteria noted in Section 9.3 of Part I of this Report except that 15 kv shielded cable will be required in addition to the types listed in Section 9.3.1.

9.4 Grounding System Design Criteria

The grounding design criteria for the B&W AFB plant are identical to the base plant criteria noted in 9.4 of Part I of this Report.

10.0 CONTROL SYSTEMS AND INSTRUMENTATION

10.1 General

The general design criteria for control systems and instrumentation for B&W AFB plant will be identical to those of the base plant as detailed under Section 10 of Part I. The AFB plant employs similar conventional techniques for load control, start-up, emergency shutdown, and trips. This section presents a brief description of the control system, highlights of the protective system, and a summary of the start-up and loading procedure for the fluidized bed boiler equipment. Operation and controls of other major systems are described in the appropriate system descriptions in Appendix IIIA-B.

NOTES:
1. SCALE: $\frac{1}{4}'' = 1'-0''$

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ERDA CONTRACT NO. EF-77-C-01-2583

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APPROVED FOR RELEASE	DATE
TITLE: GENERAL ARRANGEMENT ASH HANDLING	

ASB 11/12/2010
S&W DWG. NO J291902A-EM-212A

TABLE IIIA-6

LARGE MOTOR LOADS - B&W AFB

<u>Service</u>	<u>No. Conn</u>	<u>Voltage</u>	<u>HP</u>	<u>RPM</u>
Start-up Boiler Feed Pump	1	13,200	10,000	3,600
Forced Draft Fan	2	13,200	10,000	1,200
Induced Draft Fan	2	13,200	5,000	1,200
Air Compressor	1	13,200	4,500	1,800
Circulating Water Pump	2	4,000	3,000	400
Primary Air Fan	2	4,000	1,750	1,200
Condensate Pump	2	4,000	1,500	1,200
Limestone Crusher	2	4,000	1,000	1,200
Coal Crusher	2	4,000	800	1,200
Tempering Air Fan	2	4,000	450	1,800
Conveyor No. 20	1	4,000	300	1,800
Conveyor No. 23	1	4,000	300	1,800
Cooling Tower Makeup Pump	1	4,000	350	900
Bed Letdown Blower	3	460	250	1,800
Fly Ash Pressure Blower	2	460	250	1,800
Dust Collector Pressure Blower	2	460	250	1,800
Cooling Tower Fan	12	460	50/200	1,800
Boiler Circulating Pump	4	460	125	1,800

TABLE IIIA-7

RUNNING AUXILIARY POWER - BABCOCK & WILCOX AFB PLANT
(All Figures in Kilowatts)

	<u>Plant Load</u>		
	<u>VWO</u>	<u>75%</u>	<u>50%</u>
Forced Draft Fans	10,769	4,544	1,346
Induced Draft Fans	4,713	1,989	590
Primary Air Fans	1,492	630	174
Tempering Air Fans	379	160	47
Carbon Reinjection Blowers	189	80	24
Fly Ash Transport Blowers	378	159	47
Bed Material Transport Blowers	378	159	47
Coal and Limestone Conveyors	Included in margin below		
Coal and Limestone Crushers	Included in margin below		
Material Stock-out/Reclaim Equipment	Included in margin below		
Circulating Water Pumps	3,133	3,133	3,133
Condensate Pumps	1,641	692	205
Start-up Boiler Feed Pump	-	-	-
Boiler Circulation Pumps	1,530	1,530	1,530
Cooling Tower Makeup Pumps	207	155	104
Cooling Tower Fans	1,443	1,082	721
Air Compressors	3,357	2,518	1,679
Precipitator	4,500	4,500	4,500
Margin for Intermittent Loads and Undefined Loads	<u>3,247</u>	<u>2,787</u>	<u>2,319</u>
Total Running Auxiliary Power	38,638	24,118	16,466

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PLAN ELO-0"

NOTES:
1. SCALE: 3/8" = 1'-0"

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DESIGNED BY: R.B. PITTMAN, DATE: 3-2-77
CHECKED BY: D.F. ROOD, DATE: 10-19-77
APPROVED BY: E.E. LIPARI, DATE: _____

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TITLE: CABLE TRAY ARRANGEMENT
BOILER AREA-SH1-B&W AFB PLANT
S&W DWG. NO. J29B02A-EE-612A

NOTES:
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DESIGNED BY: R. PITTMAN DATED: 2-22-77 DRAWN BY: D. F. RODD DATED: 10-18-77 CHECKED BY: P. F. LIPARI DATE:	APPROVED BY:
TITLE: CABLE TRAY ARRANGEMENT BOILER AREA-SH-2-B&W AFB PLANT S&W DWG. NO. 291902A-E-612B-4	

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NOTES:
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DRAWN BY: STONE & WEBSTER ENGINEERING CORP. BOSTON, MASS. 02107	DESIGNED BY: R. R. PITTMAN DATE: 9-22-77
CHECKED BY: R. F. BOBB DATE: 10-18-77	APPROVED BY: J. L. BARR DATE: _____
TITLE: CABLE TRAY ARRANGEMENT BOILER AREA-SH3-B&W AFB PLANT	
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12919.02A-EE-251A-1

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UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
MAJOR FACILITIES PROJECT MANAGEMENT DIVISION
CONCEPTUAL DESIGN ATMOSPHERIC FLUIDIZED BED POWER PLANT
EPDA CONTRACT NO. EP-77-C-01-250

DESIGNED BY:
STONE & WEBSTER ENGINEERING CORP.
BOSTON, MASS 02107

DESIGNED: B.S. PITTMAN DATE: 9-15-77
DRAWN: B.S. PITTMAN DATE: 9-15-77
CHECKED: D.F. RODD DATE: 10-12-77
APPROVED: D.F. LIPARI DATE:

UNITED STATES
ENERGY RESEARCH
AND
DEVELOPMENT ADMINISTRATION

TITLE: ARRANGEMENT-B&W AFB PLANT
CONTROL, RELAY & BATTERY ROOMS
S&W DWG. NO. 12919.02A-EE-251A-1

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An instrument list has been compiled to identify the quantity of instrumentation required and to supplement the information contained in the system flow diagrams. The instrument list is made up in two parts and is included under Appendix IIIA-E. Part C of the instrument list shows all the instruments common to both boiler designs - B&W and FWEC, whereas Part A shows the instrumentation for the particular boiler design included in this report.

Equipment technical data sheets have been prepared for all significant control components which are not a part of any vendor engineered and supplied subsystem. These data sheets are in two parts and are included under Appendix IIIA-D. Part C combines data sheets common for both boiler manufacturers and Part A combines data sheets for the Babcock & Wilcox design.

Wherever appropriate, this description shall be supplemented by the details contained in the report supplied by the boiler manufacturer (Appendix IIIA-C).

The presentation is conceptual in nature and it will be apparent that there are many interface areas that must be defined completely before a plant can be instrumented.

It should be recognized that the development of the control systems design is based on incomplete test data from smaller size units and their similarity with the conventional pulverized coal power plant systems. It will be improper to use these controls on any large unit until the performance of these large utility sized units are simulated using mathematical modeling techniques and the interrelationships of the various process parameters are well established.

10.2 Control System

10.2.1 General

The control systems objective for the B&W AFB steam generator power plant is to provide controls to operate the plant efficiently, safely, and with the maximum amount of plant availability. To accomplish this, the following features are provided:

- a. The automation required to start up and shut down the various plant components required for load changes
- b. A loading scheme that will provide the best heat rate at all times
- c. An emergency or safety system to handle contingency conditions

- d. A control system to operate all of the plant components properly

A total analog control system, with a digital information system of the type currently used on conventional pulverized coal plants, is applied to the B&W AFB plant. To some extent, digital equipment will be used for plant automation, sequential loading, and safe shutdown.

The digital portion includes a Bed Segment Control System which incorporates the necessary controls for purging, ignition, and sequential loading. A safety system to monitor the critical boiler parameters and, if necessary, to shut down the B&W AFB boiler in a safe and orderly fashion is a part of the segment control.

The analog control system develops necessary control signals corresponding to unit load demand, monitors fuel flow, airflow, feedwater flow, etc., and controls these parameters to achieve the required steam flow, pressure, and temperature. Included in the analog control systems are all the sensors, controllers, hand/auto stations, and final drive units. The analog system will provide suitable buffered outputs to indicators and/or recorders in the main control room. The hand/auto stations will be mounted in the control room. The following is a brief description of the major analog control systems of Babcock & Wilcox designed AFB drum-type subcritical steam generator.

10.2.2 Unit Load Control

The Unit Load Control System regulates process mass and energy balance. The unit load control system will contain feed forward elements and establish demand for the boiler and turbine subsystems. The unit load control system will place megawatt load demand on the turbine valves from either a load dispatch system or operator setting, while the consequent steam flow demand corrected by the throttle pressure error will be used for the boiler load demand. The boiler load demand sets the demand for boiler firing rate. Various equipment, operational limits, and runbacks will prevent the load demand to exceed unit capability at all times.

10.2.3 Combustion Control in Main Beds

Refer to Logic Diagrams 12919.02A-LSK-18.5A and 18.5C for schematic logics.

The combustion control is designed to satisfy the energy input demand from the fuel-air demand. At the outset, it should be recognized that the utility sized AFB boiler design mandates the use of horizontal surface within the bed and consequently requires that bed expansions be maintained at a relatively

constant value by maintaining a constant air velocity through the bed. This restricts variation of air mass to a very narrow band throughout the entire load range. Thus, the combustion control of the AFB boiler is really restricted to control of the fuel only.

The basic fuel demand for each cell is developed by suitably modifying the boiler load demand to achieve proper split between the boiling beds and superheater beds based on designed heat distribution within the furnace. The adjusted signal is then compared with the actual measured total fuel flow to derive the master fuel demand for all operating bed segments in the boiling or the superheater beds.

For the boiling beds (12919.02A-LSK-18.5A), the master fuel demand is further corrected for the feedwater inlet temperature. For the superheater beds (12919.02A-LSK-18.5C), the master fuel demand is adjusted for the superheat temperature error.

Mean bed temperature is monitored for all beds and imposes a trimming signal on the individual bed segment fuel demand signal. Normally, the bed temperature is regulated around 1,550 F (adjustable) set point. If the bed temperature increases, the fuel feed will be proportionately reduced and vice versa. A limited amount of load turndown capability will be achieved by varying the bed temperature between 1,450 F and 1,650 F to change the heat flux.

Airflow is measured on each bed segment and controlled to maintain a constant air velocity. The airflow measurement is adjusted for undergird air temperature and mean bed temperature to compute the air velocity. The calculated velocity is compared with the set point to derive the modified air demand signal.

To prevent fuel from exceeding available air, the fuel demand signal is always limited by the measured airflow.

Individual bed segment Hand/Auto stations in the control room will allow the operator to interrupt or bias the fuel-air demand.

Final control of combustion is achieved by positioning the individual segment combustion air control damper and by varying the coal feeder speed corresponding to air and fuel demand, respectively.

10.2.4 Bed Material Control in Main Beds

Refer to Logic Diagrams 12919.02A-LSK-18.5B and 18.5C.

The inventory of bed material is regulated by control of the limestone feed rate and the bed letdown rate.

Limestone feed rate is maintained as a ratio of coal flow demand. This ratio is based on the recent as-fired coal sampling and is adjustable by the operator. The limestone demand is adjusted to compensate for the effect of temperature on CaO sulfur capture efficiency. Normally, when the beds are operated around 1,550 F, this compensation will not be operative. However, when bed temperature is modulated to achieve a load turndown, the limestone feed rate will be changed based on the Calcium Oxide/Sulfur Utilization Temperature Curve.

Limestone feed rate is also increased manually by the operator if an average SO₂ value of greater than set point is detected in the SO₂ monitors.

Bed material letdown rate is matched with limestone feed rate to provide the necessary bed material inventory at any time. Although it will not be possible to measure the bed height accurately, a bed level measurement using differential pressure transmitters (PDTs) will be employed to determine the approximate bed level error from the set point. This deviation will be used to bias the bed letdown control, to restore bed level error to zero, and to maintain proper mass of bed material.

10.2.5 Combustion Control in Carbon Burnup Beds

Refer to Logic Diagrams 12919.02A-LSK-18.5E for schematic logic.

The fuel demand for the CBB is developed from the boiler demand after appropriate modification based on the boiler heat distribution. During normal operation CBB burns high carbon content char (fly ash) elutriated from the other beds, which is consumed at the rate it is produced. Char inventory in the char feed tank remains constant. To accomplish the carbon burnup, the bed temperature in CBB must be maintained at a constant higher value (1950 F $\pm$ 50 F). The bed temperature error is used for further adjusting the fuel and air demand signal. The adjusted fuel demand signal is then compared with the char flow to develop a fuel error signal.

Bed segment excess oxygen is measured and airflow corrected as necessary to maintain oxygen within limits.

Bed fluidizing velocity is computed from the airflow measurement modified by undergrid air temperature and the mean bed temperature.

10.2.6 Bed Material Control in Carbon Burnup Beds

Refer to Logic Diagram 12919.02A-LSK-18.5F for schematic logic.

The fluidized mass of bed material in the CBB normally does not need any regulation. The lost bed material inventory due to

NOTES:

1. CONTROL FOR ONE BOILING BED SEGMENT IS SHOWN.
2. CONTROL FOR OTHER BOILING BED SEGMENTS IS SIMILAR.

THIS DIAGRAM IS BASED ON BABCOCK & WILCOX DESIGN

BED MATERIAL CONTROL
BED LETDOWN AND LIMESTONE FEED CONTROL
BOILING BEDS

ERDA AFB STUDY

STONE & WEBSTER ENGINEERING CORPORATION

12919.02A - LSK-18.5B

11-28-77	607	1	2	3	4	5	6	7
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P								
E

- 13.8KV SWGR BUS 1
T1- AUX STEPDOWN XFMR B
T2- INCOMING LINE-NORM STATION SERVICE XFMR
T3- INDUCED DRAFT FAN 4-2
T4- FORCED DRAFT FAN 4-2
T5- INCOMING LINE-RES STATION SERVICE XFMR
T6- BUS 1 METERING & INSTRUMENTATION
T7- START UP BOILER FEED PUMP 4-1

- 4.16KV SWGR BUS M
- N1- CONVEYOR NO.20
 - N2- PRIMARY AIR FAN 4-1
 - N3- TO 480V SUBS-3000KVA
 - N4- TO 480V SUBS-3000 KVA
 - N5- TO 480V SUBS-3000KVA
 - N6- BUS M METERING AND INSTRUMENTATION
 - N7- TEMPERING AIR FAN 4-1
 - N8- AUX STEPDOWN XFMR A
 - N9- CIRCULATING WATER PUMP 4-1
 - N10- CONDENSE PUMP 4-1
 - N11- COAL CRUSHER 4-1
 - N12- LIMESTONE CRUSHER 4-1
 - N13- TIE TO 4.16KV SWGR BUS P

- 4.16KV SWGR BUS P
- P1 - MAKE UP WATER PUMP 4-1
 - P2 - CIRCULATING WATER PUMP 4-1
 - P3 - CONDENSATE PUMP 4-2
 - P4 - COAL CRUSHER 4-2
 - P5 - PRIMARY AIR FAN 4-2
 - P6 - LIMESTONE CRUSHER 4-2
 - P7 - TEMPERING ROLLER FAN 4-2
 - P8 - BUS P METERING & INSTRUMENTATION
 - P9 - AUX STEADFAST KFR 8
 - P10 - TO 480V SUBS-3000 KVA
 - P11 - TO 480V SUBS-3000 KVA
 - P12 - TO 480V SUBS-3000 KVA
 - P13 - CONVEYOR NQ.23

NOTES:
1. SCALE: 1"=1'-0"

THIS DRAWING BASED ON BABCOCK &
WILCOX COMPANY AFB DESIGN

NOT TO BE USED FOR CONSTRUCTION

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UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
MAJOR FACILITIES PROJECT MANAGEMENT DIVISION

CONCEPTUAL DESIGN ATMOSPHERIC FLUIDIZED BED POWER PLANT
ERDA CONTRACT NO. EF-77-C-01-2583

DRAWING BY: STONE & WEBSTER ENGINEERING CORP. BOSTON, MASS. 02107	UNITED STATES ENERGY RESEARCH AND
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DESIGNED J. F. WALSH DATE 9-21-77
DRAWN J. F. WALSH DATE 9-21-77

CHECKED D. ROOD DATE 10-21-77 BY
APPROVED P. F. LIPARI DATE

ARRANGEMENT SWITCHGEAR AREA
BABCOCK & WILCOX AFB PLANT

S&W DWG. NO. 12919.02A-EE-251B -

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THIS DIAGRAM IS BASED ON BARCOCKY WALCOY DESIGN

BED MATERIAL CONTROL

BED LETDOWN AND LIMESTONE FEED CONTROLS

CARBON BURNUP CELL

ERDA AFB STUDY

STONE & WEBSTER ENGINEERING CORPORATION

11-28-77

1291902A-LSK-18.5F

attrition and elutriation, will be made up by extraction from the main bed letdown at a point after the cooler. Whenever supplemental coal burning is required to maintain the CBB operating temperature, fresh limestone feed and associated bed letdown control will be activated.

Limestone feed rate is determined as a ratio of the coal flow demand. The ratio adjustment incorporates correction for lower sulfur capture efficiency at higher (1,950 F) CBB operating temperature. SO₂ indication will be provided for manual adjustment of the limestone demand by the operator, whenever required.

Bed level is measured by using differential pressure transmitters and is used to control the bed material replenishment from the main beds into the CBB for lower than normal (set point) CBB bed level.

Bed material withdrawal rate from the CBB is matched with the limestone feed rate to provide a constant bed material inventory at any time.

For a bed level higher than normal, the bed letdown control device demand signal is biased by the level error to keep the bed level within limits.

10.2.7 Feedwater Control

Refer to Logic Diagram 12919.02A-LSK-18.5D for schematic logic.

The feedwater control is designed to provide a demand for feedwater flow to the boiler. The boiler demand is used to establish a demand for feedwater flow. The feedwater flow demand is established using a three-element control with the steam flow (function of the first stage steam pressure), the drum level error, and the temperature compensated feedwater flow plus the spray flows.

10.2.8 Forced Draft Fan

Refer to Logic Diagram 12919.02A-LSK-18.5D.

The forced draft fan supplies the total secondary air to all the six beds for fluidizing the coal and limestone bed material and maintains adequate air for proper combustion and excess air control. A programmed (based on firing rate demand) secondary air duct pressure is maintained by regulating the F.D. fan inlet vanes.

Airflow to the bed segments is regulated by the individual segment undergrid dampers.

10.2.9 Induced Draft Fan

Refer to Logic Diagram 12919.02A-LSK-18.5D for schematic logic.

The draft control system maintains the combustion cells at a constant (slightly negative) pressure at the inlet to the transverse convection pass at steady state conditions and minimizes deviations during transient disturbances. The draft control system provides a demand for the I.D. fan blades. The control system uses the total airflow corrected by the transverse convection pass inlet draft error as the feed forward demand signal. The total air is determined as the sum of all combustion airflows through the main beds increased by the computed combined primary and tempering airflow. This demand is then compared with actual I.D. fan suction pressure and the resultant error signal then controls the I.D. fan blades.

A damper in the CBB gas outlet controls the CBB pressure to the designed negative value.

10.2.10 Superheat Steam Temperature

Refer to Logic Diagram 12919.02A-LSK-18.5G for schematic logic.

The main steam temperature is a function of the heat absorbed by the superheat surface. The superheater surface was designed to absorb more heat than is required to superheat the steam, with spray at temperatures controlling the main steam temperature to its desired value. However, rapid changes in load calls for rapid temporary correction by extra spray while the firing rate is being adjusted to produce a slower permanent correction.

The superheat temperature controls are designed for a two-stage attemperation system with sprays at the inlets to the second full superheater bed and the final full superheater bed.

The set point for the final steam temperature is compared with the measured superheater outlet temperature and this temperature error is used to trim the final superheater bed inlet temperature set point. This set point is then compared with the actual measured final superheater bed inlet temperature to develop resultant demand signal for the spray valve. The total spray demand goes directly to the second full superheater bed spray control valves for final temperature control. The final full superheater bed sprays receive the same demand as the second full superheater sprays. If the demand to second full superheater bed sprays are not limited, the final superheater bed spray demand is zero. When second full superheater bed spray is limited, final superheater sprays will make up for the balance of the demand.

10.2.11 Reheat Steam Temperature Control

Refer to Logic Diagram 12919.02A-LSK-18.5G for schematic logic.

The Heat Recovery Area Dampers located in the gas pass provides the primary control for the reheat steam temperature control. These dampers are operated between minimum and maximum limits with additional control provided through the use of spray systems, if required. The spray system controls transient temperature excursions on a rapid, temporary basis. For low reheat temperature, when the reheat pass damper is at its extreme open position, the firing rate in all beds will have to be readjusted. The reheater outlet temperature error modified by the boiler demand signal is used sequentially to position the reheat and superheat pass dampers.

10.2.12 Turbine Start-up Bypass for Minimum Flow Through Beds

Refer to Logic Diagram 12919.02A-LSK-18.5H for schematic logic.

A turbine bypass system, sized to pass 40 percent of VWO main steam flow to the condenser, is required as a prerequisite to maintain flow and temperature conditions through the fired bed segments during start-up and shutdown.

The bypass control valves operate to maintain the minimum flow through the AFB boiler during start-up. As turbine load is ramped to 40 percent, the turbine bypass control valve gradually closes responding to keep the throttle pressure set point. At 40 percent MCR flow through the turbine, the turbine bypass will be fully closed.

The bypass control system includes spray attemperation for temperature matching of the bypass steam flow at the condenser.

10.2.13 Steam to Reheat Cooling

Refer to Logic Diagram 12919.02A-LSK-18.5H for schematic logic.

A 40 percent MCR steam to reheat cooling system is provided to protect the reheater tubes from overheating following a turbine trip. The reheater cooling inlet valves redirect the main steam around the HP turbine into the reheater and reheater cooling outlet valves redirect the outlet steam around the IP/LP turbine and into the main condenser.

10.3 Plant Protection and Safety

10.3.1 General

The AFB plant is designed with a reliable protective system to maintain plant safety. This system overrides all other plant

controls to return the plant to a safe condition, either operational or shutdown. The protection system consists of the two basic modes of operation.

1. Emergency Shutdown and Trips
2. Runbacks and Limits

10.3.2 Emergency Shutdown and Trips

Refer to Logic Diagrams 12919.02A-LSK-1-3A and 1-3B.

The plant will usually be shut down using the normal shutdown procedures. Emergency conditions can occur, however, which will require emergency shutdown procedures. The emergency shutdown can result from several types of failures. Major categories, which have been evaluated, are as follows:

1. Boiler circulation inadequate - The forced circulation pump is used to establish the differential pressure necessary to provide an even circulation through the boiler tubes. If this differential pressure falls below the design differential for the load as established by the boiler manufacturer, it will be necessary to trip the boiler fuel.
2. Boiler drum low level - Low drum level trip is to protect against tube failures resulting from a high firing rate with insufficient water circulation. This condition includes loss of feedwater pump. This will create a boiler/turbine trip. Fuel feed will be tripped to keep the bed from overheating. The unit will then be safely shut down with an airflow runback to the minimum fluidizing velocity with the steam to reheat cooling system in operation.
3. Boiler drum high level - High drum level will be alarmed. On extreme high level the turbine should be tripped to avoid water induction. Boiler trip is optional.
4. Failure of boiler tubes - Tube leaks would be determined by measuring the total difference between the feedwater flow and final steam flow. Smaller tube leaks can be detected by sudden changes in the boiler water chemistry. In case of a major leak, the AFB boiler-turbine unit should be shut down immediately.
5. Total loss of air - Total loss of combustion air would trip the boiler.

NOTES:

1. THE FOLLOWING ACTIONS ARE INITIATED WHEN THE BOILER TRIP LOCKOUT RELAY IS ENERGIZED:
 - A. TURBINE TRIPPED
 - B. BOILER EMERGENCY SHUTDOWN PROCEDURE INITIATED IN THE FOLLOWING SEQUENCE FOR ALL OPERATING BEDS:
 - B1. FUEL FEED TRIPS
 - B2. HP & LP BYPASS VALVES FOR REHEAT COOLING OPENS AND ON AUTOMATIC CONTROL
 - B3. FEEDWATER FLOW RUNS BACK TO 40%.
 - B4. AIR FLOW RUNS BACK. MAINTAINS MINIMUM FLUIDIZING VELOCITY
 - B5. WHEN BED TEMPERATURE DROPS BELOW 1000°F
 - B5.1 AIR FLOW TRIPS
 - B5.2 SUPERHEATER BLOCK & SPRAY VALVES CLOSE
 - B5.3 REHEATER BLOCK & SPRAY VALVES CLOSE
 - B5.4 HP & LP BYPASS VM FOR REHEAT COOLING CLOSES & TURBINE BYPASS VALVE OPENS
 - B6. WHEN BED TEMPERATURE IS 700°F FEEDWATER FLOW TRIPS
 - B7. TURBINE BYPASS VALVE CLOSES AS THE PRESSURE DECAYS IN SUPERHEATER

2. PRETRIP ALARMS WILL BE PROVIDED FOR ALL MAJOR PROCESS PARAMETERS THAT GENERATES A BOILER OR BED SEGMENT TRIP.

* LOCATED IN BED SEGMENT CONTROL INSERT ON MAIN CONTROL BOARD.

THIS DIAGRAM IS BASED ON BABCOX & WILCOX DESIGN

BOILER TRIP & RUNBACK - SHEET 1 OF 2

ERDA AFB STUDY

STONE & WEBSTER ENGINEERING CORPORATION

12919.02A-LSK-1-3A

DATE	11-28-77
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CHECKED BY	42
APPROVED BY	

6. Loss of airflow to the bed - The fuel and limestone feed to that bed will be stopped and the boiler will continue to operate at reduced load.
7. Loss of coal feeding equipment - Loss of coal feed to a bed will automatically shut down that bed. The remainder of the system would continue to operate safely at a reduced load.
8. High bed temperature - This condition would initiate an alarm for operator attention/correction. An excessively high temperature will trip the bed.
9. Turbine trip - On a turbine trip, the boiler would be run back to operation at 40 percent MCR load. This trip signal would open the bypass lines around the turbine to provide cooling of the boiler beds. The boiler at this point could remain in service with fires cut back to proper level. This operational flexibility provides the AFB boiler with the advantage of remaining in a hot standby mode on a turbine trip. However, if it was determined that a restart of the turbine could not be initiated, then the boiler would be tripped.

10.3.3 Runback and Limits

A system of runbacks and limits will form part of the control system and maintain the plant at a safe load during abnormal conditions. This system will override the load demand to adjust the operating level as required. The runbacks and limits will be operational only when the plant is in automatic control. When operating in a manual mode, the alarm system will warn the operator of the abnormal condition and, if necessary, the trip system will shut down part or all of the plant to prevent damage.

The control items that will be included in the runback scheme are:

- High Bed Temperature
- Insufficient feedwater flow
- Insufficient sorbent flow
- Turbine Trip

The plant operating limits are determined by the availability of critical equipment in service, such as

- F.D. Fans
- I.D. Fans
- Fuel/Sorbent Feeding Equipment, etc.

10.4 Start-up and Loading Procedure

10.4.1 General

The normal start-up of the AFB unit is sequential. The components are placed in operation in a definite order. The procedure is similar to other B&W drum-type subcritical pulverized coal fired steam generators except for the firing and sequencing of the various beds.

10.4.1.1 Purging

Bed purging is performed at each individual level starting with the lower beds and working upward. Each bed is purged with 25 percent MCR air similar to the NFPA requirement for a P.C. boiler.

10.4.1.2 Light Off

After completion of purging, the boiler drum is filled. The boiling beds are then lit off using ignition oil. The lower boiling bed is fired first and then the split bed and carbon burnup bed. The firing rate is increased by starting additional sections of the boiling beds to raise fluid temperature and pressure. During this phase steam generation starts.

10.4.1.3 Turbine Bypass, Warm, and Roll

During start-up of the unit, all generated steam is diverted to the condenser via the turbine bypass system. Superheater beds are not fired until sufficient steam flow is established to prevent tube overheating. Once the bottom superheater beds are fired, the gas temperature is quenched by adding air through the upper beds. During this phase steam lines are warmed and the turbine valves are opened for warming and rolling. At about 1,000 psi, the turbine is brought up to speed and the unit is synchronized and initial loading applied. Steam flow is then transferred from the bypass system to the turbine. Above 40 percent load, the bypass valve is completely closed and the entire steam flow passes through the turbine. Load is then increased by placing additional segments in service.

10.4.2 On-line Loading

The plant load can be varied by adjusting the firing of the bed segments simultaneously or sequentially. Sequential operation of the segments requires starting and stopping equipment. The fastest load changes are accomplished by adjusting the segments already in service. Since time is required to ignite additional segments, load increases beyond the operating range of the equipment already in service will be slower. Also it may be

possible to accomplish rapid load decrease by slumping portions of the operating beds.

The sequential segment loading scheme is used for normal demands for increase or decrease of the load. As a part of the Bed Segment Control, a computer program determines the most desirable starting and loading sequence.

11.0 ENVIRONMENTAL SYSTEMS

The B&W plant is designed to comply with all existing federal, state, and local environmental regulations.

11.1 Air Quality

Operation of the plant will result in emissions of particulate matter, sulfur dioxide, and nitrogen oxides to the atmosphere. These emissions will be controlled to comply with EPA New Source Performance Standards. Particulate matter will be controlled by use of an electrostatic precipitator. Sulfur dioxide emissions will be controlled by use of a sulfur sorbent bed of limestone. Nitrogen oxides will be maintained well below conventional boiler emissions due to the low combustion temperatures in the fluidized bed. Emissions of these contaminants and applicable regulations are summarized below:

	<u>Plant Emission</u>	<u>New Source Performance Standards</u>
Particulate matter	0.06 lb/10 ⁶ Btu	0.1 lb/10 ⁶ Btu
Sulfur Dioxide	1.2 lb/10 ⁶ Btu	1.2 lb/10 ⁶ Btu
Nitrogen Oxides	0.5 lb/10 ⁶ Btu	0.7 lb/10 ⁶ Btu

Emissions of particulate matter, sulfur dioxide, and nitrogen oxides are approximately 331 lb/hr, 6,624 lb/hr, and 2,760 lb/hr, respectively.

11.2 Noise

The B&W plant is designed to comply with OSHA inplant noise levels to ensure worker safety. There will be a fan room, inlet silencers, and acoustical lagging to control the noise from the forced draft fans.

Additional equipment which contributes to high noise levels will be silenced by enclosures, acoustical lagging, and/or silencers. Examples of this equipment include boiler feed pumps, power control valve, and HVAC equipment.

11.3 Waste Treatment

Liquid wastes resulting from operation of the B&W plant will be conveyed to an existing liquid waste treatment system. Typical wastes which will be conveyed include boiler blowdown, equipment drains, floor drains, and coal pile runoff. Sanitary waste will be treated in an existing system.

Solid wastes from plant operation include fly ash and bed letdown. These wastes consist primarily of fly ash, calcium sulfate, and calcium oxide. The wastes will be collected and pneumatically conveyed to silos located at the landfill area. Trucks will then transport the material to the area of the landfill which is being worked. The solid waste represents approximately 140,000 lb/hr and 187.5 acre-ft/yr based on the performance coal and a unit capacity factor of 53.53 percent.

11.4 Environmental Monitoring

An environmental monitoring system is provided for continuously monitoring opacity, sulfur dioxide, nitrogen dioxide, and carbon dioxide. These instruments are installed to ensure compliance with New Source Performance Standards and will signal an alarm if levels of these contaminants in the flue gas exceed the standards.

APPENDIX IIIA-A

DESCRIPTION OF WORK

FOR A

BABCOCK & WILCOX COMPANY

570 MW ATMOSPHERIC FLUIDIZED BED BOILER
ELECTRIC GENERATING PLANT

October 1977

STONE & WEBSTER ENGINEERING CORPORATION
Boston, Massachusetts

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*Change from base plant

BLOCK NO. 1 - LAND AND LAND RIGHTS

As this unit is the fourth extension to an existing site already owned by the Client, no land or land rights are included.

In addition, transmission line rights-of-way or ownership is presumed to exist.

BLOCK NO. 2 - YARD WORK1100.00000 YARD WORK1100.10000 Clearing, Grading, and Surfacing1100.11000 Clearing

No clearing is included in this scope.

1100.12000 Grading-Yard

Preliminary site grading is assumed to be complete. Minor regrading for the construction of the new structure will be performed.

Final site grading will be done immediately before commercial operation of the plant.

1100.13000 Surfacing-Yard

No surfacing is included in this scope.

1100.14000 Landscaping

No landscaping is included in this scope.

1100.20000 Roads, Parking Areas, and Fences1100.21000 Roads and Parking Areas

No parking areas are included in this scope. Station access road will be 24 ft-0 in. wide asphalt paved using one course 3 in. thick for a total of 1,200 L.F. The 8 in. crushed stone base and 4 in. stabilized topping for the station access road will be provided. Finish grading will be provided before applying the asphalt paving. Station service roads will be 24 ft-0 in. wide using an 8 in. crushed stone base and 4 in. stabilized topping for a total of 4,300 L.F. being provided. No asphalt paving is provided on station service roads. All railroad grade crossings will be provided. Any subgrade work required to establish the specified grades before applying the base material will be provided.

1100.23000 Fences

No fencing is included in this scope.

1100.30000 Water and Sewer Systems and Other Service Lines**1100.31000 Water Systems****Domestic Water**

Domestic water for the plant will be supplied from the previous unit.

Service Water

Service water for the station will be taken from the existing well water system. Service water will be used for the makeup water demineralizers, and hose stations.

River Water

River water for the station will be taken from the existing makeup water pump house. River water will be used for cooling tower makeup. Air preheater washing will be from the existing ash sluice system.

Water Piping

Piping, valves, and fittings will be provided.

1100.33000 Storm Sewer System

The storm sewer system will receive surface runoff, roof drainage, and the effluent from oil separators which serve plant floor drains, equipment drains and station transformers. The storm sewer will terminate at a connection furnished with the previous unit.

1100.34000 Fire Protection System

The yard fire system will consist of a buried pipe distribution system serving fire hydrants with connections to the plant to serve interior hose stations and special fire protection systems.

All yard hydrants will be provided with fully equipped hose houses. Yard fire piping shall be buried and shall be 150 lb seamless carbon steel pipe, with welded fittings, protected with X-TRV-Coat coating, or equivalent. Piping for interior hose stations and stand-pipe systems shall be seamless carbon steel with welded fittings. Post indicator isolation valves will be 175 lb type.

1100.36000 Yard Steam Lines

Piping, valves, and fittings will be provided.

1100.60000 Trackwork

An existing railroad spur from the main line will provide access to the main powerhouse. Removal of the existing trackwork in the boiler and turbine areas will be performed as required.

1100.70000 Yard Lighting

The yard lighting will serve the additional roadway requirements of the site. Lighting will be provided at corners, curves, and gate entrances and the lighting level will be no greater than 1/2 ft candle in these areas.

BLOCK NO. 3 - MAIN POWERHOUSE1101.00000 MAIN POWERHOUSE

The main powerhouse consists of the boiler area, turbine area, silo bay, auxiliary bay, and the control room area.

The main powerhouse consists of the following:

Boiler Related Equipment

Boiler Room	- 88.5 ft x 113.5 ft x 74 ft	743,311 ft ³
	- 121 ft x 113.5 ft x 15 ft	206,000 ft ³
	- 182 ft x 333.5 ft x 133 ft	8,072,700 ft ³
Switchgear Room (2)	- 33 ft x 51 ft x 20 ft x 2	67,320 ft ³
Fan Room	- 64.8 ft x 288 ft x 27 ft	503,884 ft ³
Total boiler area volume		9,593,215 ft ³
Total boiler room floor space		82,725 ft ²

Turbine Related Equipment

Turbine Room	- 98 ft x 185 ft x 101 ft	1,831,130 ft ³
Auxiliary Bay	- 39 ft x 185 ft x 101 ft	728,715 ft ³
Deaerator Enclosure	- 39 ft x 92 ft x 29.5 ft	105,846 ft ³
Control Room	- 35 ft x 167 ft x 101 ft	590,345 ft ³
Total turbine area volume		3,256,036 ft ³
Total plant volume		12,784,038 ft ³

1101.10000 Substructure

The building foundation will consist of reinforced concrete footings supported on piles. Grade beams will be provided around the perimeter of the building extending below the frost line. Pile cap and grade beam type foundation will be used except in cases where subslab proves more economical. The ground floor slabs and equipment foundations will be reinforced concrete supported on piles. Flood protection and/or design will be provided to El. (-) 1 ft-0 in.

1101.20000 Superstructure

The superstructure will be steel frame construction braced against wind and impact loads. Connections will utilize high strength bolts.

The exterior building walls will be uninsulated metal siding supported by steel channel girts. The 12 in. thick reinforced concrete fire wall along the B column line will be extended approximately 80 ft from the previous unit. Fixed and operating aluminum louvers as required for ventilation will be provided.

Transluscent wall panels will be provided on the east wall to match the panels of the existing unit. The building roofs will consist of a steel supported painted metal roof deck with insulation and built-up roofing. Interior partitions will be concrete block.

Boiler steel consisting of columns, girders, beams, and supplementary steel to support the boiler, retractable soot blowers, and temperature probe will be furnished.

Hollow steel doors will be provided for both exterior and interior application for the main powerhouse. Industrial rolling steel doors will be located at the railroad access to the turbine building and other areas of the main powerhouse to provide equipment and truck access. Where possible, doors will be relocated from the previous unit north wall to the north wall of this unit.

Superstructure floors and walkways will generally be of grating or concrete floors.

There will be a control room at the operating floor next to the turbine area. The control room will be an extension of the previous unit control room and will contain a main control board for operating all prime-order equipment. There will also be a number of auxiliary control boards for supervising equipment having a secondary order of operations. Interior walls of the control room and associated rooms will be concrete block. Doors will be of hollow steel construction with pressed steel frames. Floors will be vinyl asbestos tile. A hung luminous ceiling will be provided for the entire area. Special care will be taken to ensure maximum sound attenuation in the control room.

Two stairwells will be located in the boiler area for access and egress and additional stairs, as required, for access to equipment. Stairs will generally have grating treads with abrasive nosings. Two enclosed crossover walkways will be provided above the conveyor house level extending between this and the previous unit.

Grating and treads are to be welded steel painted black for interior use and galvanized for exterior use. Grating will be a minimum of 1 1/4 in. by 3/16 in. except stair landing will be 1 in. by 3/16 in. bars.

All handrails will be double rail pipe handrails with a smooth continuous top rail. Exterior platforms and caged ladders will be provided for emergency access from boiler room roof to ground using intermediate roof levels at platforms where possible.

1101.40000 Service Equipment**1101.41000 Plumbing System**

Floor and equipment drains will be collected in pipes and trenches and empty into an in-plant sump. From here the drains will be pumped to an existing valved connection which leads to the above ground oil separator system for subsequent disposal to the ash pond.

Roof drainage system consisting of roof boxes, horizontal piping and downspouts will be provided. Water will discharge directly into the storm sewer system.

Potable water will be provided by the previous unit. Water will be distributed to drinking water coolers within the powerhouse. Emergency shower and eyewash stations will be provided in acid areas. Hot water and sanitary facilities are not being provided for this unit.

1101.42000 Heating System

Steam unit heaters will be provided.

1101.43000 Ventilation System (air density equals .0754 lb/cu ft at 60 F)

Boiler room ventilation will require approximately 1,200,000 cfm of air to be supplied to and exhausted from the boiler room to limit the indoor temperature to 120 F during maximum summer ambient temperature of 96 F. Air will be brought in through fan rooms in the upper levels of the boiler room and distributed through ductwork to the hot region of the room. Air will also enter the plant by natural ventilation through motor-operated hooded louvers and doors. Air will exhaust through gravity roof ventilators.

Turbine room ventilation will require approximately 500,000 cfm to limit the indoor temperature to 110 F during maximum summer temperatures. Air will be brought in by fan and duct systems and by natural means. Air forced into the turbine room will be filtered with 85 percent ASHRAE weight arrestance, roll type filters. Fans will exhaust the air through the roofs and walls.

Other areas within the powerhouse will be ventilated by conventional means. These include the conveyor gallery, auxiliary bay, deaerator area, switchgear area, battery room, cable room, clean and dirty oil tanks room, limestone preparation area and the laboratory and sample area of the turbine room.

New yard structures will also be ventilated. These include the cooling tower pump house and the new crusher house.

The control and relay rooms will each be air conditioned by separate, independent systems. Heating will be provided by means of duct-mounted electric air heaters.

1101.46000 Fire Protection System

To bring fire protection water into the plant, connections will be made to the existing below ground fire protection loop which surrounds this unit.

Halon fire protection systems will be provided for the computer room, selected areas of the control room, the electrical equipment room, and miscellaneous electrical areas.

Water spray systems will be provided to protect the turbine lubrication oil tank, oil pumps and coolers, oil conditioning equipment, oil storage rooms, hydrogen seal oil unit, and the outdoor transformers.

Water hose stations will be strategically located throughout the entire powerhouse.

1101.47000 Elevator

Electric freight and passenger elevators will not be provided. Elevator access will be from the previous unit.

1101.5000 Lighting System

The main powerhouse lighting system will be a combination of vapor lighting fixtures, fluorescent fixtures, and incandescent fixtures as required to give a level of 100 ft candles in the main control board areas; 30 ft candles on the operating floor, in the relay equipment rooms, and in the switchgear areas; and 20 ft candles in other areas. Fixtures will be suitable for each area as classified. Emergency d-c lighting will be provided for safe egress from all areas.

1101.90000 Painting

Structural steel will be sand blasted and painted with one coat of an inorganic zinc primer and a top coat of an acrylic latex in the shop. It will be touched up as required. At selected areas, concrete block will be given one coat of filler and one finish coat of paint.

BLOCK NO. 4 - ADMINISTRATION BUILDING

As the existing facility includes an administration building/office, no provision is included for an administration building.

BLOCK NO. 5 - MISCELLANEOUS BUILDINGS

The existing facility includes a number of miscellaneous buildings for construction and/or operation which will be utilized for this unit.

BLOCK NO. 6 - BOILER EQUIPMENT BY VENDOR1200.10000 Boiler Equipment

The boiler will be a controlled circulation, drum type, balanced draft AFB boiler, producing 3,972,963 lb/hr of steam at 2,620 psig/1,000 F, with single reheat to 1,000 F. The boiler will be designed to burn Midwest bituminous coal with No. 2 fuel oil provided for ignition. The coal will have a heat value of 11,081 Btu per lb, an ash content of 10 percent, a moisture content of 13.52 percent, and a sulfur content of approximately 3 percent. Final feedwater temperature will be 487 F.

1200.11100 Boiler Pressure Parts

Pressure parts include boiler tubing, headers, safety valves, power relief valve, and boiler trim. The furnace will be designed for ± 20 in. H₂O (± 32 in. H₂O yield).

1200.11310 Support Steel With Boiler

The boiler package includes hangers for top supporting unit and auxiliary equipment from the main girders, columns, beams, and supplementary steel which are not included in the boiler package, but are included as part of the building frame.

1200.11400 Boiler Casing

Outer casing for boiler, furnace, reheater, superheater and economizer and air heater will be of 18 gage galvanized steel, except for the top of the boiler, and will be furnished on a delivered basis with the boiler.

1200.11800 Boiler-Circulating Pumps

Four circulating pumps with motor drives will be furnished with the boiler. The pumps will be supported by the suction header. Each pump will be fitted with a manually operated stop-check in the pump discharge.

1200.12100 Boiler Superheater and Reheater

The superheater and reheater will maintain steam temperatures at 1,000 F with a tolerance of 10 F over the range of 60 percent to full load. Included with the boiler are the necessary controls, valves, piping, and nozzles for attemperatur water flow.

The reheater is designed for reheating to 1,000 F.

1200.13000 Boiler Economizer

The economizer, installed within the boiler setting, will be of the smooth tube type and have sufficient capacity to pass the entire quantity of feedwater required when operating at full load.

1200.14000 Boiler Setting and Insulation

Boiler setting, insulation, casing, and lagging are included with the boiler package. Insulation for flues, ducts, mechanical collectors, and air heaters will be covered with 18 gage ribbed aluminum. Piping insulation will be covered with 0.020 in. thick aluminum.

1200.15000 Coal and Limestone Distribution and Injection Equipment

Twenty pairs of belt feeders (18 tph coal and 8 tph limestone; one per segment) are included to deliver coal and limestone at a controlled rate from the bunkers to the main bed coal injection system. Each feeder is equipped with 1.5 hp and 1.0 hp (coal and limestone, respectively) variable speed, 460 v 3 phase, 60 Hz drive motor.

In addition, 5 pairs of belt feeders (11 tph coal and 5.5 tph limestone) are included to deliver coal and limestone from the bunkers to the CBB coal injection system or the main bed ignition segments. Each feeder is equipped with a 1.5 hp and a 1.0 hp (coal and limestone, respectively) variable speed, 460 v, 3 phase, 60 Hz drive motor.

Two half-capacity (202,000 cfm at 600 F) primary fans will be supplied with the boiler. Each fan is equipped with a 1,750 hp, 1,200 rpm, 13.2 kv, 3 phase, 60 Hz motor. These fans will be located in the enclosed fan room.

Two half-capacity (97,800 cfm at 130 F) tempering air fans will be supplied with the boiler. Each fan is equipped with a 450 hp, 1,800 rpm, 13.2 kv, 3 phase, 60 Hz motor. These fans will be located in the enclosed fan room.

1200.16000 Boiler Burners and Ignition Equipment

A belt feeder outlet hopper, rotary seal valve, mixing bustle, coal and limestone transport pipes, a 40:1 flow distributor and the 40 coal/limestone injection pipes will be supplied with the boiler for each bed segment.

Twenty retractable, electrically ignited light oil ignitors will be furnished with the boiler in the air plenum and ignition segment of the main beds. Twelve will be furnished for the CBB.

1200.17100 Boiler Soot Blowers

The boiler will be furnished with air soot blowers. The blowers will be furnished with all interconnecting piping, valves, drives, motors, supports at the casing, and complete with an automatic/manual sequential control system.

1200.22200 Draft Ducts with Boiler

- a. Forced draft air ducts between air heaters and fuel burners, including sectionalizing dampers, tempering air ducts, dampers, and controls for secondary air dampers at burners.
- b. Flue gas ducts between economizer outlet and air heaters.

1200.22920 Boiler Duct Insulation with Boiler

Insulation for ducts will be mineral fiber covered with 18 gage ribbed aluminum.

1200.26100 Air Heaters

Two bisector regenerative type air heaters will be included with the boiler. Included will be oil coolers, oil piping, main and auxiliary electric motor drives, air soot blowers, and water wash devices.

1200.26200 Other Boiler Equipment

Carbon Reinjection System

A vacuum-pressure carbon collection system is supplied with the boiler to transport the high-carbon ash from the main bed precipitators hoppers to the carbon reinjection tank and then to the carbon burnup bed.

Four full size carbon collection vacuum blowers are supplied, equipped with 100 hp, 1,800 rpm, 460 v, 3 phase, 60 Hz motors, to convey the ash to the carbon reinjection tank.

Ash collected in the carbon reinjection tank is conveyed pneumatically to the CBB by supply air from the primary and tempering air fan systems.

Each main bed precipitator hopper is equipped with a material handling valve. Each hopper on the carbon reinjection tank will be supplied with a rotary feeder.

Bed Letdown Cooler

Twenty-five water-cooled screw conveyor coolers are supplied with the boiler to cool the material removed from the main bed to 250 F and deliver it to the bed material removal and disposal system (Block 7B, Account 1200.51).

Each screw conveyor will be equipped with a variable speed 2 hp, 460 v, 3 phase, 60 Hz motor.

Eight water-cooled screw conveyor coolers are supplied with the boiler to cool the material removed from the CBB bed segments. Each screw conveyor is equipped with a .5 hp, 460 v, 3 phase, 60 Hz motor.

Flow control will be provided with a rotary feeder at the outlet of each screw conveyor cocler. Each rotary feeder will be equipped with a variable speed 1/2 hp, 460 v, 3 phase, 60 Hz motor.

Carbon Burnup Bed (CBB) Dust Collector

A cyclone type mechanical dust collector will be supplied with the boiler at the outlet of the CBB.

BLOCK NO. 7A - BALANCE OF BOILER PLANT EQUIPMENT1200.22100 Draft Ducts Not With Boiler

Air ductwork from the F.D. fans to the air heaters and gas ductwork from the air heaters to the I.D. fans, from the I.D. fans to 18 in. outside of the stack will be supplied. Ductwork from 18 in. outside of the concrete stack to the liner will be furnished with the stack.

1200.22400 Air Preheaters

Combustion air is preheated after the forced draft fans by steam-air heating coils designed to maintain the minimum average cold end temperature of the regenerative air heaters.

1200.22910 Duct Insulation Not With Boiler

Gas ducts not supplied with the boiler will be insulated with prefabricated factory-assembled, mineral fiber, panels with 18 gage ribbed aluminum lagging. (This insulation will include the precipitator and hoppers.)

1200.23000 DRAFT FANS1200.23100 Forced Draft Fans

Two half-capacity centrifugal type forced draft fans, each with a rated capacity of 742,035 cfm at 96 F (.0695 lb/cu ft), will be furnished. The fans will be located indoors in enclosed fan rooms. Each fan will be driven by one 10,000 hp, 1,200 rpm, 13.2 kv, 3 phase, 60 Hz motor.

1200.23200 Induced Draft Fans

Two half-capacity axial type induced draft fans, each with a rated capacity of 749,500 cfm at 299 F, will be furnished. The fans will be located outdoors. Each fan will be driven by a 5,000 hp, 700 rpm, 13.2 kv, 3 phase, 60 Hz motor.

1200.30000 FEEDWATER EQUIPMENT1200.31000 Feedwater Heaters

Seven stages of extraction feedwater heating will be furnished consisting of three low pressure stages, a deaerator, and three high pressure stages. All closed heaters are the horizontal shell and tube type. The feedwater heater insulation will be mineral fiber with aluminum lagging.

High Pressure Heaters

The 1st, 2nd, and 3rd point heaters will be located on the operating floor level and will have carbon steel tubes. High

pressure heater drains will cascade in sequence to the deaerator under normal level conditions and to the condenser under extreme high level conditions. Tube side design pressure will be 4,500 psig. Feedwater bypasses will be provided for the high pressure heaters.

Deaerator (4th Point Heater)

The deaerator will be a tray type equipped with internal sprays and a vent condenser. The deaerator storage tank will have a 5 min capacity at full load. Design pressure will be 75 psig.

Low Pressure Heaters and Drain Coolers

The 5th point, 6th point, and split 7th point heaters will have stainless steel tubes and will be located in the condenser necks. Heater drains from the 5th point and from the 6th point heaters cascade to their respective separated drain coolers and then directly to the condenser. The 7th point heater drains flow through loop seals to the condenser. Tube side design pressure will be 600 psig.

The 5th, 6th, and 7th point heaters will be provided with a common bypass with motor-operated valves.

1200.32000 BOILER FEED PUMP

1200.32100 Boiler Feed Pump, Turbine Driven

One full-capacity centrifugal barrel type boiler feed pump with shaft driven matched booster pump will be furnished. The booster pump will take suction from the deaerator and supply the boiler feed pump which, in turn, discharges to the high pressure heaters. The boiler feed pump with its matched booster pump will be driven by a steam turbine. The pump will have an approximate capacity of 10,700 gpm.

Start-up Boiler Feed Pump, Motor Driven

One 5,860 gpm start-up boiler feed pump will be furnished with a 10,000 hp, 1,800 rpm, 13.2 kv, 3 phase, 60 Hz drive motor. The motor-driven start-up pump will take suction from the deaerator and supply water to the boiler through the high pressure heaters.

1200.33000 BOILER CHEMICAL TREATMENT EQUIPMENT

A covered steel measuring tank and chemical feed pump will be provided to feed phosphate to the boiler drum. The pump will have a nominal capacity of 5-10 gal per hr and a discharge pressure suitable for the service. The tank will be equipped with a level indicator and a low level switch.

1200.34000 Condensate Chemical Treatment Equipment

Facilities will be provided for feeding hydrazine to the condensate system. Each system will consist of a covered steel measuring tank and chemical feed pump. The chemical feed pumps will have a nominal capacity of 10-30 gal per hr and discharge pressures suitable for the service. The tanks will be equipped with a level indicator and a low level switch.

1200.34900 SAMPLING SYSTEM

Sampling Panel

Sampling and analysis for chemical control in condensate, boiler feed, boiler water, and steam systems will be provided by a central sampling system which includes two freestanding central sampling panels located in the laboratory and sample area in the previous unit boiler room.

The sampling panel provided for terminal points of sampling lines will include two sections. It will provide for sample conditioning, pressure and flow control, and sample analysis, including continuous automatic analyzers for conductivity, hydrazine, pH, silica, phosphate, and dissolved oxygen. Sinks for collection of samples and necessary piping for returning samples to the system or dumping to waste will be installed.

Sampling System

Samples to be piped to the central sampling panel shall include the following:

- Condensate pump discharge
- Condensate at deaerator inlet
- Boiler feed pump suction
- Economizer inlet
- Superheater outlet
- Reheater inlet
- Reheater outlet
- Heater drains

Conductivity cells, recorders, and controllers will be provided, as required, for the condensate pump discharge, feedwater entering and leaving the deaerator, economizer inlet steam, and heater drains.

Cells for pH measurement, recorders, and controllers will be provided on the panel, as necessary, for the condensate pump discharge and economizer inlet.

One oxygen analyzer will be provided to monitor the condensate pump discharge and the deaerator outlet. A silica analyzer will be provided to monitor the economizer inlet, if required, and the boiler water. These analyzers will be located at the sample panel.

1200.38000 Blowdown and Blowoff Equipment

A blowoff tank, ASME Code Section VIII, A285C and a continuous blowdown flash tank will be provided.

1200.60000 Piping and Covering

Piping, valves, fittings, and hangers will be provided for the following systems:

- Main Steam
- Auxiliary Steam
- Hot Reheat
- Cold Reheat
- Extraction
- Condensate
- Turbine Bypass
- Reheater Cooling
- Boiler Feed Discharge
- Boiler Feed Suction
- Steam Line Blowout
- LP Feedwater Heater Drains
- Condensate Makeup and Drawoff
- Ignition Oil
- Service Water
- River Water
- Potable Water
- Makeup Water
- Drains to Condenser
- Drains to Boiler Blowoff Tank
- Boiler Safety Valves,
Vents, and Drains Beyond the First Valve
- Feedwater Heater Relief, Vents, and Drips
- Chemical Feed
- Nitrogen Blanketing
- Service Air
- Instrument Air
- CO2
- Halon
- Hydrogen
- Scanner Cooling Air
- Boiler Chemical Cleaning and Acid Wash
- Preboiler and Heater Shell Chemical
Cleaning and Flush

1200.65200 Nitrogen System

A nitrogen system will be provided for blanketing the carbon steel tube feedwater heaters, boiler drum, and deaerator. The nitrogen source will be extended from the previous unit.

1200.67200 Piping - Electric Heat Tracing

Electric heat tracing will be provided on waterlines and horizontal air lines subject to freezing.

The system will be complete with heating cable, contactor, thermostats, transformers, monitoring ammeters, and circuit breakers. Primary instrument tubing out of doors will be heat traced bundles.

1200.69000 Pipe Covering

All lines requiring insulation will be insulated with mineral fiber and aluminum jacketing.

1200.84000 Miscellaneous Equipment Foundations

The forced draft and induced draft fan foundations will be reinforced concrete mats supported on piles.

1200.85000 Miscellaneous Pumps and Tanks

One full-capacity bearing cooling water pump and heat exchanger will be furnished. The bearing cooling water pump will be motor-driven. The bearing cooling water system will be cross-tied to the previous unit.

The bearing cooling water system will serve the boiler circulating water pumps, fan bearings and oil coolers, pulverizer oil coolers, condensate pump bearings, boiler feed pump turbine oil coolers, furnace doors, air heater oil coolers, and other miscellaneous coolers.

Existing tanks for fire protection water, service water, condensate, acid, caustic and ignition oil are adequate to serve this unit.

1200.86000 Hoist and Monorails

Facilities will be provided to handle the forced and primary air fan rotors and electric motors, removable sections of the combustion air preheaters, boiler room hoist, ash sluice pumps, service water pumps, and similar pieces of equipment.

Air heater baskets and pulverizer dismantling will have motorized hoists and trolley beams.

A trolley beam and hoist system will be provided by the precipitator manufacturer to remove T-R sets from their roof-mounted locations and lower the T-R sets to grade elevation.

A trolley beam and hoist system will be provided for the SO2 removal system.

1200.89000 Painting Equipment and Piping

Steel surfaces will be shop cleaned and shop painted with a prime and finish coat. No finish coat will be provided unless required by safety code. Touch-up painting will be done in the field. Items not suitable for shop cleaning and shop painting will be cleaned and painted in the field.

1200.90000 PRELIMINARY OPERATIONS AND TESTS**1200.91000 Preliminary Operations**

Provisions for preliminary operation and start-up, including blowing of the steam leads, will be included.

1200.92000 Preboiler Cycle and Boiler Chemical Cleaning

Temporary provisions will be made to alkaline clean the feedwater and condensate system.

Provisions for preoperational chemical cleaning of the boiler tubes and economizer, including the alkaline boilout, acid cleaning, acid neutralization, all flushes, and surface passivation will be included.

BLOCK NO. 7B - ASH HANDLING EQUIPMENT1200.50000 Ash Handling Equipment

The design of the ash systems will be based upon a 15 percent ash coal with 90 percent of the ash to the precipitator inlet and 35 percent of the ash in the bed material letdown.

1200.51000 Spent Bed Material Holding Tanks

A 60 ft long by 16 ft wide by 8 ft high (straight side) dry holding tank with six 6 ft high hoppers will be provided for collection of the main bed material letdown. A 40 ft long x 12 ft wide x 3 ft high dry holding tank with three 6 ft high hoppers will be provided for collection of the carbon burnup cell bed material letdown. The tanks will be made of steel and be provided with observation windows, internal illumination, and two air-operated air lock devices on each hopper.

1200.52000 Spent Bed Material Disposal System

Two half-capacity pneumatic bed material letdown removal systems will be provided complete with abrasion-resistant piping, fittings, and controls for transporting bed material from the two holding tanks to two storage silos located in the ash waste treatment area. The bed material is then removed from the silo by trucks and transported to the onsite solid waste disposal area.

Three half-size bed material letdown transport blowers will be provided to supply pressurized conveyor air to transport the ash to the silos. Each blower will be driven by a 250 hp, 1,800 rpm, 460 v, 3 phase, 60 Hz motor.

1200.54000 Fly Ash Handling System

The fly ash handling system will be designed to remove ash from the carbon burnup bed (CBB) dust collector hoppers, the CBB precipitator hoppers, the regenerative air preheater (APH) and stack hoppers, and transport the ash pneumatically using two vacuum-pressure systems to two silos located in the ash waste treatment area.

One full-size vacuum-pressure system will serve the dust collector hoppers while the other full size system will serve the CBB precipitator hoppers and the APH and stack hoppers. Each transport system is capable of serving the other.

Two full-size vacuum-producing fly ash transport blowers, each driven by a 60 hp, 1,800 rpm, 460 v motor, 3 phase, 60 Hz, and two full size pressure-producing fly ash transport blowers, each driven by a 250 hp, 1,800 rpm, 460 v motor, 3 phase, 60 Hz will provide the transport air for the CBB precipitator, preheater, and stack fly ash removal systems.

Two full size vacuum-producing dust collector fly ash blowers each driven by a 60 hp, 1,800 rpm, 460 v, 3 phase, 60 Hz motor and two full size pressure-producing dust collector fly ash blowers each driven by a 250 hp, 1,800 rpm, 460 v, 3 phase, 60 Hz motor will provide the transport air for the dust collector fly ash removal system.

Each set of silos for the spent bed material and fly ash will use air assist fluidizing air when unloading. Fluidizing air will be provided for each set by two full size blowers, each driven by a 30 hp, 1,800 rpm, 400 v, 3 phase, 60 Hz motor.

Spent bed material will be used to maintain bed level in the carbon burnup bed and also to replenish a main bed should any bed be dumped. Supply material for the main beds will be provided from a tap off the bed letdown disposal system. Material for the CBB will be conveyed pneumatically via a pair of main bed holding tank air lock devices by a blower driven by a 40 hp, 1,800 rpm, 460 v, 3 phase, 60 Hz motor.

Air-operated slide gates will control the discharge of individual collection hoppers.

Pipe, valves, fittings, primary and secondary collectors, and control gates will be furnished to make a complete system.

A fly ash panel located near the bed letdown panel with a graphic display of the fly ash handling system will be provided for each system. Each panel will include pushbuttons with indicating lights required to operate and monitor the fly ash handling system. Each panel will include a pressure and vacuum recorder.

Control room annunciators and monitoring will be provided.

BLOCK NO. 8 - COAL AND LIMESTONE HANDLING AND STORAGE
EQUIPMENT

BLOCK NO. 8A - COAL HANDLING

1241.20000 Conveying Equipment

A fixed tripper will be installed on the existing 54 in. conveyors to and from the existing stacker-reclaimer.

Four (2 in series) new 54 in. 1,800 tph conveyors will be installed between the fixed trippers and the new 200 ton crusher house surge hopper.

A new 54 in., 1,800 tph, reversible shuttle conveyor will be installed to deliver the coal or limestone to new crushers.

Two new 900 tph (at 100 percent - 1/4 in.) coal crushers and associated screens, ductwork, chutes, magnets, grizzlies, etc., will be supplied. Each crusher is equipped with a 800 hp, 4,000 v, 3 phase, 60 Hz drive motor.

Two new 900 tph (at 100 percent - 8 mesh) limestone crushers and associated screens, ductwork, chutes, magnets, grizzlies, etc., will be supplied. Each crusher is equipped with a 1,000 hp, 4,000 v, 3 phase, 60 Hz drive motor.

Four (two in series) 48 in., 1,200 tph conveyors will be installed to transport crushed coal from the crusher house to the existing 48 in., 1,200 tph main powerhouse supply conveyors.

Two new 48 in., 1,200 tph tripper conveyors will be installed to fill the new left and right side coal and limestone bunkers.

Two 48 in. tripper belt conveyor extensions for delivering coal to in-plant silos of this unit will be supplied across the front of the boiler. Drive assemblies for the existing tripper conveyors will be relocated in this unit.

1241.41000 Coal and Limestone Bunkers

Coal Bunkers

Ten hours of in-plant coal storage (full load on performance coal) will be supplied as follows:

- Three 28 ft deep by 28 ft wide by 22 ft straight side four hopper bunkers
- Six 28 ft deep x 14 ft wide x 22 ft straight side two hopper bunkers
- One 14 ft deep x 14 ft wide x 22 ft straight side single hopper bunker

Limestone Bunkers

Inplant limestone storage will be supplied as follows:

- Six 28 ft deep x 18.5 ft wide x 17.5 ft straight side four hopper bunkers
- One 9 ft deep x 14 ft wide x 17.5 ft straight side single hopper bunker

Bunkers and hoppers will be made of A-242 steel with stainless steel at the bottom portion of the hoppers.

1241.49000 Bunker Gates and Accessories

The following items will be provided:

1. 50 vibrators located one at each bunker hopper outlet.
2. 50 vibrators located one at each downspout.
3. 100 chain-operated slide gates and a 24 in. downspout to the gravimetric feeders. One gate at each hopper outlet and one at the feeder inlet.
4. 50 flow detectors located at each hopper outlet.

1241.51000 Coal Handling Service Facilities Building Service

Dust Collection

The dust collection system of the previous unit will be extended to serve this unit.

Ventilation

In-plant bunkers will be provided with ventilation.

Fire Protection

The gallery above the coal bunkers will be protected by water hose stations. Heat sensors, to detect abnormally high temperature, will also be installed in the gallery to provide alarm both locally and in the control room.

1241.52000 Coal Handling Service Facilities - Electrical

Lighting will be provided in galleries across the front of the boiler and above the in-plant bunkers.

1241.72000 Coal Storage and Reclaiming Equipment - R.R. Track

The stacker-reclaimer track will not be extended for this unit.

1241.95800 Conveyor Gallery

A conveyor gallery will be furnished across the front of the boiler to join the previous unit, including superstructure, siding, roofing, and floor.

BLOCK NO. 8B - FUEL OIL EQUIPMENT (INCLUDED IN BLOCK 7A COSTS)1242.00000 FUEL OIL EQUIPMENT AND STRUCTURES1242.20000 Fuel Oil - PumpsIgnition Oil Pumps

Two full-capacity ignition oil pumps will be furnished to supply light oil to the boiler ignitors. The pumps will be located in the boiler area. The pumps will be arranged to take suction from the existing system.

BLOCK NO. 8C - FUEL GAS EQUIPMENT

There is no plan to use gas for main or ignition fuel. There is, therefore, no provision included for the combustion of fuel.

BLOCK NO. 8D - AUXILIARY FUEL STRUCTURES

A new 39 ft-6 in. x 64 ft-6 in. x 108 ft-9 in. high crusher house will be provided.

BLOCK NO. 9 - STACK1200.81000 Stack

One 616 ft high reinforced concrete shell designed to be free standing against wind loads will be provided. Seismic design will be incorporated.

A carbon steel liner will be provided.

Test connections will be provided as required for monitoring the stack gases.

A ladder located in the annular space between the concrete shell and liner will be provided from the ground to the top of the stack. Galvanized steel grating platforms will be provided as required.

1200.81400 Stack Lighting

High intensity strobe lights will be provided on the outside of the concrete shell.

Internal lighting will be provided for the ladder and for the platforms within the concrete shell.

1200.82000 Stack Foundation

The stack will have a reinforced concrete foundation supported on piles.

BLOCK NO. 10 - PRECIPITATOR1200.25200 Precipitator - ElectrostaticMAIN BED PRECIPITATORS

One hot electrostatic precipitator will be furnished in the main bed flue gas path between the boiler outlet and the regenerative air heater inlet. The precipitator will be located outdoors in four main box sections. The precipitator will be designed to handle 2,345,436 cfm of gas at 725 F. The precipitator is designed for a 3.15 ft/sec gas velocity, a 5.6 cm/sec migration velocity, four fields long by four hoppers wide, with a 99.8 percent particulate collection efficiency.

Insulation

The precipitator insulation will be prefabricated mineral fiber panel with aluminum lagging.

Foundations and Superstructure

The foundations and superstructure for the precipitator will be constructed similar to the foundations and superstructure of the main powerhouse.

CBB PRECIPITATOR - ELECTROSTATIC

One hot electrostatic precipitator will be furnished in the CBB flue gas path between the CBB mechanical dust collector and the point where the main bed and CBB gas paths join before the regenerative air heater. The precipitator will be located outdoors in one main box section. The precipitator will be designed to handle 413,950 cfm of gas at 775 F. The precipitator is designed for a 3.3 ft/sec gas velocity, a 5.32 cm/sec migration velocity, five fields long, with a 99.44 percent particulate collection efficiency.

Insulation

The precipitator insulation will be prefabricated mineral fiber panel with aluminum lagging.

Foundations and Superstructure

The foundations and superstructure for the precipitator will be constructed similar to the foundations and superstructure of the main powerhouse.

BLOCK NO. 11 - FLUE GAS DESULFURIZATION

No flue gas desulfurization is required for this plant. There is no provision included for this equipment.

BLOCK NO. 12 - TURBINE GENERATOR EQUIPMENT BY VENDOR1400.10000 Turbine Generator Unit1400.11000 Turbine Generator

The turbine will be a tandem compound, single reheat unit, with one single flow HP-IP element and two double flow LP elements with 30 in. last stage blades operating at 3,600 rpm. Generation is 592,274 kw at out steam conditions of 2,520 psig and 1,000 F at the throttle, 1,000 F single reheat exhausting at 3.9 in. Hg abs average, with full extraction for all seven stages of feedwater heating with 0.04 percent makeup and extraction steam for a full capacity turbine-driven boiler feed pump. Nameplate rating of the turbine generator will be 552,124 kw.

The turbine generator will be supplied with electrohydraulic control system and lube oil system.

The generator will be a hydrogen-cooled, 3,600 rpm, 22 kv, 3 phase, 60 Hz unit rated at 662,946 kva at 60 psig hydrogen pressure, 0.9 PF, 0.58 short circuit ratio. An Alterrex type excitation system will be furnished.

Also included with the turbine generator equipment will be a gland steam sealing system and shell and tube gland exhaust condenser with two motor-driven gland steam exhausters, supervisory instrumentation, hydrogen coolers, and other accessories necessary for a complete installation.

1400.13000 Turbine Generator - Cooling System

Hydrogen circulated through generator coolers will be used to cool the generator rotor. Hydrogen seal oil coolers will be included with the turbine generator.

1400.14000 Turbine Generator - Oil Coolers

The turbine lube oil system consists primarily of a main oil reservoir on which will be mounted two a-c auxiliary oil pumps and a d-c emergency oil pump. Also in the main oil reservoir are two full capacity tube type oil coolers. A shaft driven main oil pump is furnished as part of the front standard. Interconnecting piping, fittings, and valves are included with the turbine.

An initial oil charge will not be furnished with the turbine.

BLOCK NO. 13 - BALANCE OF TURBINE PLANT EQUIPMENT
(EXCLUDING CONDENSING AND CIRCULATING WATER EQUIPMENT)

1400.15000 Turbine Generator - Lubricating Oil Conditioning Equipment

A filter type lube oil conditioner will be furnished including a recirculating pump and motor to continuously circulate a portion of the oil from the main oil reservoir through the filter and back to the reservoir. Also a transfer pump will be furnished to transfer oil to and from "Dirty" and "Clean" oil tanks.

1400.16000 Turbine Generator - Purge System

CO2 for generator purging will be supplied from the previous unit which is equipped with an adequate high pressure system.

1400.61000 Turbine Piping and Valves

The turbine manufacturer will furnish all pipe and fittings and all necessary valves and accessories, as required, for all integral lines involved in the operation, cooling, purging, draining, venting, sampling, sealing, and lubrication of the turbine generator and auxiliary equipment furnished. All piping, fittings, and valves are to be furnished in accordance with the requirements of ANSI code for pressure piping B31.1.0.

In addition, pipes, valves, fittings, and hangers for the following systems will be provided:

- Turbine Generator Lubricating Oil
- Component Cooling Water
- Condenser Air Removal
- Gland Sealing Steam
- Miscellaneous Drains

1400.61900 Hydrogen System

Hydrogen for generator cooling shall be extended from Unit No. 3.

1400.67000 Heat Tracing

Heat tracing will be provided for certain piping and exposed parts and will be electric.

1400.69000 Pipe Insulation

The turbine manufacturer will furnish all thermal insulation and appearance lagging required to completely insulate and finish all equipment and piping provided.

Insulation will be applied where necessary for personnel protection such that the surface temperature at any point at any time does not exceed 140 F when the ambient is 100 F.

Preformed segmented pipe insulation, mineral fiber, will be provided for all steam jacketing.

Flat, brushed aluminum jacketing will be used for all hot piping, valves, and fittings, and will be sealed to prevent the absorption of oil into the insulation.

1400.81000 Turbine Generator Foundation

The turbine generator will be supported on a reinforced concrete rigid frame pedestal resting on a reinforced concrete mat supported on piles.

1400.82000 Turbine Generator Vibration Joint

A vibration joint will be laid around the periphery of the pedestal at the operating floor.

1400.84000 Miscellaneous Equipment Foundations

Reinforced concrete foundations supported on piles will be provided for the miscellaneous equipment.

All support steel and framing, platforms, walkways, and stairs will be furnished as necessary to permit access to equipment.

1400.85000 Miscellaneous Pumps and Tanks

Two full-capacity equipment cooling water pumps will be furnished. The equipment cooling water pumps will be motor-driven. The equipment cooling water system will be cross-tied to the previous unit.

The equipment cooling water system will serve the turbine generator hydrogen, lube oil, electrohydraulic fluid, stator cooling, Alterrex, generator leads, vacuum pump seal water, a bearing cooling water heat exchanger, and the bed material letdown screw conveyor coolers.

One carbon steel "Clean" oil tank and one carbon steel "Dirty" oil tank will be furnished.

1400.86000 Monorails

Monorails will be provided for equipment such as pumps and motors.

1400.89000 Painting Equipment and Piping

Steel surfaces will be shop cleaned and shop painted with a prime and finish coat. Touch-up painting will be done in the field. Items not suitable for shop cleaning and shop painting will be cleaned and painted in the field. Insulated and jacketed equipment and piping will not be painted.

1400.90000 Preliminary Operation and Test

The turbine manufacturer will provide technical direction to the Purchaser and Engineers regarding methods and procedures for the installation and start-up of this specified equipment.

BLOCK NO. 14A - SCREENWELL STRUCTURE

As the cooling tower basin will be extended to permit the circulating water pumps to return water through the circulating water system, no provision is included for a screenwell structure.

BLOCK NO. 14B - CONDENSING SYSTEM1400.20000 CONDENSING SYSTEM1400.21000 Condenser

The turbine exhaust condenser will be a transverse, dual pressure, twin shell, single pass unit with 316,359 sq ft of 7/8 in. diam, 22 gage, 48 ft, 304 stainless steel tubes. Provisions will be made for mounting four low pressure heater shells in the condenser necks. The water box design pressure will be 75 psig,

1400.22000 Condenser-Air Removal System

Noncondensibles will be extracted from the condenser by two full-capacity mechanical air removal pumps.

1400.28100 Circulating Water Pumps

Circulating water will be pumped from the cooling tower basin to the condenser by two, half-capacity, vertical, circulating water pumps each rated at 101,356 gpm and driven by 3,000 hp, 400 rpm, 4 kv motors.

1400.28200 Condensate Pumps

Two, five-eighths capacity vertical condensate pumps with motors will be furnished. Each pump will have a capacity of approximately 4,700 gpm with a total head of 1,040 ft and be driven by a 1,500 hp, 1,200 rpm, 4 kv motor. There will be no provision for a third condensate pump.

BLOCK NO. 14C - INTAKE/DISCHARGE SYSTEM1400.30000 Intake and Discharge System

Cooling water will be pumped from the cooling tower basin through the condenser and then to the discharge line with approximately 1,500 linear ft of 7 ft diam pipe. Double fixed screens will be provided instead of traveling screens.

1400.37000 Chlorination and Inhibitor Feed Systems

The liquid chlorine evaporator, chlorine solution feed equipment, and necessary controls provided with the previous unit will be used to treat the circulating water. An inhibitor feed system consisting of a 12,500 gal sulfuric acid storage tank, a 100 gal sulfuric acid feed tank, and two 1 gpm acid metering pumps will be provided to treat the circulating water in the cooling tower.

BLOCK NO. 14D - COOLING PONDS/RESERVOIRS

Since the heat rejection system utilizes cooling towers, no provision is included for heat rejection system cooling ponds or reservoirs.

BLOCK NO. 14E - COOLING TOWER1400.34000 Cooling Tower Equipment

A mechanical draft cooling tower will be provided to reject the heat from the condenser and component cooling water systems. Twelve cells, each with motor-driven fan, rated at 50/200 hp, reversible, will be designed to cool 202,700 gpm of water from 119.5 F to 91.8 F with a wet bulb temperature of 79 F (air density equal to .0705 lb/cu ft).

A reinforced concrete foundation supported on soil will be provided.

1400.34800 Makeup Water Pump

A vertical, 9,000 gpm makeup pump will be installed in the existing pump house. The pump will be driven by a 350 hp, 900 rpm, 4 kv motor. The existing makeup line from the pump house to the existing unit cooling tower will be extended to serve the tower of this unit.

BLOCK NO. 15 - WATER TREATMENT SYSTEM1200.34000 WATER TREATING EQUIPMENT

Makeup water treatment will be extended from the previous unit to serve this unit.

1200.34320 Condensate Polisher

A full flow, Powdex condensate polishing system will be provided. The polisher will consist of two half-capacity vessels complete with holding and precoat pumps, slurry mixing tank with agitator, freestanding control panel with instrumentation, control valves, and piping.

BLOCK NO. 16 - WASTE TREATMENT SYSTEMEquipment Washing and Cleaning Treatment System

Washing and cleaning wastes will be collected and pumped to existing facilities.

Sewage Treatment System

Sewage will be pumped to existing facilities.

Oil/Water Separation System

Oily wastes will be connected to existing oil/water separator facilities.

BLOCK NO. 17 ACCESSORY ELECTRICAL EQUIPMENT**1500.00000 ACCESSORY ELECTRICAL EQUIPMENT****1500.11100 Electrical Equipment Footings**

Reinforced concrete foundations supported on piles will be provided for the main step-up, unit, and reserve station service transformers, with facilities to collect spilled oil.

Concrete block partitions will be provided between the transformers.

1500.11400 Miscellaneous Supports

Miscellaneous supports will be required for the outdoor portion of the isolated phase bus duct generator leads and the 7.2 kv station service leads.

1500.11500 Electrical Structures

Duct lines will consist of 4 in. plastic conduit encased in reinforced concrete ducts and will extend underground to site locations as required. Where roadways are crossed, or where encased in concrete slabs, steel conduits will be used in duct lines. Manholes will be provided as required.

1500.12220 Generator Leads

Isolated phase bus ducts will be provided for carrying the output of the generator to the main transformer. The buses will be of the continuous, all welded type, forced cooled for use at 22 kv. The unit station service transformer will be fed from these buses by self-cooled isolated phase bus taps. The bus assemblies will include potential transformers and forced cooling units.

1500.12300 Power Cable and Accessories

Cables for 13.2 kv and 4 kv service will be copper or aluminum, shielded or unshielded, as required, with an overall jacket. Constructions will be single, triplexed, or three-conductor flame-retardant.

Cables for 480 v service will be nonshielded, flame-retardant, triplexed or three conductor copper or aluminum, as required.

Nonsegregated phase bus duct rated 15 kv, 2,000 amp will connect the 13.8 kv station service switchgear to the unit and reserve station service transformer.

Nonsegregated phase bus duct rated 5 kv, 3,000 amp, will connect the 4,160 v switchgear to the auxiliary station service transformers.

1500.12400 Control Wiring

Cable for control wiring will be single and multiconductor copper stranded with fire-resistant 90 C thermosetting insulation over each conductor and with an overall thermosetting jacket on multiconductor cables.

Instrument cables will be twisted pair and multiconductor copper with fire-resistant thermosetting insulation, shielded, with thermosetting jacket overall.

Thermocouple extension wire will be twisted pair or multiconductor of the chromel-constantan type with fire-resistant thermosetting insulation, shielded or unshielded, as required, with thermosetting jacket overall.

1500.12500 Grounding System

The grounding system will consist of 500 mcm and No. 4/0 bare copper cable with 3/4 in. by 10 ft long ground rods and will be connected to the previous unit grid.

All equipment and/or structural steel will be connected to the main ground grid as required so that the steel will essentially extend the ground system.

All equipment will be connected to the grid or building steel, as required, using 4/0 AWG or 2 AWG bare copper cables.

1500.12600 Cathodic Protection

An induced current cathodic protection system will be designed and installed for protection of pilings, buried pipelines, condensing facilities, and other buried and submerged structures as deemed necessary.

1500.13200 Conduit - Steel

Steel rigid conduits will be used in general for all conduits embedded in concrete, including duct lines under heavily trafficked areas. Conduit in concrete will be used only when a cable-in-tray installation is impractical or more expensive.

1500.13300 Conduit-Aluminum

Rigid aluminum conduit will be used in all exposed areas both indoor and outdoor.

1500.13800 Cable Trays

Cable trays, ladder type, will be aluminum for all applications. Fire stops will be provided where cable trays penetrate walls or floors.

1500.21100 Transformer - Station Service

One three-winding unit station service transformer will be provided. The transformer will be rated 70 mva, foa, 22-13.8/13.8 kv, 65 C rise, 3 phase, oil immersed, with no load taps. Each secondary winding will be rated 35 mva.

The three-winding reserve station service transformer will be rated 42/70 mva oa/foa 138-13.8/13.8 kv with no load taps. Each secondary winding will be rated 21/35 mva oa/foa.

Two auxiliary station service transformers will be provided, each rated 16 mva, oa, 13.8-4.16 kv, 65 C rise, 3 phase, oil immersed. The auxiliary station service transformers will be equipped with load tap changers.

Transformer impedance shall be as required for short circuit and motor starting considerations.

1500.21300 Lighting and Secondary Power Transformers

Lighting and secondary power transformers, as required, will be of the single phase or 3 phase, dry type, with taps, ranging in capacity from 1 kva to 30 kva.

1500.23000 Surge and Protection Equipment

The generator neutrals will be connected through neutral grounding equipment consisting of a dry type distribution transformer and secondary loaded resistor. These will be metal-enclosed and located near the generator leads bus ducts.

1500.25220 Station Service Switchgear

The 13.8 kv switchgear consists of two buses with a total of four 2,000 amp and eight 1,200 amp, 750 mva metal-clad air circuit breakers. Each bus is fed from the unit station service transformer with the capability of being fed from the reserve station service transformer for start-up, or if the normal source is out of service for any reason.

The 4,160 v switchgear consists of two buses with a total of three 3,000 amp, 350 mva class, and twenty-one 1,200 amp, 250 mva class metal-clad air circuit breakers. Each bus will be fed from the 13.8 kv switchgear through an auxiliary station service transformer. A bus tie breaker will allow both buses to be fed from one transformer for emergency operation at reduced load.

1500.25300 Unit Substations - 480 V

Ten double-ended 480 v unit substations with drawout type thermal-magnetic trip air circuit breakers will be provided. These substations will have various combinations of 1,600 amp and 600 amp breakers as required. Each substation includes two 4,160-480 v, 1,000/1,333 kva, AA/FA dry type transformers, close

coupled to the switchgear. These substations are for unit auxiliaries in the turbine, fluidized bed boiler, precipitator, and cooling tower areas. One vertical section of spare compartments for future breakers will be provided per transformer.

1500.25600 Motor Control Centers

Motor control centers will be furnished and located throughout the plant and auxiliary buildings. Approximately 35 will be required.

Each motor control center will include molded case air circuit breakers and drawout type molded case circuit breaker combination starters. The main bus will be rated 600 or 800 amp, 600 v, and the vertical buses will be rated 300 amp, 600 v. The buses will be braced to withstand a short circuit current of 22,000 amp symmetrical. Spare compartments will be reduced to a minimum.

1500.45200 Batteries and Battery Chargers

A 125 v d-c, 59 cell lead-calcium battery, rated approximately 1,800 amp/hr at the 8 hr discharge rate, will be provided to supply power to UPS inverter, emergency bearing oil pumps, emergency seal oil pumps, emergency d-c and lighting loads, controls, indicating lights, etc. A battery output voltmeter, ammeter, shunt, and ground detector will be provided.

A regulated solid-state battery charger will be furnished to recharge the battery within 12 hr while supplying the normal d-c station load. Cross-connections will be provided to enable the spare battery charger for the previous unit to also be used as a spare for this unit.

The battery and battery charger will be connected to the 125 v d-c distribution bus. The d-c system will be ungrounded.

The battery system will have sufficient capacity to permit orderly shutdown of the unit with no other power available.

One 20 kva single-phase uninterruptible power supply will be provided for continuous power requirements to vital a-c systems such as data logger, recorders, boiler controls, and burner controls.

1500.48000 Power Transformer Fire Protection

The unit station service transformer and the reserve station service transformer will be protected by automatic deluge water spray systems. Electric dual sensor detection will be provided with local alarms and alarm annunciation in the control room. Remote-manual operation of deluge valves will be from the control room.

1500.70000 INSTRUMENTS AND CONTROLS

All principal controls for the station that are essential for the operation of the unit and require manipulation, adjustment, or monitoring during normal operation will be located in the main control room.

The main control room will be located on the operating floor.

The control room will contain the main control board, the fire and ventilation control panel, coal handling system panel, and auxiliary control panel. In addition, it will contain the logging typewriter, alarm typewriter, utility typewriter, events recorder printer, and the operator's console for the unit data logger operation.

Adjoining the control room will be an electronic equipment room. This room will contain all the electronic equipment which requires air conditioning or calibration in conjunction with the various monitoring devices located in the control room. This includes the data logger cabinets, turbine electrohydraulic control cubicles, analog control cabinets, burner control cabinets, events recorder, and annunciator cabinets, uninterruptible power supply, control power panel boards, and relay panels.

1500.71000 Main Control Board

The system shall include combination bench and vertical type control board in a central control room for this and the previous units. The main control board arrangement of this unit will be similar to that of the previous unit. The board shall contain instruments and controls for the major control systems, together with generator and station service power metering and miscellaneous controls.

Included in the front vertical section shall be the turbine supervisory instrumentation, monitoring instrumentation for the fluidized bed steam generator, illuminated annunciator units mounted near the top of the panel, and turbine water induction protection controls.

The rear vertical section shall include protective relays for the generator and transformers, metering and totalizing equipment, and a d-c distribution panel.

The benchboard section shall include the turbine electrohydraulic controls and controls for major auxiliary equipment, including the bed segment management system and boiler, and turbine control system.

Miniaturized control recording/indicating devices will be used, wherever possible, to assure maximum reliability, and the location of the devices on the boards shall allow the operator to view the alarms and major variables. The boards shall be

designed for operation by a standing operator. Voltages over 125 v and high pressure steam, water, air, or gas will not be used in the control room.

Auxiliary Control Panels

Located in the main control room there will also be auxiliary control panels which shall include instruments and controls and comprise various sections of the miscellaneous control board. These panels shall include:

1. Fly Ash and Bed Letdown Handling System Monitoring Panel
2. Cooling Tower Control Panel
3. Fire Protection System Panel
4. Soot Blower Control Panel
5. HVAC Control Panel

An auxiliary system electrical board will be adjacent to the miscellaneous control board and shall be complete with mimic bus and bench controls.

Miscellaneous Panels

Transmitter and instrument racks shall be located about the plant for mounting of instrumentation for associated equipment not located in the main control room. In addition, there will be located in the plant the following control panels and cabinets:

1. Generator Hydrogen and Seal Oil Panel
2. Bed Letdown and Fly Ash Handling Control Panels
3. Chemical Feed Control Panel
4. Water and Steam Sample Panel
5. Electrostatic Precipitator Panel
6. HVAC Panel

1500.72000 Instrumentation and Controls

Major control systems shall be electronic and part of the centralized controls in the main control room. Local control systems will be pneumatic and rack mounted where possible. Electric drives will be used, where suitable, taking economics into consideration.

A plant manual containing loop, logic, and elementary electrical diagrams, instrument list and data sheets, flow diagrams, heat balances, and computer information will be provided for personnel training.

INSTRUMENTS AND CONTROLS - MAJOR SYSTEMS

Boiler-Turbine Control System

A control system utilizing solid state electronic control components will be provided for boiler-turbine control and

miscellaneous systems. Transfers to and from the automatic and manual control modes will be bumpless. The boiler-turbine control system will place megawatt load demands on the turbine valves from either a load dispatch system or operator setting, while the throttle-pressure error will be used for the boiler load demand.

The system will be capable of operating in the boiler following control mode. Runbacks will be provided to limit the boiler and turbine load in the event of unbalance in the various systems, such as loss of one FD fan, loss of one ID fan, etc.

Steam Temperature Control

The system will provide full automatic or manual control of superheat and reheat temperature. Reheat temperature will be primarily controlled by bypass dampers and spray attemperation. Superheat temperature will be maintained by spray attemperation and adjustment of firing rate in the superheater beds.

Deaerator Level Control

A three-element level control system will be provided. The control system will operate two control valves sequentially. One valve will modulate to control the deaerator level up to approximately 50 percent load. The second valve will modulate to control deaerator level from approximately 50 percent load to maximum load.

Solid-state electronic controls will be provided with remote manual stations located on the main control board. Final operators will be pneumatic with electropneumatic converters.

Feedwater Control

A three-element feedwater control system will be provided to maintain proper flow to the boiler. The system combines steam flow, boiler drum level, and feedwater flow signals for automatic or manual control of the turbine-driven boiler feed pump. A feedwater regulator bypass control valve is provided for initial fill of the feedwater system and unit start-up.

Combustion Control

Combustion controls will be provided to maintain proper fuel and combustion airflow to generate the steam required while maintaining safe conditions. Coal feed and airflow will be regulated in response to Mw load change. The bed temperature will be used to trim fuel flow demand so that the bed temperature can be maintained within designed limits. Air flow is controlled to provide constant bed expansion. Air flow will be trimmed to maintain proper excess oxygen. Oxygen will be measured for each of the five beds.

Solid-state electronic controls will be provided with remote manual stations located on the main control board.

Bed Segment Control

A solid-state bed segment control system will be provided to safely light off the steam generator and to provide sequential operation of bed segments as a function of load. Purging will be incorporated as a precautionary measure. A preprogrammed logic for determining the optimum number of bed segments required and their sequence of firing will be included as a part of the control scheme to achieve the most efficient boiler operation.

The controls for operating the system will be mounted on the main control board. The control subpanel indicators and indicating lights will track the steps during sequential bed segment loading.

Bed Material Letdown Control

A control system will be provided to regulate bed material inventory by control of limestone feed rate and material dump feeder speed. Limestone feed rate will be primarily adjusted from the coal feed via a ratio controller based on coal sample analysis.

Solid-state electronic controls will be provided with remote manual stations located on the main control board.

Carbon Burnup Bed Controls

CBB will be controlled to maintain a constant bed temperature. The fly ash (char) feed to CBB as available from the main beds is continuous but not controlled. The temperature in CBB will be controlled by modulating the bed level and/or coal feed. Bed level will be measured by means of differential pressure transmitter. Cell excess oxygen is monitored to maintain oxygen within limits.

Solid-state electronic controls will be provided with remote manual stations located on the main control board.

Combustion Air Preheater Control System

Steam to the combustion air preheaters will be supplied from a turbine extraction stage with automatic backup of steam at reduced pressure from the auxiliary steam system. Average cold-end air preheater temperature will be used as an index of steam flow requirements. Condensed steam from the coil heaters will pass to the main condenser via two drain receivers and receiver level control valves.

Solid-state electronic controls will be provided with remote manual stations located on the main control board. Final operators will be pneumatic with electropneumatic converters.

Air Heater Cold-End Temperature Control

Two automatic control systems will be provided, one for each air heater. The cold-end temperature for each system will be obtained from six chromel-constantan thermocouples located in the air duct to the air heater and in the flue gas duct from the air heater. The temperature will be averaged and compared to a set point.

Solid-state electronic controls will be provided with remote manual stations located on the main control board.

Final operators will be pneumatic with electropneumatic converters.

Draft Control

A complete draft control system will be provided to maintain a constant pressure at the inlet to the transverse convection pass at steady state conditions and to minimize deviations during transient disturbances. The system will maintain draft consistent with the steam generator design by modulating the inlet louvers of the induced draft fans as required.

Draft will be measured at the tap in the transverse convection pass as recommended by the steam generator manufacturer.

Solid-state electronic controls will be provided with remote manual stations located on the main control board.

Final drive units will be pneumatic with electropneumatic converters.

Main Boiler Feed Pump Recirculation Control

A recirculation control system will be provided to maintain minimum flow through the main boiler feed pumps whenever the feedwater flow to the boiler is below that required by the boiler feed pumps for protection of the pump internals.

A primary flow metering device (orifice plate) at the suction side of the pumps will provide for a measurement of flow. The flow measurement will be utilized to operate a modulating recirculation control system.

The control system will operate the recirculation control valve.

An override OPEN-AUTO switch will be provided on the main control board for remote operation of this system.

All controls will be mounted locally and will be pneumatically operated.

The final operator will be pneumatically actuated and open on air failure or power failure.

Condensate Recirculation Control

A recirculation control system will be provided to maintain a specified minimum flow through the condensate pumps and the gland steam condenser. The condensate recirculation will be based on the minimum flow requirement of the condensate pumps or the gland steam condenser, whichever is higher.

A primary flow metering device (orifice plate) at the inlet of the gland steam condenser will provide for a measurement of flow. The flow measurement will be utilized to modulate the recirculation valve as required to maintain the flow requirements.

The controls for this system will be mounted locally and will be pneumatically operated.

The condensate recirculation valve will be pneumatically actuated and will open on air failure.

Turbine Lube Oil Temperature Control

A control system will be provided to maintain the temperature of the lube oil leaving the lube oil coolers at a preselected value recommended by the turbine manufacturer. Two completely separate control systems will be furnished, one for the main turbine and one for the boiler feed pump turbine.

The systems will control the lube oil temperature leaving the respective coolers by modulating pneumatically operated control valves in each common cooling water discharge line from the coolers. The temperature control will be based on the temperatures of the lube oil in each common header downstream of the coolers.

All controls will be mounted locally and be pneumatically operated.

Generator Hydrogen Temperature Control

A control system will be provided to maintain the temperature of the hydrogen leaving the coolers at a preselected value recommended by the turbine generator manufacturer.

The system will control the hydrogen temperature leaving the coolers by modulating a pneumatically actuated control valve in the common cooling water discharge line from the coolers. The temperature control will be based on the temperature of the hydrogen in the common cold hydrogen stream leaving the coolers.

All controls will be mounted locally and be pneumatically operated.

Heater Drains Control

A control system will be provided for each heater in the condensate and feedwater system to maintain the level in the heater at a preselected value.

The systems will control the level in the heaters external to the condenser neck by modulating the drain valve for that heater. An alarm will be provided for high level plus contacts which will initiate the closing of the upstream drain valve.

On extreme high level, the control systems will initiate the following actions:

1. Close extraction line nonreturn valve.
2. Close extraction line motor-operated block valve.
3. Open extraction line drain valve.

For the highest point condenser neck heaters, the systems will control the level in the drain coolers by modulating the control valve and alarm on high level. On extreme high level, the control systems will initiate the opening of the condensate line motor-operated bypass valve.

For the lowest point condenser neck heaters, the system will alarm at high level and on extreme high level will initiate the opening of the condensate line motor-operated bypass valve.

All controls will be mounted locally and will be pneumatically operated.

Final operators will be pneumatically actuated.

Turbine Control

The turbine-generator will be equipped with an electrohydraulic control system that will provide load, speed or acceleration control, and emergency functions which trip the unit on overspeed, low vacuum, thrust bearing wear, and low bearing oil pressure. An operator's subpanel, mounted on the main control

board, will be included as part of the system and will contain the operating, monitoring, and testing controls. A control cabinet containing the solid-state integrated circuits will be located in a room directly adjacent to the unit control room. A hydraulic power supply unit will be located on the ground floor elevation.

A turbine supervisory system will be located in the unit control room which will provide the following monitoring and alarming functions: vibration, eccentricity, spindle position, control valve position, speed, and rotor position. A turbine metal temperature recorder will be provided to guide turbine metal and main steam temperature matching.

The following auxiliary systems will be provided with remote panels: hydrogen seal oil system and emergency seal oil pumps, hydrogen pressure and purity, and hydrogen dryers.

Turbine generator bearing and oil temperatures will be monitored by the plant data logger.

Annunciator and Sequence of Events Printer

A coordinated control room annunciator and events printer will be provided consisting of all solid state equipment.

The alarms will be coordinated by means of logical groupings in respect to location of corresponding controls, importance, and required response time to the alarm. Additionally, alarms will be grouped under a common window with the particular alarm identified by the events printer.

Turbine Bypass Control

A turbine bypass control system is required as a prerequisite to maintain flow and temperature conditions through the fired bed segments. The turbine bypass control valve will operate to maintain the minimum flow through the boiler during start-up and shutdown.

The turbine bypass control system will include spray attemperations for temperature matching of the bypass steam flow with the flow at the condenser.

Solid-state electronic controls will be provided with remote manual stations located on the main control board. Final operators will be pneumatic with electropneumatic converters.

Drum Level Television System

A closed circuit TV system will be provided to monitor the drum level. The CRT receivers for this system will be located in the main control room.

Instruments

Sufficient instrumentation will be provided to permit safe operation of the unit when the central information system is out of service. The monitoring devices for these instruments will be located on the main control board or at local stations, depending upon their degree of importance.

A maximum of local instrumentation will be provided for local monitoring and equipment calibration. These devices will be primarily thermometers and pressure gages.

Environmental Source Monitoring System

Environmental source monitoring will be in accordance with current Environmental Protection Agency requirements.

The SO₂, NO₂, oxygen, and opacity taken from the downstream side of the scrubber will be monitored and recorded by the data logging system. Sampling connections for SO₂, NO₂, oxygen, and particulate will be provided. A strip chart recorder for oxygen and opacity meter for smoke density will also be provided.

1500.73000 Computer System

A data logger monitoring system will be provided to monitor and log the various plant parameters. The system will contain the following monitoring devices: an operator's console, a logging typewriter, an alarm typewriter, a utility typewriter, and two CRTs.

The system will be capable of performing the following functions: scan-alarm of analog and digital inputs, periodic log, demand log, group review, post-mortem review, analog trend recording (4 points), and digital trend plus performance calculation, and turbine monitoring. Application software is not included.

The system will be used for analog and digital inputs, and those contact closures used for initiating the post-mortem review. The system may also be used for operating guides.

1500.76000 Instruments, Tubing, and Wiring

Tubing, piping, fittings, valves, and instrument support materials will be provided. As many as possible or all transmitters, switches, and associated equipment will be located on local racks or panels. Level controls for the condensate receiver, deaerator storage tank, and feedwater heaters will be installed on standpipes.

In general, primary sensing lines and sampling lines will be fabricated from stainless steel tubing; whereas air supply and control signal tubing will be of copper. Since most instrumentation is electronic, copper tubing will be used only

for local control loops, such as heater level controls and simple pressure and temperature controls.

Heat tracing will be provided for all outdoor primary sensing lines.

BLOCK NO. 18 - MISCELLANEOUS POWER PLANT EQUIPMENT1600.00000 - MISCELLANEOUS POWER PLANT EQUIPMENT1600.100000 Turbine Room Traveling Crane

The existing crane furnished for the previous unit will be extended to serve this unit.

1600.20000 COMPRESSED AIR SYSTEM1600.21000 Compressors and Auxiliaries

The compressed air systems, including instrument, service, and soot-blowing air will be extended from existing facilities to serve this unit. No new air compressors will be furnished but a 4,160 v feeder will be furnished to supply one of the existing 4,500 hp air compressors from the auxiliary system of this unit.

1600.26000 Air Piping Valves and Fittings

All air system piping, valves, and fittings will be provided.

1600.41000 Shop Equipment

Existing site shop equipment will serve this unit.

1600.47000 Auxiliary Steam

Auxiliary steam will be supplied from existing facilities.

1600.70000 - Plant Communication and Signal System

Conduit and junction boxes will be provided for the plant communications system. Wiring and equipment will be furnished by others.

1600.89000 - Painting

Steel surfaces will be shop cleaned and shop painted with a primer and finish coat. Touch-up painting will be done in the field. Items not suitable for shop cleaning and shop painting will be cleaned and painted in the field. Insulated and jacketed equipment and piping will not be painted.

BLOCK NO. 19 - SUBSTATIONS5300 SUBSTATION AND SWITCHING STATION EQUIPMENT5300.10000 Connections, Supports, and Structures

Reinforced concrete foundations supported on piles will be provided for the main transformer with facilities to collect spilled oil.

Structures will be provided to facilitate takeoff of the high voltage lines from the main transformer.

All 345 kv lines, equipment, and associated relays will be by others. Controls and instruments located on boards in the main control room and wiring terminated on these boards will be provided.

One breaker position will be added by others to the existing 138 kv switchyard for the tie to the reserve station service transformer. This addition will include a disconnecting switch, a circuit breaker, pot heads, and solid dielectric power cable, relays, controls, and accessories required to provide a complete termination for this unit's reserve station service transformer leads consisting of three single conductors and one spare.

Relay panels will be added to the existing control house for the control of the above switchyard breakers.

5300.21000 Transformers

The main generator step-up transformer will be 3 phase, 580 mva FOA, 65 C temperature rise, 22-345 kv with no-load taps. Lightning arresters and auxiliary equipment will be provided.

5300.48000 Fire Protection

The main transformer will be protected by an automatic deluge water spray system. Electric dual sensor detectors will be provided with local alarms and alarm annunciation in the control room. Operation of the deluge valve will be accomplished by remote-manual means from the control room.

BLOCK NO. 20 - TRANSMISSION LINES

No provision is included for the installation, relocation, or removal of transmission lines.

APPENDIX IIIA-B
SYSTEM DESCRIPTIONS

J.O. No. 12919.02A

SYSTEM DESCRIPTION 2-1
CIRCULATING WATER - B&W

1.0 System Requirements

1.1 Function

The circulating water system removes heat from the condenser and releases it to the atmosphere through the cooling tower. In addition, the tower is utilized to release the heat collected by the component cooling water system.

1.2 Design Requirements

1.2.1 General

The circulating water system will be designed for reliable power generation.

The type and number of pumps, towers, condensers and tubes will be consistent with high reliability, operating flexibility and combined minimum investment, performance penalty and environmental impact.

1.2.2 Codes and Standards

The circulating water pumps will be designed to the Hydraulic Institute Standard and all other codes and standards referenced in specification P121N.

The condensers will be designed to the Heat Exchange Institute Standards for Surface Condensers and all other codes and standards referenced in specification P111V.

The cooling tower will be designed to the Cooling Tower Manufacturers Association Standards for cooling towers and all other codes and standards referenced in specification S106B.

The circulating water piping and valves will be designed to the codes and standards referenced in specifications S107A/S107F and P302Q.

All other system components will be designed to all codes and standards referenced in the specification(s) in Section 7.02.

1.2.3 Specific Requirements

The circulating water system will be designed to 105 ft H₂O at 92 F and full vacuum.

The circulating water system is designed to permit continued unit operation without exceeding 5.0 in. HgA back pressure or requiring load reduction on the design day with a wet bulb temperature of 79/82 F.

The cooling tower is designed to reject 2.749×10^9 Btu/hr at a flow rate of 202,730 gpm on the design day while maintaining a cold water basin temperature of 92 F.

The pump discharge valve will be interlocked with the pump motor to prevent backflow through the pump on start-up, shutdown or trip.

The inlet water box butterfly valves are interlocked with the outlet water box valves to minimize hydraulic shocks to the condenser and expansion joints.

Spare pumping or cooling tower capacity is not required.

2.0 System Design

2.1 Detailed System Description

Refer to Flow Diagram 12919.01-EM-110A.

Two 101,365 gpm, 105 ft TDH, vertical centrifugal pumps take water from the cooling tower basin and discharge into one line. The line passes into the water boxes of the low pressure condenser; the water then passes to the inlet of the high pressure condenser. The condenser is a transverse, dual pressure, twin shell, single pass unit with 316,354 sq ft of 7/8 in. diam, 22 gage, 48 ft, 304 stainless steel tubes.

The water then flows to the mechanical draft cooling tower to cool the circulating water. The cooling tower is provided with 12 cells, each with a motor-driven fan rated at 50/200 hp, reversible and is designed to cool 202,730 gpm of water from 125 F to 92 F with a wet bulb temperature of 79 F.

Motor-operated valves are supplied at the discharge of the pumps.

The discharge of each pump and the inlet and outlet water boxes are equipped with an expansion joint.

Removable screens and stop logs are supplied for each pump to permit isolation for maintenance and protection against large materials entering the pumps.

2.2 Performance Characteristics

The performance characteristics of the system components will be as included in the specifications, manufacturers' drawings, instructions and/or operation books referenced in Section 7.02.

The predicted tower plume, drift and freezing data are included in the study report PS-6.

2.3 Arrangement

The schematic piping, wiring and tubing arrangement shall be as noted on the flow diagrams, elementary diagrams and loop diagrams referenced in Sections 7.03, 7.08, and 7.05, respectively.

The physical arrangement of the system, machinery and other equipment will be as noted on the piping, machine location and manufacturers' drawings referenced in Sections 7.07, 7.06, and 7.02, respectively.

2.4 Component Design

The bases of design of each component shall be as included in the specification(s) and the manufacturers' drawings, specifications and/or information referenced in Section 7.02.

2.5 Instrumentation and Controls

2.5.1 General

The specific design of the instrument and control components shall be as described in the specification and shown on the drawings referenced in the Instrument Schedule for that component.

The description of the system control and monitoring functions will be as shown and described in the logic diagrams and control descriptions referenced in Section 7.04.

2.5.2 Testability

All circulating water system components are normally in service.

2.5.3 Specific Regulatory Requirements

There are no regulatory requirements specifically applicable to the circulating water system.

2.6 System Interfaces

The system interfaces with the following other plant systems:

<u>Title</u>	<u>Number</u>
Condenser Air Removal	5-1

3.0 System Limitations, Set Points, and Precautions

Failure of one circulating water pump at full load operation will require load reduction.

The circulating water pumps will have to be tripped manually when the basin level falls 2 ft below normal water level.

4.0 System Operation

4.1 Filling

The basin is filled using the normal tower basin makeup valve (4LCV18) in approximately 6 hr using two makeup water pumps.

4.2 Start-up

Circulating water pump should be started one at a time in any order. The pump discharge valve will automatically open on a start signal to the pump.

The condenser inlet and outlet water box and cooling tower return valves should be opened.

4.3 Shutdown

The system is shut down in the reverse order described in 4.2 above.

Any side of the condenser may be isolated by closing the inlet water box isolation valve and then the corresponding outlet water box isolation valve.

5.0 Safety Features for Potential Emergencies

Not applicable

6.0 System Maintenance

The system components should be maintained in accordance with the manufacturers' operating, instruction and/or maintenance books.

7.0 Appendix

7.01 General

7.01.1 Summary of Design Conditions

7.01.2 Line Designation Table No.

7.01.3 Instrument Schedule

7.02 Specification(s)/Purchase Orders/Manufacturers' Print Prefix

E015E	4,160 V Switchgear
E041A	4 Kv Motors
P111V	Condenser
P121N	Circulating Water Pump
P302Q	Motor Operated Flanged Butterfly Valves
P305P	Rubber Expansion Joints
S106B	Mechanical Draft Cooling Tower
S106U	Stop Logs
S107A	Circulating Water Pipe
S107F	Circulating Water Pipe

7.03 Flow Diagrams

<u>Number</u>	<u>Title</u>
12919.01-EM-110A	Circulating & Makeup Water & Condenser Air Removal

7.04 Logic Diagrams

<u>Number</u>	<u>Title</u>
Later	Later

7.05 Loop Diagrams

<u>Number</u>	<u>Title</u>
Later	Later

7.06 Machine Location Drawings

<u>Number</u>	<u>Title</u>
129 19.02A-EM-202	Boiler Area Machine Location
129 19.02A-EM-203	Turbine Area Machine Location

7.07 Piping Drawings

<u>Number</u>	<u>Title</u>
129 19.02A-EP-202	Boiler Area Piping Composites

7.08 Electrical Drawings

<u>Number</u>	<u>Title</u>
129 19.02A-EE-612A,B,C	Cable Tray Arrangements, Boiler Area

7.09 Engineering Sketches and Other Engineering Information

7.09.3 Other

J.O. No. 12919.02A

Oct. , 1977

SYSTEM DESCRIPTION 3-1
MAIN STEAM - B&W
ERDA - AFB STUDY

1.0 System Requirements

1.1 Function

The main steam system transports steam from the boiler, superheat-outlet to the turbine.

1.2 Design Requirements

1.2.1 General

The main steam system is designed for reliable power generation.

1.2.2 Codes and Standards

The main steam system downstream of the main steam stop valve inlet up to but not including the turbine stop valves will be designed in accordance with ANSI B.31.1.0 and all codes and standards referenced in specification P301B.

All piping downstream of and including the turbine stop valves will be designed to the turbine manufacturer's standards.

All other system components will be designed to the codes and standards referenced in the specification(s) in Section 7.02.

1.2.3 Specific Requirements

The main steam system will be designed to set safety valve 2,620 psig at 1,005 F.

The main steam system pressure drop from the outboard isolation valve to the turbine stop valve shall not exceed 100 psi at rated flow conditions.

2.0 System Design

2.1 Detailed System Description

Refer to flow diagram 12919.02A-EM-102A.

The main steam system consists of a single header extending from two superheater outlets to the two turbine stop valves.

A motor-operated main steam stop valve is installed in main steam line to isolate the boiler from the environs.

Two spring loaded safety and one electromatic relief valves are installed on the main steam lines between the boiler and the turbine stop valve to prevent boiler main steam line overpressure (System Description 32-8). The electromatic valve will provide overpressure relief whenever required and thereby forego the operation of the safety valves on the drum and main steam leads.

The single header splits into two lines to the two turbine stop valves.

The two main steam lines are then joined in a manifold to permit pressure equalization and flow distribution to the turbine.

The stop valves are piped to the high pressure turbine through four turbine control valves. The turbine stop and control valves will close on any turbine trip. The control valves modulate the flow to the turbine to maintain the turbine speed, load, and boiler pressure.

A line is piped to the HP turbine drive for the boiler feed pump.

The main steam system is drained at several points (System Description 32-5) to prevent line quenching and turbine water induction and to permit line preheating.

Turbine Start-Up

During start-up, it is necessary to assure a minimum flow of 40 percent MCR flow through the superheater. This is accomplished as follows:

The turbine bypass valve is modulated to pass the difference between 40 percent MCR flow and HP turbine flow. This flow is desuperheated and introduced into the condenser. The turbine bypass closes on a boiler or turbine trip.

Boiler or Turbine Trip

On a boiler on turbine trip, the main steam crossover line to cold reheat and hot reheat crossover to condenser are opened to assure superheater and reheater cooling as the residual carbon in the bed is burned out.

2.2 Performance Characteristics

The performance characteristics of the system components are as included in the ammended specifications, manufacturer's drawings, instructions, and/or operation books referenced in Section 7.02.

2.3 Arrangement

The schematic piping and electrical arrangement and instrumentation is as noted on the flow diagrams and loop diagrams referenced in Sections 7.03, 7.05, and 7.08, respectively.

The physical arrangement of the system, machinery, and other equipment is as noted on the piping, machine location, and manufacturer's drawings referenced in Sections 7.07, 7.06, and 7.02, respectively.

2.4 Component Design

The bases of design of each component are as included in the specification(s) and the manufacturer's drawings, specifications, and/or information referenced in Section 7.02.

2.5 Instrumentation and Controls

2.5.1 General

The specific design of the instrument and control components are as described in the specification and shown on the drawings referenced in the Instrument Schedule for that component.

The description of the system control and monitoring functions shall be as shown and described in the logic diagrams and control descriptions referenced in Section 7.04.

2.5.1.2 Design Information

2.5.2 Testability

Each main steam stop valve, turbine stop valve, and turbine control valve is equipped with test circuits which permit closure to prove operability.

2.5.3 Specific Regulatory Requirements

None

2.6 System Interfaces

The system interfaces with the following other plant systems:

<u>System Title</u>	<u>System Number</u>
Cold Reheat	3-2
Hot Reheat	3-3
Extraction Steam	3-4
Miscellaneous Turbine Building Drains	11-1
Main Steam Safety Valve Vents and Drains	11-4

3.0 System Limitations, Set Points, and Precautions

Refer to the loop and logic diagrams for the set point of specific instruments.

4.0 System Operation

Refer to turbine manufacturer's operation instruction for operation of the main steam system.

5.0 Safety Features for Potential Emergencies

Not Applicable

6.0 System Maintenance

All system components should be maintained in accordance with the manufacturer's operating instruction and/or maintenance books.

7.0 Appendix

7.01 General

7.01.1 Summary of Design Conditions

7.01.2 Line Designation Table No. 4MSS

7.01.3 Instrument Schedule

**7.02 Specification(s)/Purchase Orders/Manufacturer's
Drawing Prefix**

<u>Number</u>	<u>Title</u>
P301B	Shop Fabricated Piping
P301C	Field Erection of Piping
P301H	Material for Main Steam Pipe
P301N	Design & Fabrication of Piping Supports
P301P	Main Steam, Feedwater Sliding Restraints

7.03 Flow Diagrams

<u>Number</u>	<u>Title</u>
12919.02A-EM-102A	Main Steam and Reheat

7.04 Logic Diagrams

<u>Number</u>	<u>Title</u>
12919.02A-LSK-18.5H	Steam to Reheat Turbine Bypass and Spray Control

7.05 Loop Diagrams

<u>Number</u>	<u>Title</u>
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7.06 Machine Location Drawings

<u>Number</u>	<u>Title</u>
12919.02A-EM-202	Boiler Area Machine Location
12919.02A-EM-203	Turbine Area Machine Location

7.07 Piping Drawings

<u>Number</u>	<u>Title</u>
12919.02A-EP-202	Boiler Area Piping Composites

7.08 Electrical Drawings

<u>Number</u>	<u>Title</u>
12919.02A-EE-612A,B,C	Cable Tray Arrangements, Boiler Area

7.09 Engineering Sketches and Other Information

7.09.1 Heat Balances

<u>Number</u>	<u>Title</u>
12919.02A-HRSK-1	Turbine VWO
12919.02A-HBSK-2	75% Turbine VWO
12919.02A-HBSK-3	50% Turbine VWO
12919.02A-HBSK-7	25% Turbine VWO

7.09.2 Stress Analysis

<u>Number</u>	<u>Title</u>
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7.09.3 Other

<u>Number</u>	<u>Title</u>
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J.O. No. 12919.02A

October 1977

SYSTEM DESCRIPTION 3-2
COLD REHEAT - B&W
ERDA AFB STUDY

1.0 System Requirements

1.1 Function

The cold reheat system transports steam from the high pressure turbine exhaust to the boiler reheater and maintains the hot reheat steam temperature.

1.2 Design Requirements

1.2.1 General

The cold reheat system is designed for reliable power generation.

1.2.2 Codes and Standards

All piping will be designed to ANSI B31.1.0 and all codes and standards referenced in Specification P301B.

1.2.3 Specific Requirements

The system will be designed to 600 psia at 625 F and full vacuum.

The system pressure drop will not exceed 8 psi at rated boiler conditions.

2.0 System Design

2.1 Detailed System Description

Refer to Flow Diagram 12919.02A-EM-102A.

A single cold reheat line is piped from the high pressure turbine to the reheaters. The turbine header has double leads.

Auxiliary steam is taken off of the cold reheat line.

Six safety valves are installed on the cold reheat line.

Extraction steam for the first point extraction is taken off of the cold reheat line and piped to the heater (System Description 3-4).

Turbine Startup

During startup, it is necessary to assure a minimum flow or 40 percent MCR flow through the superheater. This is accomplished as follows:

The turbine bypass valve is modulated to pass the difference between 40 percent MCR flow and HP turbine flow. This flow is desuperheated and introduced into the condenser. The turbine bypass closes on a boiler or turbine trip.

Boiler or Turbine Trip

On a boiler or turbine trip, the main steam crossover line to cold reheat and hot reheat crossover to condenser are opened to assure superheater and reheater cooling as the residual carbon in the bed is burned out.

2.2 Performance Characteristics

The performance characteristics of the system components are as included in the specifications, manufacturer's drawings, instructions, and/or operation books referenced in Section 7.02.

2.3 Arrangement

The schematic piping and wiring arrangement is as noted on the flow diagrams and elementary diagrams referenced in Sections 7.03 and 7.08.1, respectively.

The physical arrangement of the system, machinery and other equipment is as noted on the piping, machine location, and manufacturer's drawings referenced in Sections 7.07, 7.06, and 7.02, respectively.

2.4 Component Design

The bases of design of each component are as included in the specification(s) and the manufacturer's drawings, specifications, and/or information referenced in Section 7.02.

2.5 Instrumentation and Controls

2.5.1 General

The specific design of the instrument and control components is as described in the specification and shown on the drawings referenced in the Instrument Schedule for that component.

The description of the system control and monitoring functions shall be as shown and described in the logic diagrams and control descriptions referenced in Section 7.04.

2.5.2 Testability

(Later)

2.5.3 Specific Regulatory Requirements

There are no regulatory requirements specifically applicable to the cold reheat system.

2.6 System Interfaces

The cold reheat system interfaces with the following other plant systems:

<u>System Title</u>	<u>System Number</u>
Main Steam	3-1
Hot Reheat System	3-3
Extraction Steam	3-4
Auxiliary Steam System	3-7
Drains to the Condenser	11-1
Boiler Safety Valve Vents	11-4
Turbine Bypass	3-1, 3-3

3.0 System Limitations, Set Points, and Precautions

Refer to the loop and logic diagrams for the set points of specific instruments.

4.0 System Operation

Refer to the turbine manufacturer's operating instruction for operation of the cold reheat system.

5.0 Safety Features for Potential Emergencies

Not applicable

6.0 System Maintenance

The system and its components should be maintained in accordance with the manufacturer's operating and/or maintenance instructions.

7.0 Appendix

7.01 General

7.01.1 Summary of Design Conditions

7.01.2 Line Designation Table No. 4 CRS

7.01.3 Instrument Schedule

**7.02 Specification(s)/Purchase Orders/Manufacturer's
Drawing Prefix**

P103D	Turbine Generator
P301N	Design and Fabrication of Piping Supports

7.03 Flow Diagrams

<u>Number</u>	<u>Title</u>
12919.02A-EM-102A	Main Steam and Reheat

7.04 Logic Diagrams

<u>Number</u>	<u>Title</u>
12919.02A-LSK-18.5H	Steam to Reheat Turbine Bypass & Spray Control

7.05 Loop Diagrams

Later

7.06 Machine Location Drawings

<u>Number</u>	<u>Title</u>
12919.02A-EM-203	Turbine Room Machine Locations
12919.02A-EM-202	Boiler Area Machine Locations

7.07 Piping Drawings

<u>Number</u>	<u>Title</u>
12919.02A-EP-202	Boiler Area Piping Composites

7.08 Electrical Drawings

<u>Number</u>	<u>Title</u>
12919.02A-612A,B,C	Cable Tray Arrange- ments, Boiler Area

7.09 Engineering Sketches and Other Information

7.09.1 Heat Balances

Number

Title

12919.02A-HBSK-1

Turbine VWO

12919.02A-HBSK-2

75% Turbine VWO

12919.02A-HBSK-3

50% Turbine VWO

12919.02A-HBSK-4

25% Turbine VWO

7.09.2 Stress Analysis

7.09.3 Other

J.O. No. 12919.02A

October 1977

SYSTEM DESCRIPTION 3-3
HOT REHEAT - B&W
ERDA AFB STUDY

1.0 System Requirements

1.1 Function

The function of the hot reheat system is to transport steam from the boiler reheater to the IP turbine stop/intercept valves.

1.2 Design Requirements

1.2.1 General

The hot reheat system is designed for reliable power generation.

1.2.2 Codes and Standards

All piping from the reheater outlet connection up to the stop/intercept valves will be designed to ANSI B31.1.0 and all codes and standards noted in Specification P301B.

All piping and components downstream and including the stop/intercept valves are designed to General Electric Company, Large Steam Turbine Division Standards.

1.2.3 Specific Requirements

The system will be designed to 560 psia at 1005 F.

The hot reheat system pressure drop will not exceed 25 psi at rated boiler conditions.

2.0 System Design

2.1 Detailed System Description

Refer to flow diagram 12919.02A-EM-102A.

The reheater section of the boiler receives steam from the high pressure turbine via the cold reheat system (System Description 3-2).

A single hot reheat line transports the steam to the intermediate pressure turbines through a combined stop-control valve called the combined reheat valve (CRV). The turbine header has double leads.

The two CRV's modulate on turbine overspeed and close on turbine trip.

Two electromatic relief and two safety relief valves are installed on the discharge line of the reheater to prevent system overpressure (System Description 32-8).

Turbine Startup

During startup, it is necessary to assure a minimum flow of 40 percent of MCR flow through the superheater. This is accomplished as follows:

The turbine bypass valve is modulated to pass the difference between 40 percent MCR flow and HP turbine flow. This flow is desuperheated and introduced into the condenser. The turbine bypass closes on a boiler or turbine trip.

Boiler or Turbine Trip

On a boiler or turbine trip, the main steam crossover line to cold reheat and hot reheat crossover to condenser are opened to assure superheater and reheater cooling as the residual carbon in the bed is burned out.

2.2 Performance Characteristics

The performance characteristics of the system components are as included in the turbine manufacturer's heat balance, manufacturers' drawings, instructions and operation books, and the Engineers' heat balances referenced in Section 7.09.1.

2.3 Arrangement

The schematic piping and instrumentation arrangement is as noted on the flow diagrams referenced in Section 7.03.

The physical arrangement of the system, machinery, and other equipment is as noted on the piping, machine location, and manufacturers' drawings referenced in Sections 7.07, 7.06, and 7.02, respectively.

2.4 Component Design

The bases of design of each component are as included in the specification(s) and the manufacturers' drawings, specirications, and/or information referenced in Section 7.02.

2.5 Instrumentation and Controls

2.5.1 General

The specific design of the instrument and control components are as described in the specification and shown on the drawings referenced in the Instrument Schedule for that component.

The description of the system control and monitoring functions will be as shown and described in the logic diagrams and control descriptions referenced in Section 7.

2.5.2 Testability

The CKV's can be tested to prove operability.

2.5.3 Specific Regulatory Requirements

There are no regulatory requirements specifically applicable to the hot reheat system.

2.6 System Interfaces

The hot reheat system interfaces with the following other plant systems:

<u>System Title</u>	<u>System Number</u>
Main Steam	3-1
Cold Reheat System	3-2
Drains to the Condenser	11-1
Boiler Safety Valve Vents	11-4

3.0 System Limitations, Set Points, and Precautions

Refer to the loop and logic diagrams for the set points of specific instruments.

4.0 System Operation

Refer to the turbine manufacturer's operating instruction for operation of the hot reheat system.

5.0 Safety Features for Potential Emergencies

Not applicable

6.0 System Maintenance

The system and its components should be maintained in accordance with the manufacturer's operating, instruction, and/or maintenance books.

7.0 Appendix

7.01 General

7.01.1 Summary of Design Conditions

7.01.2 Line Designation Table No. 4 HRS

7.01.3 Instrument Schedule

7.02 Specification(s)/Purchase Orders/Manufacturer's Drawing Prefix

<u>Number</u>	<u>Title</u>
P103D	Turbine Generator
P301N	Design & Fabrication of
	Piping Supports
P301B	Piping Fabrication

7.03 Flow Diagrams

<u>Number</u>	<u>Title</u>
12919.02A-EM-102A	Main Steam and Reheat

7.04 Logic Diagrams

<u>Number</u>	<u>Title</u>
12919.02A-LSK-18.5H	Steam to Reheat Turbine Bypass & Spray Control

7.05 Loop Diagrams

<u>Number</u>	<u>Title</u>
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7.06 Machine Location Drawings

<u>Number</u>	<u>Title</u>
12919.02A-EM-203	Turbine Room Machine Locations
12919.02A-EM-202	Boiler Area Machine Locations

7.07 Piping Drawings

<u>Number</u>	<u>Title</u>
12919.02A-EP-202	Boiler Area Piping Composites

7.08 Electrical Drawings

<u>Number</u>	<u>Title</u>
12919.02A-EE-612A,B,&C	Cable Tray Arrangements, Boiler Area

7.09 Engineering Sketches and Other Information

7.09.1 Heat Balances

<u>Number</u>	<u>Title</u>
12919.02A-HBSK-1	Turbine VWO
12919.02A-HBSK-2	75 Percent Turbine VWO
12919.02A-HBSK-3	50 Percent Turbine VWO
12919.02A-HBSK-4	25 Percent Turbine VWO

7.09.2 Stress Analysis

7.09.3 Other

J.O. No. 12919.02A

October, 1977

SYSTEM DESCRIPTION 3-4
EXTRACTION STEAM - B&W
ERDA AFB STUDY

1.0 System Requirements

1.1 Function

The function of the extraction steam system is to transport steam from seven levels of turbine extraction to the respective feedwater heaters, the auxiliary steam system, and to the boiler feed pump turbine (System 7-4).

1.2 Design Requirements

1.2.1 General

The extraction steam system will be designed for reliable power generation.

1.2.2 Codes and Standards

All piping will be designed to ANSI B.31.1.0 and all codes and standards referenced in specification P301B.

All other system components will be designed to the codes and standards referenced in the specification(s) in Section 7.02.

1.2.3 Specific Requirements

The systems will be designed to attain the heater shell pressures noted on the VWO heat balance noted in Appendix 7.09.01.

In addition, the extraction steam system will be designed to limit the total entrained energy to a level equal to or less than the turbine manufacturer's requirements and to prevent turbine water induction in accordance with the recommendation contained in ASME Standard TWDPS part 1.

All extraction lines inside the condenser neck will be standard weight stainless steel.

All valves 2 1/2 in. and larger operating below atmospheric pressure are water sealed.

2.0 System Design

2.1 Detailed System Description

Each of the seven extraction systems except the fifth, sixth and seventh extraction is equipped with a motor-operated gate valve and at least one air-assisted nonreturn valve between the turbine and each heater.

The gate valve is used for heater isolation during maintenance and on high heater level as additional protection against turbine water induction.

The air assist "to open" on the nonreturn valves will be released on turbine trip or high heater level to protect against turbine overspeed and water induction, respectively.

Each extraction steam system line is equipped with drains to permit preheating and minimize turbine water induction.

The extraction steam system shown on flow diagram 12919.02A-EM-103 consists of 7 subsystems as described below.

2.1.1 First Point Extraction

Two lines from the high pressure turbine are piped to a manifold; one line extends from the manifold to the first point feedwater heater through a motor-operated gate valve and two extraction nonreturn valves.

An additional line extends from the first point extraction through a motor-operated gate valve and one nonreturn valve to feed the auxiliary steam system.

2.1.2 Second Point Extraction

One line transports steam from the I.P. turbine to the second point heater via a motor-operated gate valve and a nonreturn valve.

2.1.3 Third Point Extraction

The third point extraction nozzle on the I.P. turbine is piped to the third point heater through a motor-operated gate valve and a nonreturn valve. One line is piped to the auxiliary steam system. An additional line is piped to the L.P. turbine drive on the boiler feed pump.

2.1.4 Fourth Point Extraction

The two fourth point extraction nozzles on each low pressure turbine are joined and piped to the deaerator heater

through a motor-operated gate valve and three nonreturn valves. An additional line is piped to the auxiliary steam system.

2.1.5 Fifth Point Extraction

The two fifth point extraction nozzles on the low pressure turbine are piped directly to the fifth point heater in that condenser neck.

2.1.6 Sixth Point Extraction

The two sixth point extraction nozzles on the low pressure turbine are piped directly to the sixth point heater in the condenser neck of that turbine.

2.1.7 Seventh Point Extraction

The seventh point extraction nozzles on each low pressure turbine are piped directly to the seventh point heater in the condenser neck, one per each LP turbine.

2.2 Performance Characteristics

Each extraction system is designed to maintain the heater shell pressure noted on the Engineers' heat balances noted in Section 7.09.01.

2.3 Arrangement

The schematic piping and wiring arrangement is as noted on the flow diagrams and elementary diagrams referenced in Sections 7.03 and 7.08.1, respectively.

The physical arrangement of the system, machinery, and other equipment is as noted on the piping, machine location, and manufacturers' drawings referenced in Sections 7.07, 7.06, and 7.02, respectively.

2.4 Component Design

The bases of design of each component are as included in the specification(s) and the manufacturer's drawings, specifications, and/or information referenced in Section 7.02.

2.5 Instrumentation and Controls

2.5.1 General

The specific design of the instrument and control components is as described in the specification and shown on the drawings referenced in the Instrument Schedule.

The description of the system control and monitoring functions shall be as shown and described in the logic diagrams and control descriptions referenced in Section 7.04.

2.5.2 Testability

Each nonreturn valve can be tested periodically by manually unloading the air cylinder and observing the motion of the counterweight arm to verify that the disc shaft is not bound.

2.5.3 Specific Regulatory Requirements

There are no regulatory requirements specifically applicable to the extraction steam systems.

2.6 System Interfaces

The extraction steam system interfaces with the following other plant systems.

<u>System Title</u>	<u>System Number</u>
Main Steam	3-1
Cold Reheat	3-2
Auxiliary Steam System	3-5
Condensate System	4-1
Low Pressure Heater Drains	4-2
Feedwater System	6-1
High Pressure Heater Drains	6-6
Feedwater Pump Turbine Steam and Exhaust	7-4
Drains to Condenser	11-1

3.0 System Limitations, Set Points, and Precautions

Refer to the loop and logic diagrams for the set point of specific instrumentation.

4.0 System Operation

(later)

5.0 Safety Features for Potential Emergencies

Not applicable

6.0 System Maintenance

The system components should be maintained in accordance with the manufacturer's operating, instruction, and/or maintenance books.

7.0 Appendix

7.01 General

7.01.1 Summary of Design Conditions

7.01.2 Line Designation Table

7.01.3 Instrument Schedule

7.02 Specification(s)/Purchase Orders/Manufacturer's Drawing Prefix

12919.02A-P301B	Shop Fabricated Piping
12919.02A-P301H	Field Erection of Piping
12919.02A-P301N	Design and Fabrication of Piping Supports
12919.02A-P302R	Motor-operated Carbon Steel and Alloy Valves, 2 1/2 In. and Larger
12919.02A-P303P	Turbine Extraction Steam Nonreturn Valves
12919.02A-P305Q	Stainless Steel Expansion Joints

7.03 Flow Diagrams

<u>Number</u>	<u>Title</u>
12919.02A-EM-103A	Extraction Steam

7.04 Logic Diagrams

	<u>Title</u>
Later	Extraction Control

7.05 Loop Diagrams

Later	Extraction Steam
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7.06 Machine Location Drawings

<u>Number</u>	<u>Title</u>
12919.02A-EM-203	Turbine Area Machine Locations

7.07 Piping Drawings

Later

7.08 Electrical Drawings

Later

7.09 Engineering Sketches and Other Information

7.09.01 Heat Balances

Number

Title

12919.02A-HBSK-B1

Turbine VWO

12919.02A-HBSK-B2

75% Turbine VWO

12919.02A-HBSK-B3

50% Turbine VWO

12919.02A-HBSK-B4

25% Turbine VWO

7.09.02 Stress Analysis

Later

J.O. No. 12919.02A

October , 1977

SYSTEM DESCRIPTION 4-1
CONDENSATE - B&W
ERDA AFB STUDY

1.0 System Requirements

1.1 Function

The functions of the condensate system are to deliver preheated, demineralized water to the deaerator, to supply packing seal water, and exhaust hood sprays.

1.2 Design Requirements

1.2.1 General

The condensate system will be designed for reliable power generation.

1.2.2 Codes and Standards

All piping will be designed to ANSI B.31.1.0 and all codes and standards referenced in Specification P301B.

All heat exchangers will be designed to ASME VIII. The feedwater heaters and gland steam condenser will also conform to all codes and standards referenced in Specifications P221B, P111V, and P103D, respectively.

All pumps will be designed to the Hydraulic Institute standards and all codes and standards referenced in Specification P222V.

All other system components will be designed to the codes and standards referenced in the specification(s) in Section 7.02.

1.2.3 Specific Requirements

The condensate system will be capable of delivering 62.5 percent rated feedwater flow on the loss of one condensate pump to assure continued safe VWO load operation.

The condensate system will be designed to permit the loss of at least one single component without requiring unit shutdown.

2.0 System Design

2.1 Detailed System Description

Refer to flow diagram 12919.01-EM-104A.

Two five-eighths capacity condensate pumps take suction from the condenser hotwell and deliver the condensate to the deaerator via the full flow condensate polishing demineralizer (System Description 4-6), the full flow integral bypass gland steam condenser, two drain coolers, two half-capacity seventh point heaters and the full capacity sixth and fifth point extraction feedwater heaters.

A permanent basket type strainer is installed at the suction of each condensate pump. In addition, each condensate pump is equipped with a normally open pump suction vent, an orificed normally closed pump start-up vent, and shaft packing seal water.

The condensate system also supplies water to the exhaust hood sprays, boiler fill, and the valve and pump packing seals subsystems.

The exhaust hood sprays are fed downstream of the polishing demineralizer through an isolation valve and a modulating control valve.

Valve and Pump Stem Seal Subsystem

The valve stem and pump shaft packing seal water is supplied through a pressure reducing valve. Loss of seal water pressure will be annunciated in the main control room.

Excessive condensate is drawn off to the condensate storage tank (System Description 4-3).

Minimum condensate system flow is assured by recirculating a portion of the flow back to the condenser to maintain the flow at the gland steam condenser outlet equal to or greater than the minimum flow set point.

Hotwell condensate purity is normally monitored at the condensate pump discharge header. (See System Description 21-1.) On high readings, however, provision is made to monitor the condensate purity in each half of each condenser shell and at each tube sheet to permit locating any tube leak.

Condenser pressure and hotwell level are indicated in the control room.

Low pressure heaters are equipped with isolation and bypass valves.

In addition to remote manual heater isolation, automatic heater isolation will occur on high heater level as part of turbine water induction prevention (System Description 3-4).

2.2 Performance Characteristics

The performance characteristics of the system components are as included in the specifications, manufacturer's drawings, instructions, and/or operation books referenced in Section 7.02.

2.3 Arrangement

The schematic piping, electrical, and instrumentation arrangement is as noted on the flow diagrams, elementary diagrams, and loop diagrams referenced in Sections 7.03, 7.08, and 7.05, respectively.

The physical arrangement of the system, machinery, and other equipment is as noted on the piping, machine location, and manufacturer's drawings referenced in Sections 7.07, 7.06, and 7.02, respectively.

2.4 Component Design

The bases of design of each component are as included in the specification(s) and the manufacturer's drawings, specifications, and/or information referenced in Section 7.02.

2.5 Instrumentation and Controls

2.5.1 General

The specific design of the instrument and control components is as described in the specification and shown on the drawings referenced in the Instrument Schedule for that component.

The description of the system control and monitoring functions shall be as shown and described in the logic diagrams and control descriptions referenced in Section 7.04.

2.5.2 Testability

Later

2.5.3 Specific Regulatory Requirements

None

2.6 System Interfaces

The system interfaces with the following other plant systems:

<u>System Title</u>	<u>System Number</u>
Extraction Steam	3-4
Auxiliary Steam	3-9
LP Heater Drains	4-2
Condensate Makeup and Drawoff	4-3
Condensate Polishing Demineralizer	4-7
Condenser Air Removal	5-1
Feedwater	6-1
Turbine Gland Steam	16-1
Turbine Plant Sampling	21-1
Turbine Building Floor Drains	23-7

3.0 System Limitations, Set Points, and Precautions

Refer to the loop and logic diagrams for the set point of any specific instrument.

4.0 System Operation

Later

5.0 Safety Features for Potential Emergencies

Later

6.0 System Maintenance

The system components should be maintained in accordance with the manufacturer's operating, instruction, and/or maintenance books.

7.0 Appendix

7.01 General

7.01.1 Summary of Design Conditions

7.01.2 Line Designation Table

7.01.3 Instrument Schedule

7.02 Specification(s)/Purchase Orders/Manufacturer's Drawing Prefix

P103D	Turbine Generator (Gland Steam Condenser)
P111V	Condenser
P221B	Closed Feedwater Heaters
P222V	Condensate and Boiler Feedwater Pumps
P301B	Shop Fabricated Piping
P301N	Design and Fabrication of Piping Supports
P302E	Carbon Steel Valves 2 1/2" and Larger
P302H	Forged Steel Valves 2" and Smaller

P302P	Motor-Operated Carbon Steel Valves 2 1/2" and Larger
P305D	Permanent Strainers
P305P	Rubber Expansion Joints
P306A	Thermal Insulation
E015E	4,160 V Switchgear

7.03 Flow Diagrams

<u>Number</u>	<u>Title</u>
12919.01-EM-104A	Condensate

7.04 Logic Diagrams

<u>Number</u>	<u>Title</u>
Later	

7.05 Loop Diagrams

<u>Number</u>	<u>Title</u>
Later	

7.06 Machine Location Drawings

<u>Number</u>	<u>Title</u>
12919.02A-EM-202	Boiler Area Machine Locations
12919.02A-EM-203	Turbine Area Machine Locations

7.07 Piping Drawings

<u>Number</u>	<u>Title</u>
12919.02A-EP-202	Boiler Area Piping Composites

7.08 Electrical Drawings

7.08.1 Elementary Diagram

<u>Number</u>	<u>Title</u>
Later	

7.08.2 Wiring Drawings

<u>Number</u>	<u>Title</u>
Later	

7.08.3 Cable Tray Drawings

Number

Title

Later

7.08.4 Conduit Drawings

Number

Title

Later

7.09 Engineering Sketches and Other Information

7.09.01 Heat Balances

Title

12919.02A-HBSK-B1

Turbine VWO

12919.02A-HBSK-B2

75% Turbine VWO

12919.02A-HBSK-B3

50% Turbine VWO

12919.02A-HBSK-B4

25% Turbine VWO

7.09.02 Stress Analysis

Later

7.09.3 Other

J.O. No. 12919.02A

October 1977

SYSTEM DESCRIPTION 4-2
L.P. FEEDWATER HEATER DRAINS - B&W
ERDA AFB STUDY

1.0 System Requirements

1.1 Function

The function of the Low Pressure Heater Drains System is to transfer the condensed steam drains from the shell side of the low pressure heaters to the drain coolers or condenser during normal operation and to the condenser during abnormal operation.

1.2 Design Requirements

1.2.1 General

The L.P. Feedwater Heater Drains System will be designed for reliable power generation.

The system will be designed for flashing fluids and to prevent turbine water induction in accordance with ASME Standard TWDPs, Part 1.

1.2.2 Codes and Standards

All piping will be designed to ANSI B31.1.0 and all codes and standards referenced in Specification P301B.

The feedwater heaters will be designed to ASME VIII and all codes and standards referenced in Specification P22IV.

All other system components will be designed to all codes and standards referenced in the Specification(s) in Section 7.02.

1.2.3 Specific Requirements

All control valves in the drain lines will be placed as close to the receiving vessel as possible.

Piping between the control valve and the receiving vessel shall be one schedule heavier than required before the control valve.

2.0 System Design

2.1 Detailed System Description

The low pressure feedwater heater drain system includes the following subsystems:

- a. Four LP feedwater heaters, two seventh, a sixth, and a fifth point heater located in the condenser neck along with individual level control systems for the drains
- b. LP feedwater heaters bypass and isolation system to preclude turbine water induction
- c. The deaerator level control system

Seventh Point Heater Drains

The seventh point heater is drained directly to the condenser through a loop seal drain line. No drains are cascaded to this heater. Each heater and loop seal is equipped with local gage glasses and each heater is equipped with drain temperature indication for performance testing. Each of the seventh point heaters is equipped with high level alarm. On an extreme high seventh point heater level, the whole LP heater string will be isolated and bypassed as a part of turbine water induction protection.

Sixth and Fifth Point Heater Drains

The sixth and fifth point heaters are installed in the condenser neck, and will have no drains cascaded to them. Each heater will be provided with an external drain receiver tank which will eliminate water level from the heater and keep the water further from the turbine. Also, a drain cooler will be provided between the receiver tank and the condenser. The flow of drains (from the heater drain receiver) through the cooler and to the condenser will be controlled by individual modulating "normal" water level drain control valves. In the event that normal water level cannot be maintained, a second, completely separate, modulating "emergency" water level drain control valve will drain excess level to the condenser directly from the receiver tank bypassing the drain cooler.

On an extreme high heater water level the whole LP heater string will be isolated and bypassed as a part of turbine water induction protection. High drain receiver level and extreme high heater level will also be annunciated in the control room.

Each drain receiver will be equipped with local gage glasses. Each control valve station consists of an inlet and

outlet isolation valve, an upstream and downstream pressure test connection, and an upstream drain.

Deaerator Level Control

A horizontal tray type deaerator heater with internal vent condenser will be provided. The heater is mounted on a horizontal storage tank with a capacity of about 5 min of operation at full load.

The level in the storage tank is maintained by regulating the amount of condensate entering the deaerator. A three element control system is utilized which compares the actual condensate flow to a demand (feedwater flow) and is corrected by the storage tank level.

The control system will be equipped with two level control valves, one block valve, one bypass valve, one drain valve, a narrow range, and a wide range level transmitter.

The level control valves are arranged in parallel and are sized so that only one of two valves will operate under cavitating conditions. The level control valves will close on an extreme high water level in the deaerator storage tank. The block valve is provided to facilitate isolation of the two control valves and to shut off the condensate flow when control valves fail to close. A motor-operated bypass valve is provided to enable remote-manual throttling of condensate flow when level controllers are out of service. The drain valve is provided to drain condensate from the deaerator storage tank to the condenser on high tank level and is sized to handle expected leakage through the closed control valve.

2.2 Performance Characteristics

The performance characteristics of the system components are as included in the specifications, Manufacturer's drawings, instructions and/or operation books referenced in Section 7.02.

2.3 Arrangement

The piping schematic, electrical schematic, and instrumentation arrangement are as noted on the flow diagrams, elementary diagrams and loop diagrams referenced in Sections 7.03, 7.08, and 7.05, respectively.

The physical arrangement of the system, machinery and other equipment is as noted on the Piping, Machine Location, and Manufacturer's drawings referenced in Sections 7.07, 7.06, and 7.02, respectively.

2.4 Component Design

The bases of design of each component are as included in the specification(s) and the manufacturer's drawings, specifications and/or information referenced in Section 7.02.

2.5 Instrumentation and Controls

2.5.1 General

The specific design of the instrument and control components are as described in the specification and shown on the drawings referenced in the Instrument Schedule.

The description of the system control and monitoring functions shall be as shown and described in the logic diagrams and control descriptions referenced in Section 7.04.

2.5.2 Testability

Later

2.5.3 Specific Regulatory Requirements

None

2.6 System Interfaces

The low pressure heater drain system interfaces with the following systems:

<u>System Title</u>	<u>System Number</u>
Extraction Steam	3-4
Condensate	4-1
Feedwater	6-1
High Pressure Heater Drains	6-6

3.0 System Limitations, Set Points, and Precautions

Refer to the loop and logic diagrams for the set point of specific instrumentation.

4.0 System Operation

Later

5.0 Safety Features for Potential Emergencies

Not applicable

6.0 System Maintenance

All system mechanical components are to be maintained in accordance with the operation and maintenance instructions submitted in accordance with the component specification listed in Section 7.02.

7.0 Appendix

7.0.1 General

7.01.1 Summary of Design Conditions

7.01.2 Line of Designation Table No. HDL

7.01.3 Instrument Schedule

7.02 Specification(s) /Purchase Orders

12919.02A-P221V	Closed Feedwater Heaters
12919.02A-P222V	Condensate and Boiler Feedwater Pumps
12919.02A-P301N	Design & Fabrication of Piping Supports
12919.02A-P302E	Carbon Steel Valves 2 1/2" & Larger
12919.02A-P302H	Forged Steel Valves 2" & Smaller

7.03 Flow Diagrams

<u>Number</u>	<u>Title</u>
12919.02A-EM-106A	Heater Drains

7.04 Logic Diagrams

	<u>Title</u>
Later	L.P. Feedwater Heater Drains
	L.P. Feedwater Heater Isolation and and Bypass
	Deaerator Level Control

7.05 Loop Diagrams

	<u>Title</u>
Later	L.P. Heater Drain

7.06 Machine Location Drawings

<u>Number</u>	<u>Title</u>
12919.02A-EM-203A	Turbine Room Machine Location

7.07 Piping Drawings

Later

Title

LP Heater Drain Piping
Feedwater Piping

7.08 Electrical Drawings

Later

7.09 Engineering Sketches

None

J.O. No. 12919.02A

October 1977

SYSTEM DESCRIPTION 4-3
CONDENSATE MAKEUP AND DRAWOFF - B&W
ERDA AFB STUDY

1.0 System Requirements

1.1 Function

The function of the condensate makeup and drawoff system is to maintain the condenser hotwell level at a predetermined level and supply a source of water for various other systems.

1.2 Design Requirements

1.2.1 General

The condensate makeup and drawoff system will be designed for reliable power generation.

1.2.2 Codes and Standards

All piping will be designed to ANSI B31.1.0 or as applicable and codes and standards referenced in specification P301B.

All other system components will be designed to the codes and standards referenced in the specifications in Section 7.02.

1.2.3 Specific Requirements

The normal condenser makeup and drawoff shall be sized for five percent of rated feedwater flow. The emergency condenser makeup shall be sized for (later) lb/hr.

The demineralized water storage tank overflow will be sized for the largest single flow into the tank.

2.0 System Design

2.1 Detailed System Description

Refer to Flow Diagram 12919.01-EM-104A.

2.1.1 General

A split condenser is provided with a high pressure shell and a low pressure shell. The hotwell makeup line from the demineralizer water storage tank is connected to the LP shell side. Condensate pump suction is taken from the hotwell on the HP shell side.

2.1.2 Makeup System

Makeup water is added to the condenser from the existing unit demineralized water storage tank through two control valves, the normal makeup control valve and the emergency makeup control valve. The hotwell level control valve set points are established such that during normal operating conditions the normal makeup valve is modulating and the emergency makeup valve and drawoff valves are closed. On an extreme low level, the emergency makeup valve will open to supply additional makeup to the system.

2.1.3 Drawoff System

On a high condenser hotwell level, the condensate is drawn off from the system at a point downstream of gland steam condenser and returned to the demineralized storage tank through a modulating control valve. During periods of high conductivity, the condensate drawoff will be dumped to the waste sump through a blowdown valve.

2.2 Performance Characteristics

The performance characteristics of the existing system components are as included in the specifications, manufacturer's drawings, instructions, and/or operation books referenced in Section 7.02.

2.3 Arrangement

The schematic piping and wiring arrangement is as noted on the flow diagrams and elementary diagrams referenced in Sections 7.03 and 7.08, respectively.

The physical arrangement of the system, machinery, and other equipment is as noted on the piping, machine location, and manufacturer's drawings referenced in Sections 7.07, 7.06, and 7.02, respectively.

2.4 Component Design

The basis of design of each component is as included in the specification(s) and the manufacturer's drawings, specifications, and/or information referenced in Section 7.02.

2.5 Instrumentation and Controls

2.5.1 General

The specific design of the instrument and control components is as described in the specification and shown on the drawings referenced in the Instrument Schedule for that component.

The description of the system control and monitoring functions shall be as shown and described in the logic diagrams and control descriptions referenced in Section 7.04.

2.5.2 Testability

No specific requirements.

2.5.3 Specific Regulatory Requirements

None

2.6 System Interfaces

The condensate makeup and drawoff system interfaces with the following systems:

<u>System Title</u>	<u>System Number</u>
Chemical Feed	-
Condensate	4-1
Condensate Demineralizer	-
Boiler Feed	6-1

3.0 System Limitations, Set Points, and Precautions

Refer to the instrument schedule for the set point of any instrument.

The normal condenser makeup valve maintains hotwell normal water level (NWL) at El. (later). The emergency condenser makeup valve will start opening (later) in. below NWL and will be fully open (later) in. below NWL.

4.0 System Operation

4.1 Normal Operation

As noted in Section 2.1, system operation is basically automatic with several manual intermittent demands.

4.2 System Shutdown and Draining

Any demand or return may be shut down using the manual isolation valves supplied. After isolation these lines can be drained.

5.0 Safety Features for Potential Emergencies

Not applicable

6.0 System Maintenance

All system components should be maintained in accordance with the manufacturer's operating, instruction, and/or maintenance books.

7.0 Appendix

7.01 General

7.01.1 Summary of Design Conditions

7.01.2 Line Designation Table

7.01.3 Instrument Schedule

7.02 Specification(s)/Purchase Orders/Manufacturer's Print Prefix

<u>Number</u>	<u>Title</u>
P301B	Shop Fabricated Piping
P301N	Design and Fabrication of Piping and Supports
P302E	Carbon Steel Valves 2 1/2 In. and Larger
P302H	Forged Steel Valves 2 In. and Smaller

7.03 Flow Diagrams

<u>Number</u>	<u>Title</u>
12919.01-EM-104A	Condensate

7.04 Logic Diagrams

<u>Number</u>	<u>Title</u>
Later	

7.05 Loop Diagrams

<u>Number</u>	<u>Title</u>
Later	

7.06 Machine Location Drawings

<u>Number</u>	<u>Title</u>
12919.02A-EM-203	Turbine Area Machine Locations
12919.02A-EM-202	Boiler Area Machine Locations

7.07 Piping Drawings

<u>Number</u>	<u>Title</u>
12919.02A-EP-202	Boiler Area Piping Composites

7.08 Electrical Drawings

<u>Number</u>	<u>Title</u>
Later	

7.09 Engineering Sketches and Other Engineering Information

7.09.1 Heat Balances

<u>Number</u>	<u>Title</u>
12919.02A-HBSK-B1	Turbine VWO
12919.02A-HBSK-B2	75% Turbine VWO
12919.02A-HBSK-B3	50% Turbine VWO
12919.02A-HBSK-B4	25% Turbine VWO

7.09.2 Stress Analysis

7.09.3 Other

J.O. No. 12919.02A

October 1977

SYSTEM DESCRIPTION 5-1
CONDENSER AIR REMOVAL - B&W
ERDA AFB STUDY

1.0 System Requirements

1.1 Function

The function of the condenser air removal system is to provide the required start-up vacuum for turbine generator operation and to remove noncondensable gases from the condenser shells during plant operation.

1.2 Design Requirements

1.2.1 General

The air removal system will be designed for reliable power generation.

The system shall have sufficient duplication to assure continued operation.

The capacity of the air removal pumps shall be determined in accordance with potential air leakage, and the water vapor contained in the air-gas mixture.

1.2.2 Codes and Standards

All piping will be designed to ANSI B.31.1 and all codes and standards referenced in specifications P111V and P112E.

Motor driven air removal pumps will be sized in accordance with the recommendations of the Heat Exchange Institute Standards for Condensers.

1.2.3 Specific Requirements

None

2.0 System Design

2.1 Detailed System Description

2.1.1 General

Refer to flow diagram 12919.01-EM-110A

Two perforated pipes run the length of each of the two condenser shells to evacuate the noncondensables. These four pipes combine to form the main air removal suction header.

The system consists of two full-capacity water seal vacuum pumps which take suction through a common line from the main air removal suction header.

Each system consists of an air removal pump, inlet separator, outlet reservoir separator and associated controls.

During start-up both air removal pumps are manually started to evacuate the condenser as quickly as possible. Once normal volume is obtained, one pump can be shut down and placed in the standby mode.

Each pump discharges through a discharge moisture separator/silencer.

Seal water carried over with the air is collected in each discharge moisture separator/silencer. Seal water is supplied from the condensate system and the level is automatically controlled.

2.2 Performance Characteristics

The performance characteristics of the system components are as included in the specifications, manufacturers' drawings, instructions, and/or operation books referenced in Section 7.02.

2.3 Arrangement

The schematic piping, wiring and tubing arrangement is as noted on the flow diagrams, elementary diagrams and loop diagrams referenced in Sections 7.03, 7.08, and 7.05, respectively.

The physical arrangement of the system, machinery and of the equipment is as noted on the Piping, Machine Location and manufacturers' drawings referenced in Sections 7.07, 7.06, and 7.02, respectively.

2.4 Component Design

The bases of design of each component are as included in the specification(s) and the manufacturers' drawings, specifications, and/or information referenced in Section 7.02.

2.5 Instrumentation and Controls

2.5.1 General

The specific design of the instrument and control components are as described in the specification and shown on the drawings referenced in the Instrument Schedule for that component.

A description of the system control and monitoring functions shall be as shown and described in the logic diagrams and control descriptions referenced in Section 7.04.

2.5.2 Testability

All standby equipment is periodically tested.

2.5.3 Specific Regulatory Requirements

There are no regulatory requirements directly applicable to the condenser air removal system.

2.6 System Interfaces

The condenser air removal system interfaces with the following other plant systems:

<u>System Title</u>	<u>System Number</u>
Condensate	4-1
Condensate Makeup and Drawoff	4-3

3.0 System Limitations, Set Points, and Precautions

Refer to instrument schedule for the set point of specific instrumentation.

4.0 System Operation

4.1 Start-up

Start-up vacuum, i.e., less than or equal to 5 in. HgA, is established by opening vacuum pump inlet valves and starting both air removal pumps. The start-up vacuum will be attained in approximately 1 hour.

After attaining 5 in. HgA, the vacuum pumps will automatically transfer to their holding mode.

4.2 Normal Operation

During normal operation, the air removal system requires little attention. Periodically, the standby vacuum pump should be cycled and/or placed in service.

5.0 Safety Features for Potential Emergencies

Not applicable

6.0 System Maintenance

The system components should be maintained in accordance with the manufacturers' operating instruction and/or maintenance book.

7.0 Appendix

7.01 General

7.01.1 Summary of Design Conditions

7.01.2 Line Designation Table 4ARC

7.01.3 Instrument Schedule

7.02 Specification(s)/Purchase Orders

P111V	Condenser
P112E	Condenser Air Removal Pumps
P301B	Shop Fabricated Piping
P301N	Design and Fabrication of Piping Supports
P302E	Carbon Steel Valves 2 1/2" & Smaller - Category II

7.03 Flow Diagrams

<u>Number</u>	<u>Title</u>
12919.01-EM-110A	Circ. & Makeup Water & Condenser Air Removal

7.04 Logic Diagrams

<u>Number</u>	<u>Title</u>
Later	

7.05 Loop Diagrams

<u>Number</u>	<u>Title</u>
Later	

7.06 Machine Location Drawings

<u>Number</u>	<u>Title</u>
12919.02A-EM-202	Boiler Area Machine Locations
12919.02A-EM-203	Turbine Area Machine Locations

7.07 Piping Drawings

<u>Number</u>	<u>Title</u>
12919.02A-EP-202	Boiler Area Piping Drawings

7.08 Electrical Drawings

<u>Number</u>	<u>Title</u>
(later)	

7.09 Engineering Sketches

None

J.O. No. 12919.02A

October 1977

SYSTEM DESCRIPTION 6-1
BOILER FEEDWATER - B&W
ERDA AFB STUDY

1.0 System Requirements

1.1 Function

The function of the feedwater system is to deliver feedwater from the condensate system to the boiler at the required pressure and temperature.

1.2 Design Requirements

1.2.1 General

The feedwater system up to, but not including, the outboard boiler isolation valve will be designed for reliable power generation.

1.2.2 Codes and Standards

Piping from the boiler feed pump discharge up to, but not including, the outermost boiler isolation valve will be furnished in accordance with the latest ANSI B31.1.0 and all codes and standards referenced in Specification P301B.

Piping from the boiler to the outermost isolation valve will be furnished in accordance with the latest ASME I and all codes and standards referenced in Specification P301B.

All heat exchangers will be designed to ASME VIII and all codes and standards referenced in Specification P221B.

The feedwater pumps will be designed to the Hydraulic Institute Standards and all codes and standards referenced in Specification P222V.

All other system components will be designed to the codes and standards referenced in the specifications in Section 7.02.

1.2.3 Specific Requirements

The feedwater system shall be capable of delivering 3,813,688 lb of water per hour at 484.03 F and 2,920 psia to the boiler at turbine valve wide open condition.

2.0 System Design

2.1 Detailed System Description

Refer to flow diagram 12919.02A-EM-105A.

One full-capacity, centrifugal barrel type, steam-turbine driven boiler feed pump with shaft driven matched booster pump is provided. The booster pump will take suction from the deaerator and supply the suction of the boiler feed pump which, in turn, discharges to the economizer section of the boiler via, in series, the three high pressure heaters. Boiler feedwater is also used for desuperheating the superheater and the reheater.

Feedwater to the superheater desuperheaters is provided from a tap off the boiler feedwater line downstream of the motor-operated isolation valve. Feedwater is taken from one tap and then divides into two lines, each with a flowmeter and feedwater control valve which closes on a turbine trip. These two lines then divide into two lines each having a temperature control valve before entering the superheater desuperheater section of the boiler.

Feedwater to the reheat desuperheater is provided directly from an interstage portion of the feedwater pump. Feedwater flows through a flowmeter, through a feedwater control valve which shuts off on a turbine trip, and a temperature control valve before entering the reheat desuperheater section of the boiler.

Feedwater is also provided by the interstage takeoff to the turbine bypass system. Feedwater flows through a flowmeter, through a feedwater control valve which shuts off on a turbine trip, and a temperature control valve before entering the turbine bypass desuperheater.

Feedwater is also provided by the interstage takeoff to the reheater cooling system for desuperheating. A single line is provided for the desuperheating of the cooling steam into the reheater. Feedwater flows through a flowmeter, through a feedwater control valve which shuts off on a turbine trip, and a temperature control valve before entering the reheat cooling steam desuperheater. A single line which divides into two separate lines is provided for

the reheater cooling outlet steam desuperheater. Feedwater flows through a flowmeter, a feedwater control valve which closes on a turbine trip, and then divides into two lines each having a temperature control valve before entering the reheater cooling outlet steam desuperheater.

A heater bypass line with manually-operated isolation valves is provided for use during the isolation of any heater.

A boiler fill line from the condensate system, bypassing the feedwater pumps and the flow control valves, is connected to the economizer inlet piping.

A new start-up boiler feedwater pump, check valve, and motor-operated isolation valve are provided to bypass the feedwater pump isolation valve and check valve when feedwater demands are low during start-up. The start-up pump will also permit main pump warmup.

The start-up pump is able to supply 40 percent MCK minimum flow to the boiler and spray water for the reheat cooling steam system in the event of a boiler feed pump turbine trip.

Both the start-up and feedwater pumps are equipped with a pump recirculation back to the deaerator storage tank to prevent pump damage at low loads.

The feedwater pumps are provided with a seal injection system to minimize outleakage of heated feedwater through the seals. Condensate from the condensate pump discharge is injected into the inboard and outboard seals of each pump. Seal injection water pressure is automatically controlled by a modulating pressure control valve.

2.2 Performance Characteristics

The performance characteristics of the system components are as included in the specifications, manufacturer's drawings, instructions, and/or operation books referenced in Section 7.02.

2.3 Arrangement

The piping schematic, electrical schematic, and instrumentation arrangement are as noted on the flow diagrams, elementary diagrams, and loop diagrams referenced in Sections 7.03, 7.08.1, and 7.05, respectively.

The physical arrangement of the system machinery and other equipment is as noted on the piping, machine location, and manufacturer's drawings referenced in Sections 7.07, 7.06, and 7.02, respectively.

2.4 Component Design

The bases of design of each component are as included in the specification(s) and manufacturer's drawings, specifications, and/or information referenced in Section 7.02.

2.5 Instrumentation and Controls

2.5.1 General

The specific design of the instrument and control components is as described in the specification and shown on the drawings referenced in the Instrument Schedule for that component.

The description of the system control and monitoring functions shall be as shown and described in the logic diagrams and control descriptions referenced in Section 7.

2.5.2 Testability

Later

2.5.3 Specific Regulatory Requirements

None

2.6 System Interfaces

The system interfaces with the following other plant systems:

<u>System Title</u>	<u>System Number</u>
Extraction Steam	3-4
Condensate	4-1
H.P. Heater Drains	6-6
Turbine Plant Sampling	22-1

3.0 System Limitations, Set Points, and Precautions

Refer to the loop and logic diagrams for any specific instrument.

4.0 System Operation

A tap from the condensate system downstream of the demineralizer permits initial boiler fill prior to starting of the feed pumps.

The start-up feed pump will be utilized for start-up and low load operation and will also permit pump warmup. During start-up, the feedwater flow will be manually controlled. Whenever the feedwater demand exceeds a certain limit, the three-element feedwater control system regulates the feedwater flow to the boiler. The control system combines steam flow, boiler drum level, and feedwater signals for automatic control of the turbine driven boiler feed pump flow by controlling turbine speed.

5.0 Safety Features for Potential Emergencies

Not applicable.

6.0 System Maintenance

All system mechanical components are to be maintained in accordance with the operation and maintenance instructions submitted in accordance with the component specification listed in Section 7.02.

7.0 Appendix

7.01 General

7.01.1 Summary of Design Conditions

7.01.2 Line Designation Table

(Later)

7.01.3 Instrument Schedule

7.02 Specification(s)/Purchase Order(s)/ Manufacturer's Print Prefix

12919.02A-P222V	Condensate, Heater Drain, and Boiler Feedwater Pumps
12919.02A-P221V	Closed Feedwater Heaters
12919.02A-P301B	Shop Fabricated Piping
12919.02A-P301N	Design and Fabrication of Piping Supports

12919.02A-P302E	Carbon Steel Valves 2 1/2 In. and Larger - Category II
12919.02A-P302H	Forged Steel Valves 2 In. and Smaller - Category II
12919.02A-P302P	Motor-Operated Carbon Steel Valves 2 1/2 In. and Larger - Category II

7.03 Flow Diagrams

Title

12919.02A-EM-105A	Boiler Feed
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7.04 Logic Diagrams

Title

(Later)	Boiler Feedwater
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7.05 Loop Diagrams

(Later)	Boiler Feedwater
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7.06 Machine Location Drawings

Title

12919.02A-EM-203A	Turbine Room Machine Location
12919.02A-EM-202A,B	Boiler Area

7.07 Piping Drawings

Title

12919.02A-EP-202A-G	Boiler Feedwater Piping
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7.08 Electrical Drawings

(Later)

7.09 Engineering Sketches

(None)

J.O. No. 12919.02A

October 1977

SYSTEM DESCRIPTION 6-6
H.P. FEEDWATER HEATER DRAINS - B&W
ERDA AFB STUDY

1.0 System Requirements

1.1 Function

The function of the H.P. Feedwater Heater Drains System is to transfer condensed steam drains from the shell side of the high pressure heaters to the next lower pressure heater or, during abnormal operation, the condenser.

1.2 Design Requirements

1.2.1 General

The high pressure feedwater heater drain system will be designed for reliable power generation.

1.2.2 Codes and Standards

All piping will be designed to ANSI B.31.1.0 and all codes and standards referenced in Specification P301B.

The feedwater heaters will be designed to ASME VIII and all codes and standards referenced in Specification P221B.

All other components will be designed to the codes and standards referenced in the specifications in Section 7.02.

1.2.3 Specific Requirements

The H.P. feedwater heater drain system will be designed to minimize turbine water induction in accordance with ASME Standard TWDPs, Part 1.

All control valves in the drain lines will be placed as close to the receiving vessel as possible.

Piping between the control valve and the receiving vessel shall be one schedule heavier than that required before the control valve.

2.0 System Design

2.1 Detailed System Description

Refer to flow diagram 12919.02A-EM-106A.

The H.P. heater drain system consists of three subsystems, one for each extraction heater stage.

On extreme high level trip of any heater, operator response is required to reset the system to return to a normal mode.

The temperature of each normal heater drain line is monitored for performance testing.

Each heater is equipped with a local level indicator and a level switch which will alarm if a high level occurs in the heater, close the normal drain valve of the next higher heater, and fully open the "emergency" drain to the condenser.

In addition, each heater is equipped with a level switch with independent connections to the heater which will alarm if high-high level occurs, trip the extraction NRV to vent, and close the extraction steam isolation valve.

First Point Heater Drain

The first point heater will normally drain to the second point heater through a modulating fail-close level control valve. The normal drain will close on high water level in the second point heater.

On higher than normal level in the first point heater shell, the heater will be drained to the condenser through a modulating fail-open "emergency" level control valve.

Second Point Heater Drain

The second point heater will normally drain to the third point heater through a modulating fail-close level control valve. The normal drain will close on high water level in the third point heater.

On higher than normal level in the second point heater shell, the heater will be drained to the condenser through a modulating fail-open "emergency" level control valve.

Third Point Heater Drain

The third point heater will normally drain to the deaerator through a modulating fail-close level control valve. The normal drain will close on high water level in the deaerator.

On higher than normal level in the third point heater shell, the heater will be drained to the condenser through a modulating fail-open "emergency" level control valve.

2.2 Performance Characteristics

The performance characteristics of the system components are as included in the specifications, manufacturer's drawings, instructions, and/or operation books referenced in Section 7.02.

2.3 Arrangement

The piping schematic, electrical schematic, and instrumentation arrangement are as noted on the flow diagrams, elementary diagrams, and loop diagrams referenced in Sections 7.03, 7.08, and 7.05, respectively.

The physical arrangement of the system, machinery, and other equipment is as noted on the piping, machine location, and manufacturer's drawings referenced in Sections 7.07, 7.06, and 7.02, respectively.

2.4 Component Design

The bases of design of each component are as included in the specification(s) and the manufacturer's drawings, specifications, and/or information referenced in Section 7.02.

2.5 Instrumentation and Controls

2.5.1 General

The specific design of the instrument and control components are as described in the specification and shown on the drawings referenced in the Instrument Schedule for that component.

The description of the system control and monitoring functions will be as shown and described in the logic diagrams and control descriptions referenced in Section 7.04.

2.5.2 Testability

Later

2.5.3 Specific Regulatory Requirements

None

2.6 System Interfaces

The H.P. heater drain system interfaces with the following systems:

<u>System Title</u>	<u>System Number</u>
Extraction Steam	3-4
Condensate	4-1
Low Pressure Heater Drains	4-2
Feedwater	6-1

3.0 System Limitations, Set Points, and Precautions

Refer to the loop and logic diagrams for the set point of specific instrumentation.

4.0 System Operation

Later

5.0 Safety Features for Potential Emergencies

Not applicable

6.0 System Maintenance

All system components are to be maintained in accordance with the operation and maintenance instructions submitted in accordance with the component specification listed in Section 7.02.

7.0 Appendix

7.01 General

7.01.1 Summary of Design Conditions

7.01.2 Line Designation Table No. HDH

7.01.3 Instrument Schedule HDH

7.02 Specification(s)/Purchase Orders/Manufacturers' Print Prefix

12919.02A-P221B	Closed Feedwater Heaters
12919.02A-P301B	Shop Fabricated Piping
12919.02A-P301N	Design and Fabrication of Piping Supports
12919.02A-P302E	Carbon Steel Valves 2 1/2 In. and Larger
12919.02A-P302H	Forged Steel Valves 2 In. and Smaller

7.03 Flow Diagrams

S&W Number

Title

12919.02A-EM-106

Heater Drains

7.04 Logic Diagrams

Number

Title

Later

H.P. Heater Drains

7.05 Loop Diagrams

Later

H.P. Heater Drains

7.06 Machine Location Drawings

Number

Title

12919.02A-EM-3

Turbine Room
Machine Location

7.07 Piping Drawings

Title

HP Heater Drain Piping
Feedwater Piping

7.08 Electrical Drawings

Later

7.09 Engineering Sketches

None

SYSTEM DESCRIPTION 8-1
COAL AND LIMESTONE HANDLING - B&W
ERDA - AFB STUDY

1.0 SYSTEM REQUIREMENTS

1.1 Function

The coal and limestone system prepares and transports coal and limestone from the yard to the boiler.

1.2 Design Requirements

1.2.1 General

The coal and limestone handling system is designed for reliable power generation.

1.2.2 Codes and Standards

The coal and limestone handling system components will be designed to the codes and standards referenced in the specifications in Section 7.02.

1.2.3 Specific Requirements

The coal and limestone handling system will be designed to deliver 543,360 lb/hr of coal and 277,452 lb/hr of limestone to the main boiler beds.

2.0 SYSTEM DESIGN

2.1 Detailed System Description

Refer to the flow diagrams 12919.02A-EM-170A, 170B, 170C, and 115B.

The coal and limestone handling system consists of a yard handling system and an in-plant distribution and injection system.

The yard coal/limestone handling system consists of a dual series of conveyors tied into the existing conveyor system that serves Units 1-3.

The conveyors transport the coal/limestone to a new crusher house. The crusher house contains two new coal crushers and two new limestone crushers each rated at a gross capacity of 900 tph.

A series of new conveyors transports the crushed coal/limestone to the existing coal conveyors in the yard which transport the coal/limestone to the existing and new tripper conveyors in the plant which fill the coal and limestone bunkers.

There are 25 coal and 25 limestone hoppers. There is a gravimetric belt feeder at each hopper outlet. Coal and limestone are combined in a mixing bustle and transported by primary air to the 40:1 distributors which feed under the main beds and the CBC of the boiler.

2.2 Performance Characteristics

The performance characteristics of the system components are as included in the specifications, manufacturer's drawings, instruction and/or operation books referenced in Section 7.02.

2.3 Arrangement

The schematic piping arrangement and instrumentation is as noted on the flow diagrams and loop diagrams referenced in Sections 7.03 and 7.05, respectively.

The physical arrangement of the system machinery and other equipment is as noted on the piping, machine location, and manufacturer's drawings referenced in Sections 7.07, 7.06, 7.02, respectively.

2.4 Component Design

The bases of design of each component are included in the specifications and the manufacturer's drawings, specifications, and/or information referenced in Section 7.02.

2.5 Instrumentation and Controls

2.5.1 General

The specific design of the instrument and control components are as described in the specification and shown on the drawings referenced in the instrument schedule for that component.

The description of the system control and monitoring functions shall be as shown and described in the logic diagrams and control descriptions referenced in Section 7.04.

2.5.2 Testability

The coal and limestone handling system in the yard operates intermittently when loading the bunkers.

The distribution and injection system is normally in service.

2.5.3 Specific Regulatory Requirements

There are no regulatory requirements specifically applicable to the coal and limestone handling system.

2.6 System Interfaces

The system interfaces with the following other plant systems:

<u>Title</u>	<u>Number</u>
Combustion Air and Flue Gas	12919.02A-EM-115A

3.0 SYSTEM LIMITATIONS, SET POINTS, AND PRECAUTIONS

Later

4.0 SYSTEM OPERATION

Later

5.0 SAFETY FEATURES FOR POTENTIAL EMERGENCIES

Fire protection will be provided for the crusher house.

6.0 SYSTEM MAINTENANCE

All system components should be maintained in accordance with the manufacturer's operating instruction and/or maintenance books.

7.0 APPENDIX

7.01 General

7.01.1 Summary of Design Conditions

7.01.2 Line Designation Table No. Later

7.01.3 Instrument Schedule

7.02 Specifications, Purchase Orders/Manufacturers' Drawing Prefix

<u>Number</u>	<u>Title</u>
P 301B	Shop-Fabricated Piping
P 301C	Field-Fabricated Piping
P 301N	Design and Fabrication of Piping Supports
-	Coal and Limestone Handling Equipment

7.03 Flow Diagrams

<u>Number</u>	<u>Title</u>
12919.02A-EM-170A	
12919.02A-EM-170B	
12919.02A-EM-170C	
12919.02A-EM-115B	Coal and Limestone Distribution and Injection

7.04 Logic Diagrams

<u>Number</u>	<u>Title</u>
Later	

7.05 Loop Diagrams

<u>Number</u>	<u>Title</u>
Later	

7.06 Machine Location Drawings

12919.02A-EM-211A	Sh. 1 Gen Arrg't Coal/Limestone Handling in Plant
12919.02A-EM-211B	Sh. 2 Gen Arrg't Coal/Limestone Handling in Yard
12919.02A-EM-211C	Sh. 3 Gen Arrg't Crusher House

7.07 Piping Drawings

<u>Number</u>	<u>Title</u>
12919.02A-EP-202A	Composite Boiler Area Plan El. 0'-0"
12919.02A-EP-202B	Composite Boiler Area Plan El. 55'-0"
12919.02A-EP-202F	Composite Boiler Area Section 1-1
12919.02A-EP-202G	Composite Boiler Area Section 2-2

7.08 Electrical Drawings

<u>Number</u>	<u>Title</u>
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7.09 Engineering Sketches and Other Information

7.09.1 Heat Balances

Not applicable.

7.09.2 Stress Analysis

Later

7.09.3 Other

J.O. No. 12919.02A

October , 1975

SYSTEM DESCRIPTION 9-15
MAKEUP WATER - B&W
ERDA - AFB STUDY

1.0 SYSTEM REQUIREMENTS

1.1 Function

The functions of the makeup water system are:

1. To deliver river water to the plant site for use as makeup for cooling tower losses, i.e., evaporation, blowdown, and drift.
2. To supply water for other plant uses.

1.2 Design Requirements

1.2.1 General

The makeup water system will be designed for reliable power generation.

1.2.2 Codes and Standards

All pumps will be designed to the Hydraulic Institute Standards and all codes and standards referenced in specification P222G or P222W.

All tanks will be designed to ASME VIII, API, or ANWA and all codes and standards referenced in specification P223A or P223F.

All piping will be designed to ANSI B.31.1.0 or ASME III, as applicable, and all codes and standards referenced in specification P301B.

All other system components will be designed to all codes and standards referenced in the specification(s) in Section 7.02.

1.2.3 Specific Requirements

The river water subsystem shall be designed to permit the removal of any one of the mechanical components without requiring the shutdown of the power generating unit.

2.0 SYSTEM DESIGN

2.1 Detailed System Description

Refer to Flow Diagram 12919.01-EM-110A.

A full capacity, vertical, 9,000 gpm makeup pump is provided. The pump delivers river water from the makeup pump house to the cooling tower. Three pumps are located in the pump house, two existing and one new. The existing makeup line from the pump house to the existing unit cooling tower will be extended to serve the tower of this unit.

A motor-operated discharge valve is provided to open automatically when the makeup pump is started.

The pump will be tied into the existing unit makeup line and will supply makeup water to the cooling tower basin through the level control valve.

A motor-operated strainer is provided at the discharge of the makeup pump. The strainer is supplied with automatic backwash control to permit intermittent backflushing. The control consists of a pneumatic cylinder-operated ball valve which is actuated by a pressure differential.

2.2 Performance Characteristics

The performance characteristics of the system components are as included in the amended specifications, manufacturers' drawings, instructions and/or operation books referenced in Section 7.02.

2.3 Arrangement

The schematic piping and wiring arrangement is as noted on the flow diagrams and elementary diagrams referenced in Sections 7.03 and 7.08, respectively.

The physical arrangement of the system, machinery, and other equipment is as noted on the piping, machine location, and manufacturers' drawings referenced in Sections 7.07, 7.06, and 7.02, respectively.

2.4 Component Design

The bases of design of each component are as included in the specification(s) and the manufacturer's drawings, specifications, and/or information referenced in Section 7.02.

2.5 Instrumentation and Controls

2.5.1 General

The specific design of the instrument and control components are as described in the specification and shown on the drawings referenced in the instrument schedule for that component.

A description of the system control and monitoring functions shall be as shown and described in the logic diagrams and control descriptions referenced in Section 7.04.

2.5.2 Testability

All standby components can be tested to prove operability.

Standby and operating equipment are alternated periodically.

2.5.3 Specific Regulatory Requirements

There are no regulatory requirements specifically applicable to the makeup water system.

2.6 System Interfaces

The makeup water system interfaces with the following other plant systems:

<u>System Title</u>	<u>System Number</u>
Circulating Water	2-1

3.0 SYSTEM LIMITATIONS, SET POINTS, AND PRECAUTIONS

Refer to the loop and logic diagrams for the set point of any specific instrument.

4.0 SYSTEM OPERATION

4.1.1 Fill and Start-up

During initial fill and after a system shutdown, one of the makeup pumps should be started with its discharge valve closed. The motor-operated discharge valve should be jogged opened to fill the piping system and prevent system water hammer. When the system is filled, the discharge valve control switch on all pumps should be placed in the AUTO position.

4.1.1 Normal Operation

One manually started makeup pump is normally running. When the common pump discharge header pressure drops below the set point, it is annunciated in the control room, and the second automatic standby pump starts a second pump. The discharge valve of the second pump will automatically open in response to the pump starting.

When pump flow decreases below the low flow set point, it is annunciated and the operator should secure one of the operating pumps. The discharge valve of that pump will automatically close.

SHOULD THE SECOND PUMP BE REQUIRED TO START MORE THAN (LATER) TIMES PER (LATER), IT SHOULD BE LEFT IN THE RUNNING MODE FOR (LATER), OR UNTIL ATMOSPHERIC CONDITIONS CHANGE TO PRECLUDE THE RESTART OF THE SECOND FOR (LATER).

4.1.3 Shutdown

The makeup pumps may be shut down only if both units are shut down and some other unit in the plant is in operation. If all units are shut down, one of the makeup pumps must be left in service to assure that river water is available to the site.

5.0 SAFETY FEATURES FOR POTENTIAL EMERGENCIES

Not applicable

6.0 SYSTEM MAINTENANCE

All system components should be maintained in accordance with the manufacturers' operating, instruction, and/or maintenance books.

7.0 APPENDIX

7.01 General

7.01.1 Summary of Design Conditions

7.01.2 Line Designation Table

7.01.3 Instrument Schedule

7.02 Specification(s)/Purchase Order(s)/Manufacturers' Print Prefix

P121D	Water Screens
P222G	Miscellaneous Vertical Centrifugal Pumps
P301B	Shop-Fabricated Piping
P301N	Design and Fabrication of Piping Supports
P302E	Carbon Steel Valves 2 1/2 In. and Larger
P302H	Forged Steel Valves 2 In. and Smaller
P302P	Motor-Operated Carbon Steel Valves 2 1/2 In. and Larger

7.03 Flow Diagrams

<u>Number</u>	<u>Title</u>
12919.01-EM-110A	Circ. Water and Cond. Air Removal

7.04 Logic Diagrams

<u>Number</u>	<u>Title</u>
Later	Later

7.05 Loop Diagrams

<u>Number</u>	<u>Title</u>
Later	Later

7.06 Machine Location Drawings

<u>Number</u>	<u>Title</u>
12919.02A-EM-203	Turbine Area Machine Locations
12919.02A-EM-202	Boiler Area Machine Locations

7.07 Piping Drawings

<u>Number</u>	<u>Title</u>
12919.02A-EP-202	Boiler Area Piping Composites

7.08 Electrical Diagrams

<u>Number</u>	<u>Title</u>
Later	Later

7.09 Engineering Sketches and Other Information

7.09.1 Heat Balances

<u>Number</u>	<u>Title</u>
12919.02A-HBSK-1	Turbine VWO
12919.02A-HBSK-2	75% Turbine VWO
12919.02A-HBSK-3	50% Turbine VWO
12919.02A-HBSK-4	25% Turbine VWO

8.09.2 Stress Analysis

S7.09.3 Other

J.O. No. 12919.02A

October, 1977

SYSTEM DESCRIPTION 17-1
BED LETDOWN, TRANSFER, AND DISPOSAL - B&W
ERDA-AFB STUDY

1.0 SYSTEM REQUIREMENTS

1.1 Function

The bed letdown system transports cooled spent bed material collected from the main beds either to the bed letdown silos, to replenish the main beds, or to carbon burnup bed makeup. Bed material collected from the carbon burnup bed goes to waste (silos).

1.2 Design Requirements

1.2.1 General

The bed letdown system is designed for reliable power generation.

1.2.2 Codes and Standards

The bed letdown system piping will be designed to the ash handling manufacturer's standard.

All other system components will be designed to the codes and standards referenced in the specification(s) in Section 7.02.

1.2.3 Specific Requirements

The bed letdown system will be designed to remove bed letdown material at the rate of 150 tons per hour.

2.0 SYSTEM DESIGN

2.1 Detailed System Description

Refer to Flow Diagram 12919.02A-EM-120A.

The bed letdown system consists of a double header extending from the blowers to the silos.

Three blowers, two running and one standing, convey the ash from bed letdown holding tanks via air lock devices to two silos.

A line extending from each header combines to a single line to a 5 to 1 distributor box. This serves to supply spent bed material to any one of the 5 beds.

A single carbon burnup bed makeup blower is used to supplement the carbon burnup bed.

Each header has the capability to supply ash to either silo.

Fluidizing blowers are supplied with the silos to provide air assist when removing ash from the silos.

2.2 Performance Characteristics

The performance characteristics of the system components are as included in the amended specifications, manufacturers' drawings, instructions, and/or operation books referenced in Section 7.02.

2.3 Arrangement

The schematic piping arrangement and instrumentation is as noted on the flow diagrams and loop diagrams referenced in Sections 7.03 and 7.05, respectively.

The physical arrangement of the system, machinery, and other equipment is as noted on the piping, machine location, and manufacturers' drawings referenced in Sections 7.07, 7.06, 7.02, respectively.

2.4 Component Design

The bases of design of each component are as included in the specification(s) and the manufacturer's drawings, specifications, and/or information referenced in Section 7.02.

2.5 Instrumentation and Controls

2.5.1 General

The specific design of the instrument and control components are as described in the specification and shown on the drawings referenced in the instrument schedule for that component.

The description of the system control and monitoring functions shall be as shown and described in the logic diagrams and control descriptions referenced in Section 7.04.

2.5.2 Testability

All bed letdown system components are normally in service.

2.5.3 Specific Regulatory Requirements

There are no regulatory requirements specifically applicable to the bed letdown system.

2.6 System Interfaces

The system interfaces with the following other plant systems:

<u>Title</u>	<u>Number</u>
Fly Ash Collection & Disposal	17-2
Carbon Collection & Reinjection	17-3

3.0 SYSTEM LIMITATIONS, SET POINTS, AND PRECAUTIONS

Refer to the loop and logic diagrams for the set point of specific instruments.

4.0 SYSTEM OPERATION

Refer to ash handling manufacturer's operating instructions for operation of the bed letdown system.

5.0 SAFETY FEATURES FOR POTENTIAL EMERGENCIES

Not applicable.

6.0 SYSTEM MAINTENANCE

All system components should be maintained in accordance with the manufacturer's operating instructions and/or maintenance books.

7.0 APPENDIX

7.01 General

7.01.1 Summary of Design Conditions

7.01.2 Line Designation Table No. (Later)

7.01.3 Instrument Schedule (Later)

7.02 Specification(s) Purchase Orders/Manufacturer's Drawing Prefix

<u>Number</u>	<u>Title</u>
P301B	Shop Fabricated Piping
P301C	Field Erection of Piping
P301N	Design and Fabrication of Piping Supports
-	Ash Handling Equipment

7.03 Flow Diagrams

<u>Number</u>	<u>Title</u>
12919.02A-EM-120A	Bed Letdown, Transfer, and Disposal System

7.04 Logic Diagrams

<u>Number</u>	<u>Title</u>
Later	

7.05 Loop Diagrams

<u>Number</u>	<u>Title</u>
Later	

7.06 Machine Location Drawings

<u>Number</u>	<u>Title</u>
12919.02A-EM-202	Boiler Area Machine Locations
12919.02A-EM-203	Turbine Area Machine Locations

7.07 Piping Drawings

<u>Number</u>	<u>Title</u>
12919.02A-EP-202	Boiler Area Piping Composites

7.08 Electrical Drawings

<u>Number</u>	<u>Title</u>
12919.02A-EE-612A, B, C	Cable Tray Arrangements, Boiler Area

7.09 Engineering Sketches and Other Information

7.09.1 Heat Balances

<u>Number</u>	<u>Title</u>
12919.02A-HBSK-1	Turbine VWO
12919.02A-HBSK-2	75% Turbine VWO
12919.02A-HBSK-3	50% Turbine VWO
12919.02A-HBSK-4	25% Turbine VWO

7.09.2 Stress Analysis

7.09.3 Other

J.O. No. 12919.02A

October , 1977

SYSTEM DESCRIPTION 17-2
FLY ASH COLLECTION AND DISPOSAL - B&W
ERDA-AFB STUDY

1.0 SYSTEM REQUIREMENTS

1.1 Function

The fly ash collection and disposal system collects fly ash from the CBB dust collector, CBB hot precipitator, air preheater, and stack hoppers and transports it to the fly ash silos.

1.2 Design Requirements

1.2.1 General

The fly ash collection system is designed for reliable power generation.

1.2.2 Codes and Standards

The fly ash collection system piping will be designed to the ash handling manufacturer's standard.

All other system components will be designed to the codes and standards referenced in the specification(s) in Section 7.02.

1.2.3 Specific Requirements

The fly ash collection system will be designed to remove fly ash material at the rate of 68 tons per hour.

2.0 SYSTEM DESIGN

2.1 Detailed System Description

Refer to Flow Diagram 12919.02A-EM-120C.

The fly ash collection system consists of a pair of vacuum-pressure systems. Each system will consist of two full-size pressure blowers, primary and secondary collectors, two vacuum producers, and one silo. One full-size vacuum system will serve the CBB dust collectors while the other serves the hot precipitators, stack, and air preheaters.

Each vacuum-pressure system will have the capability to convey the entire ash flow should one become inoperable.

Each transfer line out to the silos has the capability to supply ash to either silo.

Fluidizing blowers are supplied with the silos to provide air assist when removing ash from the silos.

2.2 Performance Characteristics

The performance characteristics of the system components are as included in the amended specifications, manufacturers' drawings, instructions, and/or operation books referenced in Section 7.02.

2.3 Arrangement

The schematic piping arrangement and instrumentation is as noted on the flow diagrams and loop diagrams referenced in Sections 7.03 and 7.05, respectively.

The physical arrangement of the system, machinery, and other equipment is as noted on the piping, machine location, and manufacturers' drawings referenced in Sections 7.07, 7.06, 7.02, respectively.

2.4 Component Design

The bases of design of each component are as included in the specification(s) and the manufacturer's drawings, specifications, and/or information referenced in Section 7.02.

2.5 Instrumentation and Controls

2.5.1 General

The specific design of the instrument and control components are as described in the specification and shown on the drawings referenced in the instrument schedule for that component.

The description of the system control and monitoring functions shall be as shown and described in the logic diagrams and control descriptions referenced in Section 7.04.

2.5.2 Test Ability

All fly ash collection system components are normally in service.

2.5.3 Specific Regulatory Requirements

There are no regulatory requirements specifically applicable to the fly ash collection system.

2.6 System Interfaces

The system interfaces with the following other plant systems:

<u>Title</u>	<u>Number</u>
Bed Letdown Transfer and Disposal	17-1
Carbon Collection and Reinjection	17-3

3.0 SYSTEM LIMITATIONS, SET POINTS, AND PRECAUTIONS

Refer to the loop and logic diagrams for the set point of specific instruments.

4.0 SYSTEM OPERATION

Refer to ash handling manufacturer's operating instructions for operation of the fly ash collection and disposal system.

5.0 SAFETY FEATURES FOR POTENTIAL EMERGENCIES

Not Applicable

6.0 SYSTEM MAINTENANCE

All system components should be maintained in accordance with the manufacturer's operating instructions and/or maintenance books.

7.0 APPENDIX

7.01 General

7.01.1 Summary of Design Conditions

7.01.2 Line Designation Table No. (Later)

7.01.3 Instrument Schedule

7.02 Specification(s) Purchase Orders/Manufacturer's Drawing Prefix

<u>Number</u>	<u>Title</u>
P301B	Shop Fabricated Piping
P301C	Field Erection of Piping
P301N	Design and Fabrication of Piping Supports
--	Ash Handling Equipment

7.03 Flow Diagrams

Number

Title

12919.02A-EM-120C Fly Ash Collection and Disposal

7.04 Logic Diagrams

Number

Title

7.05 Loop Diagrams

Number

Title

7.06 Machine Location Drawings

Number

Title

12919.02A-EM-202 Boiler Area Machine Locations
12919.02A-EM-203 Turbine Area Machine Locations

7.07 Piping Drawings

Number

Title

12919.02A-EP-202 Boiler Area Piping Composites

7.08 Electrical Drawings

Number

Title

12919.02A-EE-612A,B,C Cable Tray Arrangements, Boiler Area

7.09 Engineering Sketches and Other Information

7.09.1 Heat Balances

Number

Title

12919.02A-HBSK-1 Turbine VWO
12919.02A-HBSK-2 75 Percent Turbine VWO
12919.02A-HBSK-3 50 Percent Turbine VWO
12919.02A-HBSK-4 25 Percent Turbine VWO

7.09.2 Stress Analysis

7.09.3 Other

J.O. No. 12919.02A

October, 1977

SYSTEM DESCRIPTION 17-3
CARBON COLLECTION AND REINJECTION - B&W
ERDA-AFB STUDY

1.0 SYSTEM REQUIREMENTS

1.1 Function

The carbon reinjection system collects ash of high carbon content from the main bed precipitator hoppers and transports it to the carbon burnup bed via the carbon reinjection tank.

1.2 Design Requirements

1.2.1 General

The carbon reinjection system is designed for reliable power generation.

1.2.2 Codes and Standards

The carbon reinjection system piping will be designed to the ash handling manufacturer's standard.

All other system components will be designed to the codes and standards referenced in the specification(s) in Section 7.02.

1.2.3 Specific Requirements

The carbon reinjection system will be designed to pneumatically convey high carbon fly ash material at the rate of 94 tons per hour to the CBB.

2.0 SYSTEM DESIGN

2.1 Detailed System Description

Refer to Flow Diagram 12919.02A-EM-120B.

The carbon reinjection system consists of four vacuum blowers, four primary and secondary collectors, one carbon reinjection tank, eight rotary feeders, and eight 30:1 distributors.

Only one vacuum blower will operate at any one time.

Ash collected in the carbon reinjection tank is conveyed pneumatically to the CBB by either primary or tempering air, or both.

Ash flow from the carbon reinjection tank is controlled by rotary feeders.

2.2 Performance Characteristics

The performance characteristics of the system components are as included in the amended specifications, manufacturers' drawings, instructions, and/or operation books referenced in Section 7.02.

2.3 Arrangement

The schematic piping arrangement and instrumentation is as noted on the flow diagrams and loop diagrams referenced in Sections 7.03 and 7.05, respectively.

The physical arrangement of the system, machinery, and other equipment is as noted on the piping, machine location, and manufacturers' drawings referenced in Sections 7.07, 7.06, 7.02, respectively.

2.4 Component Design

The bases of design of each component are as included in the specification(s) and the manufacturers' drawings, specifications, and/or information referenced in Section 7.02.

2.5 Instrumentation and Controls

2.5.1 General

The specific design of the instrument and control components are as described in the specification and shown on the drawings referenced in the instrument schedule for that component.

The description of the system control and monitoring functions shall be as shown and described in the logic diagrams and control descriptions referenced in Section 7.04.

2.5.2 Testability

All carbon reinjection system components are normally in service.

2.5.3 Specific Regulatory Requirements

There are no regulatory requirements specifically applicable to the carbon reinjection system.

2.6 System Interfaces

The system interfaces with the following plant systems:

<u>Title</u>	<u>Number</u>
Fly Ash Collection and Disposal	17-2
Bed Letdown, Transfer, and Disposal	17-1

3.0 SYSTEM LIMITATIONS, SET POINTS, AND PRECAUTIONS

Refer to the loop and logic diagrams for the set point of specific instruments.

4.0 SYSTEM OPERATION

Refer to ash handling manufacturer's operating instructions for operation of the carbon collection and reinjection system.

5.0 SAFETY FEATURES FOR POTENTIAL EMERGENCIES

Not applicable.

6.0 SYSTEM MAINTENANCE

All system components should be maintained in accordance with the manufacturer's operating instructions and/or maintenance books.

7.0 APPENDIX

7.01 General

7.01.1 Summary of Design Conditions

7.01.2 Line Designation Table No. (Later)

7.01.3 Instrument Schedule (Later)

7.02 Specification(s) Purchase Orders/Manufacturer's Drawing Prefix

<u>Number</u>	<u>Title</u>
P301B	Shop Fabricated Piping
P301C	Field Erection of Piping
P301N	Design and Fabrication of Piping Supports
-	Ash Handling Equipment

7.03 Flow Diagrams

<u>Number</u>	<u>Title</u>
12919.02A-EM-120B	Carbon Collection and Reinjection

7.04 Logic Diagrams

<u>Number</u>	<u>Title</u>
Later	

7.05 Loop Diagrams

<u>Number</u>	<u>Title</u>
Later	

7.06 Machine Location Drawings

<u>Number</u>	<u>Title</u>
12919.02A-EM-202	Boiler Area Machine Locations
12919.02A-EM-203	Turbine Area Machine Locations

7.07 Piping Drawings

<u>Number</u>	<u>Title</u>
12919.02A-EP-202	Boiler Area Piping Composites

7.08 Electrical Drawings

<u>Number</u>	<u>Title</u>
12919.02A-EE-612A, B, C	Cable Tray Arrangements, Boiler Area

7.09 Engineering Sketches and Other Information

7.09.1 Heat Balances

<u>Number</u>	<u>Title</u>
12919.02A-HBSK-1	Turbine VWO
12919.02A-HBSK-2	75% Turbine VWO
12919.02A-HBSK-3	50% Turbine VWO
12919.02A-HBSK-4	25% Turbine VWO

7.09.2 Stress Analysis

7.09.3 Other

J.O.No. 12919.02A

October, 1977

SYSTEM DESCRIPTION-19-2
PRIMARY AND TEMPERING AIR - B&W
ERDA AFB STUDY

1.0 SYSTEM REQUIREMENTS

1.1 Function

The function of the Primary and Tempering Air System is to transport and dehumidify the coal-limestone mixture from the bunkers to the boiler beds for combustion.

1.2 Design Requirements

1.2.1 General

The Primary and Tempering Air System will be designed for reliable power generation.

1.2.2 Codes and Standards

All system components will be designed to all codes and standards referenced in the specification(s) in Section 7.02.

1.2.3 Specific Requirements

The Primary and Tempering Air System will be designed to pneumatically convey coal and limestone to the FBC at the rate of 300 tons per hour and to convey high carbon fly ash material to the CBB at the rate of 94 tons per hour.

2.0 SYSTEM DESIGN

2.1 Detailed System Description

Refer to Flow Diagram 12919.02A-EM-115A.

The Primary and Tempering Air System consists of two hot primary air fans and two tempering air fans.

Each of the half-capacity hot primary air fans takes suction from the forced draft fan discharge downstream of the air preheater and discharges through the mixing bustles to the furnace.

Each of the half-capacity tempering air fans takes suction from the forced draft fan discharge upstream of the air preheater and discharges to the mixing bustles to control the temperature of the primary air.

Primary and tempering airflow is controlled, based on load, by varying the position of the inlet (suction) vanes on the fans.

2.2 Performance Characteristics

The performance characteristics of the system components are as included in the specifications, manufacturer's drawings, instructions, and/or operation books referenced in Section 7.02.

2.3 Arrangement

The piping schematic, electrical schematic, and instrumentation arrangement are as noted on the flow diagrams, elementary diagrams, and loop diagrams referenced in Sections 7.03, 7.08, and 7.05, respectively.

The physical arrangement of the system, machinery, and other equipment is as noted on the piping, machine location, and manufacturer's drawings referenced in Sections 7.07, 7.06, and 7.02, respectively.

2.4 Component Design

The bases of design of each component are as included in the specification(s) and the manufacturer's drawings, specifications, and/or information referenced in Section 7.02.

2.5 Instrumentation and Controls

2.5.1 General

The specific design of the instrument and control components is as described in the specification and shown on the drawings referenced in the Instrument Schedule.

The description of the system control and monitoring functions shall be as shown and described in the logic diagrams and control descriptions referenced in Section 7.04.

2.5.2 Testability

Later

2.5.3 Specific Regulatory Requirements

None

2.6 System Interfaces

The Primary and Tempering Air Systems interface with the following systems:

<u>System Title</u>	<u>System Number</u>
Coal and Limestone Handling	-
Carbon Collection and Reinjection	17-3
Secondary Air and Flue Gas	19-3

3.0 SYSTEM LIMITATIONS, SET POINTS, AND PRECAUTIONS

Refer to the loop and logic diagrams for the set point of specific instrumentation.

4.0 SYSTEM OPERATION

Later

5.0 SAFETY FEATURES FOR POTENTIAL EMERGENCIES

Not applicable

6.0 SYSTEM MAINTENANCE

All system mechanical components are to be maintained in accordance with the operation and maintenance instructions submitted in accordance with the component specification listed in Section 7.02.

7.0 APPENDIX

7.0.1 General

7.01.01 Summary of Design Conditions

7.01.2 Line Designation Table

7.01.3 Instrument Schedule

7.02 Specification(s)/Purchase Orders

Later

7.03 Flow Diagrams

<u>Number</u>	<u>Title</u>
12919.02A-EM-115A	Combustion Air and Flue Gas

7.04 Logic Diagrams

<u>Number</u>	<u>Title</u>
Later	

7.05 Loop Diagrams

Number

Title

Later

7.06 Machine Location Drawings

Number

Title

12919.02A-EM-202A,B

Boiler Area Machine Locations

7.07 Piping Drawings

Number

Title

12919.02A-EP-202A-G

Boiler Area Piping Composites

7.08 Electrical Drawings

Later

7.09 Engineering Sketches

None

J.O.No. 12919.02A

October 1977

SYSTEM DESCRIPTION - 19-3
SECONDARY AIR AND FLUE GAS - B&W
ERDA AFB STUDY

1.0 SYSTEM REQUIREMENTS

1.1 Function

The function of the Secondary Air and Flue Gas System is twofold:
1. Supply heated air to the boiler for combustion, and 2. Remove the flue gas from the boiler and particulate from the flue gas before being discharged to the stack.

1.2 Design Requirements

1.2.1 General

The Secondary Air and Flue Gas System will be designed for reliable power generation.

1.2.2 Codes and Standards

All system components will be designed to all codes and standards referenced in the specification(s) in Section 7.02.

1.2.3 Specific Requirements

The forced draft (F.D.) fans shall be capable of supplying 3,004,884 lb of air per hour at 600 F to the boiler at turbine valves wide open (VWO) conditions.

The electrostatic precipitators shall be capable of meeting the current Federal Standard for particulate emission of 0.1 lb/10⁶ Btu of heat input.

The induced draft (I.D.) fans shall be capable of supplying 5,959,115 lb of flue gas per hour at 279 F to the stack at turbine VWO conditions.

2.0 SYSTEM DESIGN

2.1 Detailed System Description

Refer to Flow Diagram 12919.02A-EM-115A.

The Secondary Air portion of the system has two half-capacity F.D. fans to take outside air from a fan room and discharge the air into a regenerative air heater (APH). The APH heats the combustion air before discharging it, through suitable ductwork, to the undergrid plenums of the main beds and CBB.

Two steam/air heaters are provided upstream of the APH to maintain the average cold end temperature of the APH and minimize corrosion.

Air flow is regulated by adjusting the inlet (suction) vanes on the F.D. fans. The F.D. fans also supply air to the suction of the primary and tempering air fans (see 19-2).

The Flue Gas portion of the system has an electrostatic precipitator (ESP) in the ductwork from the main beds and a mechanical collector and an ESP in the ductwork from the CBB.

The ESP in the gas stream from the main beds is used to reduce particulate emissions and to recapture any unburned carbon that may have become entrained in the flue gas. The recaptured carbon is reinjected into the CBB portion of the boiler to increase boiler efficiency and reduce fuel costs.

The mechanical collector and ESP in the gas stream from the CBB are used for the purpose of reducing particulate emissions.

The flue gas enters the APH and transfers heat to the secondary air before entering the two half-capacity, axial type I.D. fans. The I.D. fans pull the flue gas from the boiler through the preceding equipment and discharges to the atmosphere via the stack.

The flue gas flow is maintained by varying the blade angle of the I.D. fans.

2.2 Performance Characteristics

The performance characteristics of the system components are as included in the specifications, manufacturer's drawings, instructions, and/or operation books referenced in Section 7.02.

2.3 Arrangement

The piping schematic, electrical schematic, and instrumentation arrangement are as noted on the flow diagrams, elementary diagrams, and loop diagrams referenced in Sections 7.03, 7.08, and 7.05, respectively.

The physical arrangement of the system, machinery, and other equipment is as noted on the piping, machine location, and manufacturer's drawings referenced in Section 7.07, 7.06, and 7.02, respectively.

2.4 Component Design

The bases of design of each component are as included in the specification(s) and the manufacturer's drawings, specifications, and/or information referenced in Section 7.02.

2.5 Instrumentation and Controls

2.5.1 General

The specific designs of the instrument and control components are as described in the specification and shown on the drawings referenced in the Instrument Schedule.

The description of the system control and monitoring functions shall be as shown and described in the logic diagrams and control descriptions referenced in Section 7.04.

2.5.2 Testability

Later

2.5.3 Specific Regulatory Requirements

None

2.6 System Interfaces

The Secondary Air and Flue Gas System interfaces with the following systems:

<u>System Title</u>	<u>System Number</u>
Fly Ash Collection and Disposal	17-2
Carbon Collection and Reinjection	17-3
Primary and Tempering Air	19-2

3.0 SYSTEM LIMITATIONS, SET POINTS, AND PRECAUTIONS

Refer to the loop and logic diagrams for the set point of specific instrumentation.

4.0 SYSTEM OPERATION

Later

5.0 SAFETY FEATURES FOR POTENTIAL EMERGENCIES

Not applicable

6.0 SYSTEM MAINTENANCE

All system mechanical components are to be maintained in accordance with the operation and maintenance instructions submitted in accordance with the component specification listed in Section 7.02.

7.0 APPENDIX

7.0.1 General

7.01.1 Summary of Design Conditions

7.01.2 Line Designation Table

Later

7.01.3 Instrument Schedule

7.02 Specification(s)/Purchase Orders

12919.02A-P212A

Forced Draft Fans - Centrifugal

12919.02A-P212D

Driven for Forced Draft and Induced Draft Fans

12919.02A-P212F

Induced Draft Fans - Axial

7.03 Flow Diagrams

Number

Title

12919.02A-EM-115A

Combustion Air and Flue Gas

7.04 Logic Diagrams

Number

Title

Later

7.05 Loop Diagrams

Number

Title

Later

7.06 Machine Location Drawings

Number

Title

12919.02A-EM-202A, B

General Arrangement
Boiler Area

7.07 Piping Drawings

Number

Title

12919.02A-EP-202A-G

Composite Boiler Area

7.08 Electrical Drawings

12919.02A-EW-1A

Main One Line Diagram

7.09 Engineering Sketches

None

APPENDIX IIIA-C

BABCOCK & WILCOX COMPANY FINAL REPORT

BOILER TRIP & RUNBACK - SHEET 2 OF 2

ERDA AFB STUDY
STONE & WEBSTER ENGINEERING CORPORATION
12919.02A-LSK-1-3B

11-28-77	1	2	3	4	5	6	7	8	9	10	11	12
1	2	3	4	5	6	7	8	9	10	11	12	
1	2	3	4	5	6	7	8	9	10	11	12	
1	2	3	4	5	6	7	8	9	10	11	12	

PRELIMINARY DESIGN OF A 570 MW
ATMOSPHERIC FLUIDIZED BED BOILER

Prepared by:

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I. ABSTRACT

In recent years, fluidized bed combustors have received a great deal of attention as a result of their ability to reduce undesirable stack emission when burning sulfur bearing fuels. While these abilities are well supported by fundamental data, it must be recognized that fluidized bed combustors have not reached the state of commercial application attained by stack gas scrubbers and, more obviously, conventional coal fired boilers. The fact remains, however, that the fluidized bed combustor has the ability to reduce sulfur dioxide emissions and limit nitric oxide formation and, therefore, it is desirable to pursue its development.

Presently many investigators are directing their attention toward the development of fundamental fluidized bed combustion technology. While this work is necessary, engineering studies are also required to investigate the commercial practicality and estimate the economic feasibility of fluidized bed boilers.

Until recently, the bulk of fluidized bed boiler development has been fundamental in nature. Early in 1977, the Federal ERDA initiated a major effort to investigate the engineering aspects of fluid bed boilers by making funds available to two architect/engineering firms and, in turn, the three major boiler manufacturers. This document describes the results of the work performed by B&W over the last seven months and represents the Company's input to ERDA's fluidized bed boiler commercialization investigation. More specifically, B&W has prepared a conceptual design of a 570 MW fluidized bed boiler with its auxiliaries, prepared preliminary drawings showing the arrangement of this equipment, and prepared a cost estimate for the equipment. This final report summarizes the results of this work.

II. OBJECTIVE

To develop a preliminary design for a conceptualized 570 MW atmospheric pressure fluidized bed boiler (AFB) capable of burning high sulfur coal in an environmentally acceptable manner without recourse to flue gas desulfurization. This preliminary design will be in sufficient detail to describe the technical feasibility and costs associated with the conceptualized AFB boiler and equipment.

III. DESIGN PHILOSOPHY

A. General

The steam generating portion of the fluid bed system consists of two major units, the main fluid bed boiler and a separate carbon burn-up bed unit. The overall design arrangements of these units are shown on pages A-13, A-14, and A-2 .

The main bed unit is made up of five (5) beds, each 71 feet wide and 24 feet deep. All of the coal and limestone and a major portion of the combustion air are fed to this unit. The boiler is arranged with two elevations of beds on the front wall; two on the rear, and one at the base of the central furnace. While time did not permit extensive study of various bed arrangements, the selected arrangement appears to have merit in that it did not require unusual unit height or plan area. Also, it permitted reasonable integration of the bed enclosure walls into the overall boiler enclosure circulation system. While this arrangement is not optimum, we believe it is adequate.

In retrospect, there may have been some added benefit if four larger beds had been utilized, eliminating the upper rear bed. This might have alleviated some of the congestion at the back of the unit and permitted a slightly more efficient arrangement of reheat surface. If future studies are performed, this alternative should be pursued.

An inspection of the arrangement drawings will reveal that the windbox areas located between the vertically disposed beds are rather large. This arrangement was dictated by the significant structural requirements within the windbox, due to high gas pressure differentials, distributor plate support systems, and thermal expansion requirements. In addition, routing of the many coal and stone feed pipes added to the congestion problem in these areas.

The main boiler design was predicated on the philosophy of not placing any reheater surface within the beds. This eliminated the need for a sophisticated by-pass system for protection of the reheater during start-up and unit trip conditions. The downflow convection pass which resembles a conventional boiler arrangement consists of a primary superheater section and a primary reheater

section in parallel, with gas flow biasing for reheat steam temperature control. The major portion of the superheater surface is submerged in the beds. The superheater surface is located in three and one-half ($3\frac{1}{2}$) of the five (5) beds. The remaining one and one-half ($1\frac{1}{2}$) beds contain boiling heat transfer surface.

A pump-assisted circulation boiler design was selected rather than a once through design. The AFB system with its many enclosure walls for both main unit and the CBB as well as the in-bed horizontal boiler surface in the main beds presents a large number of tubes to be cooled. The use of a once through design would require several sequential passes through the enclosure in order to achieve sufficiently high mass velocities in the tubes to assure that departure from nucleate boiling would not occur. Considering the design problems that are known on conventional 2400 psi once through boilers, if multiple passes must be used, it seemed prudent not to utilize the once through design philosophy. In addition, the avoidance of a once through design permits the use of large ($2\frac{1}{2}$ " OD) diameter enclosure tubes. This size, as opposed to the $1\frac{1}{4}$ " or $1\frac{1}{2}$ " OD tubes usually used in once through designs provides greater enclosure wall rigidity and hence reduces structural design requirements.

A pump assisted circulation design was selected over natural circulation for two primary reasons. First, the horizontal boiler tubes submerged in the beds require relatively high fluid mass flows to assure that there will be no departure from the nucleate boiling regime. Second, the heat absorbed by the vertical wall enclosure tubes is significantly lower than for a conventional coal fired unit, resulting in insufficient natural pumping head.

The carbon burn-up bed unit is designed as a physically separate enclosure, although it is fed by the common circulating pumps and its water circuitry is integral with the main boiler. The alternative of physically integrating the CBB into the main boiler setting was discarded for structural reasons. Under certain operating conditions, significant gas pressure differentials could exist between the main unit and the CBB, and if a common tubular wall was used to separate the two units, there appeared to be no reasonable means of buck-staying this wall to accommodate the resulting forces.

The CBB consists of four (4) beds with vertical water cooled tubular enclosure walls. Unlike the FBC there is no horizontal transfer surface within

the beds. The CBB has been oversized by 20 percent for flexibility reasons. For example, in the event that the main bed combustion efficiency is poorer than anticipated, additional heat would be liberated in the CBB. Bed temperature can be controlled by slumping of bed compartments or varying bed depth or a combination of the two. Coal and limestone can be fed to the beds for start-up or for supplementary feed if required.

Due to the shortness of this contract schedule, it was necessary, very early in the contract, to assume many design parameters based on the best knowledge and experience available at that time. Also, time did not permit major changes in these assumptions once the design was underway. The primary design factors used for this study are as follows:

Main bed and CBB superficial velocity	8 ft./sec.
Main bed and CBB bed depth	4 ft.
Main bed operating temperature	1550°F.
Main bed excess air	15%
CBB operating temperature	2000°F.
CBB excess air	50%

B. Development of Design Parameters

The design parameters used for this study were developed by B&W as part of their inhouse AFB development program and during an AFB boiler design study performed for TVA/ERDA under Contract TV-45715A. The details of the TVA development work will be published later by TVA. That study and the subject commercial AFB design were performed concurrently, and the TVA study results were utilized in the commercial design insofar as possible. In some cases, however, time did not permit major design changes. For example, the TVA studies indicated that significant operating cost savings should be realized by the use of lower bed velocities (or higher bed gas retention times). This is discussed in more detail in Section XII "AFB Demonstration Plant".

A brief discussion of the results of the more important design relationship studies is presented below.

1. Calcium-Sulfur Ratio

Model development and comparison to

experimental data yielded a relationship between calcium-sulfur ratio, sulfur capture, stone sizing and gas residence time. This relationship matched the data reported by PER* and ANL** as well as data obtained by B&W under an EPRI contract with reasonable accuracy. Using this relationship and the selected bed operating conditions yielded a required calcium-sulfur ratio of 2.5 for this design, in order to lower the SO₂ emissions from the AFB system combustion to 1.2 lb/10⁶ BTU input.

2. Combustion Efficiency

A model was developed to define the combustion process. This model yielded a relationship that considered such items as coal sizing, volatile matter of the coal, gas residence time, excess air and bed temperature. This relationship was compared to published data of combustion efficiencies determined by several investigators(1). While the reported data showed considerable scatter, the relationship of the model, with appropriate evaluation of constants relating to isothermal combustion rates, provided reasonable agreement with the statistical trend. For the selected bed operating conditions and coal characteristics, the overall bed combustion efficiency was predicted to be 88%. The split between in-bed and above bed combustion was assumed to be 91%/9% for the selected bed velocity. This value is based on judgment and available experimental results. The combustion efficiency for the CBB was evaluated using the same model as for the main bed unit but with the assumption that the reactivity of the char was an order of magnitude less than for the coal. For the selected operating conditions this yielded the same combustion efficiency for the CBB as for the main unit.

3. Heat Transfer

As suggested in Reference (1) it was assumed that the outside heat transfer coefficient could be expressed as

$$U = hc + hr$$

Where: U = outside heat transfer coefficient
hc = convection-conduction coefficient
hr = radiation coefficient

* Pope, Evans & Robins
** Argonne National Lab

Also, as suggested by Reference (1) the radiation coefficient could be evaluated using the bed temperature, the tube temperature and an overall emissivity of 0.8.

The convective-conductive coefficient was evaluated using the MIT suggested modification to the Vreedenberg Equation ⁽²⁾. This single tube coefficient was converted to a bundle coefficient by means of the equation developed by Gel'perin⁽³⁾.

The original work with the Vreedenberg equation and its modification was based on low temperatures where the gas properties could be evaluated at bed temperature. In fitting this correlation to the reported data of BCURA, PER and the B&W combustor, it was determined that the gas properties should be evaluated at other than bed temperature. Using this latter method of estimating gas temperatures and evaluating gas properties, good agreement with the reported data was achieved. For the selected bed operating conditions the outside heat transfer coefficient (bed to tube) was in the range of 45 to 50 Btu/hr-ft²-°F.

C. Operating Characteristics and Philosophy

Based on B&W's studies of fluid bed combustion as applied to utility power plants and cycles, one of the major concerns that has surfaced is the probability of reduced operating flexibility as compared to conventional coal fired boilers. For a standard 2400 psi, 1000°F cycle, a considerable portion of the heat absorbed to satisfy the cycle must be in superheat. Since a large portion of the heat released in an FBC boiler is within the bed, the major portion of the superheater must be immersed in the bed for this cycle. This requirement merely adds to the operating restrictions that have been experienced and reported on several laboratory scale apparatus. Within a fluid bed, and within our present knowledge of the process, the following operating restrictions would appear to apply (for this discussion we are ignoring the possibility of serious in-bed corrosion).

1. For optimum sulfur capture the bed temperature should be maintained reasonably close to 1550°F (1500°F-1600°F might be a practical range).

2. Coal flow must be regulated to meet load demand, and air flow must be kept within reasonable excess air limits as with any boiler.
3. In-bed superheater input must be regulated sufficiently so that reasonable external means (attemperators) can be used for accurate control of steam temperature to the turbine.
4. In-bed heat transfer does not diminish greatly as fuel and air are decreased (assuming the bed temperature is maintained within required limits). Steam flow quantities decrease, however, with diminishing load, resulting in superheater metal design problems at reduced loads. This phenomenon also requires that surface is removed from service as load is decreased to control superheat temperature.
5. For a commercially sized fluid bed utility boiler, the bed area must be large. This, in B&W's opinion, eliminates the option of using vertical surface and mandates the use of horizontal surface within the bed. In turn, this makes it difficult to anticipate the use of bed height as a primary tool for significant bed turn down ability.
6. The above anticipated operating restrictions have led B&W to conclude that it is not practical to obtain load turn down by keeping all beds in service and modulating fuel and air to them, except for a severely limited control range. Instead, we have elected to proceed with a design that splits the main operating beds into a number of separate compartments, with individual coal, limestone and air controls. This philosophy anticipates that slumping of individual bed compartments will be a practical operating mode and will overcome many of the above listed operating problems.

D. Coal and Limestone Feed System

In developing the philosophy of design for the coal and limestone feed and transport systems, B&W endeavored to meet the following design goals:

1. Utilize a feed system from under the bed, to minimize the length of coal nozzle subjected to bed temperature conditions. The purpose of this approach was to minimize the possibility of coal feed line coking.
2. Each coal and limestone feed nozzle was to service approximately nine square feet of

bed area, suggested by existing technology for reasonable bed distribution.

3. The design should eliminate the need for predrying coal or limestone.
4. Existing conventional boiler coal feeding and transport technology should be utilized as much as possible.

The resulting coal and limestone system is shown in sketch form on page 3-12.

The coal and limestone injection system takes the crushed coal and limestone from their respective silos, mixes the coal and the limestone in the proper ratio for sulfur removal, dries, transports, distributes and injects the mixture into the fluid bed boiler and carbon burn-up beds.

The design of the coal and limestone injection system is based on an almost identical system supplied by B&W for injecting crushed coal into B&W Cyclone Furnaces.

Twenty-five (25) identical transport systems are used in parallel. Each starts at the outlet of the coal and limestone silos and ends at the injection point just above the distributor plate in the fluid bed boiler.

As shown on the sketch, crushed coal and limestone are fed by gravity through fifty (50) gravimetric belt feeders to a discharge hopper. The mixture then passes through a rotary seal and to a mixing bustle. Here, the material is mixed and partially dried. Hot air to dry the mixture of coal and limestone and to convey it from the bustle is supplied by the primary air fans. A tempering air fan is used to provide ambient air to control the temperature into the mixing bustle. This air temperature will be dependent on the outlet temperature of the two-phase mixture transported from the mixing bustle. This solids-air mixture is split into forty (40) streams before injection into the fluid bed boiler.

In addition to the above, a similar system to convey limestone and coal was provided for CBB start-up, or for supplementary feed if it is found necessary.

The described system has been used and proven on commercial conventional coal fired units, with the exception of two areas that require further development:

1. Some concern has been voiced with regard to the possibility of bunker hang ups with wet limestone. If wet limestone feed to the belt feeder is not a problem, B&W is satisfied that the pneumatic transport system will adequately dry the limestone to prevent further pluggage problems. For this study it is assumed that wet limestone bunker feed will not be a problem and that pre-drying will not be required.
2. We have demonstrated at our Alliance Research Center that a coal-limestone-air stream can be satisfactorily split from one to four feed pipes. The required split for this design, one to forty (40), has not been done and needs to be demonstrated.

E. Char Collection and Reinjection

One of the problem areas in FBC design that has become apparent is the poor combustion efficiency and unburned combustible losses even when utilizing a carbon burn-up bed. Ways and means of significantly reducing these losses must be developed if FBC is to be of practical use for utility boilers.

The base system arrangement shown on page 3-13 is the one that was originally considered, utilizing a mechanical solids collector following the main boiler for removal of char which in turn is burned in the CBB. We believe that, practically, only about 90 percent of the char can be removed in this manner, contributing to the combustion inefficiency.

A study was made of a modified arrangement, also shown on page 3-14, eliminating the main boiler mechanical collector and using a separate hot precipitator for collection of the char.

Although some questions have been raised with regard to the ability of hot electrostatic precipitators to remove carbon efficiently, this question has been reviewed with Rothemuhle in Germany and they have given assurance of 99 percent removal of carbon with proper precipitator design. To substantiate their claims, Rothemuhle has submitted a list (page 3-10) of operating electrostatic precipitators which are operating satisfactorily on high carbon content fly ash. The arrangement shown on page 3-14 has been used for the commercial design, resulting in an overall system thermal efficiency gain of about one percent over the original scheme. The modified system will require an additional hot precipitator (for the CBB) but the fuel savings gain overshadows

the higher equipment costs.

A mechanical solids collector is utilized following the CBB and prior to the CBB electrostatic precipitator. The reason for this is economics, since the gas solids loading leaving the CBB is much higher than leaving the FBC, and use of a mechanical collection device at this point significantly reduces the CBB precipitator size (and cost).

F. Boiler Sootblower Design

The number and spacing of sootblowers for this boiler arrangement were set in accordance with B&W standards for conventional P.C. fired units using the contract fuel. Some authorities predict that fluid bed fired boilers (with lower combustion temperatures and high stone carryover rates) will need fewer or no sootblowers and there may be some justification for this speculation. However, this point is presently unknown and therefore we have adopted a conservative position.

ROTHEMUHLE ELECTROSTATIC PRECIPITATORS
OPERATING SATISFACTORILY ON HIGH
CARBON CONTENT FLY ASH

	<u>Name of Plant</u>	<u>Location</u>	<u>Fuel</u>	<u>Firing Type</u>	<u>Unburned Carbon %</u>
1.	Feldmuehle AG	Feldmuehle Arnsberg, Germany	Bituminous	Wet Bottom	16.2
2.	Steag Kraftwerks- betriebsgesellschaft MBH	Luenen Germany	Bituminous	Wet Bottom	9.5-17.7
3.	Lansirannikon Voima Oy	Tahcoluoto Finland	Bituminous	Dry Bottom	11.7-62.2
4.	Rheinische Braunkohlenwerke AG	Fortunga Nord, Niederaussem Germany	Lignite	Stoker	21.5-50
5.	EVS/DKW ULM	ULM, Germany	Bituminous	Stoker	23.5
6.	Universitaet Muenster	Muenster Germany	Bituminous		48.3-60.9

References

- (1) Babcock & Wilcox, EPRI No. RP 412-1 Interim Report, "Preliminary Evaluation of Atmospheric Pressure Fluidized Bed Combustion Applied to Electric Utility Large Steam Generators," Feb. 1976.
- (2) B. R. Andeen and L. R. Glickman, "Heat Transfer to Horizontal Tubes in Shallow Fluidized Beds, ASmE-AIChE Heat Transfer Conference, St. Louis, Mo., Aug. 1976, Paper No. 76-HT-67.
- (3) N. I. Gel'perin, "Heat Transfer Between a Fluidized Bundle and Staggered Bundles of Horizontal Tubes", International Chemical Engineering, Vol. 9, No. 1, Jan. 1969

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APP'D /Z

FLUID BED COAL & LIMESTONE
FEEDING & DISTRIBUTION SYS.

SCALE 7/8"

INCHES = 1 FOOT

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 AND ONE PRECIPITATOR FOR
 OVERHEAD SOLIDS
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3-13

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IV SYSTEM DESCRIPTION

A. Process Description

1. Plant Arrangement (See page A-13)

The steam generator for the 570 MW atmospheric pressure fluidized bed power plant consists of two separate but integral units. The main unit (FBC) is equipped with five (5) fluidized beds, each 71 feet wide and 24 feet deep. Each of the main beds is divided into five (5) compartments, each with separate fuel and air controls. This arrangement was developed to provide for operational flexibility. Four of the compartments in each bed are 16 feet wide and 24 feet deep. The fifth compartment, the start-up compartment, located at the center of each bed, is 7 feet wide by 24 feet deep.

Horizontal heating surface is located in the fluidized beds. One and one-half (1 1/2) of the beds contain boiling surface and three and one-half (3 1/2) of the beds contain superheat surface. The surface was designed to maintain a bed temperature of 1550°F with full load heat input to the bed. There is no submerged heating surface in the start-up compartments.

Horizontal reheater surface is located in the upflow section of the main unit. This is the high temperature portion or outlet bank of the reheat. The downflow convection section is divided into two (2) flow paths for reheat control. Horizontal reheat surface is located in the front section with primary superheater surface in the rear section. Economizer surface is located at the bottom of both gas paths.

Gas flow across the divided reheater and primary superheater sections is controlled by dampers at the boiler outlet.

The unburned char, ash and elutriated calcium compounds, from the main unit are collected in hot precipitators. This material is then stored and injected into the carbon burn-up bed (CBB) (See page A-2). The CBB is made up of four (4) fluid beds 10 feet 6 inches wide and 52 feet deep separated by water cooled walls. Each bed is divided into two (2) compartments each with separate fuel and air controls. Each compartment is 10 feet, 6 inches wide and 26 feet deep. A bed temperature of 2000°F,

at full load input, is maintained by virtue of furnace design. There is no in-bed heating surface, but the membraned boiler peripheral walls are designed to remove sufficient heat to maintain bed temperature.

Three walls on three and one-half (3-1/2) foot centers, plus the enclosure walls, provide the required heat transfer surface. Boiling surface comprises the entire CBB. Horizontal boiling surface is located above the beds to recover the heat from the combustion gas.

CBB flue gas particulate removal is obtained with a mechanical dust collector and hot electrostatic precipitator in series. Flue gas from the CBB hot precipitator then is mixed with flue gas from the FBC hot precipitators prior to entering the two (2) regenerative air heaters. From the air heaters the gas passes through the induced draft fans and then exits to the stack.

2. Air Flow (See page A-14)

Combustion air is supplied by two (2) forced draft fans. The air passes through steam coil air heaters, required for air heater cold end protection at low loads; and is preheated by two (2) regenerative air heaters. The combustion air leaving the air heaters is divided into two (2) streams with approximately twenty percent going to hot primary air fans and the remaining eighty percent supplying the secondary air for the FBC and the CBB. The secondary air flow to the individual compartments of the beds is controlled with dampers at the windboxes. Air foils are provided for flow measurement at the individual windboxes. The air then passes through a perforated distribution plate for fluidization of the coal-limestone mixture. The hot air leaving the primary air fans flows to the coal-limestone feed system where, after it is mixed with tempering air for air temperature control, it is used to transport the feed material to each bed compartment.

3. Coal-Limestone Feed System (See page A-1)

The coal-limestone feed rates to the individual bed compartments in the main unit are controlled by gravimetric feeders. Twenty-five (25) coal and twenty-five (25) limestone feeders are provided. A coal feeder and a limestone

feeder operate together to provide the proper coal to limestone ratio. Both feeders discharge into a common chamber. This mixture passes through a rotary seal and into a mix bustle where it mixes with the hot primary air for drying and transport. The air-coal-limestone mixture travels through a single coal pipe to a distributor bottle. At the distributor bottle, the flow is split into forty (40) streams for feeding the main bed compartments and into eighteen (18) streams for feeding the start-up compartments. The individual injector feed lines pass through the perforated plate and into the bed on approximately three (3) foot centers.

4. Char Feed System (See page A-3)

The char feed to the CBB is controlled to the individual compartments by a system similar to the FBC coal-limestone feed system. The char, ash and calcium compounds collected by the FBC precipitators are conveyed from the precipitator hoppers to a CBB feed tank. Rotary feeders are used to feed this material to a mix bustle where the primary air is introduced for transport. The mixture then flows through a single coal pipe to a distributor bottle where the flow is split one (1) to thirty (30) to feed each bed's compartments.

5. Bed Solids Removal System (See page A-13)

Bed level is controlled and spent material removed from the beds by a bed let-down system. The bed material is removed and cooled by a screw-type ash cooler. The ash cooler also serves as a feeder. The cooled bed material then travels through a rotary seal and to a storage tank. From the storage tank, the bed material is either sent to ash disposal, or stored for re-use during boiler start-up, or recycled to the CBB to make up for bed material losses due to particle attrition.

6. Water Flow (See page A-13)

Feedwater to the unit enters an up-flow economizer located in the FBC. From the economizer outlet header, the water flows out both ends and to the steam drum. Water from the drum flows down five (5) downcomers to the four (4) circulation assist pumps. From the assist pumps the water is routed to the FBC and the CBB to supply the required flow to the boiler circuits. In the FBC these circuits are made up of all the enclosure walls plus the horizontal water cooled tubes located in one and one-half (1 1/2) of the beds. In the CBB the enclosure and convection banks are supplied

from this source. The steam-water mixture from the boiler circuits exits the outlet headers via risers which run directly to the steam drum. The steam-water mixture is separated in the steam drum by cyclone separators.

7. Steam Flow (See page A-13)

The saturated steam leaving the cyclone separator passes through a secondary scrubber and exits the drum through multiple connections running to a collecting header. The steam exits the collecting header through end connections which are routed to the primary superheater inlet header. The steam flows through the up-flow primary superheater located in the rear gas pass of the down-flow convection pass. The steam then flows to the secondary superheater which is located in three and one-half (3 1/2) of the beds and flows through these banks in series. More specifically the steam exits the primary superheater via quarter point outlet connections on the outlet header and enters the superheater located in the lower rear fluidized bed. This bed contains both boiling and superheater surface. The superheater surface is located in the right two compartments. The inlet and outlet headers have quarter point connections. The steam is routed from the split bed to the top rear wall bed, which is the first all superheater bed. The inlet header is located on the boiler right hand side and has quarter-point connections. The steam passes through the superheater and exits via quarter point outlet connections on the outlet header located on the boiler left hand side. Spray attenuators, located in the cross-over piping between the first and second full superheater bed, reduce the inlet enthalpy to the second all superheater bed. The second all superheater bed is the lower front wall bed and has quarter point inlet and outlet connections. The inlet header is located on the boiler left side while the outlet header is on the boiler right side. A second stage of spray attenuation is provided in the cross-over piping between the second all superheater bed and the third all superheater bed. This is the final stage of superheater and is the top front wall bed. The steam enters the inlet header, located on the boiler right side, via quarter point connections; and exits the outlet header, located on the boiler left hand side, via a center point outlet connection. The steam exits the B&W terminal at 2620 psig and 1005°F.

8. Reheat Steam Flow

Cold reheat steam enters the reheat inlet header via a single end inlet connection. The steam passes through the counter-flow reheater, located in the down-flow convection section of the FBC, flows to the high temperature section located in the up-flow of the FBC, and exits via a center point outlet connection on the outlet header. The outlet header is located at the front of the unit. Reheat steam temperature is controlled by biasing the gas flow in the parallel back end. An attemperator is provided in the cold reheat line to control temporary temperature excursions.

9. Predicted Performance Summary Sheet (See pg. 4-6)

The AFB is designed to perform as shown on the Predicted Performance Summary Sheet. Boiler and air heater heating surfaces are also summarized. It should be noted that slight discrepancies between the predicted performance summary sheet and the material balance sheet exist. The material balance sheet was not prepared from the final boiler efficiency calculations. Sufficient time was not available to update the material balance sheet to the final boiler efficiency calculations; and where discrepancies occur, the information on the Predicted Performance Summary sheet should be used.

B. Mechanical Design

A review of the mechanical design of the FBC was performed. Existing procedures and techniques were used whenever possible. While these existing procedures covered numerous areas of the design, many unique design features were identified as being specific to fluid bed boilers. These unique areas were investigated to a sufficient degree to establish their feasibility and to establish a basis for an approximate cost estimate, but within the scope of this contract, the details of the structural design in these areas could not be completely developed. The final and detailed mechanical design will have to be addressed in much more detail in subsequent design phases.

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C. DESIGN BASIS

Plant Capacity

The information listed below is the basis for the preliminary design of a conceptualized 570 MW atmospheric fluidized bed boiler capable of burning high sulfur coal in an environmentally acceptable manner without recourse to flue gas desulfurization. All the following are based on performance coal except as noted.

1. Coal, Limestone and Ash

Coal Analysis:

Analysis of both performance coal and worst coal is as follows:

<u>Constituent</u>	<u>% In Performance Coal</u>	<u>% In Worst Coal</u>
Inherent Moisture	2.50	2.50
Ash	10.00	15.00
Carbon	61.15	55.4
Hydrogen	4.27	3.87
Nitrogen	1.21	1.10
Oxygen	7.27	6.58
Sulfur	2.55	4.50
Surface Moisture	11.05	11.05

Limestone Analysis:

<u>Constituents</u>	<u>% In Limestone</u>
CaCO ₃	94.10
MgCO ₃	3.30
R ₂ O ₃	0.60
Inherent Moisture	2.00 (1)

(1) Plus 8% Surface Moisture

Ash Analysis:

<u>Constituent</u>	<u>% In Ash</u>	<u>Constituent</u>	<u>% In Ash</u>
P ₂ O ₅	0.15 - 0.18	Na ₂ O	0.58 - 0.80
SiO ₂	35.32 - 44.12	K ₂ O	1.55 - 2.93
Fe ₂ O ₃	23.8 - 25.20	MgO	0.70 - 1.04
Al ₂ O ₃	18.57 - 23.85	SO ₃	0.60 - 9.26
TiO ₂	0.69 - 0.93	R ₂ O	0.00 - 0.05
CaO	2.25 - 8.75		

Crushed Coal Size	1/4" x 0
Limestone Size	7-8 Mesh (US Std.) Top Size
Bulk Density of Coal (Lbs/Ft ³)	50
Bulk Density of Limestone (Lbs/Ft ³)	90

The coal and limestone bunkers, gravimetric feeders and rotary seals are designed for worst coal conditions. The storage capacity of the coal bunkers and limestone bunkers are 12 and 26 hours respectively.

2. Feed Water and Steam:

Feed Water Temperature (°F)	487
Feed Water Pressure (PSIG)	2,840
High Pressure Steam Flow (Lbs/Hr)	3,972,960
Main Steam Pressure (PSIG)	2,620
Main Steam Temperature (°F)	1,005
Cold RH Inlet Temperature (°F)	630
Cold RH Inlet Pressure (PSIG)	591
Hot RH Outlet Temperature (°F)	1,005
Hot RH Outlet Pressure (PSIG)	561

3. Main Fluidized Bed (FBC) and Carbon Burn-Up Bed (CBB)

FBC

Bed Operating Temperature (°F)	1,550
Combustion Efficiency (%)	88
Bed Pressure Drop (In. H ₂ O)	29.1
Pressure Drop Across Bed Plate (In. H ₂ O)	9.0
Superficial Gas Velocity (Ft./Sec.)	8

CBB

Bed Operating Temperature (°F)	2,000
Combustion Efficiency (%)	88
Bed Pressure Drop (In. H ₂ O)	29.1
Pressure Drop Across Bed Plate (In. H ₂ O)	9.0
Superficial Gas Velocity (Ft./Sec.)	8

4. Emission Limits

Maximum SO ₂ Emission Level (Lbs./10 ⁶ BTU Heat Input)	1.2
Maximum NO _x Emission Level (Lbs./10 ⁶ BTU Heat Input)	0.7
Maximum Particulate Emission (Lbs./10 ⁶ BTU Heat Input)	0.06

5. Dust Collection

FBC Precipitator (%)	99.79
CBB Precipitator (%)	99.44
CBB Mechanical Dust Collector:	
For Char and Ash (%)	80
For Stone (%)	99

Ash coolers and rotary feeders are designed for worst coal conditions.

D.

THE BABCOCK & WILCOX COMPANY
HEAT AND MATERIAL BALANCEPROCESS 570 MW FLUID BED BOILER
CUSTOMER STONE & WEBSTER
PLANTCONTRACT NO. 591-0261
PROPOSAL NO.
DATEOPERATING CONDITIONS
PERFORMANCE COAL

1	2	3	4	5	6 *	7	8	9	10	11	12	REV	NO
2	STREAM DESCRIPTION	COAL	LIMESTONE	CHAR.	FBC	FBC	CBB	CHAR.	CBB	CBB	FLUE	FLUE	TOTAL
3	FEED	FEED	STONE,	UNDERFLOW	PRECIPI-	UNDERFLOW	STONE,	MECH.	PRECIPI-	GAS	GAS	FLUE	MARK
4			& GAS		TATOR		& GAS	D.C.	TATOR	FROM	FROM	GAS	
5			FROM FBC		UNDERFLOW		FROM CBB	UNDERFLOW	UNDERFLOW	CBB	FBC		
6													
7	PROCESS CONDITIONS												
8	TEMPERATURE (°F)	80	80	725	1550	700	2000	775	750	750	750	700	710
9	PRESSURE (IN.WG) ①			-7.4	30			-3.4			-8.6	-8.6	-8.6
10	PRESSURE (PSIG)												
11	FLOW RATE (GAS OR LIQUID ONLY)												
12	LB MOLE/HR			157,826				27,289			27,289	157,826	185,115
13	LB/HR			4,627,802				821,217			821,217	4,627,802	5,449,019
14	SCFM (OR GPM) @ 60°F, 1 ATM.			997,726				772,513			172,513	997,723	1,170,239
15	ACFM (OR GPM) @ CONDITIONS			2,315,730				413,176			410,097	2,273,809	2,689,964
16													
17	PHYSICAL PROPERTIES												
18	MOLE WT (GAS OR LIQUID ONLY)			29.3				30.1			30.1	29.3	29.4
19	STATE (S, L, G)	S	S	S & G	S	S	S	S & G	S	S	S & G	S & G	S & G
20	DENSITY (LB/FT ³) (GAS OR LIQUID)			0.033				0.033			0.033	0.034	0.033
21													
22	ENTHALPY (MMB/HR), BASE 77°F			810.58	21.70	17.97	1.45	156.81	9.98	1.436	140.94	749.85	890.79
23													
24													
25	COMPOSITION (LB/HR) (GAS OR LIQUID)												
26	O ₂			140,429				60,508			60,508	140,429	200,927
27	N ₂			3,189,644				590,124			590,124	3,189,644	3,799,768
28	H ₂ O		2,107	309,939				14,148			14,148	309,939	324,087
29	CO ₂			981,527				156,087			156,087	981,527	1,137,614
30	SO ₂			6,263				350			350	6,263	6,613
31													
32													
33	TOTAL		2,107	4,627,802				821,217			821,217	4,627,802	5,449,019
34	SOLIDS (LB/HR)												
35	CACO ₃		99,154										
36	SiO ₂ + INERTS		4,110	1,439	2,671	1,439	137	1,439	1,425	14			
37	CAO			13,407	27,669	13,407	1,419	11,736	11,619	117			
38	CASO ₄			14,656	20,494	14,656	1,051	18,711	18,524	187			
39	COAL	498,199											
40	C ₈ H			49,206		48,911		5,869	4,695	1,150	24	295	319
41	S			1,292		1,284		154	122	31	1	8	9
42	ASH			37,365	12,455	37,365	638	37,365	29,892	7,473			
43													
44	TOTAL	498,199	103,264	117,364	63,289	117,061	3,245	75,274	66,308	8,941	25	303	328

NOTES: ① ATMOSPHERIC PRESSURE = 14.696 psi

*Flow should be zero (o) under expected normal operating conditions (See page 6-4 under "Carbon Burn-Up Bed")

OPERATING CONDITIONS

PERFORMANCE COAL

DATE _____

PAGE 4-70

NOTES: ① ATMOSPHERIC PRESSURE = 14.696 psi

OPERATING CONDITIONS
PERFORMANCE COAL

HEAT AND MATERIAL BALANCE

CUSTOMER

STONE & WEBSTER

PROPOSAL NO.

DATE _____

PAGE 4-11

NOTES: ① ATMOSPHERIC PRESSURE = 14.696 psi

E

THE BABCOCK & WILCOX COMPANY
HEAT AND MATERIAL BALANCEPROCESS 570 MW FLUID BED BOILER
CUSTOMER STONE & WEBSTER
PLANTCONTRACT NO. 591-0261
PROPOSAL NO.
DATE

OPERATING CONDITIONS

WORST COAL

1	2	3	4	5	6 *	7	8	9	10	11	12	REV NO	REV MARK	DATE	DESCRIPTION
1	2	3	4	5	6 *	7	8	9	10	11	12				
2	3	4	5	6	7	8	9	10	11	12					
3	4	5	6	7	8	9	10	11	12						
4	5	6	7	8	9	10	11	12							
5	6	7	8	9	10	11	12								
6	7	8	9	10	11	12									
7	8	9	10	11	12										
8	9	10	11	12											
9	10	11	12												
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35															
36															
37															
38															
39															
40															
41															

NOTES: ① ATMOSPHERIC PRESSURE =

* Flow should be zero (0) under expected normal operating conditions (See Page 6-4 under "Carbon Burn-Up Bed")

OPERATING CONDITIONS

WORST COAL

DATE _____

PAGE 4-13

NOTES: ① ATMOSPHERIC PRESSURE = _____

OPERATING CONDITIONS
WORST COAL

WORST COAL

NOTES: ① ATMOSPHERIC PRESSURE = _____

V EQUIPMENT LIST

The fluidized bed boiler system included in B&W's scope of supply is divided into several systems with respect to classification of the equipment by either type or purpose. These systems are:

- A. Coal and Limestone Feed
- B. Fluid Bed Boiler
- C. Solids Collection and Removal
- D. Air Heater
- E. Steel
- F. Controls

The following summary is a synopsis of the major components and assemblies by system:

A. Coal and Limestone Feed System

- 25 Coal Bunkers
- 25 Limestone Bunkers
- 25 Coal Feeders
- 25 Limestone Feeders
- 25 Rotary Feeders
- Lot Piping, Valves, Expansion Joints, Ducts, Dampers
- Lot BRIL (Brickwork, Refractory, Insulation and Lagging)

B. Fluid Bed Boiler System

- 1 Fluid Bed Boiler and Furnace (FBC)
- 1 Carbon Burnup Bed Boiler (CBB)
- 1 Steam Drum
- 4 Recirculating Pumps and Drives
- Lot Steam Leads
- Lot Flues, Ducts, Piping, Valves, Expansion Joints
- 34 Sootblowers
- Lot Thermoprobes, Thermocouples
- Lot BRIL

C. Solids Collection and Removal System

- 4 FBC Hot Precipitators
- 1 Char Conveying System
- 1 CBB Feed Tank
- 8 Char Rotary Feeders
- 1 CBB Mechanical Dust Collector
- 1 CBB Hot Precipitator
- 20 Main Bed Ash Coolers
- 5 Start Up Bed Ash Coolers
- 8 CBB Ash Coolers
- Lot Flues, Ducts, Piping, Valves, Expansion Joints
- Lot BRIL

D. Air Heater System

2 Regenerative Air Heaters
2 Steam Coil Air Heaters
2 FD Fans and Drives
2 ID Fans and Drives
2 Tempering Air Fans and Drives
2 Primary Hot Air Fans and Drives
Lot Flues, Ducts, Piping, Valves, Expansion Joints

E. Steel

Lot Top Steel

F. Controls

Lot Controls and Instrumentation

VI. DESCRIPTION OF MAJOR EQUIPMENT AND SPECIFICATIONS

A. Main Fluidized Bed Boiler (FBC) (See pg. A-13)

The main fluidized bed boiler has five (5) fluidized beds. Each bed is 71 feet wide and 24 feet deep. The bed enclosures are formed by water wall membrane panels made of 2-1/2 inch O.D. tubes on 3 inch centers. The five (5) beds are attached to a "common furnace" 71 feet wide and 24 feet deep.

A counter-flow reheat is located in the upper portion of the common furnace and in the front half of the down-flow convection pass. The down flow convection pass is 71 feet wide with a total depth of 24 feet. A division wall formed by water wall membraned panels of 2-1/2 inch O.D. tubes on 3 inch centers separates the down flow convection pass into two 12 feet deep parallel flow gas passes. Counter flow primary superheat surface is located in the top part of the rear gas pass. Economizer surface is located at the bottom of both gas paths. Sootblowers are provided above, below and in the cavities formed by the convective heating surfaces.

Horizontal heating surface is submerged in each main bed over four (4) air compartments. A fifth air compartment is located under the center part of each bed. This is the start-up compartment for each bed and has no heating surface submerged in the bed above it. The start-up compartment is 7 feet wide and 24 feet deep. The remaining four (4) compartments are each 16 feet wide and 24 feet deep. Of the twenty (20) compartments with heating surface submerged in the fluidized beds, six (6) have boiling surface and fourteen (14) have superheat surface. The tubes comprising the in-bed heating surface have a staggered arrangement. The air compartments are separated from the fluidized beds by a perforated plate which distributes the air flow throughout the beds.

Four (4) circulation assist pumps are provided in the downcomer system and are located in front of the FBC. The circulation system is described on pg. 6-5.

Access doors and observation ports are provided over the walls of the FBC to provide for maximum observation and sampling.

Sections and panels are designed to be shop assembled complete with headers attached, wherever possible. For section tube penetration through the membraned panels, wall tubes would be shipped loose and field welded and refractory seals installed.

The FBC settings are top supported. Loads are transferred to the boiler top steel by hanger rods attached to the water wall headers, steam drum, superheat and reheat headers, downcomers and risers.

B. Carbon Burn-Up Bed Boiler (CBB) (See Pg. A-2)

Four (4) fluidized beds each 10-1/2 feet wide and 52 feet deep are formed by water wall membraned panels made of 2-1/2 inch O.D. tubes on 3 inch centers. Boiling surface is located in the reduced cross-sectional area convection pass formed by the wall tubes. Sootblowers are located under the convective surface and in the two cavities formed by the convective surface.

Two (2) air compartments are located under each bed. Each compartment is 10-1/2 feet wide and 26 feet deep. A perforated plate separates the air compartment from the fluidized bed and provides the air distribution to the bed.

Sections and panels are designed to be shop assembled complete with headers attached, wherever possible. For section tube penetration through the membraned panels, wall tubes would be shipped loose and field welded and refractory seals installed.

The CBB settings are top supported. Loads are transferred to the top steel by hanger rods attached to the water wall headers and risers.

Access doors and observation ports are provided in the walls of the CBB to provide for maximum observation and sampling.

C. Bed Surface Setting and Heat Transfer

Main Beds (See Pg. A-5)

To maintain a bed temperature of 1550^oF in the main fluidized beds, heating surface is immersed in the beds. The B&W Modified Vreedenburg Equation was used for the convective component of heat transfer. The radiation component was calculated using a constant emissivity of 0.8. No heating surface was located in the start-up compartments of the beds.

The heating surface required to maintain bed temperatures of 1550°F is as follows:

All boiler bed = 12,940 Sq. Ft.

Split bed

Boiler surface = 6,470 Sq. Ft.

Superheat surface = 6,470 Sq. Ft.

1st full superheater bed

In bed surface = 13,640 Sq. Ft.

2nd full superheater bed

In bed surface = 7,230 Sq. Ft.-left half-
1.75" OD tubes
8,260 Sq. Ft.-right half-
2.0" OD tubes
15,490 Sq. Ft.

Final superheat bed

In bed surface = 8,360 Sq. Ft.-right half-
1.75" OD tubes
9,550 Sq. Ft.-left half-
2.0" OD tubes
17,910 Sq. Ft.

The inlet and outlet sides of the last two all superheat beds require different amounts of heating surface. In the pressure-enthalpy range that the last two superheat beds operate, the temperature of the steam is increasing more rapidly than in the split bed or the first all superheat bed. As the temperature of the steam increases, the overall heat transfer rate decreases for a given bed temperature (1550°F). This results from the lower temperature differential between the steam and the fluidized bed. The surface change is accomplished by changing from 1.75 inch O.D. tubes in the inlet half to 2.0 inch O.D. tubes in the outlet half.

The tube metals were selected by applying upset absorption rates to account for bed temperature variations and variations in the heat transfer coefficient; and accounting for reduction of steam flow through the tubes due to possible tube to tube flow unbalances.

The materials selected for the tubes submerged in the fluidized beds are identical to materials used in conventional coal fired boilers. The selection was based on pressure-stress calculations per the A.S.M.E. Code and the oxidation limits of the materials. No allowance was made to account for the possible corrosive effects that could occur in the beds.

The following materials were used in the design of the AFB:

SA-178A	SA-213T11
SA-178C	SA-213T12
SA-210A1	SA-213T22
SA-209T1A	SA-213T5
SA-213T2	SA-213TP304H

The horizontal boiling tubes in the fluidized beds are cold finished, multiple lead ribbed tubes. All other heating surface is cold finished smooth tubes.

Provision is made for heating surface adjustments, if required.

Carbon Burn-Up Bed (See pg. A-2)

The CBB bed temperature of 2000°F is maintained by bed height and heat input. Vertical walls provide the necessary heat transfer surface. No horizontal submerged surface is located in the CBB beds. The CBB was designed for 120 percent of the full load expected char flow to allow for variations in the combustion efficiency in the FBC. Additional flexibility is provided by the ability to feed coal and limestone to the CBB, if required.

The CBB is split into four (4) beds with two (2) compartments per bed. Each bed compartment has separate air and char feed systems. Auxiliary coal firing is provided to one compartment of each bed. The coal and limestone feeders that supply the CBB also supply four (4) of the five (5) start-up compartments in the FBC. The system is designed to feed either the CBB or the FBC start-up compartment, but not both simultaneously.

D. Spray Attenuators

Superheater Attenuator (See pg. 6-14)

Two stages of main steam spray attenuation will be furnished. The first stage of attenuation occurs in the two pipes connecting the first and second all superheater beds. The second stage of attenuation occurs in the two pipes connecting the second full bed of superheater surface and the final superheater bed. The attenuators will include the following:

Attenuator Body

First stage; including internals consisting of spray nozzle, thermal sleeve and venturi.

Second stage; including internals consisting of spray nozzle and thermal sleeve.

Valves

The following valves are included with the attemperators;

Spray Water Control Valves
Block Valves

Reheater Attemperator (see pg. 6-13)

One set of spray attemperator internals comprising a thermal sleeve plus spray water connection and nozzle is furnished to be installed in the steam piping at the inlet to the reheater.

E. Reheater (See pg. 6-4)

The entire reheater is located in the common furnace enclosure above the fluidized beds and the front half of the parallel down-flow convection pass. This design philosophy avoided placing reheat surface in the beds and eliminates the need for a protection system for start-ups, shutdowns and unit trips; and also facilitates matching of main and reheat steam temperatures to the turbine over the load range.

Reheat steam temperature control is obtained by biasing the gas flow over the reheater surface located in the down-flow section. The surface was designed to obtain a reheat steam temperature of 1005°F, with no gas biasing, at the boiler's maximum continuous rating. The draft loss indicated on the performance summary sheet was, however, calculated by biasing gas over the reheater to account for possible gas temperature fluctuations entering the reheater.

The only lower load that time permitted checking was seventy-five percent load. Reheat steam temperature was easily attained with a minimum of gas biasing. Based on these results, we would anticipate that full reheat steam temperature can be maintained at loads considerably below seventy-five percent, possibly as low as sixty percent.

F. Circulation Pumps

This unit employs four (4) wet motor pumps to assist in maintaining the desired rate of circulation for protection of the enclosure and bed circuits. This design concept, with the pumps installed in the drum downcomer system, is similar to the one used on several lignite fueled cyclone radiant boilers recently built by the Babcock & Wilcox Company. It is necessary to assist the circulation of both the FBC and the CBB because the physical characteristics of

some of the enclosure circuits are such that natural circulation imparted by heat absorption is not adequate. The absorption rates to the enclosure walls are greatly reduced from the rates in conventional coal fired units utilizing natural circulation and to obtain the desired velocities in the tubes requires additional available pressure differential than is provided by the heat absorbed. The motors of these pumps are immersed in boiler water and subject to full boiler pressure. Each pump is capable of handling one-third of the flow required at maximum continuous load, thereby permitting one pump to be removed from service for maintenance. Each pump will be valved with one motor operated inlet gate valve and two non-return stop-check outlet valves, permitting the valves to be left open when the pump motor is out of service, and providing means of positive isolation when required.

Water flows from the drum by means of the discharge downcomers which feed the circulating water to a suction manifold. The four (4) pumps are mounted between this suction manifold and a discharge manifold. The flow is then through two secondary downcomers and a branch downcomer to bottles from which FBC and CBB circuits are supplied. Each of the three (3) bottles are fitted with a manhole access to allow adjustment in the orifices determining the flow rate to the various heat absorbing water cooler circuits, if required.

G. Sootblowing System

A complete automatic sequential air blowing electrically driven and operated sootblowing system for cleaning the primary superheater, reheater, air heater, economizer, and horizontal convective boiler surface is included. The sootblowing system consists of the following:

Convective Surfaces

IK sootblower including wall boxes and drives.

Air Heaters

Cleaning devices including drives.

Accessory Equipment

One graphic insert type, selectronic automatic sequential panel with unit and group variable control.

Piping, valves, and fittings

Safeguards and interlocks

Pushbutton stations at each blower

Blower mounted starters

H. Precipitators (See Pgs. 6-15 and 6-16)

An important area in the design of fluidized bed combustion systems is the control of particulate emissions. The fluidized bed is specially designed to control SO₂ emission. The NO_x emissions are expected to be acceptable due to the low combustion temperatures. The question that arises, will the particulate emission suffer while the SO₂ and NO_x are being reduced? The question is especially critical since a great deal of extra noncombustible material (in this case limestone) is being added to the combustor for sulfur dioxide reduction.

Hot Rothemuhle electrostatic precipitators have been designed and sized to meet the particulate requirements of 0.06 Lb. per 10⁶ Btu. The Rothemuhle precipitator is conservatively designed based on extensive knowledge and many years of experience and evaluation of test results.

Rothemuhle precipitators are arranged to pass flue gases horizontally through a series of fields containing alternating parallel lanes of discharge frames and collecting plates. An electrical field develops between the negative discharge frames and the grounded collecting plates. A portion of the flue gas is ionized and the ions adhere to the dust particles carried by the gases. The dust particles, thus, charged are attracted to the positive collecting surfaces. Rapping devices periodically strike the base of each collecting plate-curtain and dislodge the dust particles which are then collected in hoppers.

Each Rothemuhle precipitator consists of a shell casing reinforced to withstand positive and negative gas pressures and maintain a gas tight enclosure. Inlet and outlet flanges are provided for attachment of dampers or flue transition sections. Proper gas distribution is accomplished by means of a model test which establishes the number of perforated plates to be placed in series at the inlet.

The self-supporting shell casing, consists of plates reinforced by stiffeners of standard rolled sections welded together. Roof support beams are designed as hollow box girders and carry the loads of all internal equipment as well as house the high voltage insulators. The precipitator structure rests on special sliding bearings which allow movement due to thermal expansion. Sufficient number of access doors are provided for maintenance and inspection purposes. Hoppers are provided under the precipitators for collection and disposal of entrapped dust.

Collecting plates are roll formed from cold rolled strip incorporating a number of parallel grooves and recesses. These recesses are designed to form flow shadows which enhance collecting properties and minimize dust reentrainment. The plates feature high frequency vibration characteristics which aid in adequate cleaning performance. Each plate is rigidly connected at top and bottom to assure maximum transmission of rapping forces.

Rapping devices are of the hammer and anvil type. Rappers are mounted on slowly rotating shafts across the width of the unit, and staggered so that each surface row is rapped independently.

Each precipitator field is equipped with its own high voltage transformer and silicon rectifier set which steps line voltage up to 60 KV and provides pulsating direct current to the electrodes.

The control system components are housed in a separate control cabinet. The system seeks to maintain optimum voltage under varying load and operating conditions. The voltage and current fluctuations at a flash-over are instantly monitored and adjustments made to the operating voltage to automatically extinguish possible arcs.

I. Mechanical Dust Collector

A mechanical dust collector is included for particulate removal prior to the hot precipitator for the CBB. The dust collector will be a U.O.P. 105AWHT #15-360. Refer to page 6-27.

J. FBC Precipitator Ash Removal System (See Pg. 6-28)

Four precipitators are used to remove the particulate matter from the flue gas leaving the FBC. Each precipitator is fitted with sixteen (16) hoppers for ash storage. Periodically, the accumulated ash is removed from the hoppers and transported to the CBB feed tank by the FBC precipitator ash removal system.

The FBC precipitator ash removal system is made up of four (4) independent vacuum transport systems with one system servicing each of the four (4) precipitators. Further, the main transport line of each system is split into four branch lines with each branch line serving four (4) precipitator hoppers. Thus, the four branch lines per system serve all sixty-four (64) hoppers.

During operation only four (4) of the sixteen (16) hoppers per precipitator are emptied at one time. These hoppers discharge into a single branch line which in turn discharges to the main transport line. The remaining twelve (12) hoppers are isolated from their respective branch lines by air operated valves. In addition, the three inactive branch lines are isolated from the main transport line to minimize vacuum requirements.

Each of the main transport lines feeds an air-solids separation system located on top of the CBB feed tank.

Each separation system consists of a primary cyclone, a secondary cyclone and a tertiary bag filter. In this system the cleaned transport air is discharged to the atmosphere and the separated solids flow into the CBB feed tank.

Four (4) blowers are provided (one for each system) to induce the required transport air flow and create the desired vacuum. Each blower is rated at 1300 CFM at 18 inches of mercury and is driven by a 100 HP motor. All conveying lines are fabricated from 8 inch Ashcolite wear resistant pipe. Further, the primary cyclone collectors are fitted with wear liners.

K. Bed Solids Removal System

Ash, unreacted stone and sulfur compounds are drawn off from each of the twenty-five (25) compartments of the main bed (FBC) to maintain bed height. These compounds leave the FBC at approximately 1550°F. They are cooled to 200°F in twenty-five (25) water cooled screws and then stored in the FBC storage tank.

Similarly, to maintain bed height in the CBB, solids are removed at approximately 2000°F, cooled to 200°F as they pass through eight (8) water cooled screws, and then stored in the CBB storage tank.

From each of the storage tanks there is the option of either reinjecting the solids into the FBC and CBB or conveying the solids to a facility for disposal.

Piping from each of the beds up to the ash coolers is Incolloy 800. For ash cooler specifications see pages 6-31, 6-32, and 6-33.

L. Rothemuhle Regenerative Air Heaters

The Rothemuhle Regenerative Air Heater is of the rotary regenerative type which employs static heating surface contained within a fixed housing (stator). Alternating gas and air flow is obtained by the rotation of a distributing duct (hood) on each face of the stator. Both hoods are keyed to a common main shaft.

The heating surface elements are arranged in the stator. Access door permits removal and maintenance of elements.

A geared electric drive unit rotates the hoods. An auxiliary air motor drive is provided for emergency operation should electric power to the main drive be interrupted.

The following items are included with the air heater assembly:

Driving mechanism including speed reducer and motor.

Auxiliary air motor drive.

Cold end layer of heating elements of corrosion resistant low alloy steel mounted in baskets for removal.

Hot end and intermediate layers of baskets are of mild carbon steel.

Lubricating oil system including piping, valves and fittings.

Access doors as required for maintenance.

Terminal frame flanges integral to the air heater assembly at cold air inlet and spent gas outlet.

Cleaning Devices

The air heaters are equipped with sootblowing devices at the cold side of the stator. The blowing devices are installed at the air hoods between the two wings and rotate with the hoods. Permanent water washing nozzles are also provided.

M. Steam Coil Air Heaters

Steam coil air heating is included to preheat the combustion air for lower load air heater cold-end protection. The coils will be mounted in the forced draft air ducting with provision for removal of coils.

N. Fans

Two (2) forced draft, two (2) induced draft, two (2) booster hot primary air fans, and two (2) booster tempering primary air fans are included. Stone & Webster design criteria were followed in establishing the fan requirements.

Forced Draft Fans

The forced draft fans are designed to supply all of the combustion air, (in addition to the expected air heater leakage) required to maintain the boiler's maximum continuous rating.

The net and design (test block) conditions are as follows:

Capacity/Fan (Expected = 2,713,110 Lb/Hr)	
Net	= 2,925,735 lb/hr
Design	= 3,072,025 lb/hr
Static (Expected System Resistance = 53.2 in. H ₂ O)	
Net	= 55.6 in. H ₂ O
Design	= 74.5 in. H ₂ O
Inlet Temperature	
Net	= 80°F
Design	= 105°F

The specifications for the fans are on page 6-42.

Induced Draft Fans

The induced draft fans are designed to convey the entire gaseous products of combustion, in addition to the expected air heater leakage, produced at the boiler's maximum continuous rating. The net and design (test block) conditions are as follows:

Capacity/Fan (Expected = 2,988,760 Lb/Hr)	
Net	= 3,313,440 lb/hr
Design	= 3,479,110 lb/hr
Static (Expected = 14.7 in. H ₂ O)	
Net	= 16.5 in. H ₂ O
Design	= 22.2 in. H ₂ O
Inlet Temperature	
Net	= 274°F
Design	= 299°F

The specifications for the fans are on page 6-43.

Hot Primary Air Fans

The hot primary air fans are designed to convey the entire air flow required to transport and dry the coal and limestone feed to the beds. In addition, the air quantity required to transport the char feed to the carbon burn-up beds can be supplied should drying be required. The net and design (test block) conditions are as follows:

Capacity/Fan (Expected = 492,340 Lb/Hr)	
Net	= 542,800 lb/hr
Design	= 569,940 lb/hr
Static Rise (Expected = 16.2 in. H ₂ O)	
Net	= 18.6 in. H ₂ O
Design	= 24.9 in. H ₂ O
Inlet Temperature	
Net	= 600°F
Design	= 625°F

The specifications for the fans are on page 6-44.

Tempering Primary Air Fans

The tempering air fans are designed to supply sufficient cold air to the primary air system to reduce the air temperature entering the mix bustles to 300°F at the boiler's maximum continuous rating. The net and design (test block) conditions are as follows:

Capacity/Fan (Expected = 360,250 Lb/Hr)	
Net	= 397,200 lb/hr
Design	= 417,060 lb/hr
Static Rise (Expected = 12.1 in. H ₂ O)	
Net	= 14.5 in. H ₂ O
Design	= 19.6 in. H ₂ O
Inlet Temperature	
Net	= 105°F
Design	= 130°F

The specifications for the fans are on page 6-45.

O. Boiler Top Steel

The boiler top steel is designed in accordance with the current A.I.S.C. standards and B&W standards. The top steel is designed for support of B&W supplied equipment only.

The total weight for the structural steel for the FBC is 720 KIPS and for the CBB is 148 KIPS. The column loadings are shown on Page 6-18.

P. Safety Valves

Pressure-relieving valves are included to satisfy the requirements of the current ASME Code.

Safety valves are included for full reheater steam flow in accordance with the ASME Code.

The safety valves for the reheater are to be mounted in piping external to the B&W terminal.

In addition, an electromatic relief valve is included at the superheater outlet.

Spray attemperator

Superheater spray attemperator

ROTHEMUHLE PRECIPITATOR

GENERAL DESCRIPTION

1. Discharge frame rappers
2. Collector plate rappers
3. Discharge electrodes
4. Collector plates
5. Discharge frame
6. Collecting plate fastener

ROTHEMUHLE PRECIPITATOR

GENERAL DESCRIPTION

1. Collector plates	7. Discharge frame support bracket
2. Collector plate support beams	8. Discharge frame carrier
3. Collector plate rapping bars	9. Discharge frame rapping device
4. Collector plate rapping device	10. Discharge frame anvil
5. Dust hopper	11. Support insulator
6. Discharge electrode frame assembly	

GENERAL DESCRIPTION

Rothemuhle regenerative air heater

THIS DRAWING FOR ESTIMATING PURPOSES ONLY
AND NOT TO BE USED FOR DESIGN OR CONST. OF PIERS

SHEAR LOAD OVERTURNING ± WIND OR E.Q. ALL LOADS IN KIPS	GRAVITY LOADS L = LIVE LOADS D = DEAD LOADS
	N = NET UPLIFT N = ± LOAD - (D.L. x .75)

ATMOSPHERIC FLUIDIZED BED
DIRECT COMBUSTION
POWER GENERATING PLANT
FOR STONE & WEBSTER

ES-261

DATE ~ 10 4 77

DWG NO SK-1 T.D.S.

COAL AND LIMESTONE GRAVIMETRIC FEEDERS

Bunker Outlet Valve

Valve Body

Material - - - - - 304 SS
Thickness - - - - - 3/8"

Outlet and Inlet

Inlet Opening - - - - - 24"
Outlet Opening - - - - - 24"
Inlet End Connection - - - - - Flange
Outlet End Connection - - - - - Flange
Flange Thickness - - - - - 3/4"
Flange Material - - - - - Mild Steel
Flange O.D. - - - - - 32"

Downspouts

Outside Dia. - - - - - 24-3/4"
Material Thickness - - - - - 3/8"
Material - - - - - 304 SS
Thickness of Flange (Inlet Only) - - - - - 3/4"
Flange Material - - - - - Carbon Steel
Flange O.D. - - - - - 32"
Outlet end has provision for Dresser Coupling.

Dresser Coupling

Pipe O.D. - - - - - 24-3/4"
Middle Ring Size - - - - - 1/4" x 7"
Material - - - - - 410 SS

Nuclear Monitors

Radiation Source - - - - - Radium 226

Gravimetric Feeders

	<u>Coal Feeder</u>	<u>Limestone Feeder</u>
Capacity Lbs/Hr.	36000	16000
Size of Material Handled	1/4" x 0	7-8 Mesh (U.S.Std)Top
Bulk Density (Lbs/Ft ³)	50	85 Size
Material of Construction	Rubber & 304SS	Rubber & 304SS
Inlet	24-3/4" OD	24-3/4" OD
Motor H.P.	1-1/2	1
Design Pressure (PSI)	50	50

Feeder Outlet Hopper

Inlet Connection Flange O.D. - - - - - 42"
Hopper Plate Thickness - - - - - 3/8"
Material - - - - - 304SS
Outlet Connection Flange OD - - - - - 24"
Flange Thickness - - - - - 3/4"
Flange Material - - - - - Carbon Steel

Miscellaneous

Cans Plastic Metallic Gasket Material
Lots Bolts and Nuts

ROTARY FEEDER/SEAL DATA
THE BABCOCK & WILCOX COMPANY

1 NAME Coal & Limestone Rotary Seal FILE NO. ES-261
2 NUMBER -- DATE 11-2-77 BY H. S. Doss
3 SERVICE OF UNIT SEAL X FEEDER REVERSIBLE
4 DUTY OF UNIT CONTINUOUS X INTERMITTENT
5 NO. OF UNITS 25

PERFORMANCE

6 MATERIAL HANDLED Coal and Limestone
7 SCREEN OR MICRON SIZE 1/4x0 Top size on coa; 7-8 mesh (U.S. Std.) Top
8 INLET TEMPERATURE, °F 80 MOISTURE CONTENT 9.6% on limestone
9 CAPACITY, LB/HR MIN 6950 MAX 38,920
10 MATERIAL WEIGHT, LB/FT³ BULK MIN 50 MAX 70
11 DESIGN CAPACITY, FT³/HR 556 to 139
12 HOURS PER 24 HR. DAY EQUIPMENT WILL OPERATE 24
13 INLET PRESSURE, PSIG 0 OUTLET PRESSURE, PSIG 2.2
14 PRESSURE DIFFERENTIAL, PSI 2.2
15 DESIGN PRESSURE, PSIG 2.2
16 DESIGN TEMPERATURES, °F 600
17 EXPECTED GAS LEAKAGE, ACFM @ INLET CONDITIONS
18 OPERATING SPEED, RPM 10.6 CONSTANT VARIABLE X
19 MATERIALS OF CONSTRUCTION Cast Steel with Body Chrome Plated

DRIVER

20 ELECTRICAL CHARACTERISTICS VOLTS 460 PHASE 3 CYCLE 60
21 MOTOR HP REQUIRED 2
22 TOTALLY ENCLOSED X FAN COOLED X EXPLOSION PROOF
23 VARIABLE SPEED X CONSTANT SPEED MIN. RPM 7.5
24 MAX. RPM 30

25 NOTES

(1) Values are for each seal.

PUMP DATA SHEET

THE BABCOCK & WILCOX COMPANY

BY J. S. Bloss

PAGE _____

DATE 11/23/77FILE NO. ES-261

1	NUMBER		
2	NAME	Boiler Water Recirculation	
3		Pump	
4	GENERAL TYPE	Centrifugal	
5	PROCESS REQUIREMENTS	For Each Pump (1)	
6	FLUID HANDLED	Boiler Water	
7	SUCTION TEMP., °F	665	
8	MOLECULAR WEIGHT	18.02	
9	DENSITY, LB/FT ³	35	
10	SP. GRAVITY @ T	0.56	
11	SOLIDS, %	0.02	
12	VISCOSITY @ T, CP	0.079	
13	VAPOR PRESS., PSIA	2450	
14	AVAIL. NPSH @ CENTERLINE, FT.	----	
15	SUCTION PRESS., PSIG	2800	
16	DISCHARGE PRESS., PSIG	2821	
17	DIFFERENTIAL PRESS., PSIG	21	
18	CAPACITY, MLB/HR	8500	
19	CAPACITY, LB MOLE/HR	41700	
20	CAPACITY, SGPM @ 60°F	17810	
21	CAPACITY, GPM @ T	31740	
22			
23			
24	DESIGN AND CONSTRUCTION		
25	DRIVER TYPE	Motor	
26	BRAKE HORSEPOWER @ % EFF.	450 HP @ 85%	
27	RPM OF PUMP	-----	
28	MATERIALS	-----	
29	CASING DESIGN TEMP., °F	-----	
30	CASING DESIGN PRESS., PSIG	-----	
31			
32	NOTES		

(1) 4 pumps required

SOOTBLOWER

Name Fluid Bed Boiler Sootblower File No. ES-261

Number - By H.S. Doss

Boiler Data

No. Of Boilers 1 Type Fluid Bed

Fuel Coal and Limestone Design Pressure (PSIG) 2925

Operating Pressure (PSIG) 2620 Operating Temperature (°F) 1005

Capacity (Lbs/Hr) 4,150,000 Furnace Width (Ft) 71

Sootblower

Type Retractable

No. of Units 16 Valve Mechanical Poppet Type

Coverage (Ft) 35.5 (For Double Installation)

Motor (HP) 1-1/2 Electrical Characteristics 460V, 3PH, 60 HZ

Blowing Medium Steam from primary superheater outlet at 2750 PSI/720°F
reduced to 600 PSI by pressure reducing valve.

Type of System Automatic Sequential - Electric Motor Drive

SOOTBLOWER

Name Carbon Burnup Bed Sootblower File No. ES-261

Number _____ By H.S. Doss

Boiler Data

No. of Boilers 1 Type Fluid Bed

Fuel Coal and Limestone Design Pressure (PSIG) 2925

Operating Pressure (PSIG) 2620 Operating Temperature (°F) 1005

Capacity (Lbs/Hr) 4,150,000 Furnace Width (Ft) 71

Sootblower

Type Extended Lance

No. of Units 4 Valve Mechanical Poppet Type

Coverage (Ft) 21 with 21'-0" Lance Tube Extension (For Single
Installation)

Motor (HP) 1-1/2 Electrical Characteristics 460V, 3PH, 60HZ

Blowing Medium Steam from primary superheater outlet at 2750 PSI/
720°F reduced to 600 PSI by pressure reducing valve.

Type of System Automatic Sequential - Electric Motor Drive

SOOTBLOWER

Name Carbon Burnup Bed Sootblower File No. ES-261
Number - By H.S. Doss

Boiler Data

No. Of Boilers 1 Type Fluid Bed
Fuel Coal and Limestone Design Pressure (PSIG) 2925
Operating Pressure (PSIG) 2620 Operating Temperature (°F) 1005
Capacity (Lbs/Hr) 4,150,000 Furnace Width (Ft) 71

Sootblower

Type Retractable
No. of Units 2 Valve Mechanical Poppet Type
Coverage (Ft) 21 (For Double Installation)

Motor (HP) 1-1/2 Electrical Characteristics 460V, 3PH, 60HZ
Blowing Medium Steam from primary superheater outlet at 250 PSI/720°F
reduced to 600 PSI by pressure reducing valve.
Type of System Automatic Sequential - Electric Motor Drive

SOOTBLOWER

Name Fluid Bed Boiler Sootblower File No. ES-261

Number - By H.S. Doss

Boiler Data

No. Of Boilers 1 Type Fluid Bed

Fuel Coal and Limestone Design Pressure (PSIG) 2925

Operating Pressure (PSIG) 2620 Operating Temperature (°F) 1005

Capacity (Lbs/Hr) 4,150,000 Furnace Width (Ft) 71

Sootblower

Type Extended Lance

No. of Units 12 Valve Mechanical Poppet Type

Coverage (Ft) 17.75 with 17.75 Lance Tube Extension (For Double
Installation)

Motor (HP) 1-1/2 Electrical Characteristics 460V, 3PH, 60HZ

Blowing Medium Steam from primary superheater outlet at 2750 PSI/720°F
reduced to 600 PSI by pressure reducing valve.

Type of System Automatic Sequential - Electric Motor Drive

PRECIPITATOR DATA

1.	NAME <u>Main Fluidized Bed Boiler Precip.</u>	FILE NO. <u>ES-261</u>
2.	NUMBER <u>-</u>	DATE <u>11-4-77</u> BY <u>H.S. Doss</u>
3.	NO. OF UNITS/BOILER <u>4</u>	
4.	GAS VOLUME PER BOILER (ACFM)-----	2,388,583
5.	GAS TEMPERATURE (°F)-----	725
6.	PREDICTED EFFICIENCY (%)-----	99.79
7.	PREDICTED OUTLET GRAIN LOADING (LBS/10 ⁶ BTU)-----	0.06
8.	DESIGN INLET GRAIN LOADING (GRAINS/ACF)-----	6.77
9.	OUTLET GRAIN LOADING (GRAINS/ACF)-----	0.014
10.	EFFECTIVE MIGRATION VELOCITY (CM/SEC)-----	5.64
11.	NO. OF PRECIP. CASINGS FOR ONE BOILER-----	4
12.	NO. X DEPTH OF FIELD-----	4x13'-1 $\frac{1}{4}$ "
13.	GAS VELOCITY (FT/SEC)-----	3.5
14.	SURFACE AREA (SQ. FT./CASING)-----	330,750

MECHANICAL DUST COLLECTOR EQUIPMENT

THE BABCOCK AND WILCOX COMPANY

1.	NAME	CBB Mechanical Dust Collector	FILE NO.	ES-261
2.	NUMBER	DATE	11-3-77	BY H.S. Doss
3.	TYPE OF UNIT	Multiclone		
4.	NUMBER OF UNITS	1		

PERFORMANCE

	CASE			
5.	INLET GAS FLOW, ACFM	413,927		
6.	INLET GAS FLOW, LB-MOLE/HR	27,339		
7.	INLET GAS DENSITY, LB/ACF	.0330		
8.	INLET TEMPERATURE, °F	775		
9.	INLET PRESSURE, INCHES "WG"	-3.4		
10.	GAS MOLECULAR WT, LB/LB-MOLE	30.0		
11.	INLET DUST LOAD, LB/10 ³ LB WET GAS	180		
12.	OUTLET DUST LOAD, LB/10 ³ LB WET GAS	17.35		
* 13.	COLLECTION EFFICIENCY, %	90.37		
14.	PRESSURE DROP, INCHES H ₂ O	3.4		

CONSTRUCTION

15.	DESIGN PRESSURE, PSIG	.36	DESIGN TEMPERATURE, °F	800
16.	ASME CODE STAMPED	YES	NO	X
17.	CORROSION ALLOWANCE, INCHES	-		
18.	SHELL THICKNESS, INCHES	1/4"	SHELL MATERIAL	Carbon Steel Plate
19.	LINING MATERIAL	-		
20.	GAS INLET CONNECTION, 25' x 15.7'		GAS OUTLET CONNECTION, 25' x 6.2'	
21.	BODY SHELL ID (Over all Dimension)	length-25'-0" width-16'0"	Height-18'-6"	

22. NOTES

- * Collection Efficiency
 - Char -- 80%
 - Stone - 99%

FBC PRECIPITATOR ASH REMOVAL SYSTEM SPECIFICATION

By: J. S. Bloss
Date: 11/23/77

Page: _____
Reference: ES-261

Conveying Mode: Pneumatic
System Type: Vacuum

Piping:

Type: 8 inch Ashcolite
0.55 inch wall thickness
280-340 Brinnell hardness
Length: 1470 Ft. (approximate)

Material Handling Valves:

Number of Valves: 64
Location: Precipitator Hopper Discharges
Size: 6 x 8 inch
Operation: Air Operated

Branch Line Valves:

Type: Slide Gate
Number of Valves: 16
Location: At junction of branch lines with
main conveying lines
Size: 8 Inch
Operation: Air Operated

Wear Back Fittings:

Number of Fittings: 64
Location: Between material handling valve
and branch
Size: 6 x 8 x 8 Inch

Couplings:

Number: 114 (approximate)
Size: 8 Inch

Collectors:

Primary:
Number of Units: 4
Type: T-60 Cyclone
5/16" N1-hard wear plates included
Secondary:
Number of Units: 4
Type: Cyclone
Tertiary:
Number of Units: 4
Type: Bag Filter

Vacuum Blowers:

Number of Units: 4
Capacity: 1300 CFM/Ea
Pressure: 18 inch Hg vacuum
Power Requirements: 80 Hp/Ea
Driver Size: 100 Hp

ROTARY FEEDER/SEAL DATA

THE BABCOCK & WILCOX COMPANY

1 NAMECBB Feed Tank Char Feeder/Seal FILE NO. ES-261
2 NUMBER DATE 11-2-77 BY H. S. Doss
3 SERVICE OF UNIT SEAL X FEEDER X REVERSIBLE
4 DUTY OF UNIT CONTINUOUS X INTERMITTENT
5 NO. OF UNITS 8

PERFORMANCE

6 MATERIAL HANDLED Char
7 SCREEN OR MICRON SIZE Max. 420 Micron; Min. 1 Micron
8 INLET TEMPERATURE, °F 700 MOISTURE CONTENT 0
9 CAPACITY, LB/HR MIN 4923 MAX 26850
10 MATERIAL WEIGHT, LB/FT³ BULK MIN 55 MAX 75
11 DESIGN CAPACITY, FT³/HR 358 to 89.5
12 HOURS PER 24 HR. DAY EQUIPMENT WILL OPERATE 24
13 INLET PRESSURE, PSIG 0 OUTLET PRESSURE, PSIG 2.2
14 PRESSURE DIFFERENTIAL, PSI 2.2
15 DESIGN PRESSURE, PSIG 2.2
16 DESIGN TEMPERATURES, °F 800
17 EXPECTED GAS LEAKAGE, ACFM @ INLET CONDITIONS --
18 OPERATING SPEED, RPM 11.85 CONSTANT VARIABLE X
19 MATERIALS OF CONSTRUCTION Cast-Steel (Body hardened to 450 BHN)

DRIVER

20 ELECTRICAL CHARACTERISTICS VOLTS 460 PHASE 3 CYCLE 60
21 MOTOR HP REQUIRED 1 1/2
22 TOTALLY ENCLOSED X FAN COOLED X EXPLOSION PROOF
23 VARIABLE SPEED X CONSTANT SPEED MIN. RPM 7.5
24 MAX. RPM 30

25 NOTES

(1) Values are for each feeder.

PRECIPITATOR DATA

1.	NAME <u>Carbon Burnup Bed Boiler Precip.</u>	FILE NO. <u>ES-261</u>
2.	NUMBER <u>-</u>	DATE <u>11-4-77</u> BY <u>H.S. Doss</u>
3.	NO. OF UNITS/BOILER <u>1</u>	
4.	GAS VOLUME PER BOILER (ACFM)-----	439,195
5.	GAS TEMPERATURE (°F)-----	725
6.	PREDICTED EFFICIENCY (%)-----	99.44
7.	PREDICTED OUTLET GRAIN LOADING (LBS/10 ⁶ BTU)-----	0.06
8.	DESIGN INLET GRAIN LOADING (GRAINS/ACF)-----	2.49
9.	OUTLET GRAIN LOADING (GRAINS/ACF)-----	0.014
10.	EFFECTIVE MIGRATION VELOCITY (CM/SEC)-----	5.320
11.	NO. OF PRECIP. CASINGS FOR ONE BOILER-----	1
12.	NO. X DEPTH OF FIELD-----	5x9'-9-3/4"
13.	SURFACE AREA (SQ.FT)-----	217,556
14.	GAS VELOCITY (FT/SEC)-----	3.3

CHAR COOLER DATATHE BABCOCK AND WILCOX COMPANY

1 NAME FBC Main Bed Underflow Cooler FILE NO. ES-261
2 NUMBER - BY H.S. Doss
3 SERVICE OF UNIT COOLER X HEATER OTHER
4 NO. OF UNITS 20

PERFORMANCE (1)

5 MATERIAL HANDLED Spent Stone
INLET
6 FEED, LB/HR 6206 BULK DENSITY LB/FT³ 60 FLOW FT³/HR 104
7 TEMPERATURE °F 1550 MOISTURE OR VOLATILE CONTENT, % -
OUTLET
8 RATE, LB/HR 6206 BULK DENSITY, LB/FT³ 60 FLOW, FT³/HR 104
9 TEMPERATURE, °F 200 MOISTURE OR VOLATILE CONTENT, % -
10 SPECIFIC HEAT, BTU/LB-°F SOLIDS 0.23 HEAT TRANSFER AGENT 1.0
11 LATENT HEAT OF VAPORIZATION, BTU/LB - LMTD, °F 405 MTD, °F -
12 TOTAL HEAT LOAD, BTU/HR 1,884,142
13 HEAT EXCHANGE AGENT Water
14 RATE, LB/HR 72,467
15 TEMPERATURE, °F INLET 77 SUPPLY PRESSURE
16 OUTLET 103 FOR SCREWS, PSIG 30
17 SUPPLY PRESSURE FOR JACKET, PSIG 15

CONSTRUCTIONSCREWS

18 HEAT TRANSFER AREA, FT²/TIER₂ 445 NO. OF TIERS 1
19 TOTAL HEAT TRANSFER AREA, FT² 445
20 PRODUCT CONTACTING PARTS Mild Steel
21 FLIGHT THICKNESS, INCHES 1/4 OPERATING PRESSURE, PSIG
22 ASME CODE STAMP YES NO X

TROUGH

23 NET INTERNAL VOLUME, FT³ 74
24 PRODUCT CONTACTING PARTS Mild Steel
25 OPERATING PRESSURE, PSIG 15 DESIGN PRESSURE, PSIG 30
26 HEAT TRANSFER AGENT Water SUPPLY PRESSURE, PSIG 15
27 ASME CODE STAMP YES NO X

DRIVER

28 ELECTRICAL CHARACTERISTICS VOLTS 460 PHASE 3 CYCLE 60
29 MOTOR HP REQUIRED 2
30 TOTALLY ENCLOSED X FAN COOLED X EXPLOSION PROOF -
31 VARIABLE SPEED X CONSTANT SPEED - MIN. RPM 1.1
32 MAX RPM 2.2

NOTES

) Figures are for one cooler only.

CHAR COOLER DATA

THE BABCOCK AND WILCOX COMPANY

1	NAME	FBC Startup Bed Underflow Cooler	FILE NO.	ES-261
2	NUMBER	-	BY	H.S. Doss
3	SERVICE OF UNIT	COOLER <u>X</u>	HEATER	OTHER
4	NO. OF UNITS	5		
<u>PERFORMANCE (1)</u>				
5	MATERIAL HANDLED	Spent Stone		
INLET				
6	FEED, LB/HR	3049	BULK DENSITY LB/FT ³	60
7	TEMPERATURE °F	1550	MOISTURE OR VOLATILE CONTENT, %	-
OUTLET				
8	RATE, LB/HR	3049	BULK DENSITY, LB/FT ³	60
9	TEMPERATURE, °F	200	MOISTURE OR VOLATILE CONTENT, %	-
10	SPECIFIC HEAT, BTU/LB-°F		SOLIDS	0.230
11	LATENT HEAT OF VAPORIZATION, BTU/LB	-	HEAT TRANSFER AGENT	1.0
12	TOTAL HEAT LOAD, BTU/HR	946,715	LMTD, °F	465
13	HEAT EXCHANGE AGENT	Water		
14	RATE, LB/HR	31,557		
15	TEMPERATURE, °F		INLET	77
16			OUTLET	107
17	SUPPLY PRESSURE FOR JACKET, PSIG	15	SUPPLY PRESSURE FOR SCREWS, PSIG	50
<u>CONSTRUCTION</u>				
<u>SCREWS</u>				
18	HEAT TRANSFER AREA, FT ² /TIER	2	188	NO. OF TIERS
19	TOTAL HEAT TRANSFER AREA, FT ²		188	1
20	PRODUCT CONTACTING PARTS	Mild Steel		
21	FLIGHT THICKNESS, INCHES	3/16"	OPERATING PRESSURE, PSIG	50
22	ASME CODE STAMP	YES	NO	X
<u>TROUGH</u>				
23	NET INTERNAL VOLUME, FT ³	32		
24	PRODUCT CONTACTING PARTS	Mild Steel		
25	OPERATING PRESSURE, PSIG	15	DESIGN PRESSURE, PSIG	50
26	HEAT TRANSFER AGENT	Water	SUPPLY PRESSURE, PSIG	15
27	ASME CODE STAMP	YES	NO	X
<u>DRIVER</u>				
28	ELECTRICAL CHARACTERISTICS		VOLTS	460
29	MOTOR HP REQUIRED	1-1/2	PHASE	3
30	TOTALLY ENCLOSED	X	CYCLE	60
31	VARIABLE SPEED	X	FAN COOLED	X
32	MAX RPM	2.8	EXPLOSION PROOF	-
33	NOTES		CONSTANT SPEED	-
			MIN. RPM	1.4

(1) Figures are for one cooler only

CHAR COOLER DATATHE BABCOCK AND WILCOX COMPANY

1 NAME Carbon Burnup Bed Underflow Cooler FILE NO. ES-261
2 NUMBER - BY H.S. Doss
3 SERVICE OF UNIT COOLER X HEATER OTHER
4 NO. OF UNITS 8

PERFORMANCE (1)

5 MATERIAL HANDLED Spent Stone
INLET
6 FEED, LB/HR 883 BULK DENSITY LB/FT³ 60 FLOW FT³/HR 15
7 TEMPERATURE °F 2100 MOISTURE OR VOLATILE CONTENT, % -
OUTLET
8 RATE, LB/HR 883 BULK DENSITY, LB/FT³ 60 FLOW, FT³/HR 15
9 TEMPERATURE, °F 200 MOISTURE OR VOLATILE CONTENT, % -
10 SPECIFIC HEAT, BTU/LB-°F 0.23 HEAT TRANSFER AGENT 1.0
11 LATENT HEAT OF VAPORIZATION, BTU/LB - LMTD, °F 640 MTD, °F -
12 TOTAL HEAT LOAD, BTU/HR 385,700
13 HEAT EXCHANGE AGENT Water
14 RATE, LB/HR 12,857
15 TEMPERATURE, °F INLET 77 SUPPLY PRESSURE
16 OUTLET 107 FOR SCREWS, PSIG 60
17 SUPPLY PRESSURE FOR JACKET, PSIG 15

CONSTRUCTIONSCREWS

18 HEAT TRANSFER AREA, FT²/TIER₂ 62.2 NO. OF TIERS 1
19 TOTAL HEAT TRANSFER AREA, FT² 62.2
20 PRODUCT CONTACTING PARTS 316L Stn. Stl.
21 FLIGHT THICKNESS, INCHES 3/16 OPERATING PRESSURE, PSIG 60
22 ASME CODE STAMP YES NO X

TROUGH

23 NET INTERNAL VOLUME, FT³ 6.5
24 PRODUCT CONTACTING PARTS 316L Stn. Stl.
25 OPERATING PRESSURE, PSIG 15 DESIGN PRESSURE, PSIG 60
26 HEAT TRANSFER AGENT Water SUPPLY PRESSURE, PSIG 15
27 ASME CODE STAMP YES NO X

DRIVER

28 ELECTRICAL CHARACTERISTICS VOLTS 460 PHASE 3 CYCLE 60
29 MOTOR HP REQUIRED 1/2
30 TOTALLY ENCLOSED X FAN COOLED X EXPLOSION PROOF -
31 VARIABLE SPEED X CONSTANT SPEED - MIN. RPM 2.2
32 MAX RPM 4.4

NOTES

1) Figures are for one cooler only.

ROTHERMÜHLE AIR HEATER DATA

THE BABCOCK AND WILCOX COMPANY

1. NAME Primary Air Heater FILE NO. ES-261
2. NUMBER _____ BY H.S. Doss
3. NO. OF UNITS 2

PERFORMANCE

4. TEMPERATURE OF AIR IN (°F)-----	<u>106</u>
5. TEMPERATURE OF AIR OUT (°F)-----	<u>596</u>
6. TEMPERATURE OF GAS IN (°F)-----	<u>700</u>
7. TEMPERATURE OF GAS OUT (UNCORRECTED) °F-----	<u>290</u>
8. TEMPERATURE OF GAS OUT (CORRECTED) °F-----	<u>274</u>
9. TOTAL WEIGHT OF AIR LEAVING AIR HEATER (Lbs/HR)	<u>4,916,100</u>
10. TOTAL WEIGHT OF GAS LEAVING AIR HEATER (Lbs/HR)	<u>5,467,100</u>
11. TOTAL EXPECTED AIR LEAKAGE (Lbs/HR)-----	<u>510,100</u>
12. AIR SIDE PRESSURE DROP ("W.G.)-----	<u>3.9</u>
13. GAS SIDE PRESSURE DROP ("W.G.)-----	<u>3.0</u>

AIR HEATER DESIGN

14. STATOR SIZE-----	<u>13.2(Meters)</u>
15. COLD END DEPTH (INCHES)-----	<u>12</u>
16. INTERMEDIATE DEPTH (INCHES)-----	<u>32</u>
17. HOT END DEPTH (INCHES)-----	<u>18</u>
18. TOTAL DEPTH (INCHES)-----	<u>62</u>
19. STATOR DEPTH (INCHES)-----	<u>73</u>
20. TOTAL HEATING SURFACE AREA/AIR HEATER(FT ²)----	<u>422,918</u>

NOTES

MOTOR DATA

The Babcock and Wilcox Company

1. Name Motor For FD Fan Date 11-15-77 File No. ES-261
2. Number - By H.S. Doss
3. No. of Units 2 Installation (Indoor or Outdoor) Indoor
4. Driven Equipment Air Foil F.D. Fan
5. Motor Horsepower 10,000
6. Motor RPM 1180
7. Electrical Characteristics 4160V/3PH/60CY
8. WR^2 of Driven Equipment 48,000
9. Type of Enclosure WP-II
10. Class of Insulation B
11. Temperature Rise °F 176
12. Maximum Ambient Temperature °F 105
13. Direct Connected O/V-Belt Direct
14. How Mounted -
15. Driving thru Fluid Drive? No

Extras

16. Mounting Half Coupling X
17. Export Boxing _____
18. Dual Shaft Extension _____
19. Sole Plates X
20. Tropical Protection _____
21. Space Heaters _____
22. Pot Head _____
23. Tachometer _____
24. Temperature Detectors X
25. Type of Bearings Split Sleeve - Ring Oil
26. Non-Standard Service Factor Required _____

Notes

MOTOR DATA

The Babcock and Wilcox Company

1. Name Motor for I.D. Fan Date 11-15-77 File No. ES-261
2. Number - By H.S. Doss
3. No. of Units 2 Installation (Indoor or Outdoor) Indoor
4. Driven Equipment Axial ID Fan
5. Motor Horsepower 5000
6. Motor RPM 700
7. Electrical Characteristics 4160V/3PH/60CY
8. WR^2 of Driven Equipment 178000
9. Type of Enclosure WP-II
10. Class of Insulation B
11. Temperature Rise $^{\circ}F$ 176
12. Maximum Ambient Temperature 105
13. Direct Connected O/V-Belt Direct
14. How Mounted -
15. Driving thru Fluid Drive? No

Extras

16. Mounting Half Coupling X
17. Export Boxing _____
18. Dual Shaft Extension _____
19. Sole Plates X
20. Tropical Protection _____
21. Space Heaters _____
22. Pot Head _____
23. Tachometer _____
24. Temperature Detectors X
25. Type of Bearings Split Sleeve - Ring Oil
26. Non-Standard Service Factor Required _____

Notes

MOTOR DATA

The Babcock and Wilcox Company

1. Name Motor For Temp Air Fan Date 11-15-77 File No. ES-261
2. Number - By H.S. Doss
3. No. of Units 2 Installation (Indoor or Outdoor) Indoor
4. Driven Equipment Temp Air Fan (Air Foil)
5. Motor Horsepower 350
6. Motor RPM 1200
7. Electrical Characteristics 230/460V/3PH/60CY
8. WR^2 of Driven Equipment 5500
9. Type of Enclosure WP-II
10. Class of Insulation B
11. Temperature Rise $^{\circ}F$. 176
12. Maximum Ambient Temperature $^{\circ}F$ 105
13. Direct Connected O/V-Belt Direct
14. How Mounted -
15. Driving thru Fluid Drive? -

Extras

16. Mounting Half Coupling X
17. Export Boxing _____
18. Dual Shaft Extension _____
19. Sole Plates X
20. Tropical Protection _____
21. Space Heaters _____
22. Pot Head _____
23. Tachometer _____
24. Temperature Detectors X
25. Type of Bearings Split Sleeve-Ring Oil
26. Non-Standard Service Factor Required _____

Notes

MOTOR DATA

The Babcock and Wilcox Company

1. Name Motor for Primary Air Fan Date 11-15-77 File No. ES-261
2. Number - By H.S. Doss
3. No. of Units 2 Installation (Indoor or Outdoor) indoor
4. Driven Equipment Hot Primary Air Fan (Modified Radial Tip)
5. Motor Horsepower 1250
6. Motor RPM 1200
7. Electrical Characteristics 4160V/3PH/60CY
8. WR^2 of Driven Equipment 32000
9. Type of Enclosure WP-11
10. Class of Insulation B
11. Temperature Rise $^{\circ}F$ 176
12. Maximum Ambient Temperature $^{\circ}F$ 105
13. Direct Connected O/V-Belt Direct
14. How Mounted -
15. Driving thru Fluid Drive? No

Extras

16. Mounting Half Coupling X
17. Export Boxing _____
18. Dual Shaft Extension _____
19. Sole Plates X
20. Tropical Protection _____
21. Space Heaters _____
22. Pot Head _____
23. Tachometer _____
24. Temperature Detectors X
25. Type of Bearings Split Sleeve - Ring Oil
26. Non-Standard Service Factor Required _____

Notes

SAFETY VALVES

Name Electromatic Relief Valve File No. ES-261
Number - Date 11-28-77 By H.S. Doss

Boiler Data

Type Natural Circulation
Capacity (Lbs/Hr) 4,150,000
Design Pressure (PSIG) 2925
Drum Operating Pressure (PSIG) 2780
Superheater Operating Pressure 2620 PSIG @ 1005°F
S.H. ΔP 160
S.H. ΔP 5.9%
ERV Set
S.H. ΔP 5.8%
Low Set S.H. Vlv.
Drum Valves To Be Paired Yes No X
S.H.O. Valves To Be Paired Yes No X

Reheater Data

Capacity (Lbs/Hr) 3,709,000
Design Pressure (PSIG) 750
Reheater Inlet Pressure @ Temp. 604 PSIG @ 630°F
Reheater Outlet Pressure @ Temp. 579 PSIG @ 1005°F
R.H. ΔP 25
R.H.I. Valves To Be Paired Yes No X
R.H.O. Valves To Be Paired Yes No X

Electromatic Relief Valve

Set @ 2700 PSIG @ 1005°F, CF = 0.8058
Pressure To Be Sensed From Drum S.H.O. X
Relieving Capacity Based on Bore Dia 1.812 In.
Relieving Capacity Based on Bore Area 2.5802 Sq. In.
Relieving Capacity Based on 100 % of Full Capacity
Minimum Blow Down 1 % Based On Indicated Capacity

REVISIONS		
NO.	DESCRIPTION	DATE

FOUR HOPPERS
CAPACITY-23423 FT.³
3 REQD.

ONE HOPPER
CAPACITY-5857 FT.³
1 REQD.

TWO HOPPERS
CAPACITY-11174 FT.³
6 REQD.

- NOTES:
- 1- ALL MATERIAL A36 CARBON STEEL
 - 2- SIDES- $\frac{3}{8}$ THK. R.
 - 3- HOPPER- $\frac{3}{8}$ THK. R. w/ $\frac{1}{8}$ THK. 303 STN. STL. CLADDING
 - 4- COVER- $\frac{3}{8}$ THK. R.

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STONE & WEBSTER	
DESIGNED BY M. JOHNSON	COAL BUNKERS
DRAWN BY	
CHECKED BY	
APPROVED BY	
DATE	ES-261
SCALE	
250389 E 0	

3880GZ-250388E

REVISIONS		
NO.	DESCRIPTION	DATE

FOUR HOPPERS
CAPACITY-12332 FT.³
6-REQD.

ONE HOPPER
CAPACITY-3083 FT.³
1-REQD.

NOTES:

- 1-ALL MATERIAL A36 CARBON STEEL
- 2-SIDES 1/2 THK. R.
- 3-HOPPERS 1/2 THK. R. 7 1/8 THK. 303 STN. STL. CLADDING
- 4-COVER 3/8 THK. R.

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STONE & WEBSTER

DESIGN BY	M. JOHNSON
CHECK BY	
FORWARDED BY	
APPROVED BY	
DATE	11-10-77
ES-261	

LIMESTONE
BUNKERS

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FAN OR BLOWER DATA SHEET

THE BABCOCK & WILCOX COMPANY

H. S. Doss

PAGE

DATE November 14, 1977

FILE NO. ES-261

1	NUMBER		
2	NAME	FD Air Fan	FD Air Fan
3	Condition	Net	Test Block
4	GENERAL TYPE	Air Foil	Air Foil
5	FLUID HANDLED	Air	Air
6	SUCTION TEMP., °F	80	105
7	DENSITY @ T, LB/FT ³	0.0690	0.0724
8	MOLECULAR WEIGHT	28.60	28.60
9	% WATER (WEIGHT)	1.3	1.3
10	VISCOSITY @ T, CP	--	--
11	BARO. PRESS., " H ₂ O Abs	407	407
12	SUCTION PRESS., " H ₂ O Abs	407	407
13	DISCHARGE PRESS., " H ₂ O Abs	462.6	481.5
14	DIFFERENTIAL PRESS., " H ₂ O Abs	55.6	74.5
15	CAPACITY, MLB/HR	2925.75	3072.025
16	CAPACITY, LB MOLE/HR	102299	107414
17	CAPACITY, MSCFM @ 60°F, 1 ATM.	711.881	770.015
18	CAPACITY, MACFM @ INLET	673.463	742.035
19	Cp/Cv	--	--
20	TEMP. RISE, °F	20	27
21			
22			
23			
	DESIGN AND CONSTRUCTION	--	--
24	DRIVER TYPE	Motor	Motor
25	BRAKE HORSEPOWER @ % EFF.	7218 @ 77.9	9734 @ 84.
26	RPM OF FAN OR BLOWER	1180	1180
27	MATERIALS	---	--
28	CASING DESIGN TEMP., °F	--	--
29	CASING DESIGN PRESS.,	--	--
30			
31			

32 NOTES

FAN OR BLOWER DATA SHEET

THE BABCOCK & WILCOX COMPANY

BY H. S. DossPAGE DATE November 14, 1977FILE NO. ES-261

1	NUMBER		
2	NAME	ID Flue Gas Fan	ID Flue Gas Fan
3		Net	Test Block
4	GENERAL TYPE	Axial	Axial
5	FLUID HANDLED	Flue Gas	Flue Gas
6	SUCTION TEMP., °F	274	299
7	DENSITY @ T, LB/FT ³	0.053	0.0501
8	MOLECULAR WEIGHT	29.43	29.43
9	% WATER (WEIGHT)	5.56	5.56
10	VISCOSITY @ T, CP	--	--
11	BARO. PRESS., " Water Abs.	407	407
12	SUCTION PRESS., " Water Abs.	392.3	392.3
13	DISCHARGE PRESS., " Water Abs.	408.8	414.5
14	DIFFERENTIAL PRESS.,	16.5	22.2
15	CAPACITY, MLE/HR	3313	3479.1
16	CAPACITY, LB MOLE/HR	112572	118216
17	CAPACITY, MSCFM @ 60°F, 1 ATM.	480.726	514.815
18	CAPACITY, MACFM @ INLET	690.302	749.5
19	Cp/Cv	--	--
20	TEMP. RISE, °F	8	12
21			
22			
23	DESIGN AND CONSTRUCTION	--	--
24	DRIVER TYPE	Motor	Motor
25	DRAKE HORSEPOWER @ % EFF.	3159 @ 85.5	4609 @ 85.1
26	RPM OF FAN OR BLOWER	700	700
27	MATERIALS	--	--
28	CASING DESIGN TEMP., °F	--	--
29	CASING DESIGN PRESS.,	--	--
30			
31			

32 NOTES

FAN OR BLOWER DATA SHEET

THE BABCOCK & WILCOX COMPANY

H. S. Doss

PAGE

DATE November 14, 1977

FILE NO. ES-261

1	NUMBER		
2	NAME	Hot Primary Air Fan	Hot Primary Air Fan
3	Conditions	Net	Test Block
4	GENERAL TYPE	Modified Radial Tip	Modified Radial Tip
5	FLUID HANDLED	Air	Air
6	SUCTION TEMP., °F	594	619
7	DENSITY @ T, LB/FT ³	0.0398	0.0408
8	MOLECULAR WEIGHT	28.6	28.6
9	% WATER (WEIGHT)	1.3	1.3
10	VISCOSITY @ T, CP	--	--
11	BARO. PRESS., " H ₂ O Abs	407	407
12	SUCTION PRESS., " H ₂ O Abs	450	450
13	DISCHARGE PRESS., " H ₂ O Abs	468.6	474.6
14	DIFFERENTIAL PRESS., " H ₂ O	18.6	24.6
15	CAPACITY, MLB/HR	542.800	569.940
16	CAPACITY, LB MOLE/HR	18979	19928
17	CAPACITY, MSCFM @ 60°F, 1 ATM.	188.830	126.369
18	CAPACITY, MACFM @ INLET	210.388	226.117
19	C _p /C _v	--	--
20	TEMP. RISE, °F	12	17
21			
22			
23			
	DESIGN AND CONSTRUCTION	--	--
24	DRIVER TYPE	Motor	Motor
25	BRAKE HORSEPOWER @ % EFF.	975 @ 66.7	1185 @ 78.1
26	RPM OF FAN OR BLOWER	1180	1180
27	MATERIALS	--	--
28	CASING DESIGN TEMP., °F	--	--
29	CASING DESIGN PRESS.,	--	--
30			
31			

32 NOTES

FAN OR BLOWER DATA SHEET

THE BABCOCK & WILCOX COMPANY

BY H. S. DossPAGE DATE November 14, 1977FILE NO. ES-261

1	NUMBER		
2	NAME	Cold Primary Air Fan	Cold Primary Air Fan
3	Condition	Net	Test Block
4	GENERAL TYPE	Air Foil	Air Foil
5	FLUID HANDLED	Air	Air
6	SUCTION TEMP., °F	105	130
7	DENSITY @ T, LB/FT ³	0.077	0.074
8	MOLECULAR WEIGHT	28.6	28.6
9	% WATER (WEIGHT)	1.3	1.3
10	VISCOSITY @ T, CP	--	--
11	BARO. PRESS., " H ₂ O Abs	407	407
12	SUCTION PRESS., " H ₂ O Abs	453.9	453.9
13	DISCHARGE PRESS., " H ₂ O Abs	468.4	473.5
14	DIFFERENTIAL PRESS., " H ₂ O Abs	14.5	19.6
15	CAPACITY, MLB/HR	397.200	417.060
16	CAPACITY, LB MOLE/HR	13888	14582
17	CAPACITY, MSCFM @ 60°F, 1 ATM.	90.903	95.185
18	CAPACITY, MACFM @ INLET	85.974	93.932
19	Cp/Cv	--	--
20	TEMP. RISE, °F	5	7
21			
22			
23			
	DESIGN AND CONSTRUCTION	--	--
24	DRIVER TYPE	Motor	Motor
25	BRAKE HORSEPOWER @ % EFF.	254 @ 77.2	347 @ 83.5
26	RPM OF FAN OR BLOWER	1180	1180
27	MATERIALS	--	--
28	CASING DESIGN TEMP., °F	--	--
29	CASING DESIGN PRESS.,	--	--
30			
31			
32	NOTES		

VII. B&W SYSTEM TERMINALS

A. Water Connections

1. Inlet to feedwater stop-check at economizer inlet header.
2. Inlet to chemical feed valve on steam drum.
3. Inlet and outlet connections of all B&W furnished equipment requiring water cooling such as ash coolers.
4. Inlet to water cleaning device on regenerative air heater.
5. Inlet to spray water nozzle on spray attemperator.
6. Water level recorder valves at steam drum.
7. Feedwater regulator connections at steam drum.
8. Inlet to valve at all acid cleaning inlet connections.
9. Outlet of drain valves for water column and gage located at operating floor level.
10. Outlet of drain valves.
11. Outlet of continuous blowdown valve on steam drum.
12. Outlet of water sampling valve on economizer inlet header.
13. Outlet of valve at all acid cleaning outlet connections.

B. Fuel Connections

1. Inlet to oil lighter control package located at fluidized beds.
2. Coal and limestone inlets to the crushed coal and limestone bunkers.

C. Steam Connections

1. Inlet of reheater piping at reheat inlet header on boiler right hand side.
2. Outlet of superheater piping at boiler front wall on boiler left hand side.
3. Outlet of reheater piping at reheat outlet header on boiler front wall.
4. Outlet of each safety valve.
5. Outlet of electromatic relief valve.
6. Outlet of each vent valve.
7. Outlet of pressure gage test valve.
8. Outlet of steam sampling valve.
9. Outlet of auxiliary steam valve on steam drum.
10. Outlet of drain valve in sootblower piping.

D. Air Inlets

1. Forced draft fans.
2. Air piping at air atomized oil lighters at lighter control package.
3. Air piping manifold for air blowing sootblowers located at side of boiler at operating floor level.

E. Miscellaneous Terminal Points

1. Blank connections at wall boxes for future sootblowers.
2. Outlet flange of mechanical dust collector hoppers.
3. Outlet flange of CBB hot precipitator hoppers.
4. Thermometer well connections as required.
5. Draft connections as required.
6. Air measurement connections as required.
7. Blanked test connections for air and gas traverses.
8. Inlet and outlet of steam coil air preheaters.

F. Gas Outlets

1. Gas outlet at stack breeching.

G. Piping

Stone & Webster will furnish all piping external to the boiler.

As an exception to the above, B&W will furnish the following:

1. Coal piping from bunker outlet to fluidized beds.
2. All piping from FBC hot precipitator to CBB fluidized beds.
3. Water gage and column drain piping terminating at valve located at operating floor level.
4. Drum pressure gage to operating floor level.
5. Piping for air blowing sootblowers from manifold at side of boiler.
6. Drain piping for primary, secondary and R.H. headers to include second valve at operating floor level.
7. Seal air piping.
8. Oil piping to airheaters from lubrication sets.
9. Electromatic relief valve piping to controller.
10. Continuous blowdown piping to operating floor level.

H. Wiring

Stone and Webster will furnish all electrical wiring from power sources to the terminals located on the equipment furnished by B&W. Also S&W will furnish all control and interlock wiring.

As an exception to the preceding, the following wiring will be furnished by B&W.

1. Permanent thermocouples with leads to terminal box located at side of boiler.

I. Tubing

Stone and Webster will furnish all power and control tubing to connect the equipment furnished by B&W except the pressure control line for the electro-matic relief valve.

J. The following equipment is included in B&W's scope of supply

1. Sootblower control panel for mounting on S&W's control panel.
2. Reheat attemperator sleeve and spray nozzle to be installed in cold reheat piping.
3. Controller for electromatic relief valve.
4. Bailey Meter Company's switches and indicators.

VIII CONTROLS AND INSTRUMENTATION

A. Conceptualized Control Philosophy And Unit Operation

The control philosophy incorporated for most of the systems for the AFB is very similar to that used in conventional coal fired units. The major new area that was addressed is the start-up, shut-down (slumping) and control of the fluidized beds.

Operation of the fluidized bed boiler is quite different from a conventional drum type unit. A large portion of the heat transfer in the AFB occurs in the fluidized beds of the FBC and CBB. The heat transfer, however, must be properly split between the boiling surface and the superheat surface. The steam flow rate and pressure are established by the amount of heat absorbed by the boiling surface while the main steam temperature is a function of the heat absorbed by the superheat surface. The superheater surface was designed to absorb more heat than is required to superheat the steam with the spray attemperators controlling the main steam temperature to its desired value (1005°F).

The primary method utilized to change load is by either removing bed compartments from service (slumping) or placing them into service (fluidizing) depending on if the load is to be increased or decreased. The total number of compartments in service is a function of boiler load also the ratio of superheat compartments to boiling surface compartments must be such that steam generation as well as superheat temperature are satisfied. This is pre-programmed in the boiler controls.

To start the unit up, a turbine by-pass valve is required to establish flow through the superheat tubes for protection of the superheat surface. A steam flow of approximately forty percent is required prior to the start-up of any superheat compartments. This flow is dumped to the condenser via the turbine by-pass valve. Superheat compartments are then placed into service to superheat the steam for turbine warming, rolling and synchronization. Turbine load is then increased while the turbine by-pass valve is closing until the entire steam flow passes through the turbine. Load is then increased by placing additional compartments in service.

To remove the unit from service, the load is reduced by removing compartments from service until the steam flow is reduced to approximately forty percent of full load steam flow. The turbine by-pass valve is then opened to accept the excess steam flow as load on the turbine is reduced. When the turbine is no longer taking steam flow, the superheater compartments are removed from service. After the superheat compartments have cooled the boiling compartments are slumped and the unit bottled up.

In the event of a unit trip while any superheat bed is in service, the turbine by-pass valve will open to assure steam flow through the superheat tubes for protection.

The conceptualized control system for the AFB is attached in Sections: B, C and D. Items shown with an underlined blank are areas that require additional study or testing before a value can be assigned.

B. Analog Control System

Index

<u>Section</u>	<u>Subject</u>
1	Boiler Demand
2	Fuel Demand Master
3	Compartment Group Control
4	Air Flow Calibration
5	Primary Air Control
6	Secondary Air Flow Control
7	Forced Draft Fan Control
8	Induced Draft Fan Control
9	Furnace/CBB Draft Control
10	Superheat Temperature Control
11	Reheat Temperature Control
12	Feedwater Flow Control
13	Air Heater Control
14	Steam Turbine Bypass Control

1 Boiler Demand (Target Load)

Purpose

The purpose of the boiler demand subsystem is to develop the firing rate demand for combustion control, to develop a signal for Btu correction related to variations in the Btu input of the fuel, and to initiate boiler runbacks for boiler safety.

Firing Rate Demand Development

As the turbine valves are positioned to vary the generated megawatts, energy demand and throttle pressure will vary. At a constant throttle pressure (and temperature), megawatts are proportional to the energy delivered by the boiler to the turbine. The product of megawatts and throttle pressure error is a direct indication of the energy demanded by the turbine. This energy flow gained by the throttle pressure error, is referred to as target load since it represents the actual energy required by the unit at zero throttle pressure error. The target load (required energy output) sets the demand for fuel flow (required energy input) to the unit. The throttle pressure error is an indication of the overfiring or underfiring requirements, during load changes, which compensate for changing energy storage levels in the boiler at various load ratings.

Btu Correction

Under ideal conditions, the firing rate demand will accurately determine the fuel flow into the boiler. However, because of variations in the Btu content of the fuel, it is necessary to provide a correction to the actual fuel flow into the boiler. The basis for this correction is the integrated throttle pressure error at steady state conditions. This correction is applied through the Btu correction station to the feeder speed control to reduce the throttle pressure error to zero. It should be noted that under a fast rate of load change, the integral on the throttle pressure error is blocked.

Fuel Demand Master Subsystem

Purpose

The purpose of the fuel demand master subsystem is to develop a demand for fuel and to distribute this demand to the furnace and CBB compartments.

Furnace Fuel (Coal) Demand Development

In order to maintain proper distribution of heat input within the furnace, it is necessary to turn down compartments containing boiler surface at a different rate than the compartments containing superheater surface. The furnace firing rate demand is split between boiler surface compartment demand and superheater surface compartment demand. The split can be biased by the operator. In addition, to assure that proper absorption is maintained in the superheater surface the split is modified based on superheater absorption i.e. superheater spray flow. The firing rate demands are compared to the total fuel flow into the compartments. Both error signals are scaled in "sensitivity" multipliers by the number of compartments in service. The function generator provides a reciprocal function so that when a large number of compartments are in service the output of the multiplier will be reduced, and when only a few compartments are in service the output of the multiplier will be increased. Proportional plus integral control action on this modified error signal then provides an output signal representative of fuel demand for each of the compartments under the influence of the control system. The output signal is low limited to a per compartment minimum.

CBB Fuel (Char) Demand Development

During normal operation char is consumed in the CBB at the rate that it is produced in the furnace. That is, char inventory remains constant. The CBB firing rate demand as modified by any change in char inventory is compared to the total fuel flow into the CBB. This error signal is then scaled in the "sensitivity" multiplier by the number of compartments in service. The function generator provides a reciprocal function so that when a large number of compartments are in service, the output of the multiplier will be reduced, and when only a few compartments are in service, the output of the multiplier will be increased. Proportional plus integral control action on this modified error signal then provides an output signal representative of fuel demand for each of the bed sections under the influence of the control system. The output signal is low limited to a per compartment minimum.

Compartment Group Control

Purpose

he purpose of the compartment control logic is to control feeder and rotary seal speed and to generate the demand for secondary air flow.

Furnace Compartment

The fuel demand from the fuel master through the compartment fuel master selector stations becomes the demand for compartment Btu input. This demand determines the set point for compartment bed level and secondary air. The compartment bed temperature is used as a feedforward index signal for both the Btu demand and bed level demand whenever the bed temperature exceeds its upper or lower operating limit. After being scaled by the Btu correction the demand is proportioned, biased, and modified by a feedforward index signal to establish the limestone feeder speed demand. SO_2 as measured leaving the unit cannot be used as a trim on limestone flow because of the overall sluggishness of the fluid bed. This measurement rather should be used as an indication to the operator of the need to make changes in a predetermined sorbent flow ratio.

Feeder Speed Control

The feeder speed demand will be the output of the Btu corrected fuel demand, provided the feeder speed station is on auto and that secondary air is not crosslimiting the fuel flow through the low auctioneer. The secondary air flow crosslimit uses compartment secondary air flow plus the feeder speed correction for Btu correction.

Feeder Speed Totalizing

If the feeder has been in service for ____ seconds (startup timer), the feeder speed is selected for totalizing in the fuel master subsystem. When the feeder stops, the current feeder speed is stored for ____ seconds (shutdown time). After this, or when the close primary air flow signal is received from the fuel equipment digital control system, the zero feeder speed is selected for the fuel totalizing circuit. This allows the control system to have representative values of fuel flow into the furnace during the transient shutdown conditions so as to minimize upsets in the process.

CBB Compartment

The fuel demand from the fuel master through the CBB fuel master selector station becomes the demand for compartment fuel. This demand determines the set point, compartment bed level and secondary air. The compartment bed temperature is used as a feedforward index signal for both the fuel demand and bed level demand whenever the bed temperature exceeds its upper or lower operating limit.

4. Air Flow Calibration

Purpose

This subsystem works in conjunction with the individual bed section air flow controls to maintain the proper total boiler air flow for the existing combustion conditions. The air flow calibration subsystem prevents the oxygen content of the main bed or carbon burn-up bed exit flue gas from dropping below a minimum allowable value.

Analog Logic Description Minimum O₂ Limit

The minimum oxygen limit is determined by considering the increased efficiency gained by reducing the excess air and the possibility of incomplete combustion and boiler tube corrosion which will result from very low excess air operation.

Air Flow Correction

The subsystem compares the measured O₂ content to the minimum limit and raises the air flow demand to the compartments if the O₂ content ever drops below the minimum. A proportional plus integral controller operates to keep the oxygen content from dropping below the minimum limit. The output of the controller is limited so that it can only raise the air flow.

An air flow trim station is provided for manual control of excess air. The output of the controller is limited to allow only reasonable adjustments to the air flow.

The air flow correction goes to the secondary air flow demands in all active bed sections.

5. Primary Air Control

Primary and Tempering Air Fan Control

The maximum fuel demand provides the set point for air duct pressure. An operator adjusted bias is also provided. If two fans are in operation, the error signal is brought directly to a proportional plus integral controller which, through the primary air fan selector station, positions the inlet damper to provide the proper air duct pressure. A bias may be applied to the individual fans if necessary. If only one fan is in operation, an increased gain is applied to the error signal to provide better response to the system. Interlocks downstream of the station allow closing the dampers regardless of station mode of operation.

Primary Air Flow Control

The air flow is compared to the set point demand, and the error signal is modified by a proportional plus integral control which, through the primary air flow control stations, provides positioning of the primary air control damper. When a compartment is not in service, as indicated by the logic developed in the fuel equipment digital control system, the primary air flow will be reduced to zero through the transfer below the control station.

Primary Air Temperature Control

The temperature of the air is measured at the outlet of the mixing bustle. This temperature is compared to an operator adjustable fuel-air temperature set point and the resultant error signal is brought to a proportional plus integral controller which, through the air tempering selector station, controls the hot air damper and tempering air damper. These two dampers are controlled in a reciprocal fashion so that when one opens, the other closes thereby controlling the outlet temperature.

6. Secondary Air Flow Control

Purpose

This logic regulates total bed section air flow for all operating conditions by modulating the secondary air flow control damper.

Secondary Air Flow Description

The secondary air flow control subsystem programs total secondary air flow using the combustion air flow demand plus the excess air demand (operator adjustable bias). The excess air demand is trimmed by a correction from the air flow calibration subsystem. The demand is compared to bed section air flow and the compartment secondary air dampers are positioned through proportional plus integral control action. During purge or light-off, the fuel equipment digital control system will demand light-off flow through a transfer module. When the compartment is shut down, a minimum air flow will be maintained through the compartment for cooling purposes. The secondary air flow is measured by use of an air foil at the entrance of the compartment. This measurement is temperature corrected to compensate for changes in the secondary air density.

7. Forced Draft Fan Control

General Description

The forced draft (FD) fans provide the total secondary air required by the boiler. The FD fan inlet dampers are modulated to maintain a programmed secondary air duct pressure. This control logic also incorporates safety features to protect the boiler and fans during both manual and automatic startup operation.

FD Fan Inlet Damper Control

The FD fan inlet dampers are modulated to control the secondary air duct pressure. By varying the secondary air duct pressure, it is possible to reduce the modulation required by the secondary air dampers on each fluidized bed section. Ideally, the secondary air dampers will remain fixed for all loads. A program based on firing rate demand is used to develop the set point for the secondary air duct pressure. This program can be biased by the operator to effect a program change without requiring recalibration of the associated function generator. This set point will respond instantly to load increase, while responding slowly to load decreases. This assures that the air flow will increase faster than fuel on load increases and will decrease at the same rate as fuel on load reductions.

Secondary air duct pressure is compared to the developed set point. Control action applied to any deviation develops the base control signal for FD fan inlet damper position when only one FD fan is in auto, the gain on the gas flow error signal is doubled to maintain a uniform dynamic response.

FD Fan Inlet Damper Control Stations

The FD fan inlet damper control stations permit the operator to select either auto or manual control of the inlet dampers.

FD Fan Inlet Damper Interlocks and Discharge Damper Controls

The FD fan inlet and discharge digital logic interlocks the inlet dampers and positions the discharge dampers to maintain safe operation of the unit.

8. ID (Induced Draft) Fan Control

General Description

The ID fans provide the exhausting force for gas flow through the boiler. When the FD fans and ID fans are properly balanced, the furnace pressure will be at the proper value. The ID fans' function is to control the ID fan inlet plenum pressure. A feedforward from firing rate demand allows rapid response to load changes. Provisions to protect the furnace and CBB from exceeding low pressure limits are included.

Draft Control

Pressure is measured by a pressure transmitter. The operator selects a draft set point. This set point is compared to the furnace or CBB draft. Since the draft control is inherently a low gain high integral control, a non-linear function generator is added between the error and the proportional plus integral controller. This configuration provides a control stability by using a high gain proportional correction on large pressure errors but low gain control when near set point.

Feedforward Program

Under normal conditions, the firing rate demand will provide the feedforward signal for the ID fans. This feedforward signal is corrected by the draft control (described above) to maintain the furnace or CBB pressure at set point. The feedforward signal is low limited to a value which will keep the ID fan blades open the required amount to exhaust the no-load boiler air flow.

ID Fan Gas Flow Control

The pressure drop between the furnace and the ID inlet plenum can be used as an indication of the gas flow rate through the ID fans. Since the furnace pressure is always close to atmospheric, the ID fan inlet pressure is a direct indication of gas flow rate. Therefore, the ID inlet plenum pressure signal is converted to flow rate by a function generator.

The actual gas flow signal is compared to the demand for gas flow. Any error has proportional plus integral action applied to develop the ID fan blade position control signal. When only one ID fan is in auto, the gain on the gas flow error signal is doubled to maintain a uniform dynamic response.

ID Fan Blade Control

The developed inlet blade control signal is sent to the blades of each ID fan. The operator may increase the bias to one fan and at the same time reduce the bias to the other fan. This allows the

ID Fan Blade Control - (Cont'd)

operator to achieve balance gas flow between the two fans. A hand-auto station allows the operator to select the developed blade control signal or manually control the blades of the fan. The output of the inlet damper selector station can be overridden by interlocks which ensure safe operation during fan startups and shutdowns and finally interlocks which maintain furnace protection.

Furnace Implosion Protection

If furnace or CBB pressure drops below a nominal set point, a special control circuit downstream of the selector stations will be activated. This circuit will override the normal control signal and close the ID fan blades (as required) to keep the pressure from dropping below set point. This circuit is implemented in such a way that no failure of the pressure transmitter or control circuitry will cause the ID fan blades to open beyond their desired position.

This control system recognizes when a main fuel trip has occurred and takes action to reduce the resulting negative pressure excursion. When a main fuel trip occurs, a large negative bias, based on load, is added to the control signal to the ID fan blades. This immediately starts the blades running closed. This "kicker" signal decays to zero percent in a short time.

ID Fan Inlet and Discharge Damper Interlocks

The ID fan dampers are interlocked to ensure safe unit operation during fan startups and shutdowns. The interlocks prevent a complete blockage of the air flow path through the boiler.

Furnace/CBB Draft Control

Purpose

This logic regulates furnace and CBB pressure by modulating the economizer and CBB outlet dampers.

Draft Control Description

The draft control system maintains furnace and CBB operating pressure through the modulation of outlet dampers. Pressure is compared to a set point. Control action applied to any deviation develops the base control signal. Firing rate demand is used as a feedforward signal for damper position.

10. Superheat Temperature Control with Two Stage Attenuation

The superheat temperature control system provides control over the normal temperature range of the boiler. It is designed for use with a two stage attenuating system where spray water is introduced at the inlet of the second full superheater bed, as well as the final full superheater bed inlet. The system recognizes the need for extra spray when overfiring on load increase and spray reduction for load decreases over and above the steady feedforward program. Limits are provided to prevent spraying the final full superheater bed inlet into saturation.

Set Point Generation

The set point is manually adjusted by the operator, however, the throttle pressure error, as an indication of over and underfiring, temporarily biases the set point to more rapidly increase or decrease the sprays at load change.

Superheater Inlet Temperature Program

The secondary inlet temperature set point is programmed from load. As the program will vary with changing boiler conditions, the set point is trimmed from final steam temperature error through a proportional plus integral error. The proportional and integral controllers are separated to permit the high gain and low integral rates required on final steam temperature control.

Superheater Inlet Control

The higher of the two secondary inlet temperatures is compared to the set point generated above, and through a proportional plus integral controller, sets the spray valve demand. This signal is limited to zero percent to prevent the integral from winding down below zero when the boiler is below temperature rating.

Second Full Superheater Bed Spray Control

The total spray demand goes directly to the second full superheater bed control valves for final temperature control. However, under high load or rapid load increases, this may drive the inlet temperature into saturation. To prevent this, the steam pressure is calibrated to saturation temperature plus 50°F and compared to the second full superheater bed inlet temperature and limiting the opening of the second full superheater bed spray valves.

For balancing the side to side temperatures, a manual bias is available to the operator.

Final Full Superheater Bed Spray Control

The final full superheater bed sprays receive the same demand as the second full superheater bed sprays. If the demand to the second

full superheater bed sprays are not limited, however, this demand is subtracted from the demand to the final full superheater sprays, leaving a net zero demand for the final full superheater bed sprays. When the second full superheater bed sprays are limited, the demand to these sprays will be less than the total demand, increasing the final full superheater bed sprays.

Block Valves Control

These valves open wide when the control valves are open greater than zero. They are closed whenever the control valves are closed. Whenever the boiler or turbine is tripped, both the control valves and block valves are closed. The block valves may also be tripped from a manual trip button. Once the block valves are tripped from a boiler, turbine or manual trip, the reset button must be actuated before they will again open automatically from the control system.

1. Reheat Temperature Control

Reheat steam temperature is basically controlled by biasing the gas flow in the parallel back end of the unit. The system also provides for spray attemperation to control temporary temperature excursions.

Spray Control

The spray control is normally not required. Whenever the damper control is not limited the set point for the spray is bias $+10^{\circ}\text{F}$. Thus, the spray acts as a safety override coming into service when reheat temperature reaches 10°F above set point. As the damper control is limited, the bias is removed and spray will control to set point.

Reheat Spray Block Valves

The reheat spray block valves open whenever the spray control valve is not required closed, and close when the control valve is required closed. On a boiler or turbine trip or operator initiated spray trip, both control and block valves are closed. The valves will not respond to automatic control after a trip until the operator has energized the reset pushbutton.

12. Feedwater Flow Control

Purpose

An adequate feedwater flow is required at all loads to replace the water which has been converted to steam and sent to the turbine. The feedwater flow control subloop uses a cascaded feedforward type of control to regulate the feedwater pumps. Drum level set point is selected by the operator. Shrink and swell effects are minimized by using a feedforward load index based on steam flow.

Feedwater Flow Demand Development

Steam flow is used as the feedforward signal to generate the basic demand for feedwater flow. This feedforward signal is modified by proportional action applied to drum level error. The operator selects the drum level set point which is compared to the actual drum level. Any error, such as errors due to blowdown, meter error, etc., is used to correct the feedforward program. Since the basic demand for feedforward is developed based on load, shrink and swell have only minimal effect on the control system.

Feedwater Flow Control

The feedwater flow from each feedwater pump is measured by a differential pressure transmitter. The ΔP is converted through square root action to a flow signal. The feedwater flow signal is also temperature compensated.

The demand for feedwater flow is compared to the actual temperature compensated feedwater flow. Any error is operated on by a proportional plus integral controller through a control station to correct the feedwater pump speed.

3. Air Heater Controls

Purpose

During low load operation and/or low ambient temperatures, there exists the possibility that the metal temperatures in the heater will be below the dewpoint of the flue gas. This condition could result in condensation forming on the surfaces of the heater which leads to rapid corrosion and plugging. To prevent this condition from occurring, the air entering the air heater is heated. The corrective action will increase the temperature of the surfaces of the heater.

Air Heater Fluid Flow Control

The temperature of the air entering the air heater and the temperature of the flue gas leaving the air heater are averaged to provide average air heater metal temperature. The average metal temperature is compared to an operator adjustable set point to provide the average metal temperature error. This error has proportional plus integral action applied to develop the fluid flow control valve position demand. Limits on the integral prevent the signal from exceeding either 0% or 100%. A hand/auto control station is provided to permit direct operator control of the fluid valve.

4. Steam Turbine Bypass Control System

Purpose

The purpose of the steam turbine bypass control system is to dump superheater outlet steam to the condenser.

Description

During startup of the unit superheater steam will be diverted to the condenser until steam temperature is achieved. During normal shutdown, steam flow is maintained through the unit by diverting steam to the condenser. Following unit or appropriate equipment trips the control system will demand the bypass valve to open through a transfer module.

C. Fuel Equipment Digital Controls

Index

Section	Subject
1	General Requirements
2	Operating Modes
3	Operator Interface
4	Unit Purge and Monitor
5	Start-Stop Sequences
6	Oil Lighter Control
7	Primary Air Flow Control
8	Secondary Air Flow Control
9	Feeder Control
10	Flame Monitoring
11	Combustion Control Interface

1. General Requirements

The fuel equipment digital control system shall incorporate a continuous purge of the furnace to insure that the boiler is free of any accumulation of combustibles for light-off and that the boiler will remain so during operation. The fuel equipment digital control system shall also supervise the operation of the fuel-air equipment associated with each compartment. It shall accept operator commands and if the required permissives are met, perform the required operation. Equipment shall be continuously monitored and any deviation shall be alarmed while the system either corrects the deviation or shuts down equipment as necessary to avoid hazardous conditions or equipment damage.

The system shall monitor the operation of the fuel equipment and if the equipment fails to respond to commands from the fuel equipment digital control system, the equipment tripped status shall be set. Indications shall be provided to allow the operator to determine the equipment level which initiated a trip of fuel equipment. Tripped equipment shall be successfully shutdown before reset of the trip is permitted. The status of the fuel-air equipment shall be displayed to the operator at all times.

The fuel equipment digital control system shall interface with a master fuel trip system. It also shall interface with the analog fuel control system to position and monitor devices for start-up and shutdown which are normally modulated during on-line operation. The fuel equipment digital control system shall be designed to operate reliably and to minimize the number of false trips which occur in order to establish operator confidence in this system, such that the system will be maintained in service and available to respond if hazardous conditions develop.

The term compartment group as used in this guide specification refers to the coal feeder, limestone feeder, rotary seals and primary and secondary air systems associated with an individual bed section.

2. Operating Modes

In the manual sequence control mode, the operator has the responsibility for initiating

each step in the start and stop sequences at the proper time and for positioning the modulating devices controlled by the analog fuel and air control system. This system shall monitor the operator's progress and inhibit him from departing from the proper operating sequences. The manual control mode does not include sequence timing functions other than for lighter and boiler purge functions. The manual mode of control includes the basic supervisory interlocks, trips and monitoring functions including proper positioning of functions controlled by the analog system.

In the automatic sequence control mode, the fuel equipment digital control system shall automatically place the compartment group in service, or remove it from service on operator initiation to start or stop that compartment group. In the automatic mode, start/stop sequences, including timing between the steps, are superimposed over the manual mode. As such, all of the interlocking and tripping functions that are part of the manual mode shall be an integral part of the automatic mode.

3. Operator Interface

To provide for operator interaction with the fuel equipment digital control system, inserts for boiler purge control and feeder group control (one for each compartment group) which are suitable for mounting on the plant's main control board from which system operations can be monitored and directed, shall be provided.

Means shall be provided for the operator to initiate a compartment group emergency trip which will shutdown all compartment group equipment.

4. Unit Purge and Monitor

The unit purge control shall incorporate a continuous purge of the furnace and CBB to insure that the boiler is free of any accumulation of combustibles for light-off and that the boiler will remain so during operation.

Prior to light-off, the air and gas passages of the unit shall be purged of any combustible that may have accumulated. This purging shall be accomplished by maintaining a minimum of 30 percent air flow through all compartments with all sources of fuel to the unit shut-off for at least _____ minutes. Purge permissives shall include: _____

1. All rotary seals stopped.
2. All feeders stopped.
3. All primary air control dampers closed.
4. All lighter oil valves closed.
5. Lighter oil header trip valve closed.
6. All air heaters running.
7. At least one FD and ID fan running.
8. No primary or tempering air fan running.
9. Purge air flow established through all compartments.
10. Furnace and CBB air flow greater than 30 percent.

Accumulation of purge credit shall start automatically when the purge permissives are established. Once the purge is complete, a continuous purge with greater than 30 percent boiler air flow must be maintained. The boiler shall not be tripped on low air flow, but the start of any additional fuel equipment shall be blocked until air flow has been restored for at least _____ minutes. A continuous purge of one minute with greater than 30 percent air flow shall occur after the start or trip of any feeder, or rotary seal, or the occurrence of a compartment group emergency trip, before any additional fuel equipment may be started.

Completion of the furnace and CBB purge shall allow reset of the master fuel trip. A purge shall be required on a master fuel trip, no FD fans operating, or when all lighters and compartment groups are stopped or tripped after main fuel firing has been initiated. Purge required shall trip the master fuel trip, the lighter oil header trip valve and all fuel equipment in the compartment groups.

The unit monitor shall prevent starting any fuel equipment if the firing permissives are not met. The firing permissives shall include:

1. Master fuel trip not present.
2. Continuous purge requirements met.
3. All compartment group equipment trips reset.
4. Lighter oil header valve open.
5. Lighter oil header pressure above minimum.

The purge control insert shall provide indications to the operator of the status of the purge and firing permissives and the progress of the purge. These shall include:

1. Purge required.
2. Purge in progress.
3. Purge complete.
4. Status of each individual purge permissive.
5. Status of each individual firing permissive.

A first-out annunciator shall be included to indicate to the operator the initiating cause of a unit trip. Points to be included in the first-out display shall include:

1. Master fuel trip.
2. Turbine trip.
3. FD fan trip.
4. ID fan trip.
5. Furnace pressure high trip.
6. Furnace pressure low trip.
7. CBB pressure high trip.
8. CBB pressure low trip.
9. PA fan trip.
10. Tempering fan trip.
11. All fuel off trip.
12. Drum level trip.
13. Secondary air duct pressure high.
14. Primary air duct pressure high.
15. Tempering air duct pressure high.

5. Start-Stop Sequences

The fuel equipment digital control system shall start and stop the compartment group following fixed sequences. The system shall be capable of transferring between the start-up and shutdown sequences at any time.

The recommended start-up sequence for main bed compartments with lighters is:

1. Establish compartment secondary air flow at light-off through the manipulation of the analog air flow control subloop.
2. Start lighters.
3. Hold for bed temperature to reach light-off value (minimum 1000°F).
4. Start primary air flow.
5. Hold to allow primary air flow to stabilize (approximately _____ seconds).
6. Start rotary seals.
7. Start feeders.

8. Release mixing bustle outlet fuel-air temperature control to automatic.
9. Hold for initial stabilization period (approximately ____ minutes).
10. Release compartment secondary air flow control to automatic.
11. Release compartment group demand to automatic control.
12. Hold for final stabilization period (approximately ____ minutes).
13. Stop lighters after stable combustion has been established (approximately ____ minutes).

The recommended start-up sequence for main bed compartments without lighters is:

1. Establish compartment secondary air flow at light-off through the manipulation of the analog air flow control subloop.
2. Hold for bed temperature to reach light-off value (minimum 1000°F).
3. Start primary air flow.
4. Hold to allow primary air flow to stabilize (approximately ____ seconds).
5. Start rotary seals.
6. Start feeders.
7. Release mixing bustle outlet fuel-air temperature control to automatic.
8. Hold for stabilization period (approximately ____ minutes).
9. Release compartment secondary air flow control to automatic.
10. Release compartment group demand to automatic control.

The recommended start-up sequence for CBB compartments is:

1. Establish compartment secondary air flow at light-off through the manipulation of the analog air flow control subloop.
2. Start lighters.
3. Hold for bed temperature to reach light-off value (minimum 1000°F).
4. Start primary air flow.
5. Hold to allow primary air flow to stabilize (approximately ____ seconds).
6. Start rotary seals.
7. Start feeders.
8. Release mixing bustle outlet fuel-air temperature control to automatic.
9. Hold for initial stabilization period (approximately ____ minutes).

10. Release compartment secondary air flow control to automatic.
11. Hold for final stabilization period (approximately ____ minutes).
12. Stop lighters after stable combustion has been established (approximately ____ minutes).
13. Release compartment group demand to manual.
14. Reduce coal-limestone demand to minimum.
15. Close hot air damper and open cold air damper to reduce primary air temperature to minimum.
16. Hold for mixing bustle cooling (approximately ____ minutes).
17. Stop feeders.
18. Stop rotary seals.
19. Establish compartment air flow at light-off.
20. Stop coal-limestone primary air flow.
21. Start char primary air flow.
22. Hold to allow primary air flow to stabilize (approximately ____ seconds).
23. Start rotary seals.
24. Release char mixing bustle outlet fuel-air temperature control to automatic.
25. Hold for initial stabilization period (approximately ____ minutes).
26. Release compartment secondary air flow control to automatic.
27. Release fuel demand to automatic control.

The recommended shutdown sequence for all compartments is:

1. Reduce fuel demand to minimum.
2. Close hot air damper and open cold air damper to reduce primary air temperature to minimum.
3. Stop fuel flow.
4. Stop rotary seals.
5. Establish compartment secondary air flow at light-off.
6. Stop primary air flow.
7. Hold for compartment burn out (approximately 15 minutes).
8. Release compartment secondary air flow to cooling value.

Start-up and shutdown sequence indications shall be provided to allow the operator to follow the progress of compartment start-up or shutdown sequences when in the automatic sequence mode and to guide the operator through the sequence in the manual sequence mode. These indications shall show the next

mode. These indications shall show the next step to be performed as well as the progress through the sequence.

6. Oil Lighter Control

Each lighter equipped compartment has either one secondary air duct lighter or one secondary air duct lighter and one bed lighter. Each lighter or lighter set will be controlled by a separate electro-pneumatic lighter control package. All of the lighters associated with a compartment shall be started or stopped at the same time. Each lighter or lighter set shall be independently monitored and tripped.

The fuel equipment digital control system shall provide a start lighter command upon which the electro-pneumatic control package will:

1. Insert lighter (s) (as required).
2. Insert high energy spark (s).
3. Admit atomizing medium to the lighter (s).
4. Purge condensate from atomizing line (s) (steam atomized lighters only) for approximately 30 seconds.
5. Energize the high energy spark (s).
6. Open oil valve.
7. After a delay de-energize and retract the high energy spark (s).

The fuel equipment digital control system shall provide a stop/clean lighter command upon which the electro-pneumatic control package will:

1. Insert and energize high energy spark (s).
2. Close oil valve (s).
3. Open purge valve.
4. Clean lighter (s) for approximately one minute.
5. Close purge valve.
6. Close atomizing medium valve.
7. De-energize and retract high energy spark (s).
8. Retract lighter (s) (as required).

The fuel equipment digital control system shall provide an emergency stop lighter command when a master fuel trip or an operator initiated compartment group emergency trip occurs, upon which the electro-pneumatic control package will:

1. Close oil valve (s).

2. Close purge valve.
3. Close atomizing medium valve.
4. De-energize high energy spark (s).
5. Retract high energy spark (s).
6. Retract lighter (s) (as required).

The following outputs from the electro-pneumatic control package are available for use by the fuel equipment digital control system:

1. Lighter (s) inserted.
2. Purge pressure to atomizer (s) greater than minimum (purge valve open).
3. Oil pressure to atomizer (s) greater than minimum (oil valve (s) open).

A lighter group shall be tripped if:

1. Boiler tripped.
2. Compartment group emergency trip initiated by operator.
3. Lighter fails to start when commanded.
4. Lighter oil valve not open after trail for ignition.
5. Lighter flame not detected after trail for ignition.

Maintained lighter selection on a compartment group basis shall be provided for any system which includes automatic sequence control. This capability shall allow the operator to start or stop the lighter (s) any time firing is permitted in the boiler, provided the automatic sequence does not require the lighter (s) in service at that time. If the lighter is in service, selection of maintained lighter (s) shall prevent shutdown of the lighter (s) by the automatic sequence control.

Indications shall be provided to the operator on the status of the lighter (s). These shall include:

1. Lighter (s) ready to start.
2. Lighter (s) maintained.
3. Lighter group successfully lit.
4. Lighter group successfully shutdown.
5. Lighter group tripped.
6. Lighter group cleaning.
7. Lighter group trouble due to unsuccessful shutdown or shutdown without cleaning.

7. Primary Air Flow Control

With common primary air fans, the fuel equipment digital control system shall provide commands to open or close the compartment group primary air flow control damper. This damper is normally controlled by the analog control system.

Permissives to start the primary air flow on a compartment group shall include the following:

1. Boiler firing permissives met.
2. Any primary air fan running.
3. Any tempering air fan running.
4. Cold air damper open and hot air damper closed.
5. Bed temperature above light-off value (minimum 1000°F).
6. Feeder seal air pressure above minimum.

The primary air flow shall be tripped if the boiler is tripped, primary air flow is less than ____%, or the compartment group is tripped.

The hot and cold primary air control dampers are normally controlled by the analog control system to maintain mixing bustle outlet fuel-air temperature. The fuel equipment digital control system shall provide commands to open and close the hot and cold air damper. The hot air damper shall be closed and the cold air damper opened whenever the rotary seals are not operating.

Indications provided to the operator on the status of the primary air flow control shall include:

1. Primary air flow started.
2. Primary air flow stopped.
3. Primary air flow tripped.
4. Primary air flow low.
5. Hot air damper closed and cold air damper open.
6. Mixing bustle temperature control released to automatic.

8. Secondary Air Flow Control

Secondary air flow control shall normally be the responsibility of the analog control system. The fuel equipment digital control system shall

provide outputs to the analog control system to establish the air flows required for boiler purge and compartment start-up and shutdown. During operation at lower loads the digital control system shall avoid calling for individual compartment air flows which could reduce total boiler air flow below its minimum value. On a master fuel trip, the digital control system shall avoid any conflict with the normal analog control of secondary air flow.

Indications provided to the operator on the status of the secondary air flow control shall include:

1. Secondary air flow control released to automatic.
2. Secondary air flow at light-off.
3. Secondary air flow released to cooling.

9. Feeder Control

The feeder may be started if the feeder inlet gate is open, both rotary seals are running, firing permissives are met, coal or limestone is detected at the feeder inlet and the feeder outlet is not plugged. The feeder shall be stopped if the boiler is tripped or either rotary seal is stopped. The feeder shall be tripped if the feeder outlet is plugged, primary air flow is below minimum for 20 seconds or no coal or limestone is detected at the feeder inlet or on the feeder belt for 20 seconds.

Indications provided to the operator on the status of the feeder control shall include:

1. Feeder running.
2. Feeder stopped.
3. Feeder tripped.
4. Feeder inlet gate closed.
5. No coal or limestone detected at feeder inlet.

10. Flame Monitoring

The fuel equipment digital control system shall minimize the possibility of developing hazardous conditions by shutting down lighter equipment on loss of ignition. It shall also minimize the number of false trips which occur.

Indications of the status of each flame detector shall be provided to the operator.

11. Interface with Analog Control System

The digital control system shall interface with the analog control system to position devices for start-up and shutdown which are normally modulated during on-line operation. This interface shall be designed such that the loss of power in one system does not interface with the proper operation of the other system.

Signals from the digital control system to the analog control system shall include, but are not limited to:

1. Close primary air control damper.
2. Allow secondary air flow to cooling value.
3. Set secondary air flow to light-off value.
4. Close hot air damper and open cold air damper.
5. Set compartment fuel demand to light-off valve.

Signals from the analog control system to the digital control system shall include:

1. Furnace and CBB air flow greater than 30%.
2. Either PA fan running.
3. Either tempering air fan running.
4. Unit load greater than 35%.
5. Unit load less than 30%.
6. Unit load greater than 60%.
7. Compartment fuel demand at light-cff.
8. Primary air control damper closed.
9. Secondary air flow at light-cff.
10. Secondary air flow at cooling.

D. Guide Specifications
Metering and Control Equipment
Control Systems
Recommended Interlocks

INDEX

<u>Section</u>	<u>Subject</u>
I.	Total Unit Trip
	A- Boiler Trip
	B- Turbine Trip
	C- Generator Circuit Breaker Trip
II.	Fan Trips
	A- FD Fans
	B- ID Fans
III.	Turbine Low Load
IV.	Initial Pressure Regulator, Throttle Pressure Regulator or Throttle Pressure Limit (IPR, TPR, or TPL)
V.	Recommend Boiler Interlocks and Alarms
	A - Steam Cycle
	B - Internal, Water & Steam
	C - Boiler Feedwater
	D - Boiler Air and Gas
	E.- Fuel

All of the following alarm and interlocks are to be considered as recommended.

Notations have been specified to indicate types of interlock or alarm operation with the following term definition.

I. Interlocks
Automatic

Interlock designed to operate automatically without operator intervention to take the required action for safe operation.

Recommended

Operation of this action is required for safe operation but the action may be initiated by the operator or it may be automated if the customer desired.

Optional

May be placed under direct supervision and manual control of the operator.

II. Alarms
Required

Alarm is required for safe operation of the boiler.

Recommended

Alarm is recommended but not required.

BOILER PROTECTION TRIPS FOR UNIT CONNECTED UTILITY BOILER - TRIP SEQUENCES

Whenever a fault develops on a system, or the safety of the equipment is in jeopardy due to a malfunction, a trip will be initiated to protect that equipment. Depending upon the magnitude of the problem and the equipment involved, the following trip sequence will occur:

I. TOTAL UNIT TRIP will initiate;

A. BOILER TRIP (All actions to occur simultaneously)

1. Master Fuel Trip
 - a. Trip Primary and Tempering Air Fans, Feeders, Rotary Seals
 - b. Close Lighter Fuel Supply Shut-Off Valves
 - c. After Master Fuel Trip, Open Register Post Purge of Boiler and Purge Required Before Reset of Master Fuel Trip
2. Close Reheater Attemperator Water Spray Control and Block Valves
3. Close Superheater Attemperator Water Spray Control and Block Valves
4. Slowly Decrease Air Flow to Minimum Purge Air Flow (Forced Draft Fans may be Shutdown Manually by Operator Following a Post-Purge)
5. Maintain ID Fans on Automatic to Control Furnace Draft (ID Fans may be Shutdown Manually by Operator Following a Post-Purge)
6. Trip Automatic Sootblowers
7. Open Steam Turbine By-Pass Valve

B. TURBINE TRIP
Turbine Relay

Boiler will normally trip through action of interlocks on turbine throttle and reheat stop valves.
Close All Attemperator Block Valves
Open Steam Turbine By-pass Valve

C. GENERATOR CIRCUIT BREAKER TRIP (Loss of all load)

1. Trip Generator Breakers
2. Trip Turbine
3. Trip Boiler

II. FAN TRIPS

A. FD FANS (LOSS OF ALL FD FANS)

Initiate Master Fuel Trip
ID fans shut-down manually or continue to operate

B. ID FANS (LOSS OF ALL ID FANS)

Initiate Master Fuel Trip
Trip all FD fans

III. TURBINE LOW LOAD SWITCH

Refer to Turbine Manufacturer for recommendation

IV. INITIAL PRESSURE REGULATOR, THROTTLE PRESSURE REGULATOR OR THROTTLE PRESSURE LIMIT (IPR, TPR, or TPL)

Refer to Turbine Manufacturer for recommendation

V. RECOMMENDED BOILER INTERLOCKS AND ALARMS

A. STEAM CYCLE

1. OPERATOR ACTION - Manual Switch	
a. TRIP Boiler	Required
2. TURBINE TRIP - Originated by Turbine Interlocks	
a. TRIP Boiler (See I-A)	AUTOMATIC
3. GENERATOR BREAKER TRIP - Loss of All Load	
a. TRIP Turbine (See I-B)	AUTOMATIC
b. TRIP Boiler (See I-A)	AUTOMATIC
4. LOSS OF CONTROL POWER	
a. ALARM loss of power to analog controls	Required

b.	TRIP boiler on loss of power to analog controls after 0-5 second time delay when alternate power supply is not available.	Optional
c.	ALARM loss of power to all control drives and valves	Required
d.	TRIP boiler on loss of power to all control drives and valves after 0-5 second time delay	Optional
e.	ALARM loss of power to fuel equipment digital control system	Required
f.	TRIP boiler on loss of power to fuel equipment digital control system after 0-5 second time delay	Optional
5. REHEAT WATER SPRAY CONTROL AND BLOCK VALVES
a.	ALARM the condition where the block and control valves are demanded closed and the by-pass valve is not closed. (Applicable when a by-pass valve around the control valve is provided.)	Required
b.	CLOSE control and block valves whenever unit load is less than 25 percent or the demand for control valve position is requiring the control valve closed.	Recommended
c.	TRIP control and block valves closed on a Master Fuel Trip or a Turbine Trip. Prevent reset of control and block valve trip until Master Fuel Trip and Turbine Trip are reset, the demand for control valve position is zero, unit load is greater than 25 percent, and reset is initiated by the operator.	AUTOMATIC
6. SUPERHEATER WATER SPRAY CONTROL AND BLOCK VALVES
a.	ALARM the condition where the by-pass valve is not closed under a Master Fuel Trip condition. (Applicable when a by-pass valve around the control valve is provided.)	Required

b.	TRIP control and block valves closed on a Master Fuel Trip. Prevent reset of control and block valve trip until Master Fuel Trip is reset, the demand for control valve position is zero, and block valve reset is initiated by the operator.	AUTOMATIC

7. STEAM TURBINE BY-PASS VALVE

a.	OPEN by-pass valve on a Master Fuel Trip or a Turbine Trip. Prevent closing of by-pass valve until Master Fuel Trip and Turbine Trip are reset.	AUTOMATIC

B. INTERNAL, WATER & STEAM

1. SECONDARY SUPERHEATER OUTLET TEMPERATURE

a.	ALARM high steam temperature	Required
b.	BOILER TRIP - high steam temperature	Optional
c.	ALARM low steam temperature	Recommended
d.	TURBINE TRIP - low steam temperature	Turb. Manuf.

2. FINAL SUPERHEATER BED INLET TEMPERATURE

a.	ALARM low steam temperature ($T_{SAT} + \text{___}^{\circ}\text{F}$)	Required

3. STEAM PRESSURE - at turbine stop valves

a.	ALARM low steam pressure (load cutback by turbine initial or throttle pressure regulator)	Turb. Manuf.

4. REHEATER OUTLET TEMPERATURE

a.	ALARM high steam temperature	Required

5. CIRCULATING WATER PUMPS

a.	ALARM - circulating pump manifold differential pressure switch imbalance.	Required
b.	ALARM - 4 pumps in service and pump manifold differential pressure ___psi.	Required
c.	ALARM - 3 or more pumps in service and pump manifold differential pressure ___psi.	Required

d. ALARM - less than 2 pumps in service or pump manifold differential pressure < __ psi.	Required
e. ALARM - less than 3 pumps in service and throttle pressure < __ psi.	Required
f. ALARM - motor cavity temperature > __°F	Required
g. ALARM - cooling water flow < __ gpm.	Required
h. TRIP boiler - less than 2 pumps in service	AUTOMATIC
i. TRIP boiler - less than 3 pumps in service and either throttle pressure > __ psi (this condition must exist for __ minutes).	AUTOMATIC
j. TRIP pump - motor cavity temperature > __ F.	AUTOMATIC
k. TRIP pump - motor amps > __ amps (motor overload).	AUTOMATIC

C. BOILER FEEDWATER

1. DRUM WATER LEVEL - Water level recorder or manometric water level device with taps located 15 inches above and below normal water level (NWL).	
a. LOW WATER LEVEL-ALARM when water level is 7 in. below NWL.	Required
b. BOILER TRIP when water level drops below 9 in. below NWL	AUTOMATIC
(after 20 sec.
time delay)
c. HIGH WATER LEVEL-ALARM when water level is 6 in. above NWL	Required
d. BOILER TRIP when high water level is 8 in. above NWL	Optional
e. TURBINE TRIP when high water level exceeds the point at which the cyclones may be flooded (High Boiler Trip) and result in carryover.	Optional

f. BOILER FEEDPUMP TRIP - when water level exceeds the level at which the cyclones may be flooded (High Boiler Trip) and result in carryover after the fuel and turbine have been tripped. Optional

2. ECONOMIZER RECIRCULATION VALVE - (Automatic Operation) - the feedwater flow started should be developed by the feed pumps started and the feedwater flow path to the boiler open (i.e., feedwater shut-off valves open and feedwater control valves not closed).

a. CLOSE - economizer recirculation valves - AUTOMATIC when feedwater is flowing to the boiler or when firing is stopped.

b. OPEN - economizer recirculation valves - AUTOMATIC when feedwater flow to the boiler is stopped and firing is in progress.

c. ALARM - economizer recirculation valves - Recommended malfunction if action in a. or b. above fails to take place.

D. BOILER AIR AND GAS

1. Interlocks required for start of any Induced Draft (ID) Fan:

a. Shut-off dampers and control blades closed on ID fan to be started. Dampers remain open on other ID fan. AUTOMATIC

b. Shut-off and control dampers open on at least one and preferably all centrifugal FD fans. Recommended

c. At least one of each kind of shut-off damper (air heater, etc.) between the FD fan inlet and the stack open. Recommended

d. For air pollution control systems, at least one set of shut-off dampers open on a per module basis. Recommended

e. Open shut-off damper on operating ID fan after first ID and FD fan have been started. AUTOMATIC (Simultaneous with 2e.)

- f. Close shut-off dampers on idle ID fans after first ID fan, and FD fan has been started with their shut-off dampers open. AUTOMATIC
- g. Establish lube oil pressure on all force lubricated fans prior to start-up. Recommended
- 2. Interlocks required for start of any forced-draft (FD) fan:
 - a. Shut-off dampers and control dampers closed on FD fan to be started. Dampers remain open on other F.D. fan. AUTOMATIC
 - b. At least one ID fan running with its shut-off damper open and its control damper on automatic or not closed. AUTOMATIC
 - c. Prevent closing of shut-off and control dampers on idle FD fans until first FD fan is started with its shut-off damper open and its control damper on automatic or not closed. AUTOMATIC
 - d. At least one of each kind of shut-off damper (air heater, etc.) between the FD fan inlet and the stack open. Recommended
 - e. Close shut-off and control dampers on idle FD fans when first FD fan is started with its shut-off damper open and its control damper on automatic, or not closed. AUTOMATIC (Refer 1f)
- 3. High Boiler Pressure
 - a. Alarm if furnace or CBB pressure exceeds +2 in. H₂O (for nominal operating range of +0.5 to -1.0 in. H₂O) Required
 - b. Trip master fuel trip if furnace or CBB pressure exceeds continuous design pressure or exceeds by more than 5 in. H₂O the normal operating pressure, whichever is less, for 2 seconds. Continue air flow with at least one ID and at least one FD fan in operation. AUTOMATIC

- c. Before main fuel firing and following a five minute period after a master fuel trip (furnace post purge), trip FD fans if the furnace or CBB pressure exceeds continuous design pressure or exceeds by more than 5 in. H₂O the normal operating pressure, whichever is less, for 2 seconds. AUTOMATIC
- d. Trip all FD fans and master fuel trip if furnace or CBB pressure exceeds continuous design pressure by more than 3 in. H₂O for 5 seconds. AUTOMATIC
4. High Secondary, Primary or Tempering Air Duct Pressure. Applicable when maximum fan static discharge pressure capability exceeds the duct design pressure plus 20% or the specified transient design pressure, whichever is greater.
- a. Alarm if duct pressure exceeds a value midway between maximum operating pressure and design pressure. Required
- b. Trip master fuel trip if duct pressure exceeds continuous design pressure for 2 seconds. AUTOMATIC
- c. Before main fuel firing and following a five minute period following a master fuel trip (unit post purge), trip FD fans if secondary duct pressure exceeds continuous design pressure for 2 seconds. AUTOMATIC
- d. Trip fans and master fuel trip if duct pressure exceeds continuous design pressure by 10%, or 3 in. H₂O, or the specified transient design pressure, whichever is greatest for 5 seconds. AUTOMATIC
5. High Boiler Draft (balanced-draft units with nominal operating range of +.5 to -1.0 in. H₂O)
- a. Alarm if negative furnace or CBB pressure exceeds - 3.0 inches H₂O. Required

- b. Trip master fuel trip if negative furnace or CBB pressure exceeds negative 7 in. H₂O for two seconds, Required
 - c. Before main fuel firing and following a five minute period after a master fuel trip (unit post purge), trip all FD and ID fans if furnace or CBB pressure exceeds negative 7 in. H₂O for two seconds, AUTOMATIC
 - d. An emergency control system to close the ID fan blades in the event of high draft should be considered. This control would act even if the fans were on manual control. For units with high negative head capabilities such as those with gas clean-up systems, the emergency control should preferably also be applied to a separate set of dampers. (See — Pg. 8-65) Optional
- 6. Loss of Forced-Draft Fans -- pressure switch or electrical interlock. Include a limit switch on each FD fan shut-off damper to prove open.
 - a. Alarm loss of individual fan and close dampers on tripped fan. Required
 - b. Trip master fuel trip on loss of all all FD fans. Open all FD fan dampers which are not already open, after a time delay to avoid high duct pressure during fan coast down. Dampers to remain open (except on the fan to be started). ID fans may continue to operate or be shutdown manually. AUTOMATIC
- 7. Loss of Induced Draft Fans -- pressure switch or electrical interlock. Include a limit switch on each ID fan shut-off damper to prove open.
 - a. Alarm loss of individual fan and close dampers and blades on tripped fan. Required
 - b. Trip master fuel trip on loss of all ID fans -- Trip all FD fans. Open all ID fan dampers after a time delay (0-1 minute should be adequate to avoid high draft during fan coast down). Dampers to remain open except on the fan to be started until at least one ID fan is started and its shut-off damper opened. AUTOMATIC

8. Multiple, Variable Speed Fans -- on start of second fan and subsequent fans, whether FD, PA or tempering, it is required that the fan be delivering air flow prior to opening of its dampers. Proof of air flow can be established with a differential pressure switch and time delay. AUTOMATIC
9. Axial Flow ID Fans
 - a. Multiple Axial Flow Fans -- on start of second ID fan, inhibit start of second fan if first fan is delivering greater than specified starting draft limit. (Minimum saddle pressure.) AUTOMATIC
 - b. Alarm when axial flow fan approaches the surge line. Required
10. AIR HEATER - REGENERATIVE
 - a. ALARM if air heater stops - On single heater installations, or on multiple air heaters without provisions for isolation, the fuel and air may have to be tripped to prevent the temperature differential between the incoming air to the burners and that of the fluid in the wall tubes from exceeding 250°F. This will be a customer decision. Required
 - b. ALARM low lube oil level - Required
 - c. ALARM - Loss of lube oil flow Required
 - d. ALARM high lube oil temperature Required
11. LOW AIR FLOW
 - a. ALARM when air flow below 30 percent Required
 - b. FOR air temperature below 350F, it is recommended that temperature compensation be held at the value corresponding to 350F. Recommended

12. PENTHOUSE SEALING AIR

a. ALARM high (2.5" H ₂ O) and low
(0.2" H ₂ O) penthouse differential
pressure (differential across roof)	Required
b. ALARM on high pressure equal to design
pressure	Required

13. PRECIPITATORS

a. TRIP - Precipitator rectifier control
units on master fuel trip and prevent
energizing precipitator until boiler
master fuel trip is reset.	Recommended

E. FUEL

1. LOSS OF FUEL FLOW

a. ALARM when fuel detectors signal no
flow, feeders tripped or rotary seal
stopped	Required
b. TRIP rotary seals when fuel detector
signal no flow after __ second time
delay	AUTOMATIC
c. TRIP feeder if fuel or limestone is not
present on belt after __ second time
delay	AUTOMATIC

2. LOSS OF FLAME ON INDIVIDUAL LIGHTER

a. ALARM - Loss of flame	Required
b. TRIP - Individual lighter	AUTOMATIC

3. LOW LIGHTER HEADER PRESSURE - Ahead of
control valve

E. FUEL - (cont'd)

a.	ALARM high or low lighter pressure after the pressure regulator	Required
b.	TRIP individual lighter	AUTOMATIC
c.	TRIP individual cyclone if no main flame detector installed	Recommended
4. LOW LIGHTER ATOMIZING STEAM OR AIR-OIL PRESSURE DIFFERENTIAL		
a.	ALARM low lighter atomizing steam or air-oil differential	Required
b.	TRIP lighters	AUTOMATIC
5. HARDWARE TROUBLE		
a.	TRIP individual compartment on secondary air shut-off damper NOT open, feeder off, or rotary seal stopped	AUTOMATIC
b.	TRIP feeder or prevent start if rotary seal is stopped	AUTOMATIC
6. LOW COAL LEVEL IN COAL LINE TO FEEDER - Nuclear or capacitance level detector		
a.	ALARM when fuel or limestone level is below bunker outlet valve. (Rappers, if used, may be automatically started at this point).	Required
7. LOSS OF PRIMARY OR TEMPERING AIR FANS		
a.	ALARM and close dampers on tripped fan on loss of individual fan.	Required
b.	TRIP FIRING on loss of both PA fans or loss of both tempering air fans	AUTOMATIC
8. PRIMARY OR TEMPERING AIR FAN START		
a.	ESTABLISH lube oil pressure on all force lubricated fans prior to start-up.	Recommended
b.	Shut-off dampers and control dampers closed on fan to be started.	AUTOMATIC

9. HIGH MIXING BUSTLE OUTLET TEMPERATURE
- a. ALARM mixing bustle outlet temperature greater than ___ F. This could indicate possible fire or malfunction of tempering air damper. Required
10. HIGH BED TEMPERATURE
- a. ALARM high bed temperature Required
 - b. TRIP compartment on high bed temperature after ___ second time delay AUTOMATIC
11. LOW BED TEMPERATURE
- a. ALARM low bed temperature Required
 - b. TRIP compartment on low bed temperature after ___ second time delay Optional

FURNACE DRAFT CONTROL

IX UTILITIES*

A. Boiler Feed Water

Lbs/Hr	Temperature (°F)
3,480,310	487

B. Service Water

Location	Flow Rate (GPM)	Temperature (°F)
FBC Underflow Ash Cooler Cooling Water	3216	77
CBB Underflow Ash Cooler Cooling Water	206	77

C. Fuel

Fuel	Feed Rate (Lbs/Hr)
Coal	543,360
Limestone	277,452
#2 Oil	7,650**

* Utilities based on worst coal.

** Based on a maximum of 10 lighters burning simultaneously during start-up.

DRIVERS

EQUIPMENT NAME	LOCATION	NO. OF UNITS	GROSS HP	TOTAL GROSS HP	NET HP	TOTAL NET HP	ELECTRICAL CHARACTERISTICS
GRAVIMETRIC FEEDER	COAL FEED	25	1-1/2	37.5	1-1/4	31.25	460V/3PH/60HZ
GRAVIMETRIC FEEDER	LIMESTONE FEED	25	1	25	3/4	18.75	460V/3PH/60HZ
CONVEYOR CHAIN MOTOR	FOR COAL AND LIMESTONE FEEDERS	50	1/4	12.5	1/4	12.5	110V/3PH/60HZ
ROTARY SEAL	COAL AND LIMESTONE FEED	25	2	50	1-3/4	47.75	460V/3PH/60HZ
ROTARY FEEDER	CBB FEED TANK TO CBB CHAR FEEDER	8	1-1/2	12	1-1/4	10	460V/3PH/60HZ
ASH COOLER	FBC UNDERFLOW START-UP	5	1-1/2	5.5	1-1/4	6.25	460V/3PH/60HZ
ASH COOLER	FBC UNDERFLOW MAIN BED	20	2	40	1-3/4	35	460V/3PH/60HZ
ASH COOLER	CBB UNDERFLOW	8	1/2	4	1/4	2	460V/3PH/60HZ
CHAR CONVEYOR VACUUM BLOWERS	FBC PRECIPITATOR TO CBB FEED TANK	4	100	400	80	320	460V/3PH/60HZ
BOILER RECIRCULATING WATER PUMPS	BOILER RECIRCULATING WATER CIRCUIT	4	450	1800	383	1530	4160V/3PH/60HZ
AIR HEATER	ROTHERMUHLE AIR HEATER	2	25	50	22.5	45	460V/3PH/60HZ
SOOTBLOWERS	FLUID BED BOILER	28	1 1/2	42	1-3/4	35	460V/3PH/60HZ
SOOTBLOWERS	CARBON BURNUP BED	6	1 1/2	9	1-3/4	7.5	460V/3PH/60HZ

DRIVERS

EQUIPMENT NAME	LOCATION	NO. OF UNITS	GROSS HP	TOTAL GROSS HP	NET HP	TOTAL NET HP	ELECTRICAL CHARACTERISTICS
FAN (AXIAL)	ID	2	5,000	10,000	3,159	6,318	4160V/3PH/60HZ
FAN (AIR FOIL)	FD	2	10,000	20,000	7,215	14,430	4160V/3PH/60HZ
FAN (AIR FOIL)	TEMPERING AIR FAN	2	350	700	254	508	460V/3PH/60HZ
FAN (MODIFIED RADIAL TIP)	PRIMARY HOT AIR FAN	2	1,250	2,500	975	1,950	4160V/3PH/60HZ

TOTAL 35,688 TOTAL 25,307

PRECIPITATORS

NAME	LOCATION	NO. OF UNITS	POWER REQUIRED	ELECTRICAL CHARACTERISTICS
FBC	EXIT FBC BOILER	4	4510 KW	460V/3PH/60HZ
CBB	EXIT CBB BOILER	1	780 KW	460V/3PH/60HZ

TOTAL 5290 KW

D. POWER REQUIREMENTS

X. BASIS OF SYSTEM COSTS AND SCHEDULE

The costs developed for the system (See Page 10-2) were based on B&W's base estimating data for those items normally supplied by B&W and on vendor quotations for items normally purchased. The costs include B&W's G & A expense and profit as normally used by B&W in a proposal for a commercial boiler. No development costs or risk contingencies were included in the estimate. All costs are present day dollars as of December 1, 1977.

As stated above, no contingency has been included in the costs presented in this section. However, it must be remembered that certain assumptions were made to establish the design of the FBC system. If these assumptions are borne out by future developments, we believe that the costs presented here represent a reasonable appraisal of what an FBC system would cost. Developing technology may identify areas and conditions which could significantly affect system costs.

Page 10-3 is a graphical representation of the design and construction schedule for the 570 MW fluid bed boiler commercial unit culminating in start-up fifty months after engineering begins.

CAPITAL COST ESTIMATE

		<u>MATERIAL</u>	<u>ERECTION MANHOURS</u>
I.	BASE	36,709,600	1,197,630
II.	CONTROLS	3,195,600	30,390
III.	PRECIPITATORS	9,035,600	154,100
IV.	TOP STEEL	307,700	5,040
V.	COAL AND LIMESTONE BUNKERS	5,673,800	28,000
VI.	BALANCE OF BOILER PLANT	2,562,700	17,840
	TOTAL	57,485,000	1,433,000

XI. AFB Boiler State of The Art

A. Introduction

Recent interest in fluidized bed combustion for utility application has been stimulated by the in-process pollution control capability of the FBC:

Low NO_x Formation

SO₂ removal is accomplished by reaction of limestone or lime with the SO₂ released during coal combustion to produce a dry CaSO₄ waste product. Low NO_x formation is experienced as well because of the low operating temperature (1500-1600°F). However, the viability of this approach must still be established relative to that of wet scrubbing:

This alternate approach also involves the reaction of limestone with SO₂ in the stack gas but produces a wet slurry of CaSO₃. Wet scrubbing is fairly well developed and accepted as a commercial system.

The above consideration is primary in nature and worth emphasizing because one of the key problems currently facing the FBC is the high limestone requirements to meet EPA sulfur dioxide emission standards (1.2 lbs. SO₂/million Btu input). This situation could be further aggravated if the EPA proceeds to enact more restrictive standards for sulfur emission. This is a likelihood based on recent reports in the literature (Energy Research Digest, November 7, 1977). In wet scrubbing systems the required Ca/S mole ratio is on the order of 1.1, while in the FBC system ratios of up to 4-5 may be needed depending on the sulfur content of the coal. The latter represents an economically unacceptable amount of limestone, and a major R&D thrust is needed to minimize these requirements. NO_x formation, on the other hand, can be comfortably maintained below current EPA emission standards (0.7 pounds per million Btu or about 525 ppm) but as low as expected because of fixation of fuel nitrogen. Values of 250 to 500 ppm of NO_x in the off-gases have been observed when burning coal containing about 1.0 to 1.4% fixed nitrogen in fluidized beds.

Nevertheless, while the economics of the fluid bed combustion process are not firmly established, some investigators feel that capital and operating costs could be lower than

conventional plants using wet scrubbing for sulfur control and that further improvement is potentially possible. To achieve an acceptable status, large-scale demonstration of the concepts is needed. However, before this can be accomplished, it is our general feeling that the level of confidence in design knowledge must be increased as the desirable configurations of the system become more clearly defined through pilot activities.

Background history and documentation is thoroughly treated in References 1-4. It is the purpose of this section to analyze some of the existing problem areas in the light of this literature and/or in-house knowledge and to identify areas requiring additional development work. In order to develop this overall picture, we will first scan a simple schematic flowsheet (page 11-28) for an FBC system and highlight such problem areas in the following pages.

B. Process Overview

Starting at the front end of the process on page 11-28, the first objective is to combine coal and limestone and to convey them to the FBC. To date the preferred method of doing this has been pneumatic transport and introduction of the feed materials near the bottom of the FBC just above the air distributor plate. Based on prior B&W experience with cyclone furnace firing, we believe that it may be possible to avoid predrying by employing preheated air as the conveying medium. This practice requires about 20% of the combustion air which is several fold greater than the amount needed from the standpoint of conveying alone. The effect of this additional amount of air on FBC performance needs to be developed.

The next step is a problem of major concern and relates to the means of splitting the feed stream into a large number of smaller ones for distribution into the FBC. This is required to assure reasonably good combustion in the FBC. As the coal enters at or near the bottom of the bed, it must be further distributed in a radial direction by means of injection nozzles. Overhead feeding and spreading in the freeboard of the FBC is an alternate approach under consideration by some investigators.

The design of the atmospheric FBC involves the selection of a number of critical operating

parameters. Those of greatest significance are:

- .Bed temperature
- .Excess air
- .Superficial gas velocity
- .Feed particle size and/or elutriation of bed solids

With regard to bed temperature the efforts of many investigators have reasonably well defined the desirable operating range. In order to promote rapid combustion and reaction rates of SO_2 with lime, temperatures above 1400°F are preferred. However, above 1600°F sorbent activity appears to drop and at higher temperatures volatilization of corrosive alkali metals can potentially commence to become a problem, in addition bed agglomeration may occur. Therefore, an operating temperature of about 1550°F is considered optimum for the FBC. Operation of the FBC at 15% excess air seems to be an acceptable design condition. However, in the case of the CBB a higher temperature of 2000°F and also a greater amount of excess air (50%) is desirable to assure adequate carbon burnout.

Wide ranges of gas velocity from 3 to 15 ft/sec have been studied, but no specific guidelines have been found in the open literature to establish design recommendations. However, general preference has developed for the use of coarse feed materials. Pope, Evans and Robbins appears to be the prime proponent of coarse grinds ($-\frac{1}{4}" \times 0$) requiring a high superficial gas velocity of 10-15 ft/sec., whereas others such as Westinghouse, the British consortiums, etc. prefer to operate under conditions permitting the use of lower velocities in the range of 3-8 ft/sec.

It should be noted that particle size, gas velocity and bed voidage are all interrelated by laws of fluid flow thru particle assemblages. These conditions can therefore not be independently selected. Predictive relationships for this purpose are suggested in Reference (3). In Reference (4) the values of voidage for given values of particle size and gas velocity were estimated based on these relationships for conditions normally encountered in the FBC. Relationships such as these are predicated on data for unrestricted beds and must still be verified or modified for use in the case where heat transfer tubes are immersed in the bed. This knowledge is needed for estimating the pressure drop across the fluid bed and is also

useful in the design of an AFB to establish an appropriate gas velocity and/or particle size distribution. For example, once an average particle size of the bed is chosen, a superficial gas velocity corresponding to a suitable bed voidage can be determined via relationships mentioned above to permit the desired turndown capability, or the particle size distribution may be selected to limit the amount of elutriation for a given velocity, etc.

The heat released in the bed is absorbed by tubes immersed in the bed. Because the temperature and the amount of heat transfer surface is "fixed", flexible response to wide load charges is not easy to attain. Such variations in load also present a problem of maintaining good air distribution thru the distribution plate without undue pressure drop at full load.

As previously mentioned, the amount of limestone required for sulfur capture in the FBC has been found to be excessive. Most of the available data base consists only of plots of % SO_2 removal versus the Ca/S ratio with or without additives as shown on Page 29. Combustion efficiency has also been found to be a problem area in FBC units in that it is generally in the range of 85-95% or less as shown on page 11-30. This graph is a plot of the available combustion efficiencies versus superficial velocity reported in Reference (3) (Page 11-12). Although this graph shows a great deal of scatter, there is a statistical trend. As the velocity is increased, the combustion efficiency is decreased. This serves as a preliminary basis for predicting the velocity dependency of combustion efficiency, but more information is needed relative to the effects of bed height and/or other variables such as air, bed voidage and temperature.

Most of the unburned char, together with a fair amount of spent lime, are elutriated and must be subsequently collected and reprocessed in order to achieve an acceptable level of thermal efficiency for the overall system. This calls for the possible use of a number of different dust collection devices such as a mechanical cyclone collector, a baghouse and a hot or cold electrostatic precipitator. The nature and performance of an appropriate dust collection system is still to be defined.

One approach for re-treating the dust collected is to recycle it back to the FBC. This practice would result in high dust loadings and potential economic penalties. Another approach is to inject the dust in a carbon burnup bed (CBB) which is another fluid bed but is operated at a much higher temperature and excess air so that acceptable single pass combustion efficiencies can be achieved. In accordance with PER experience, no decomposition of CaSO_4 should occur in this step. The degree of sulfur capture is said to vary between zero and that corresponding to equilibrium concentrations in the exit gases. The sources of this sulfur may be two fold: (1) sulfur contained in the unburned char from the FBC and (2) additional coal that may be fired in the CBB to maintain temperature control.

In commercial practice it would be anticipated that spent bed material from the FBC would provide the material comprising the fluid bed in the CBB. In any case the sensible heat lost in this material and that discharged from the CBB is significant and means for recovering this heat must be developed.

C. Process Developments and Assessments

Many problem areas still exist relative to the operation of a fluid bed combustor for steam generation. Broadly speaking, questionable areas can be classified as being mechanical or technical in nature. The former are largely associated with startup procedures, response to load changes and controls, operating compatibility of system components, and turndown. The latter relate to process conditions affecting operating performance such as heat transfer, pressure drop, reaction efficiencies, etc. Appropriate data in both of these areas still need to be developed in order to establish feasibility of an FBC system versus alternative solutions, namely a conventional PC boiler provided with a wet scrubbing system.

There are many existing R&D programs that are aimed at these broad objectives and associated subtasks. These are summarized on pages 11-13 through 11-27, "Current Projects Influencing AFBC of Coal" compiled by the Radian Corporation. In review of these efforts and prior discussions, it is apparent that most of the significant problem areas involve the new fluid bed technology and auxiliaries that is being employed in the FBC and CBB. For the purpose of subsequent discussions, those areas of major concern beyond normal efforts of obtaining or deriving design information will be covered under the following categories:

- a. Feed distribution
- b. Combustion efficiency
- c. Turndown control

- d. Sulfur capture
- e. Disposal of spent bed material
- f. Corrosion and erosion
- g. Dust collection

1. Feed Distribution

In the area of feed distribution, the main problem relates to the large number of coal injection points that are required to assure reasonably good combustion. Previous experience indicates the need for one fuel injector per nine square feet when feeding crushed coal to beds approximately 3-4 feet in depth. For operation at 8 ft/sec., this criteria requires more than 1,000 feed points in a 600 MW plant. To supply all the multiple feed points, prior splitting would therefore be desirable.

One solution to this problem is pneumatic splitting into the bottom portion of the bed. This problem will be partially addressed during the operation of the EPRI/B&W 6' x 6' unit at Alliance, Ohio, which will be equipped to split feed to four 3' x 3' quadrants. However, more scale-up information will be needed for supplying the larger number of feed points required in a demonstration plant, particularly in the presence of a pulsating back pressure of a fluidized bed. Similar problems will exist in redistributing entrained char from the FBC unit into the CBB unit.

Another approach is overhead feeding in the freeboard. This alternative is being investigated by others. It is possible that this practice may result in some sacrifice in combustion efficiency and sulfur capture unless special attention is given to coal sizing, but this remains to be proven.

Firm recommendations are also needed for the design of injection nozzles. It is probably that such information will arise thru efforts under EPRI contracts at B&W and Oregon State University (OSU) or various government sponsored activities at PER, etc.

2. Combustion Efficiency

The basic problem here results from the low single-pass combustion efficiency which is in the range of only 85-95%. In this area, we continue to need more information which will permit us to predict the effects of bed operating conditions and the amount of in-bed burning versus freeboard

performance so that we can more accurately design the heat transfer surface for the heat release expected in each zone. This information is equally as important as the capability of predicting heat transfer coefficients.

Since coal oxidation is basically a chemical reaction involving oxygen transport, it is our feeling that gas residence time is an important parameter to be studied. This infers that improved efficiency should be achieved by resorting to the use of lower velocities and higher bed heights. We would also expect significant sensitivity with temperature, excess air and coal properties. A B&W analysis (3) of fluidized bed combustion allowed us to draw some conclusions on the significance of coal sizing:

- (1) Complete burnout of the very fine coal particles (-270 mesh) is feasible in a fluid-bed combustor.
- (2) The problem of incomplete burnout may not be associated with the coarse fractions but is more likely the result of inadequate retention time of the elutriatable fraction of intermediate sizes.

It is very likely that the volatile matter in the coal is rapidly consumed. Since complete combustion of the residual char contained in the very coarse and fine fractions is also expected, then one can postulate that the prime problem is one of burning the residual char in the intermediate size fraction with the remaining combustion air.

While some of the discussion above is within the realm of speculation, it illustrates the need for a better understanding of the basic combustion process. One of the main objectives of the EPRI/B&W 6' x 6' fluid bed at Alliance, Ohio, will be to provide valuable inputs on possibilities of improving carbon utilization and to further delineate the significance of the above-mentioned variables. In addition OSU (Oregon State University) under contract to EPRI/B&W is also obtaining basic data on the flow characteristics of coarse char and concentration gradients of elutriatable fines. Hopefully this effort will increase our ability to understand the combustion process and suggest possibilities

for improving it.

The use of coarse coal as overhead feed has been logically suggested as a means for improving combustion and alleviating the problem of feed distribution. At this point in time, however, there is insufficient experience to confirm its feasibility and/or justify its application as a basis for design. If feasible, other benefits can be anticipated as well: possible elimination of the CBB by restricting most of the combustion in the main FBC, reduction of char content in the carryover material, reduction in CO formation which is probably promoted in the freeboard due to the presence of the char particles and also reducing NO_x formation because of the lower time averaged temperature during the combustion of larger coal particles. The disadvantage would be the need for coal preclassification and separate disposal of fines.

3. Turndown Control

In this area of concern, the problem is inflexibility of heat transfer versus load changes resulting from the fact that bed temperatures are "fixed".

The preferred solution to this problem appears to be the technique of "bed slumping" although there is little background experience in its application on a large scale. The approach is to compartmentalize the boiler windbox and provide separate air flow to each section, so that each section can in turn be shut off. This capability is provided in the EPRI/B&W 6' x 6' unit. Also OSU under contract to EPRI/B&W has built and will test a cold test unit to study the phenomenon of slumping.

There is, however, an urgent need for an alternate backup method, should bed slumping fail to provide the desired results. An engineering study should be undertaken to investigate the feasibility of alternate methods. One such approach might involve an unexplored concept employing graduated vertical spacing of heat transfer tubes so that just the proper amount of surface is exposed as bed height is varied with air flow. This, of course, would also call for a near constant differential pressure air distribution plate so that uniformity of fluidization is always maintained.

4. Sulfur Capture

This is a very significant problem area because based on available data the limestone requirements may be unduly high as explained earlier. The high cost of limestone, resulting thermal inefficiencies and requirements for spent lime disposal would give rise to severe economic penalties.

Again, more information is needed to permit the designer to predict the effects of bed conditions and increased gas-solids contact time. The generation of appropriate data will be within the scope of the B&W program sponsored by EPRI at Alliance, Ohio. Supporting information should also be available thru the operation of the fluidized bed combustion unit at Rivesville, West Virginia.

In addition, there are also some advanced concepts that can be conceived or are under development:

- (1) Precalcination of limestone under selected conditions (EPRI-Westinghouse),
- (2) The use of additives such as sodium chloride (EPRI, ERDA-PER, University of Maryland),
- (3) Recycle system with external regeneration (ANL),
- (4) Fine grinding of spent sorbent and recycle, etc.

We feel that some of these concepts would warrant preliminary engineering studies to establish their economic potential and future R&D priorities. Associated efforts should be closely monitored to assess future impacts as early as possible.

5. Heat Recovery from Spent Bed Material

Another problem area is the disposal of hot spent bed material. This represents a thermal inefficiency due to the sensible heat loss and the unburned carbon contained in the bed material. Solutions to counteract these inefficiencies must be found eventually. Although it is not considered critical,

engineering studies should be initiated to assess potential alternatives so that the best prospect(s) can be piloted at a later date.

6. Corrosion and Erosion

Because of the long-term nature of corrosion and related studies, they should proceed as quickly as possible so that required inputs become available before designing a demonstration plant. There are indications that high corrosion rates may exist for submerged surface in a fluidized bed of spent lime, and firm design information is lacking. Furthermore, the degree of upset conditions in an FBC and related effects on corrosion are unknown. EPRI has recently contracted work in this area to BCURA including an effort to prepare a three-dimensional corrosion map emanating around a feed point where upset conditions may be the most severe. Information is also needed on the effect of high dust loadings in convection passes, particularly from the standpoint of erosion. Certainly the fate of some recycle concepts for improving combustion efficiency and sulfur capture are dependent on such knowledge.

7. Dust Collection

The prediction and characterization of dust carryover is essential in specifying subsequent dust collection facilities, but subject information is quite sparse in the literature. Rothemuhle feels that hot electrostatic precipitators can be designed to handle final gas cleanup. Others have expressed some doubt relative to the operability of an electrostatic precipitator due to the presence of carbon particles and the reduced concentration of the SO_2 in the gas. In any case, operating data for an ESP under hot (700°F) and cold (300°F) conditions is needed to verify feasibility and determine the appropriate mode of operation.

Recent reports indicate that EPA is expected to propose a substantial reduction of particulate emissions to a fraction of the current standard (0.1 pounds per million Btu). This is noteworthy because of its potential impact on R&D. Some utility sources believe that if the level of emissions were reduced by an order of magnitude this would all but mandate the use of baghouses. Rothemuhle, however,

anticipates no problems in achieving emission levels down to at least 0.03 pounds per million Btu with a hot precipitator for the performance coal and limestone specified in this contract.

D. Summary Conclusions and Recommendations

1. Technical Performance

There is a continuing need for more data on the effects of process conditions before scale-up to commercial size utility units can be accomplished with a reasonable level of confidence.

2. Mechanical Operability

It is necessary to demonstrate the feasibility of a total system on a pilot scale. Such efforts should be expedited.

3. Additional Efforts*

- (1) Data acquisition for higher gas residence time (increased bed heights and/or lower velocities)
- (2) Feed distribution: pneumatic splitting to a large number of feed points
- (3) Turndown control: backup method needed:
 - (a) Gradated vertical spacing of heat transfer tubes
 - (b) Constant pressure drop across the air distribution plate
- (4) Effect of high dust loadings in convection passes: erosion
- (5) Heat recovery from spent bed material
 - (a) Complete combustion of remaining carbon
 - (b) Recovery of sensible heat
- (6) Engineering studies of advanced concepts (precalcination, use of additives, recycle system with external regeneration, etc.)
 - (a) Establish economic potential
 - (b) Establish R&D priorities

*Unpublicized or beyond the known scope of current or planned activities

References

1. D. H. Archer, Westinghouse Research Laboratories, "Evaluation of the Fluidized Bed Combustion Process", Volume II - Technical Evaluation, Office of Air Programs (EPA), Contract No. CPA 70-9, November 15, 1969 - November 15, 1971.
2. Babcock & Wilcox Company, "Summary Evaluation of Atmospheric Pressure Fluidized Bed Combustion Applied to Electric Utility Large Steam Generators", Volume I - Final Report, EPRI FP-308, Project 412-1 - October 1, 1976
3. Babcock & Wilcox Company, "Summary Evaluation of Atmospheric Pressure Fluidized Bed Combustion Applied to Electric Utility Large Steam Generators", Volume II - Appendices, EPRI FP-308, Project 412-1 - October 1, 1976
4. Babcock & Wilcox Company, EPRI No. RP 718 - 1, Progress Report No. 2, "Fluidized Bed Development Facility", November 15, 1976, Appendix A

PROJECTS INFLUENCING
AFBC OF COAL

9 September 1977

To:

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Radian Corporation is currently providing technical support services to ERDA Major Facilities Program Management on the ERDA sponsored program to develop conceptual designs for a 600 MWe Commercial Size and a 200 MWe Demonstration Size AFBC Utility Plant. As part of this technical support service, Radian was asked to compile a "scorecard" of current projects pertaining to fluidized bed combustion of coal. Although directed toward assisting the AFBC conceptual design effort, the ultimate purpose of the scorecard is to provide individuals working on FBC projects a quick reference guide to related studies.

To serve this purpose, the information listed for each project includes the program title, sponsor, brief project description, address and telephone number of a contact for further information, and project status (progress/date of expected results). Projects are grouped under main subject areas of investigation as shown in the Table of Contents on the following page.

Sources for the information listed in this document are as follows:

- Personal Telephone Conversations with Individuals Involved with Programs.
- EPRI Publication "Research and Development Projects".
- ERDA Publication "Direct Combustion Research and Development Program Plan".
- Proceedings of the Fluidized Bed Combustion Technology Exchange Workshop" at Reston, Virginia, April 13-15, 1977.

Radian would like to thank all of those who cooperated in the process of compiling this information.

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PROJECTS INFLUENCING AFBC OF COAL

TOPIC: AFBC DEVELOPMENT

Program Title	Sponsor	Program Description	Name/Add./Tel. of Person in Charge	Progress/Date Of Expected Results
Multi-cell Fluidized Bed Boiler; (MFBB). Pope, Evans & Robbins Inc.	ERDA	Initiated in 1972, the project is to design, construct and operate a 30 MWe size fluidized-bed boiler under practical utility conditions. The boiler, built by Foster Wheeler Energy Corp., was erected in one end of the existing power plant at the Monongahela Power Company at Rivesville, West Virginia, and consists of 4 side by side cells. Steam conditions are to match the requirements of the existing plants' turbo-generators. This is a four-phase program as follows: I. Engineering and Design Verification. II. Design and Fabrication of MFB Boiler and Auxiliaries III. Operational Testing IV. Design Manual and Test Reports	G. T. Claypoole Manager, Rivesville Operations Pope, Evans & Robbins, Inc. c/o Monongahela Power Company Rivesville, W. VA 26505 304-278-5315	Phases I and II complete. Light-off and continuous firing of one cell during December, 1977, and now in operation at testing phase. Currently de-bugging systems and controls to effect continuous runs and material balances. Monthly/Quarterly/Interim progress reports submitted to ERDA.
Alexandria, Virginia .5 MWe Fluidized Bed Combustor. Pope, Evans & Robbins, Inc.	ERDA	A laboratory research program in support of 30 MWe Multi-cell FBC project at Rivesville, West Virginia, the instrumentation, control system, and auxiliaries closely resemble those associated with the Rivesville unit. The facility is used for process testing and optimization, as well as operational planning/testing to aid the Rivesville facility.	R. R. Reed (Mgr. Alexandria Operation) Pope, Evans & Robbins, Inc. 320 King Street Alexandria, VA 22314 703-549-2884	Currently a new combustor is being purchased and will be installed in the fall of 1977. The facility has been operating since 1965, and has over 8,000 hours of coal burning test operation. Monthly/Quarterly/Interim progress reports are submitted to ERDA. (Note: these are contained in the same reports as the MFBB progress reports.)
Fluidized Bed Development Facility	EPRI RP 713	This project is aimed at building a test facility on a scale that will allow exploration of various bed designs, solids and air supply systems, and the mixing patterns and chemical reactions of the resulting solids. The primary contractor is Babcock & Wilcox.	Mr. Steve Strom Babcock & Wilcox Research & Development Division Alliance, Ohio 44601 216-821-9110	The unit has been constructed and instrumented and is currently in the shakedown phase. The unit is 6' x 6'.

PROJECTS INFLUENCING AFBC OF COAL

TOPIC: AFBC DEVELOPMENT (CONT.)

Program Title	Sponsor	Program Description	Name/Add./Tel. of Person in Charge	Progress/Date Of Expected Results
Atmospheric Fluidized Bed Combustion/Component Test and Integration Unit (AFBC/CTIU). Morgantown Energy Research Center. (MERC)	ERDA	The unit has a mission to address and resolve a number of key fluidized bed combustor/boiler development technical issues which will arise in the Rivesville 30 MWe system, and to provide solid design data for stacked-bed applications and steam generator scale-up to the AFBC Demonstration Plant. The CTIU will consist of 4 stacked cells, each approximately 6' x 6'. The proposed test plan will consist of the following: <ul style="list-style-type: none"> • Materials Handling of Large Multi-cell Stacked Bed Systems • Evaluation of Performance Features • Test Bed to Evaluate Systems/Component Integrity/Reliability 	Morgantown Energy Research Center P.O. Box 880 Morgantown, West Virginia 26505 304-599-7147	Construction is expected to be complete at the end of 1979. Currently Reynolds, Smith, & Hill is under contract and is proceeding with the plant drawings and specifications. MERC has primary project responsibility. Bid packages are currently "on the road" for the boiler, the building structure, etc.
6' x 6' Cold Model Test System Morgantown Energy Research Center Morgantown, West VA	ERDA	This is the same cold-model that was used during the initial design verification and system testing of the 30 MWe Rivesville, West Virginia MFBB facility. The system will be used for cold component testing for the Morgantown Component Test and Integration Unit (CTIU) design and also for the 30 MWe Rivesville Unit support, if needed.	Morgantown Energy Research Center P.O. Box 880 Morgantown, West Virginia 26505 Dr. John Wilson 304-599-7147	Unit should be delivered by October. Tests will include coal feeding and mixing, segmental fluidization, and other activities in support of CTIU.
Experimental and Engineering Investigations for the Development of FBC Processes	EPA	Develop an understanding of process performance for environmental assessment and to develop control technology for FBC processes. Areas of investigation include: 1) develop SO _x control systems using calcium based sorbents and alternate sorbents, 2) study NO _x formation and control, 3) project particulate emissions and control of trace materials, 4) spent sorbent and fly ash disposal, 5) systems evaluation. This is applicable to both atmospheric and pressurized applications.	Dr. Dale Keairns Westinghouse Electric Corp. R&D Center Beulah Road Pittsburgh, PA 15235 412-256-7000	Further information available thru D. Keairns or EPA.

PROJECTS IN ICING AFBC OF COAL

TOPIC: AFBC INDUSTRIAL APPLICATIONS

Program Title	Sponsor	Program Description	Name/Add./Tel. of Person in Charge	Progress/Date Of Expected Results
Fluidized Bed Combustion (FBC) for Cement Kiln; Aerojet Energy Conversion Co.	In Proposal stages with ERDA.	The ultimate objective of this program is to produce a fluidized-bed reactor that will produce 2500SCFM of low Btu gas for the cement making process.	Aerojet Energy Conversion Company Process Development Unit Sacramento, CA Mr. Alan H. Kreeger	Currently in the proposal stages. Bench scale work is currently being done by Aerojet.
Institutional Size Industrial Fluidized-Bed Boiler. Georgetown University Washington, D.C.	ERDA/Industry Cost Share	This will be a 100,000 lbs/hr. coal fired boiler plant producing 25C psi; saturated steam which is to prove that AFBC industrial boilers in the capacity range of 15,000 to 150,000 lbs/hr. can be used to supply energy for the nation's colleges, hospitals, and related institutions.	Georgetown University 37th & O Streets Washington, D.C. 20545 202-625-4932	Building permits have just been secured from the city of Washington, D.C.
Fluidized Bed Combustion Process Heater Development. Exxon Research & Engineering	ERDA/Industry Cost Shared	Phase I: All technological unknown factors presently limiting direct application of FBC to fired process heaters will be investigated. Phase II: The heaters to which the technology proves applicable will be identified, and design specs. for a 10-15 M Btu/hr. fluid-bed process development heater will be prepared. Phase III: The process development unit will be designed, constructed and operated. The operation will provide the data necessary to design a commercial fluid-bed heater.	Dean Cherrington Exxon Research & Engineering Co. P.O. Box 101 Florham Park, N.J. 07932	Currently in Phase I; cold-model, 2-dimensional flow visualization tests to determine optimum tube geometric configurations are currently being carried out. Also tests are being planned to determine the effect of high heat flux rates in FBC on the coking rate of hydrocarbon streams.
Heating Air to 900°F for Manufacturing Process and Space Heating. Fluidyne Engineering Corp.	ERDA/Industry Cost Shared	This is a demonstration unit which will consist of three beds, and will heat clean low pressure air (1 Atm) indirectly with a capacity of 28.5×10^6 Btu/hr. The air will be directed through submerged tubes in the bed, with continuous variation of output achieved by use of a thermal storage system in conjunction with the shut-down and start-up of individual beds. No turndown capacity of individual beds will be effected. The facility will be located in Owatonna, Minnesota at the Owatonna Tool Plant.	Fluidyne Engineering Corp. Minneapolis, MN Dr. Henry Hansen David DeCourfin 612-544-2721	Test program has been completed using an 18-inch combustor. (This is currently being used for corrosion tests with Oak Ridge.) A 17 ft ² bed is currently being tested. A 500 hour run simulating actual load changes is currently being planned. Preliminary designs for the demonstration unit have been completed and are awaiting ERDA approval.
Industrial Steam Generator Combustion Engineering, Inc. Great Lakes Naval Training Center Chicago, Ill.	ERDA/Industry Cost Shared	This project is to demonstrate the potential of an atmospheric pressure, natural circulation, fluidized bed unit. Phase I will develop the necessary data (by hot and cold subscale units) to design the full scale demonstration plant. The demonstration unit will be designed and constructed in Phase II. The unit will be installed at the Great Lakes Naval Training Center and will provide maximum availability for testing and evaluation purposes for observers and participants. The unit will be capable of generating 50,000 lbs./hr. of steam at 500 psig and 600°F.	William Norcross Combustion Engineering, Inc. 1000 Prospect Hill Rd. Windsor, CN 06905 203-638-1911	Cold flow subscale testing is essentially complete. Report will be issued later in fall. More cold flow work is currently being done involving segmental fluidization and bed mixing. The hot subscale unit is currently being built and is expected to be completed by November 1977. Preliminary designs have begun on the demonstration unit in Phase II.

PROJECTS INFLUENCING AFBC OF COAL

TOPIC: COMBUSTION & HEAT TRANSFER STUDIES

Program Title	Sponsor	Program Description	Name/Add./Tel. of Person in Charge	Progress/Date Of Expected Results
Methods for Improving Heat Transfer Film Coefficients in a Fluidized Bed Packed with Heat Exchangers	ERDA	Investigate the interrelationship between temperature distribution fluid flow, and heat exchanger design and performance in a coal fired fluidized-bed combustor. This is mostly pressurized work.	Dept. of Applied Sciences New York University 26-36 Stuyvesant Street Westbury, L.I., N.Y. 10003	Data has been obtained on a one foot diameter bed. A three foot diameter bed is presently under construction and further tests will be performed. Monthly reports sent to ERDA under Contract No. EF-76-C-01-22 Dist. Category UC-90E.
Bed Dynamics and Heat Transfer at Surfaces of Immersed Tubes in Fluidized Beds.	EPRI Corporate Research and Development, General Electric Company	Experimentally determine the dynamics of fluidized bed emulsion and bubbles at the surface of immersed tubes for various particle sizes and air flow rates, and measure local heat transfer coefficients around the circumference of horizontal tubes.	John C. Chen Lehigh University Dept. of Mechanical Engineering Bethlehem, PA 18015	Contact sponsor for available data.
Modeling of Heat Transfer Characteristics in a Fluidized Bed	ERDA	Investigate and model heat transfer from a fluidized bed to horizontal tubes as a function of gas velocity, particle size, particle shape, particle and gas thermal properties, tube size, shape, and pitch with different bed materials. The test unit is 12" by 12".	University of Illinois Dept. of Energy Engineering Box 4348 Chicago Circle Chicago, IL 60680	Monthly reports sent to ERDA under contract No. E (49-18)-1787.
Behavior of Fine Particles in a Fluidized Bed of Coarse Material.	EPRI RP 839	This project is intended to provide quantitative data on the behavior of fine particles in fluidized bed of coarse material, specifically on the relevant conditions near the distributor plate that bear on practical questions relating to reactant feed systems. The information could lead to substantial improvements in the efficiencies of combustion and sulfur capture upon which the economics of fluid bed boilers heavily depend.	Dr. Derek Geldart Department of Chemical Engineering Bradford University Bradford BD7 1DP West Yorkshire, England 9-011-44-274-33466	

PROJECTS INFLUENCING AFBC OF COAL

TOPIC: COMBUSTION & HEAT TRANSFER STUDIES (CONT.)

Program Title	Sponsor	Program Description	Name/Add./Tel. of Person in Charge	Progress/Date Of Expected Results
Evaluation of Combustion of Various Solid Fuels and Waste Materials in AFBC. Morgantown Energy Research Center (MERC)	ERDA/Industry Cost Shared Program	This is a program which is examining the combustibility characteristics of such potential fuels as the waste material resulting from the mining and cleaning of anthracite coal, oil shale, Texas lignite and bituminous refuse. The two 18 inch diameter AFBC combustors at the MERC facility are being used for these tests. Also planned are corrosion/erosion studies with different coals.	Morgantown Energy Research Center P.O. Box 880 Morgantown, West Virginia 26505 Dr. John Wilson 304-599-7147	Work has been completed on burning anthracite, Western sub-Bituminous Coal, Texas Lignite. Contact MERC directly for more information.
Fluidized Bed Combustion of Lignite and Western sub-Bituminous coals. Grand Forks Energy Research Center Grand Forks, North Dakota	ERDA	The program is based on the premise that the alkaline ash in some lignites and Western sub-bituminous coals retain sulfur during combustion in a similar way that the injected limestone does in burning high sulfur Eastern coals. The tests being conducted are to survey the sulfur retention capabilities of the ash of various low rank coals as a function of particle size, location of the coal feed, bed depth, air/fuel ratio, temperature, and residence time in the bed. A 6 inch I.D. AFB combustor is being used.	Grand Forks Energy Research Center Grand Forks, North Dakota Mr. Goblirsch Everett A. Sondreal 701-775-4207	18" combustor to be built in 9-12 months. Currently testing lignite, recycling ash and obtaining approximately 60% sulfur retention.
Fluidized Beds with Immersed Heat Exchange Tubes. Oregon State University	EPRI RP 315	The objective of this program is to study the effects of the size, configuration, spacing, and inclination of immersed heat transfer tubes on the behavior (bubble formation, solids mixing, circulation, heat transfer rate, elutriation, tube erosion, and tube stresses) of fluidized beds. Will use a 3' x 3' cold model.	Dr. Tom Fitzgerald Associate Professor Chemical Engineering Department Oregon State University Corvallis, Oregon 97331 503-754-2091	Model has been built and instrumented. Experiments have just commenced. Reports will be sent to EPRI. Also work being done for ERDA by the Mechanical Engineering Department at OSU.
Two-phase Flow and Heat Transfer in Fluidized Beds for Application to Power	EPRI RP 525	In this 3 year project the design correlations will be developed for the heat transfer and fluid-solid flow characteristics of atmospheric and pressurized fluidized beds with immersed tubes. The effect of the equipment scale, gas, and particle properties on the flow characteristics and heat transfer to immersed tubes in atmospheric fluidized beds and simulated high pressure beds will be determined. The effect of gas pressure, bed height, and particle properties will also be studied.	Mr. Fred Staub Thermal Branch Research & Development Center General Electric P.O. Box 43 Schenectady, N.Y. 12301 518-385-4483	Quarterly reports are being sent to EPRI. Currently are using three test units (cold); a 1' x 1' and a 2' x 2' at atmospheric pressure, and a 1' x 1' operating @ 10 atmospheres. A 2' x 2' atmospheric pressure hot model is expected to be completed by the Spring of 1978.

ES-261

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DWN. BY H. J.

CHE'S

DATE 11-23-77

APP'D

FABRICATION & ERECTION SCHEDULE
FOR 570 MW FLUID BED BOILER

SCALE

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PRINT FROM 1 OF 2

PROJECTS INFLUENCING AFBC OF COAL

TOPIC: SULFUR CAPTURE & REGENERATION OF SORBENT

Program Title	Sponsor	Program Description	Name/Add./Tel. of Person in Charge	Progress/Date Of Expected Results
Improvements in Sulfur Dioxide Sorbent Utilization in Fluidized Bed Coal Combustion. Task 1: Effect of Sorbent Particle Size	EPRI RP 7	This one year project is an investigation of the effect of limestone particle size on sulfur capture in a fluidized bed boiler. The objective is to find out if very fine particles, such as those produced in a hydrator, can reduce the quality of limestone required to meet sulfur dioxide emission standards. Ultimately, the viability of the fluidized bed combustion system, which allows in situ removal of sulfur compounds, will depend on how its economic compare with those of conventional boilers with stack gas clean-up systems. Used Pittsburgh No. 8 coal with three types of limestone.	Dr. Howard Lange Chemical Engineering Section Alliance Research Center Babcock & Wilcox P.O. Box 835 Alliance, Ohio 44601 216-821-9110	Program is complete. Final Report should be available in November, 1977, thru EPRI.
Effect of Chemical Additives on the Removal of SO ₂ by Limestone in Fluid Bed Boilers	EPRI RP 837	The purpose of this project is to determine the mechanism of action of chemical additives on sulfur capture by limestone in order to develop techniques and recommend additives to promote sulfation reaction. Measurement of kinetic parameters will be made by thermal analysis of specific reactions in existing equipment. The project will provide information on the effect of additives on sulfur removal in an attempt to reduce the quantity of limestone required during the process.	Dr. Larry Gasner Chemical Engineering Department University of Maryland College Park, MD 20742 301-454-4593	Detailed analysis of the sulfur capture process using thermogravimetric analysis of lime particles of different sizes with and without salt. Computer programs available for predicting sulfur capture capabilities of any random sample of limestone. Preliminary reports have been sent to EPRI.
Improvements in Sulfur Dioxide Sorbent Utilization in Fluidized Bed Coal Combustion; Task 2: Effect of Limestone Calcination.	EPRI RP 720	The kinetics of limestone calcination and its effect on the sulfation reaction in fluidized bed coal combustion will be investigated in a laboratory apparatus. Experimental studies will be carried out concerning the effect of calcination parameters on sorbent utilization and on the overall fluidized-bed combustion system. Should these studies indicate that pre-calcination is favored in achieving maximum limestone utilization, then optimum calcination procedures and conditions will be specified.	Dr. E. P. O'Neill Westinghouse Electric Corp. Research & Development Center Beulah Road Pittsburgh, PA 15235 412-256-7687	Program is essentially complete and results have been sent to EPRI. Results were obtained using bench scale apparatuses.
Criteria for the Selection of Sulfur Dioxide Sorbents	EPRI RP 721	The objective of this one year project is to establish criteria for predicting the ability of a given limestone to efficiently capture sulfur dioxide in a fluidized-bed coal combustor. A complete search and evaluation will be made of available data on the desulfurization capability of different limestone and dolomites.	Dr. E. P. O'Neill Westinghouse Electric Corp. Research & Development Center Beulah Road Pittsburgh, PA 15235 412-256-7687	This will be in effect a continuation of the previous work done on EPRI-RP-720 starting September, 1977. Closer definition of factors influencing sulfur capture will be addressed.

PROJECTS INFLUENCING AFBC OF COAL

TOPIC: WASTE HANDLING, UTILIZATION, & DISPOSAL

Program Title	Sponsor	Program Description	Name/Add./Tel. of Person in Charge	Progress/Date Of Expected Results
Agronomic Evaluation of Fluidized Bed Boiler Waste Material TVA Muscle Shoals, AL	ERDA	This project continues studies that have been done at TVA expense for the past year on the use of a part of AFBC waste bed-material as a nutrient and as a source of lime for the neutralizing of acid solids in soil. Also it expands its previous scope to determine whether the utilization of the waste on peanut crops in Alabama will give similar benefits to those obtained by VPI in Virginia where different soil and climatic conditions exist.	William T. Harvey Jr., Program Man. U.S. ERDA 20 Massachusetts Avenue N. W., Washington, D.C. 20545 202-376-9352	Contact Mr. Harvey (ERDA) for more information.
Utilization of Fluidized Bed Combustion Red Material Remedial Treatment of Soils. U.S. Department of Transportation Federal Highway Admin.	ERDA	The Federal Highway Administration is investigating the feasibility of using the sulphate and active lime from the AFBC bed material for stabilizing fine grain soils when they are used as a sub-base for highways. This could potentially substitute/supplement the use of Portland cement as a stabilizer.	William T. Harvey Jr., Program Man. U.S. ERDA 20 Massachusetts Ave. N. W., Washington, D.C. 20545 202-376-9352	Contact Mr. Harvey (ERDA) for more information.
Utilization of Fluidized Bed Combustion Bed Material Soil-Plant Nutrient Relationship in Peanuts Virginia Polytechnic Institute	ERDA	The project continues studies that have been done for the past two years on the use of a part of the AFBC waste bed material as a source of calcium for peanut crops. The previous studies have shown that the application of this waste material in increasing the crop yield was almost as effective as the application of a commercial procured calcium source.	William T. Harvey Jr., Program Man. U.S. ERDA 20 Massachusetts Ave. N. W., Washington, D.C. 20545 202-376-9352	Program completed. Results available through ERDA-Fossil Energy.
Agricultural Utilization Studies Fluidized-Bed Combustion Waste Materials U.S. Department of Agriculture	ERDA	This project will be worked through the Agricultural Research Service (ARS), U.S. Department of Agriculture. ARS and selected state agricultural experiment stations will perform the greenhouse and growth chamber testing, and where indicated, field testing of FBC waste material to determine its effects on land reclamation, forage, plant growth response and soil conditioning.	USDA/ARS West Virginia University Morgantown, West Virginia 26505	Contact Mr. William Harvey (ERDA) for detailed information. 202-376-9352

PROJECTS INFLUENCING AFBC OF COAL

TOPIC: CORROSION/EROSION & ENVIRONMENTAL STUDIES

Program Title	Sponsor	Program Description	Name/Add./Tel. of Person in Charge	Progress/Date Of Expected Results
High Temperature Dust Control Department of the Army Alexandria, VA Construction Engineering Research Laboratory (CERL)	ERDA	The project concentrated on verifying the performance of the Particle Precipitating Heat Transfer Surface (PPHTS). The device was placed in the exhaust duct of the Pope, Evans & Robbins FBC laboratory in Alexandria, Virginia where the existing dust collectors collect about 75% of the particulates larger than 20 microns. The device was tested to evaluate its capability of collecting particles smaller than 20 microns.	CERL Champagne, IL 217-352-6511	Work is complete, reports have been sent to ERDA. Results were inconclusive. SYSTECH Corp. may carry on work. Contact John Geffken, ERDA Fossil Energy for more information. 202-376-9350
Modeling of Fluidized Bed Combustion of Coal, MIT Cambridge, MA	ERDA	This is a 3 phase program consisting of: I. MIT review of all existing FBC literature and data, then construct a phenomenological mathematical model of the process. II. Present to ERDA a future planning document which will address both data required and possible programs for generation of those data. III. Write a training manual so that interested parties may use the computer model and its supporting data base through remote computer terminals.	Mass. Institute of Technology Room 26-147 Cambridge, MA 02139	Contact ERDA - Fossil Energy for more information. Attn. William Harvey 202-376-9352.
Corrosion/Erosion, in Fluidized-Bed Combustion	EPRI RP 388	The objective of this 16 month project is to test a number of selected bed tube and turbine blade materials in an existing fluidized-bed FBC pilot plant under controlled conditions to determine their corrosion/erosion characteristics for extended periods of time. Primary contract is to Combustion Systems, Ltd., and subcontracted to C-E and Foster Wheeler (U.S.).	Dr. John Stringer EPRI 3412 Hillview Ave. P.O. Box 10412 Palo Alto, CA 94303 415-493-4800	A series of 250 hr. tests were run. Results were significant enough to re-plan this program and initiate other EPRI programs investigating corrosion/erosion in FBC.
Fluidized Bed Combustion Corrosion/Erosion Tests	EPRI	A selected set of superheater alloys will be exposed to 2000 hours of FBC operation in order to resolve a major technical question regarding the life of boiler tubes in a fluidized bed combustor. The objectives are to: (1) by metrology, determine metal loss as a function of alloy, metal surface temperature, position of specimen in relation to the injector outlet and radial position; (2) by metallographic examination, determine whether intergranular sulfidation occurs and how it relates to alloy, metal surface temperature and specimen position; (3) predict the life of the tubes and (4) establish whether metal corrosion is accelerated when the superheater is situated close to a feed point.	Dr. John Stringer Mr. Shelton Ehrlich EPRI P.O. Box 10412 Palo Alto, CA 94303 415-493-4800	These test are being run by Central Research Establishment of the National Coal Board in Great Britain. (Mr. Paul Thurlow) 3 out of 4 tests have been run, and more tests are being planned.
Heat Exchanger Tube Materials for AFBC	ERDA	The project will evaluate the corrosion/erosion characteristics of horizontal tubes of different materials in a fluidized bed atmosphere. The bed is 24 inch diameter and will operate at approximately 9 ft/sec fluidizing velocity.	Albert Hall Metallurgical Department Battelle Memorial Institute Columbus, OH 514-424-7564	The unit has operated for 1500 hours continuously. The sample tubes have been removed and are currently being evaluated.

PROJECTS INFLUENCING AFBC OF COAL

TOPIC: AFBC ADVANCED TECHNOLOGY

Program Title	Sponsor	Program Description	Name/Addr./Tel. of Person in Charge	Progress/Date Of Expected Results
Fluidized Bed Combustion Industrial Application Demonstration Projects. Battelle Memorial Institute, Columbus, Ohio	ERDA/Industry Cost Shared	<p>This is considered a Multisolid Fluidized-Bed Combustion Process which utilizes a high specific gravity bed material in a dense fluidized phase coupled with an entrained or "fast" phase of similar or different bed material. It has been shown on a bench scale that this type of fluidization process enhances gas solid contact, therefore, enhances gas sorbent reactions. Battelle is teaming in the development, demonstration and subsequent commercialization of the process. The program will be 3-phases as follows:</p> <p>Phase I: R&D utilizing a sub-scale experimental unit in support of demonstration plant design using 400 lbs/hr. of coal producing 4000 lbs/hr. of steam.</p> <p>Phase II: Construction and start-up of demonstration plant which will produce 25,000 lbs/hr. of steam @ 100 psig. The plant will be built @ Battelle Institute.</p> <p>Phase III: Three year operational period for the collection of data to be used for future industrial application design.</p>	Battelle Memorial Institute Columbus, Ohio Mr. Herman Nack 614-424-4998	Currently in Phase I; the subscale experimental unit has just been built and is now in the pre-operational shakedown phase. Light-off is expected by Sept. 1. The unit will run at 30-40 ft/sec and the bed is approximately 1 ft x 2 ft ² . Five months of concentrated operation is planned before proceeding to Phase II.
AFBC Closed Cycle Gas Turbine Technology Test Unit. Oak Ridge National Laboratory Oak Ridge, TN	ERDA	<p>The program consists of developing a Technology Test Unit (TTU) which will be a coal burning AFBC system coupled ultimately to a closed cycle hot air gas turbine-generator. The unit capacity will be 300 to 500 KW plus approximately 2.5×10^6 Btu/hr. of recoverable waste heat. The size test unit will provide credible scale-up data to the 5 to 50 MWe range for commercial application in the industrial/institutional sector.</p> <p>Phase I: Technology studies and preliminary engineering and economic analysis (complete).</p> <p>Phase II: Complete a conceptual design for the TTU.</p> <p>Phase III: Detailed design and construction of TTU.</p> <p>Phase IV: Operation, test, analysis and evaluation of results.</p>	Mr. R. S. Holcomb Oak Ridge National Laboratory P.O. Box Y Oak Ridge, Tennessee 37830 615-483-5611 Ext. 37416	Design has been completed, current construction and performance specifications are being written in preparation for bids.

PROJECTS INFLUENCING AFBC OF COAL

TOPIC: INSTRUMENTATION & CONTROL

Program Title	Sponsor	Program Description	Name/Add./Tel. of Person in Charge	Progress/Date Of Expected Results
Particulate Analysis Instrumentation for Fluidized Bed Combustion Systems Leeds & Northrop Co.	ERDA	The project is directed to development and delivery of one particulate monitoring instrument to ERDA to measure particulate loadings of micron-size particles in the gas streams of FBC reactors. The first phase will be the design and construction of an instrument to be used on the Argonne National Laboratory 6 inch AFBC reactor. This will be followed by the installation and testing in conjunction with Curtiss Wright's 3' x 3' PFBC reactor for their 13 MWe pilot plant project.	Leeds & Northrup Company Dickerson Road North Wales, PA 215-643-2000	The instrument is currently being tested at Argonne National Laboratory. Some preliminary reports are available thru ERDA. (John Geffken, ERDA, 202-376-9350)
In-situ Laser Measurements in FBC Systems	ERDA	A laser interferometer was developed to measure particles at the Argonne National Laboratory FBC facility. The unit simultaneously measures particle size and velocity.	Spectron Development Laboratory, Inc. 3303 Harbor Blvd. Suite G-3 Costa Mesa, CA 92626	Work has been completed. Reports were sent to ERDA Contract No. EX-76-C-01-2413 (John Geffken, ERDA, 202-376-9350)
Mathematical Modeling of FBC Process for Control Analysis	ERDA	Develop mathematical models for FBC process control, acquire data to "fit" into model to check its accuracy, then analyze and optimize the control modes.	Dr. David Berkowitz The MITRE Corp. P.O. Box 208 Bedford, MA 01730	Mathematical models have been formulated. A data acquisition system was installed at Pope, Evans & Robbins FBC Lab in Alexandria, Virginia. The data has been gathered and is currently being "fit" into the models.

PROJECTS INFLUENCING AFBC OF COAL

TOEIC: MATERIAL FEEDER DEVELOPMENT

Program Title	Sponsor	Program Description	Name/Add./Tel. of Person in Charge	Progress/Date Of Expected Results
Coal Feed Testing & Development (Pressurized) Lockheed	ERDA	This program is to generate analytical and test data to permit confident design and fabrication of equipment into pressurized environments. A 3-phase program is in progress: Phase 1: Concepts Selection Phase 2: Lab-Scale Development Phase 3: Pilot Plant Development	Lockheed Missiles & Space Co., Inc. Sunnyvale, CA	Monthly reports issued to ERDA. (Attn. R. R. Fleischbein MFPM)
Coal Feeder Development Ingersoll-Rand (Primarily for PFBC)	ERDA	This is a dry coal screw feeder program for feeding coal in a reactor operating up to 1500 psig.	Ingersoll-Rand Research Inc. Princeton, NJ	Monthly reports issued to ERDA. (Attn. R. R. Fleischbein MFPM)
Dry Coal Feed System Development (Foster-Miller)	ERDA	This is a program to develop alternative methods of feeding coal into pressurized conversion processes. Four methods have been tested. 1. Centrifugal Solids Feeder 2. Fluidized Piston Feeder 3. Linear Pocket Feeder 4. Compacted Coal Plug Feeder	Foster-Miller Associates Waltham, MA	Monthly reports issued to ERDA. (Attn. R. R. Fleischbein MFPM).

PROJECTS INFLUENCING AFBC OF COAL

TOPIC: FEASIBILITY/ECONOMIC/CONCEPTUAL & GENERAL STUDIES

Program Title	Sponsor	Program Description	Name/Add./Tel. of Person in Charge	Progress/Date Of Expected Results
Engineering Evaluation of Atmospheric Fluidized-Bed Combustion (AFBC) Applied to Electric Utility Large Steam Generators	EPRI RP 412	The objective of this 16 month program is to evaluate the adequacy of available information for commercialization of the AFBC process. The program includes a study of existing designs of utility boilers using FBC.	Mr. Steve Strom Babcock & Wilcox Company Research & Development Division Alliance, Ohio 44601 216-821-9110	Project complete - report should be available thru EPRI.
Fluidized Bed Combustion (FBC) Retrofit Study for Conversion of Oil Fired Boilers to Coal.	EPRI RP 717	Because of legislative action or a curtailment of available fuel, some utilities may be forced to consider conversion of units from oil to coal firing retrofit so that a reasonable evaluation of alternatives can be made. Two retrofit concepts are available: (1) an external system that involves high sulfur oil and (2) the approach, to be evaluated in this study, that involves putting several fluidized bed combustors inside an existing furnace. The New York State Energy Research & Development Authority is the major funder. The study is being carried out by Combustion Engineering with support from Combustion Processes, Inc.	Shelton Ehrlich EPRI 3412 Hillview Ave. P.O. Box 10412 Palo Alto, CA 94303	Preliminary drafts complete, currently being reviewed by EPRI. Publications will be available in December or January from EPRI.
Preliminary Design and Cost Estimate for a Commercial Scale Atmospheric Fluidized Bed Combustion (AFBC) Steam Generator	EPRI RP 722	This project calls for preparation of a site-oriented preliminary design and estimate in order to evaluate the cost of a 200 MWe demonstration plant. The design contemplated would be at an existing utility site using as much mechanical and electrical equipment as possible so as to minimize costs.	Shelton Ehrlich EPRI P.O. Box 3412 Hillview Ave. Palo Alto, CA 94303 415-493-4800	No progress noted at this date.
Conceptual Design of an Atmospheric Fluidized Bed Combustion Steam Generating Plant.	ERDA	The objective is to prepare a conceptual design for an electric power generating plant of an approximately 600 MW commercial size AFB Boiler and a 150-200 MW demonstration size unit that is a scaled down version of the 600 MW unit. The work will be of sufficient detail such that firm bids could be made for actual construction of the plant. Two types of coal will be used: Burns & Roe - Western sub-Bituminous; Stone & Webster - Eastern Coal	William Bradley Project Engineer Burns & Roe, Inc. 185 Crossways Park Dr., Woodbury, NY 11797 516-677-4000 T. G. Wells Power Engineer Stone & Webster P.O. Box 2325 Boston, MA 02107	Burns & Roe has contracted Combustion Engineering, Inc., and Stone & Webster has contracted Foster Wheeler and Babcock & Wilcox for the boiler designs. Final Reports are due by January 1, 1978. Pope, Evans, & Robbins, Inc. is working with Stone & Webster.

THE BABCOCK & WILCOX COMPANY
POWER GENERATION DIVISION

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SCHEMATIC FLOWSHEET OF F.B.C. SYSTEM

11-28 (ES-261)

DWN. BY H.J.	CHK'D
PASSED BY	APP'D

**SCHEMATIC FLOWSHEET
OF F.B.C. SYSTEM**

SCALE	DATE 11-21-77
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THE BABCOCK & WILCOX COMPANY
POWER GENERATION DIVISION

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SULFUR CAPTURE AS A FUNCTION OF STOICHIOMETRY
AND EFFECTS OF SALT ADDITION
11-29

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COMBUSTION EFFICIENCY AS A
FUNCTION OF GAS VELOCITY

11-30

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COMBUSTION EFFICIENCY VS
SUPERFICIAL VELOCITY FT/SEC

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XII AFB Demonstration Plant Recommendations

The primary task of the subject contract consisted of an engineering study to develop a conceptual design of a 570 MW (net) atmospheric pressure fluid bed fired utility boiler system. In addition, recommendations are to be made with regard to a smaller (demonstration size) unit.

The schedule for the work conducted under this contract was very optimistic in that only six months were allowed to complete the required scope. To work within this schedule and still meet the contract objectives it was necessary to fix and freeze at an early date, many design parameters and system arrangements. A secondary effect of this tight schedule was the absence of any significant amount of boiler system studies and therefore cost optimization. As the studies progressed, a number of less than optimum conditions became apparent. The most significant area of variance appears to be the choice of bed superficial gas velocity. At the start of this study a bed velocity of eight feet per second was chosen, primarily because it represented the mid range of velocities being investigated or proposed for AFB systems.

It now appears that this may not be the optimum bed velocity from an operating cost point of view. However, sufficient work had been performed on the study at the time this effect was recognized such that it was impractical to change this basic design parameter and develop an alternative design package in the required time.

Concurrently with the subject study contract, B&W was working on a design study (for the TVA/ERDA contract No. TV-45715A) for the conceptual design of a demonstration size AFB utility boiler. As previously mentioned in Section III, Design Philosophy, many of the specific design parameters used in the subject design were developed during the TVA study, but some of the results and observations were developed too late to be practically applied to this study. The most outstanding example of this development being the effect of bed velocity on calcium utilization and combustion efficiency.

One part of the TVA study entailed a comparison of AFB conceptual designs for different bed velocities (4, 8 and 12 ft/sec). A preliminary design and approximate costs were developed for the various concepts. The results of these studies indicated little capital cost differential between the concepts with varying bed velocities. Based on the design parameters developed in the TVA study however, the lower velocity concepts appeared to have significantly improved bed carbon utilization and limestone utilization,

and therefore, improved overall boiler thermal efficiency and lowered operating costs.

The curve on page 12-3 shows the expected in-bed combustion efficiency vs. bed velocity and the plot of page 12-4 shows the expected calcium to sulfur stoichiometric requirements vs. bed velocity, both with bed depths of four feet. The logical interpretation of these curves is that increased in-bed gas residence time enhances both chemical reactions thereby increasing overall thermal efficiency and reducing limestone costs.

To further emphasize this apparent effect, the plot on page 12-5 compares main bed combustion efficiency, required Ca/S ratio, and overall thermal efficiency vs. bed superficial velocity. Combustion efficiency increases slightly and the required Ca/S ratio decreases as bed velocity is lowered, both contributing to a slightly improved boiler thermal efficiency at the lower velocity.

Page 12-6 is a bar chart indicating relative costs for the three conceptual designs in \$/KW. Equipment costs are similar and certainly within the limits of error for this approximate study. However, the differential capitalized costs of coal and limestone result in a significant cost advantage for the lower velocity design (4 ft/sec.).

These studies obviously need to be pursued in much more depth than has been possible to date, however, we are convinced that the trends shown are real and therefore are recommending a 4 ft/sec. AFB unit for the initial demonstration plant. As noted previously, this is in contrast with the subject commercial unit design (8 ft/sec.) since these TVA study results were not available in time for inclusion in this study.

Page A-15 and A-16 show a side and plan view of the 200 MW demonstration size boiler currently under development in the TVA study contract and which we are also recommending here as a feasible demonstration concept. This unit is designed for a 4 ft/sec. bed velocity with four beds 50 ft. wide and 28 ft. deep. 2-1/2 of these beds contain superheater surface and 1-1/2 contain boiling surface. No reheater surface is located in the beds, however, a parallel downflow convection pass similar to the commercial design described in this report, is included for reheat control. Other design features, such as pump assisted circulation, multiple bed compartmentation for turn down control, pneumatic under bed feeding of coal and limestone, bed operating temperatures and excess air requirements are equivalent to the commercial design. The demonstration system includes a separate carbon burn-up bed unit with a 4 ft/sec bed velocity.

THE BABCOCK & WILCOX COMPANY
POWER GENERATION DIVISION

REVISIONS			MICRO-FILM
DASH NO.	DATE	DESCRIPTION	ORIG.

SUPERFICIAL VELOCITY FT./SEC. 455

12-3

DWN. BY EP	CHK'D	COMBUSTION EFFICIENCY VS SUPERFICIAL VELOCITY	SCALE <i>7x</i>	DATE 11-30-77
PASSED BY	APP'D		DRWS. NO. 140019	A-0

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DASH NO.	DATE	DESCRIPTION	ORIG.	FILM

OWN. BY FLH	CHE'D	SO ₂ REMOVAL AS A FUNCTION OF Ca/S RATIO	SCALE $\frac{1}{2}$	DATE 11-30-71
PASSED BY	APP'D		DRWG. NO. 140018	A-0

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EFFICIENCY (PERCENT) →
Ca/S RATIO →

12-5

OWN. BY EP	CHK'D
PASSED BY	APP'D

EFFICIENCY (%) Ca/S VS
GAS VELOCITY

SCALE $\frac{1}{2}$	DATE 11-30-77
DRWG. NO. 140021	A-0

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REVISIONS				MIC
DASH NO.	DATE	DESCRIPTION	ORIG.	PI

KEY:

CAPITALIZED DIFFERENTIAL COST OF LIMESTONE

CAPITALIZED DIFFERENTIAL COST OF COAL

EQUIPMENT COSTS

↑
\$/KW

12-6

DWN. BY: FLH	CHK'D:
PASSED BY:	APP'D:

COST COMPARISON

SCALE: 7/8	DATE: 11-29
DRWG. NO. 140015A	

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DRAWING 10033

APPENDIX

APPENDIX IIIA-D
EQUIPMENT DATA SHEETS

	<u>Page</u>
Babcock & Wilcox Equipment	i
Equipment Common to Babcock & Wilcox and Foster Wheeler	39

BABCOCK & WILCOX EQUIPMENT

COOLING TOWER DATA SHEET - AFB
J.O.No. 12919.02A-B&W

Mark No. 4CTWR-1

Specification No.
Purchase Order No.

Service

Condenser Circulating Water and
Cooling Water Systems

No of Units

1

Operation

Continuous

Type

Mechanical Induced Draft

Fill

Wood

Number of Cells

12

Fans per Cell

1

Circulating Water Flow, gpm

202,713

Hot (inlet) Water Temp, F

121.23

Cold (outlet) Water Temp, F

91.87

Wet Bulb Temp, F

79

Approach

12.87

Air Density Corresponding
to 79 F, lb/ft

.0732

Motor Hp

50/200

Heat Rejected by Cooling
Tower, Btu/hr

2.945×10^9

Range, F

29.36

Maximum Drift, % of

Circulating Water Flow

.01

Codes:

ASTM

American Society for Testing and
Materials

ANSI

American National Standards
Institute

AISI

American Iron and Steel
Institute

ACI

American Concrete Institute

CTI Std

Cooling Tower Institute Standard
Specification

VERTICAL PUMP DATA SHEET - AFB
J.O.No. 12919.02A-B&W

Mark No. 4CWP-1A,B

Specification No.
Purchase Order No.

Service	Circulating Water Pumps
No. of Units	2
Indoors or Outdoors	Outdoors
Operation	Continuous
Liquid Pumped	Cooling Tower Discharge
Pumping Temp	32 F - 95 F
pH	6 - 7
Sp. Gr. at P.T.	1.0 - .994
Viscosity at P.T.	1.79 - .70 cp
Capacity at P.T.	101,365 gpm each
Pressure at suction nozzle	Flooded
Differential Pressure or	
Total Head	100 ft, 43 psig
Shutoff TDH, Max	160 ft, 68.8 psig
Hp	3,000
Pump Speed, rpm	400
Driver Type	Motor
Driver Furnished by	Purchaser
Type Lubrication	Water Pumped
Discharge Size, in.	60

Codes:

H.I.S.

Hydraulic Institute Standards

ANSI B31.1

American National Standards
Institute

B16.1

Cast Iron Pipe Flanges and Flanged
Fittings

B16.5

Steel Pipe Flanges, Flanged Valves,
and Fittings

B16.9

Factory Made Wrought Steel Butt-
Welding Fittings

B16.11

Forged Steel Fittings, Socket
Welding and Threaded

VERTICAL PUMP DATA SHEET - AFB
J.O.No. 12919.02A-B&W

Mark No. 4 MUWP-1

Specification No.
Purchase Order No.

Service
No. of Units
Indoors or Outdoors
Operation
Liquid Pumped
Pumping Temp
pH
Sp. Gr. At P.T.
Viscosity at P.T.
Capacity at P.T.
Pressure at Discharge Nozzle
Pressure at Suction Nozzle

Cooling Tower Makeup
1
Outdoors
Continuous
River Water
32 F - 95 F
6.9 - 8.4
1.0 - .994
1.79 - .70 cp
9,000 gpm
115 ft, 50 psig
Flooded

Differential Pressure or
Total Head
Hp
Pump Speed, rpm
Driver Type
Driver Furnished by
Type Lubrication
Discharge Size, Std

115 ft, 50 psi
350
900
Motor
Purchaser
External Water Source
20 in., 150 lb

Codes:

ANSI

American National Standards
Institute

H.I.S.

Hydraulic Institute Standards

ASME

ASME Boiler and Pressure Vessel
Code

STEAM SURFACE CONDENSER DATA SHEET - AFB
J.O.No. 12919.02A-B&W

Mark No. 4CND-1 (Low Pressure)	Specification No. Purchase Order No.
Service	Atmospheric Fluidized Bed Boiler Steam Turbine
No. of Condenser Units	1
Active Tube Surface, %	100
Circulating Water, gpm	185,414
Total Steam Condensed, Mlb/hr	1494.598
Heat Rejected by Condenser, Btu/hr	1.4051×10^9
Ext Drips and Vapor to Shell, Mlb/hr	0
Tube Water Velocity, ft/sec	8.70
Tube Cleanliness Factor, %	84
Circ. Water Temp, In, F	91.87
Out, F	121.23
Range, F	29.36
Temp Condensate From Hot Well, F	129.20
Abs. Press., Main Steam Inlet, in. Hg	3.35
No. of Shells	1
Passes per Shell	1
Test Pressure, psig	85
Circulating Water Source	Cooling Tower
Tube Length, ft	48
Hot Well Storage Capacity	22,000 Gal (High and Low Press. Cond.)
Tube Material, Gage, Diam	304 SS, 22 BWG, 7/8 In.
Condenser Surface Area, Sq. ft (High & Low)	316,359
Codes:	
ASME VIII	ASME Boiler and Pressure Vessel Code
ANSI	American National Standards Insti- tute
H.E.I.	Heat Exchange Institute Standards for Steam Surface Condensers, 6th Ed.

STEAM SURFACE CONDENSER DATA SHEET - AFB
J.O.No. 12919.02A-B&W

Mark No. 4CND-2
(High Pressure)

Specification No.
Purchase Order No.

Service

Atmospheric Fluidized Bed Boiler
Steam Turbine

No. of Condenser Units

1

Active Tube Surface, %

100

Circulating Water, gpm

185,414

Total Steam Condensed,

Mlb/hr

1356.040

Heat Rejected by Condenser,

Btu/hr

1.2866×10^9

Ext Drips and Vapor

to Shell, Mlb/hr

418.783

Tube Water Velocity, ft/sec

7.41

Tube Cleanliness Factor, %

84

Circ. Water Temp, in, F

91.87

out, F

121.23

Range, F

29.36

Temp Condensate from Hot

Well, F

129.20

Abs. Press., Main Steam

Inlet, in. Hg

4.43

No. of Shells

1

Passes per Shell

1

Test Pressure, psig

85

Circulating Water Source:

Cooling Tower

Tube Material, gage, diam

304 SS, 22 BWG, 7/8 in.

Condenser Surface Area,

sq ft (High & Low)

316,354

Tube Length, ft

48

Codes:

ASME VIII

ASME Boiler and Pressure Vessel Code

ANSI

American National Standards Institute

H.E.I.

Heat Exchange Institute Standards
for Steam Surface Condensers,
6th Ed.

CONDENSER AIR REMOVAL
EQUIPMENT DATA SHEET - AFB
J.O.No. 12919.02A-B&W

Mark No.	4ARP-1A,B	Specification No.	
		Purchase Order No.	
Service		Condenser Air Removal	
No. of Units		2	
Indoors or Outdoors		Indoors	
Operation		Continuous (1 pump) see Note 1	
Liquid Pumped		Air Vapor Mixture	
Capacity		504 lb/hr (air vapor mixture) see Note 2	
Capacity, Dry Air		157.5 lb/hr (35 scfm) see Note 2	
Seal Water Pressure (max)		125 psig	
Seal Water Temp (max)		95 F	
Driver Type		Motor	
Driver Furnished by		Seller	
Codes:			
ANSI		American National Standards Institute	
ASME		The American Society of Mechanical Engineers	
ASTM		American Society for Testing and Materials	

NOTE 1 On initial start-up, condenser air removal equipment (two pumps operating) shall be capable of roughing or hogging operation that will reduce the condenser pressure from atmospheric pressure to 5 in. Hg abs within 60 min. The effective volume of the condenser is 65,000 ft³ and its temperature will be 50 F when hogging.

NOTE 2 Based at 1 in. Hg abs and 71.5 F.

VERTICAL PUMP DATA SHEET - AFB
J.O.No. 12919.02A-B&W

Mark No. 4CP-1A,B

Specification No.
Purchase Order No.

Service	Condensate
No. of Units	2
Indoors or Outdoors	Indoors
Operation	Continuous
Liquid Pumped	Condensate
Pumping Temp/pH	130.64 F/9.3 to 9.7
Sp. Gr. at P.T.	.987
Viscosity at P.T.	.51 cp
Capacity at P.T.	3,750 gpm (2 pump operation) 4,700 gpm (1 pump operation)
Pressure at discharge nozzle	1,040 ft, 444.8 psig
Pressure at suction	-30.40 ft, -13 psig
Differential Pressure or Total Head	1070.4 ft, 457.8 psig
Available NPSH, ft	1.0
Hp	1,500
Pump Speed, rpm	1,200 rpm
Driver type	Motor
Driver Furnished by	Seller
Type Lubrication	Water pumped
Discharge Size, Std	14 in., 300 lb
Suction Size, Std	24 in., 150 lb

Codes:

ASME VIII

ASME Boiler and Pressure
Vessel Code

ANSI

American National Standards
Institute

NEMA MG1

National Electrical Manufacturers
Association: Motors and Standards

H.I.S.

Hydraulics Institute Standards

BOILER FEED BOOSTER PUMP DATA SHEET - AFB
J.O.No. 12919.02A-B&W

Mark No. 4 BFP-1A

Specification No.
Purchase Order No.

Service
No. of Units
No. of Stages
Indoors or Outdoors
Operation
Liquid Pumped
Pumping Temp
pH
Sp. Gr. At P.T.
Viscosity at P.T.
Capacity at P.T.
Pressure at Discharge Nozzle
Pressure at Suction Nozzle

Boiler feed booster
1
1
Indoors
Continuous
Feed Water
299 F
9.2 - 9.6
.9188
.46 cp
4,567 gpm
450 ft
56.5 ft

Differential Pressure or
Total Head

450 ft

Hp
Pump Speed, rpm
Driver Type
Driver Furnished by
Type Lubrication
Discharge Size, Std

1,032
5,845
Turbine
Purchaser
Turbine oil
14 in., 300 lb

Codes:

ANSI

American National Standards
Institute

H.I.S.

Hydraulic Institute Standards

ASME

ASME Boiler and Pressure Vessel
Code

BOILER FEED PUMP DATA SHEET - AFB
J.O.No. 12919.02A-B&W

Mark No. 4 BFP-1B

Specification No.
Purchase Order No.

Service	Boiler feed
No. of Units	1
No. of Stages	3
Indoors or Outdoors	Indoors
Operation	Continuous
Liquid Pumped	Feed Water
Pumping Temp	299 F
pH	9.2 - 9.6
Sp. Gr. At P.T.	.9188
Viscosity at P.T.	.46
Capacity at P.T.	9,567 gpm
Pressure at Discharge Nozzle	7,556 ft
Pressure at Suction Nozzle	430 ft

Differential Pressure or	
Total Head	7,556 ft
Hp	18,230
Pump Speed, rpm	5,845
Driver Type	Turbine
Driver Furnished by	Purchaser
Type Lubrication	Turbine oil
Discharge Size, Std	18 in.

Codes:

ANSI

American National Standards
Institute

H.I.S.

Hydraulic Institute Standards

ASME

ASME Boiler and Pressure Vessel
Code

START-UP BOILER FEED PUMP DATA SHEET - AFB
J.O.No. 12919.02A-B&W

Mark No. 4 SBFP-1

Specification No.
Purchase Order No.

Service
No. of Units
No. of Stages
Indoors or Outdoors
Operation
Liquid Pumped
Pumping Temp
pH
Sp. Gr. At P.T.
Viscosity at P.T.
Capacity at P.T.
Pressure at Discharge Nozzle
Pressure at Suction Nozzle

Start-up boiler feed
1
4
Indoors
Start-up
Feed Water
299 F
9.2-9.6
.9188
.46 cp
5,860 gpm
7,556 ft
96.2 ft

Differential Pressure or
Total Head

7,556 ft

Hp

10,000

Pump Speed, rpm

5,600

Driver Type

Motor

Driver Furnished by

Purchaser

Type Lubrication

Any oil greater than 150 SSU
at 100F

Discharge Size, Std

11 in., Schedule 160

Codes:

ANSI

American National Standards
Institute

H.I.S.

Hydraulic Institute Standards

ASME

ASME Boiler and Pressure Vessel
Code

DEAERATOR DATA SHEET
J.O. No. 12919.02A-B&W

Mark No.: 4 CNM-EH4

Specification No.

Quantity: 1

Purchase Order

Location: Indoors

	<u>Flow</u>	<u>Enthalpy</u>
From Blowdown Flash Tank:	2,196 lb/hr	1179.36 Btu/lb
Condensate to Heater:	3,269,420 lb/hr	237.73 Btu/lb
Feedwater Heater Returns:	617,557 lb/hr	281.9 Btu/lb
Extraction Steam to Heater:	87,789 lb/hr	1292.16 Btu/lb
Total Water Delivered To Boiler Feed Pump:	3,976,963 lb/hr	268.39 Btu/lb

Operating Pressure: 51 psig

Pressure of Extraction Steam at Deaerator: 69.2 psia

Design Temperature, Shell: 320 deg F.

Design Temperature, Steam Inlet Nozzle: 560 deg F.

Design Pressure: 70 psig

Required Storage Capacity Below Normal Level: 46,000 gal

Code Requirements: ASME Boiler and Pressure Vessel Code,
Section VIII, Div. 1
Standards of the Heat Exchange Institute

FEEDWATER HEATER
EQUIPMENT DATA SHEET - AFB
J.O. No. 12919.02A - B&W

Mark No. 4FWS-EH7

Specification No.
Purchase Order No.

Service: First Point Extraction Heater
No. of Units: 1
Installation: Horizontal

Performance

	<u>Shell Side</u>	<u>Tube Side</u>
Inlet:		
Feedwater		3,484,313 lb/hr 410.1 F 389.15 h
Steam	307,479 lb/hr 627.1 F 1308.64 h	
Drips	NA lb/hr NA F NA h	
Inlet Pressure	589.29 psia	2934.66 psia
Steam Condensed	307,479 lb/hr	
Outlet		
Temperature/		
Enthalpy	418.1 F 394.82 h	484.27 F 469.79 h

Terminal Differences: Sat temp at steam inlet minus feedwater out,
0 F. Drips out minus feedwater in, 8 F.

Construction

	<u>Shell Side</u>	<u>Tube Side</u>
Design Temperature:	650 F Barrel 700 F Nozzle	550 F
Design Pressure:	775 psig	4300 psig
Code Requirements:	ASME VIII, Div. 1 Heat Exchange Institute	
Materials:		
Tubes	ASME SA-556 GR2 of C2	

FEEDWATER HEATER
EQUIPMENT DATA SHEET - AFB
J.O. No. 12919.02A - B&W

Mark No. 4FWS-EH6

Specification No.
Purchase Order No.

Service: Second Point Extraction Heater
No. of Units: 1
Installation: Horizontal

Performance

Shell Side

Tube Side

Inlet:
Feedwater

3,484,313 lb/hr
374.46 F 351.69 h

Steam 109,214 lb/hr 838.34 F 1442.44 h
Drips 307,479 lb/hr 418.1 F 394.82 h

Inlet Pressure 270.9 psia
Steam Condensed 109,214 lb/hr
Outlet

2959.66 psia

Temperature/
Enthalpy 382.46 F 356.22 h

410.1 F 389.15 h

Terminal Differences: Sat temp at steam inlet minus feedwater out,
-2 F. Drips out minus feedwater in, 8 F.

Construction

Shell Side

Tube Side

Design Temperature: 650 F Barrel
875 F Nozzle

475 F

Design Pressure: 325 psig

4300 psig

Code Requirements: ASME VIII, Div. 1
Heat Exchange Institute

Materials:
Tubes ASME SA-556 GR2 of C2

**FEEDWATER HEATER
EQUIPMENT DATA SHEET - AFB
J.O. No. 12919.02A - B&W**

Mark No. 4FWS-EH5

**Specification No.
Purchase Order No.**

Service: Third Point Extraction Heater
No. of Units: 1
Installation: Horizontal

Performance

	<u>Shell Side</u>	<u>Tube Side</u>
Inlet:		
Feedwater		3,484,313 lb/hr 303.8 F 279.05 h
Steam	200,865 lb/hr 724.36 F 1387.8 h	
Drips	416,693 lb/hr 382.46 F 356.22 h	
Inlet Pressure	178.66 psia	2984.68 psia
Steam Condensed	200.865 lb/hr	
Outlet		
Temperature/ Enthalpy	311.8 F 281.9 h	374.46 F 351.69 h

Terminal Differences: Sat temp at steam inlet minus feedwater out, -2 F. Drips out minus feedwater in, 8 F.

Construction

	<u>Shell Side</u>	<u>Tube Side</u>
Design Temperature:	650 F Barrel 800 F Nozzle	425 F
Design Pressure:	200 psig	4300 psig
Code Requirements:	ASME VIII, Div. 1 Heat Exchange Institute	
Materials:		
Tubes	ASME SA-556 GR2 of C2	

FEEDWATER HEATER
EQUIPMENT DATA SHEET - AFB
J.O. No. 12919.02A - B&W

Mark No. 4CNM-EH3

Specification No.
Purchase Order No.

Service: Fifth Point Extraction Heater
No. of Units: 1
Installation: Horizontal

Performance

Shell Side

Tube Side

Inlet:

Feedwater 3,269,420 lb/hr
201.06 F 169.65 h

Steam 219,716 lb/hr 433.46 F 1252.46 h

Drips NA lb/hr NA F NA h

Inlet Pressure 42.18 psia 214.32 psia

Steam Condensed 219,716 lb/hr

Outlet

Temperature/
Enthalpy 270.47 F 239.43 h 268.47 F 237.73 h

Terminal Differences: Sat temp at steam inlet minus feedwater out,
2 F. Drips out minus feedwater in 69.41 F.

Construction

Shell Side

Tube Side

Design Temperature:

450 F

300 F

Design Pressure:

50 psig

550 psig

Code Requirements:

ASME VIII, Div. 1
Heat Exchange Institute

Materials:

Tubes

ASME SA-688 TP304

**FEEDWATER HEATER
EQUIPMENT DATA SHEET - AFB
J.O. No. 12919.02A - B&W**

Mark No. 4CNM-EH2

Specification No.
Purchase Order No.

Service: Sixth Point Extraction Heater
No. of Units: 1
Installation: Horizontal

Performance

	<u>Shell Side</u>	<u>Tube Side</u>
Inlet:		
Feedwater		3,269, 420 lb/hr 164.51 F 133.06 h
Steam	121,176 lb/hr 226.84 F 1158.49 h	
Drips	NA lb/hr NA F NA h	
Inlet Pressure	12.2 psia	229.32 psia
Steam Condensed	121,176 lb/hr	
Outlet		
Temperature/ Enthalpy	203.06 F 171.17 h	201.06 F 169.65 h

Terminal Differences: Sat temp at steam inlet minus feedwater out, 2 F. Drips out minus feedwater in, 38.55 F.

Construction

	<u>Shell Side</u>	<u>Tube Side</u>
Design Temperature:	350 F	300 F
Design Pressure:	50 psig	550 psig
Code Requirements:	ASME VIII, Div. 1 Heat Exchange Institute	
Materials:		
Tubes	ASME SA-688 TP304	

FEEDWATER HEATER
EQUIPMENT DATA SHEET - AFB
J.O. No. 12919.02A - B&W

Mark No. 4CNM-EH1A
4CNM-EH1B

Specification No.
Purchase Order No.

Service: Seventh Point Extraction Heater
No. of Units: 2
Installation: Horizontal

Performance

Shell Side

Tube Side

Inlet:

Feedwater: 3,269,420 lb/hr
142.11 F 110.68 h

Steam 73,287 lb/hr 166.51 F 1132.79 h
Drips NA lb/hr NA F NA h

Inlet Pressure 5.53 psia 244.32 psia
Steam Condensed 73,287 lb/hr

Outlet

Temperature/
Enthalpy 166.51 F 134.47 h 164.51 F 133.06 h

Terminal Differences: Sat temp at steam inlet minus feedwater out,
2 F. Drips out minus feedwater in, 24.4 F.

Construction

Shell Side

Tube Side

Design Temperature: 300 F 300 F
Design Pressure: 50 psig 550 psig

Code Requirements: ASME VIII, Div. 1
Heat Exchange Institute

Materials:
Tubes ASME SA-688 TP304

DRAIN COOLER
EQUIPMENT DATA SHEET - AFB
J.O. No. 12919.02A - B&W

Mark No. 4CNM-DC1

Specification No.
Purchase Order No.

Service: Fifth Point Extraction Heater Drain Cooler
No. of Units: 1
Installation: Horizontal

Performance

	<u>Shell Side</u>	<u>Tube Side</u>
Inlet:		
Feedwater		3,269,420 lb/hr
		133.18 F 101.78 h
Drips	219,716 lb/hr 270.47 F 239.43 h	
Inlet Pressure		254.32 psia
Outlet		
Temperature/		
Enthalpy	139.18 F 107.13 h	142.11 F 110.68 h

Terminal Differences: Drips out minus feedwater in, 6 F.

Construction

	<u>Shell Side</u>	<u>Tube Side</u>
Design Temperature:	300 F	300 F
Design Pressure:	50 psig	550 psig
Code Requirements:	ASME VIII, Div. 1 Heat Exchange Institute	
Materials:		
Tubes	ASME SA-688 TP304	

DRAIN COOLER
EQUIPMENT DATA SHEET - AFB
J.O. No. 12919.02A - B&W

Mark No. 4CNM-DC2

Specification No.
Purchase Order No.

Service: Sixth Point Extraction Heater Drain Cooler
No. of Units: 1
Installation: Horizontal

Performance

Shell Side

Tube Side

Inlet:

Feedwater

3,269,420 lb/hr
130.71 F 99.33 h

Drips 121,176 lb/hr 203.06 F 171.17 h

Inlet Pressure

264.32 psia

Outlet

Temperature/

Enthalpy

136.71 F 104.66 h

133.18 F 101.79 h

Terminal Differences: Drips out minus feedwater in, 6 F.

Construction

Shell Side

Tube Side

Design Temperature:

300 F

300 F

Design Pressure:

50 psig

550 psig

Code Requirements:

ASME VIII, Div. 1
Heat Exchange Institute

Materials:

Tubes

ASME SA-688 TP304

BED LETDOWN BLOWERS-AFB
12919.02A-B&W

Mark No.

Specification No.
Purchase Order

Service: Spent Bed Material Disposal

No. of Units	3
No. Running	2
Indoors or Outdoors	Indoors
Operation	Intermittent
Material Conveyed	Bed Letdown
Bed Material Temp	250 F
Bed Material Density, lb/ft ³	80
Flow Rate, T/hr	150
Blower Capacity, cfm	3,800
Blower Static, psi	15
Driver Type	Motor
Driver Hp	250
Driver Furnished by	Seller
Discharge Size, in.	12
Blower Type	Positive Displacement

**FLY ASH BLOWERS-AFB
12919.02A-B&W**

Mark No.

**Specification No.
Purchase Order**

Service: Fly Ash Disposal (CBC Dust Collector)

No. of Units	2
No. Running	1
Indoors or Outdoors	Indoors
Operation	Continuous
Material Conveyed	Fly Ash
Fly Ash Material Temp	750 F
Fly Ash Material Density, lb/ft³	40
Flow Rate, T/hr	64.5
Blower Capacity, CFM	3,800
Blower Static, psi	15
Driver Hp	250
Driver Type	Motor
Driver Furnished By	Seller
Discharge Size, in.	12
Blower Type	Positive Displacement

FLY ASH BLOWERS-AFB
12919.02A-B&W

Mark No.

Specification No.
Purchase Order

Service: Fly Ash Disposal (Hot Precip's)

No. of Units	2
No. Running	1
Indoors or Outdoors	Indoors
Material Conveyed	Fly Ash
Fly Ash Material Temp	750 F
Fly Ash Material Density lb/ft ³	40
Flow Rate, T/hr	3.36
Blower Capacity, cfm	3,800
Blower Static, psi	15
Driver Hp	250
Driver Furnished By	Seller
Intake Size, in.	8
Blower Type	Positive Displacement

FLY ASH VACUUM PRODUCERS-AFB
12919.02A-B&W

Mark No.

Specification No.
Purchase Order

Service: Fly Ash Disposal (CBC Dust Collector)

No. of Units	2
No. Running	1
Indoors or Outdoors	Indoors
Operation	Continuous
Material Conveyed	Fly Ash
Fly Ash Material Temp	750 F
Fly Ash Material Density, lb/ft ³	40
Flow Rate, T/hr	64.5
Blower Capacity, cfm	3,000
Blower Static, psi	13
Driver Hp	60
Driver Type	Motor
Driver Furnished By	Seller
Intake Size, in.	12
Blower Type	Centrifugal

FLY ASH VACUUM PRODUCERS-AFB
12919.02A-B&W

Mark No.

Specification No.
Purchase Order

Service: Fly Ash Disposal (Hot Precips)

No. of Units	2
No. Running	1
Indoors or Outdoors	Indoors
Operation	Continuous
Material Conveyed	Fly Ash
Fly Ash Material Density, lb/ft ³	40
Flow Rate, T/hr	3.36
Blower Capacity, cfm	1,800
Blower Static, psi	13
Driver Hp	60
Driver Type	Motor
Driver Furnished By	Seller
Intake Size, in.	8
Blower Type	Centrifugal

**SILLO FLUIDIZING BLOWERS-AFB
12919.02A-B&W**

Mark No.

**Specification No.
Purchase Order**

Service: Silo Ash Removal

No. of Units

4

No. Running

2

Indoors or Outdoors

Indoors

Operation

Intermittent

Blower Capacity, cfm

1,200

Blower Static, psi

6

Driver Hp

30

Driver Type

Motor

Discharge Size, in.

6

Blower Type

Centrifugal

CBC BED MAKE-UP-BLOWER-AFB
12919.02A-B6W

Mark No.

Specification No.
Purchase Order

Service: Carbon Burnup Cell Bed Makeup

No. of Units	1
No. Running	1
Indoors or Outdoors	Indoors
Operation	Intermittent
Material Conveyed	Bed Letdown
Bed Material Temp, F	250
Bed Material Density, lb/ft ³	80
Flow Rate, lb/hr	15,000
Blower Capacity, cfm	1,500
Blower Static, psi	10
Driver Type	Motor
Driver Hp	40
Driver Furnished By	Seller
Discharge Size, in.	6
Blower Type	Centrifugal

CARBON REINJECTION VACUUM PRODUCERS-AFB
12919.02A-B&W

Mark No.

Specification No.
Purchase Order

Service: Carbon Collection to CBB Feed Tank

No. of Units	4
No. Running	4
Indoors or Outdoors	Indoors
Operation	Intermittent
Material Conveyed	Main Bed Hot Precip Fly Ash
Fly Ash Material Temp, F	750
Fly Ash Density, lb/ft ³	40
Flow Rate, T/hr	93.7
Blower Capacity, cfm	1,300
Blower Static, psi	10
Driver Type	Motor
Driver Hp	100
Driver Furnished By	Seller
Intake Size, in.	3
Blower Type	Centrifugal

STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET-PART A
CONTROL VALVE

CLIENT ERDA
PROJECT AFB STUDY

PREPARER
SPECIALIST

INITIAL DATE
SBF 11-30-77

T.D.S. NO. VI
PAGE
SPEC. NO.
J.O. NO. 12919.02A

BABCOCK & WILCOX DESIGN

EQUIP. NO 4CV-503A, B, C		No. REQ'D 3		FSK-EM-102A	
SERVICE HP START-UP BYPASS CONTROL VALVES				ASME CODE - CLASS -	
S & W CATEGORY II					
SHUT-OFF PSIA			LOCATION:		
LINE SIZE/SCHED	17.5" ID 4" WALL		DESIGN PRESS. 2400	TEMP. 1000 °F	
SIZING DATA	MINIMUM		NORMAL	MAXIMUM	
INLET PSIA	2520		1000		
OUTLET PSIA	150		150		
SP. GR. OR (MW)					
FLOW RATE	533,333		533,333		
TEMP °F	1000 °F		1000 °F		
C _v REQUIRED	15.3		413		
C _v ACTUAL	*		PLANT LINE NO.		
FLUID	STEAM				
S & W SEAT LEAK CLASS	CLASS 2				
BODY-FORM	*		ACCESSORIES		
-SIZE (IN.)	*		AIR SET (W/GAGE)	YES - 2	
-ANSI RATING/CONN	2500 th / B.W		LUBRICATOR (W/ISOL. VALVE)	NO	
MATERIAL (ASTM)-BODY	CR MOLY		HANDWHEEL	YES	
-BONNET	*		POSITIONER	YES	
TRIM-CHARACTERISTIC	= 0%		MFG/MODEL	* 1	
-NO. PORTS	ONE		INPUT/OUTPUT	3-15 / *	
-PORT SIZE (IN)	FULL PORT		TRANSDUCER	YES	
-MATERIAL-PLUG	*		MFG/MODEL	* 1	
-SEAT	*		INPUT/OUTPUT	4-20MA / 3-15	
GUIDE	*		CONNS-ELEC/PNEU.	1/2" NPT 1/4" NPT	
BONNET	FLANGED/INTERNAL		SOLENOID VALVE TYPE	3-WAY	
PACKING	GRAFOIL 187/I		MFG./MODEL	*	
BACK SEAT	NO		ENERGIZE TO	OPEN / VALVE	
LEAK-OFF CONN.	NO		SOL COIL ENCL.	NEMA 4	
ACTION-AIR TO	CLOSE		ELECT. CONNS.	NEMA 1/2" NPT	
FLOW-TENDS TO	OPEN		BODY CONNS.	1/4" NPT	
ACTUATOR-TYPE	*		LIMIT SWITCH	YES	
-SIZE	*		MFG/MODEL	*	
-STROKE IN.	*		OPEN POSITION	2 SPDT	
AIR TO ACTUATOR	*		CLOSE POSITION	2 SPDT	
CALC. NOISE (dBA)	*		ENCLOSURE	NEMA 4	
VELOCITY (FPS)	*		CONDUIT SIZE	1/2"	
MANUFACTURER	*		SEISMIC DATA REQUIRED	NO	
MODEL NO.	*		WEIGHT (NET)	*	

- NOTES: 1. * INDICATES INFORMATION TO BE SUPPLIED BY MFG.
2. VALVE BODY CR. MOLY AS PER ANSI B16.34, 1977
3. MAX AIR PRESSURE FOR VALVE OPERATION WILL BE 60 PSIG

REV	1		2		3		4	
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART A
CONTROL VALVE

CLIENT ERDA
PROJECT AFB STUDY

PREPARER
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INITIAL DATE
GB7 11-30-77

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PAGE
SPEC. NO. 12919.02A
J.O. NO.

BABCOCK & WILCOX DESIGN

EQUIP. NO 4CV-512		No. REQ'D 1		FSK- EM-105A	
SERVICE HP BYPASS DESUPERHEATER SPRAY CONTROL VALVE				ASME CODE — CLASS — S & W CATEGORY II	
SHUT-OFF PSIA 1000		LOCATION:			
LINE SIZE/SCHED		DESIGN PRESS. 1000		TEMP.	
SIZING DATA		MINIMUM		NORMAL	
INLET PSIA				1000	
OUTLET PSIA				250	
SP. GR. OR (MW)				—	
FLOW RATE				1134	
TEMP °F				304°F	
C _v REQUIRED				39	
C _v ACTUAL *				PLANT LINE NO.	
FLUID		WATER			
S & W SEAT LEAK CLASS		2			
BODY-FORM		GLOBE		ACCESSORIES	
-SIZE (IN.) *				AIR SET (W/GAGE) YES-2	
-ANSI RATING/CONN *		1		LUBRICATOR (W/ISOL. VALVE) NO	
MATERIAL (ASTM)-BODY *				HANDWHEEL YES	
-BONNET *				POSITIONER YES	
-TRIM-CHARACTERISTIC		= 0%		MFG/MODEL * 1	
-NO. PORTS		ONE		INPUT/OUTPUT 3-15 / *	
-PORT SIZE (IN)		FULL PORT		TRANSDUCER YES	
-MATERIAL-PLUG *				MFG/MODEL 3-15 / *	
-SEAT *				INPUT/OUTPUT 4-20MA / 3-15 PSI	
GUIDE *				CONNS-ELEC/PNEU. 1/2" NPT 1/4" NPT	
BONNET		FLANGED/ WELDED		SOLENOID VALVE TYPE 3-WAY	
PACKING		TEFLON V-RING		MFG./MODEL *	
BACK SEAT		NO		ENERGIZE TO OPEN / VALVE	
LEAK-OFF CONN.		NO		SOL. COIL ENCL. NEMA 4	
ACTION-AIR TO		OPEN		ELECT. CONNS. NEMA 1/2" NPT	
FLOW-TENDS TO		CLOSE		BODY CONNS. 1/4" NPT	
ACTUATOR-TYPE		DIAPHRAGM		LIMIT SWITCH YES	
-SIZE *				MFG/MODEL *	
-STROKE IN. *				OPEN POSITION 2 SPDT	
AIR TO ACTUATOR *				CLOSE POSITION 2 SPDT	
CALC. NOISE (dBA) *				ENCLOSURE NEMA 4	
VELOCITY (FPS) *				CONDUIT SIZE 1/2"	
MANUFACTURER *				SEISMIC DATA REQUIRED NO	
MODEL NO. *				WEIGHT (NET) *	

NOTES: 1. * INDICATES INFORMATION SUPPLIED BY MFG
2. CAVITATION PROTECTION REQUIRED

REV	1	2	3	4
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART A
CONTROL VALVE

CLIENT ERDA
PROJECT AFB STUDY

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SPECIALIST

INITIAL DATE
GB7 11-30-77

T.D.S. NO. VI
PAGE
SPEC. NO.
J.O. NO. 12919.02 A

BABCOCK & WILCOX DESIGN

EQUIP. NO 4PCV-560A, B, C, D		No. REQ'D 4		FSK-EM-102A	
SERVICE REHEATER COOLING INLET CONTROL VALVE				ASME CODE - CLASS - S & W CATEGORY II	
SHUT-OFF PSIA 2520		LOCATION:			
LINE SIZE/SCHED 17.5" ID 4" WALL		DESIGN: PRESS.		TEMP.	
SIZING DATA		MINIMUM		NORMAL MAXIMUM	
INLET PSIA		2520			
OUTLET PSIA		700			
SP. GR. OR (MW)		-			
FLOW RATE		400,000 lb/hr			
TEMP °F		1000°F			
C _v REQUIRED		119			
C _v ACTUAL *		PLANT LINE NO.			
FLUID		STEAM			
S & W SEAT LEAK CLASS		CLASS 2			
BODY-FORM *		ACCESSORIES			
-SIZE (IN.) *		AIR SET (W/GAGE)		YES-2	
-ANSI RATING/CONN		2500# 1 B W		LUBRICATOR (W/ISOL. VALVE)	
MATERIAL (ASTM)-BODY		CR. MOLY		HANDWHEEL	
-BONNET *		POSITIONER		YES	
TRIM-CHARACTERISTIC		= 90		MFG/MODEL *	
-NO. PORTS		ONE		INPUT/OUTPUT	
-PORT SIZE (IN)		FULL PORT		TRANSDUCER	
-MATERIAL-PLUG *		MFG/MODEL *		1	
-SEAT *		INPUT/OUTPUT		4-20MA / 3-15	
GUIDE *		CONNS-ELEC/PNEU.		1/2 NPT / 1/4 NPT	
BONNET		FLANGED/ WELDED		SOLENOID VALVE TYPE	
PACKING		GRAFOIL 187/I		MFG./MODEL *	
BACK SEAT		NO		ENERGIZE TO	
LEAK-OFF CONN.		NO		SOL COIL ENCL.	
ACTION-AIR TO		CLOSE		ELECT. CONNS.	
FLOW-TENDS TO		OPEN		BODY CONNS.	
ACTUATOR-TYPE *		LIMIT SWITCH		YES	
-SIZE *		MFG/MODEL *			
-STROKE IN. *		OPEN POSITION		2 SPDT	
AIR TO ACTUATOR *		CLOSE POSITION		2 SPDT	
CALC. NOISE (dBA) *		ENCLOSURE		NEMA 4	
VELOCITY (FPS) *		CONDUIT SIZE		1/2	
MANUFACTURER *		SEISMIC DATA REQUIRED		NO	
MODEL NO. *		WEIGHT (NET) *			

NOTES: 1. INDICATES INFORMATION TO BE SUPPLIED BY MFR.
2. VALVE BODY CR. MOLY AS PER ANSI B16.34, 1977
3. MAX AIR PRESSURE FOR VALVE OPERATION WILL BE 60 PSIG

REV	1		2		3		4	
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART A
CONTROL VALVE

CLIENT ERDA
PROJECT AFB STUDY

PREPARER
SPECIALIST

INITIAL DATE
GB 7 11-30-97

T.D.S. NO. VI
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SPEC. NO.
J.O. NO. 12919.02A

BABCOCK & WILCOX DESIGN

EQUIP. NO 4CV-526		No. REQ'D 1		FSK-EM-10S A	
SERVICE REHEATER COOLING INLET		ASME CODE —		CLASS —	
STEAM DESUPERHEATER SPRAY CONTROL VALVE		S & W CATEGORY II			
SHUT-OFF PSIA 1000		LOCATION:			
LINE SIZE/SCHED		DESIGN: PRESS.		TEMP.	
SIZING DATA		MINIMUM		NORMAL	
INLET PSIA				1000	
OUTLET PSIA				800	
SP. GR. OR (MW)				—	
FLOW RATE				668 GPM	
TEMP °F				304 °F	
C _v REQUIRED				45	
C _v ACTUAL *		PLANT LINE NO.			
FLUID		WATER			
S & W SEAT LEAK CLASS		2			
BODY-FORM		GLOBE		ACCESSORIES	
-SIZE (IN.) *				AIR SET (W/GAGE) YES-2	
-ANSI RATING/CONN *		1		LUBRICATOR (W/ISOL. VALVE) NO	
MATERIAL (ASTM)-BODY *				HANDWHEEL YES	
-BONNET *				POSITIONER YES	
TRIM-CHARACTERISTIC		= 90		MFG/MODEL * 1	
-NO. PORTS		ONE		INPUT/OUTPUT 3-15 1 *	
-PORT SIZE (IN.)		FULL PORT		TRANSDUCER YES	
-MATERIAL-PLUG *				MFG/MODEL * 1	
-SEAT *				INPUT/OUTPUT 4-20 MA / 3-15	
GUIDE *				CONNS-ELEC/PNEU. 1/2 NPT / 1/4 NPT	
BONNET		FLANGED/ WELDED		SOLENOID VALVE TYPE 3-WAY	
PACKING		TEFLON V-RING		MFG./MODEL *	
BACK SEAT		NO		ENERGIZE TO OPEN / VALVE	
LEAK-OFF CONN.		NO		SOL COIL ENCL. NEMA 4	
ACTION-AIR TO		OPEN		ELECT. CONNS. NEMA 1/2" NPT	
FLOW-TENDS TO		CLOSE		BODY CONNS. 1/4 NPT	
ACTUATOR-TYPE		DIAPHRAGM		LIMIT SWITCH YES	
-SIZE *				MFG/MODEL *	
-STROKE IN. *				OPEN POSITION 2 SPDT	
AIR TO ACTUATOR				CLOSE POSITION 2 SPDT	
CALC. NOISE (dBA) *				ENCLOSURE NEMA 4	
VELOCITY (FPS) *				CONDUIT SIZE 1/2	
MANUFACTURER *				SEISMIC DATA REQUIRED NO	
MODEL NO. *				WEIGHT (NET) *	

NOTES: 1. * INDICATES INFORMATION SUPPLIED BY MFR

4193

REV	1		2		3		4	
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART A
CONTROL VALVE

CLIENT ERDA
PROJECT AFB STUDY

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INITIAL DATE
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BARCOCK & WILCOX DESIGN

EQUIP. NO 4PCV-561A,B,C,D		No. REQ'D 4		FSK- EM-102A	
SERVICE REHEATER COOLING OUTLET STEAM CONTROL VALVE		ASME CODE —		CLASS —	
		S & W CATEGORY II			
SHUT-OFF PSIA 750		LOCATION:			
LINE SIZE/SCHED 12" ID 901C		DESIGN PRESS.		TEMP	
SIZING DATA		MINIMUM		NORMAL	
INLET PSIA		675			
OUTLET PSIA		150			
SP. GR. OR (MW)		—			
FLOW RATE		400,000 lbs/hr			
TEMP °F		1000 °F			
C _v REQUIRED		486			
C _v ACTUAL *		PLANT LINE NO.			
FLUID		STEAM			
S & W SEAT LEAK CLASS		CLASS 2			
BODY-FORM *		ACCESSORIES			
-SIZE (IN.) *		AIR SET (W/GAGE)		YES-2	
-ANSI RATING/CONN		900# / B.W		LUBRICATOR (W/ISOL. VALVE)	
MATERIAL (ASTM)-BODY		CR MOLY		HANDWHEEL	
-BONNET *		POSITIONER		YES	
TRIM-CHARACTERISTIC		=90		MFG/MODEL *	
-NO. PORTS		ONE		INPUT/OUTPUT	
-PORT SIZE (IN.)		FULL PORT		TRANSDUCER	
-MATERIAL-PLUG *		MFG/MODEL *		1	
-SEAT *		INPUT/OUTPUT		4-20MA/3-15	
GUIDE *		CONNS-ELEC/PNEU.		1/2 NPT / 1/4 NPT	
BONNET		FLANGED/ W/CONNS		SOLENOID VALVE TYPE	
PACKING		GRAFOIL 187/I		MFG./MODEL *	
BACK SEAT		NO		ENERGIZE TO	
LEAK-OFF CONN.		NO		SOL. COIL ENCL.	
ACTION-AIR TO		CLOSE		ELECT. CONNS.	
FLOW-TENDS TO		OPEN		BODY CONNS.	
ACTUATOR-TYPE *		LIMIT SWITCH		YES	
-SIZE *		MFG/MODEL *			
-STROKE IN. *		OPEN POSITION		2 SPDT	
AIR TO ACTUATOR *		CLOSE POSITION		2 SPDT	
CALC. NOISE (dBA) *		ENCLOSURE		NEMA 4	
VELOCITY (FPS) *		CONDUIT SIZE		1/2	
MANUFACTURER *		SEISMIC DATA REQUIRED		NO	
MODEL NO. *		WEIGHT (NET) *			

NOTES: 1. * INDICATES INFORMATION TO BE SUPPLIED BY MFR.

2. MAX AIR PRESSURE FOR VALVE OPERATION WILL BE 60 PSIG

3. VALVE BODY CR MOLY AS PER ANSI B16.34, 1977

REV	1		2		3		4	
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART A
CONTROL VALVE

CLIENT
PROJECT

PREPARER
SPECIALIST

INITIAL DATE
GB7 11-30-77

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SPEC. NO.
J.O. NO. 12419.02A

BABCOCK & WILCOX DESIGN

EQUIP. NO 4CV-518A, B		No. REQ'D 2		FSK-EM-105A	
SERVICE REHEATER COOLING OUTLET		ASME CODE —		CLASS —	
STEAM DESUPERHEATER SPRAY CONTROL VALVE		S & W CATEGORY II			
SHUT-OFF PSIA 1000		LOCATION:			
LINE SIZE/SCHED		DESIGN: PRESS.		TEMP	
SIZING DATA		MINIMUM		NORMAL	
INLET PSIA		1000			
OUTLET PSIA		250			
SP. GR. OR (MW)					
FLOW RATE		1376 GPM			
TEMP °F		304 °F			
C _v REQUIRED		48			
C _v ACTUAL *		PLANT LINE NO.			
FLUID WATER					
S & W SEAT LEAK CLASS 2					
BODY-FORM GLOBE		ACCESSORIES			
-SIZE (IN.) *		AIR SET (W/GAGE)		YES-2	
-ANSI RATING/CONN *		LUBRICATOR (W/ISOL. VALVE)		NO	
MATERIAL (ASTM)-BODY *		HANDWHEEL		YES	
-BONNET *		POSITIONER		YES	
TRIM-CHARACTERISTIC = 1/2		MFG/MODEL *		1	
-NO. PORTS ONE		INPUT/OUTPUT		3-15 / *	
-PORT SIZE (IN) FULL PORT		TRANSDUCER		YES	
-MATERIAL-PLUG *		MFG/MODEL *		1	
-SEAT *		INPUT/OUTPUT		4-20MA / 3-15	
GUIDE *		CONNS-ELEC/PNEU.		1/2 NPT 1/4 NPT	
BONNET FLANGED/ TEFLON		SOLENOID VALVE TYPE		3-WAY	
PACKING TEFLON V-RING		MFG./MODEL *			
BACK SEAT NO		ENERGIZE TO		OPEN / VALVE	
LEAK-OFF CONN. NO		SOL COIL ENCL.		NEMA 4	
ACTION-AIR TO OPEN		ELECT. CONNS.		1/2" NPT	
FLOW-TENDS TO CLOSE		BODY CONNS.		1/4 NPT	
ACTUATOR-TYPE DIAPHRAGM		LIMIT SWITCH		YES	
-SIZE *		MFG/MODEL *			
-STROKE IN. *		OPEN POSITION		2 SPDT	
AIR TO ACTUATOR *		CLOSE POSITION		2 SPDT	
CALC. NOISE (dBA) *		ENCLOSURE		NEMA 4	
VELOCITY (FPS) *		CONDUIT SIZE		1/2	
MANUFACTURER *		SEISMIC DATA REQUIRED		NO	
MODEL NO. *		WEIGHT (NET) *			
NOTES: 1. * INDICATES INFORMATION SUPPLIED BY MFR 2. CAVITATION PROTECTION REQUIRED					
495					
REV	1	2	3	4	

STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART A
ELECTRONIC DIFFERENTIAL
PRESSURE / FLOW TRANSMITTERS

T.D.S. NO. P9

INITIAL DATE

PAGE

PREPARER
SPECIALIST

GB7 11-30-77

SPEC. NO.

J.O. NO. 12919.02A

CLIENT ERDA

PROJECT AFB STUDY

BABCOCK & WILCOX DESIGN

EQUIP. NO.	4FIT-516	4FIT-523	4FIT-531
SERVICE	TURB BYPASS DESUP SPRAY WATER FLOW	RHTR COOL OUTLET STAM DESUP SPRAY WATER FLOW	RHTR COOL INLT STAM DESUP SPRAY WATER FLOW
OPERATING CONDITIONS			
FLUID	WATER	WATER	WATER
TEMPERATURE °F	304	304	304
PRESSURE PSIG	1000	1000	1000
TEMP. LIMITS			
PRESS. LIMITS			
TYPE	INDICATING	INDICATING	INDICATING
CASE	NEMA 4	NEMA 4	NEMA 4
MOUNTING			
ELEMENT MATERIAL	316SS	316SS	316SS
BODY MATERIAL	304SS	304SS	304SS
MAX. PRESSURE RATING			
CONNECTIONS	1/2" NPT	1/2" NPT	1/2" NPT
DIFFERENTIAL RANGE			
OVERRRANGE PROTECTION TO			
SPAN LIMITS			
CONDUIT CONN. SIZE	3/4 NPT	3/4 NPT	3/4 NPT
OUTPUT SIGNAL	4-20MA DC	4-20MA DC	4-20MA DC
OUTPUT SIGNAL TO			
ACCESSORIES			
MANUFACTURER	*		
MODEL NO.	*		
WEIGHT	*		
CATEGORY			
NOTES:			
REV.	1	2	3
			4

STONE & WEBSTER ENG. LERING CORPORATION
TECHNICAL DATA SHEET-PART A
THERMOCOUPLES WITH THERMOWELLS

CLIENT ERDA
PROJECT AFB STUDY

	INITIAL	DATE
PREPARER	POZ	11-30-77
SPECIALIST		

T.D.S. NO. T3
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J.O. NO. 12919.02 A

BABCOCK & WILCOX DESIGN

[illegible]

STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART A
INDICATING FIELD MOUNTED
PRESSURE CONTROLLER

CLIENT ERDA

PROJECT AFB STUDY

BABCOCK &

WILCOX DESIGN

PREPARER
SPECIALIST

INITIAL DATE

FBZ 11-30-77

T.D.S. NO P6

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J.O. NO. 12919.024

EQUIP. NO.	4PC-562		
SERVICE	HOT REHEAT OUTLET HDR PSV CONTROL		
OPERATING CONDITIONS			
TEMPERATURE F°	1000		
PRESSURE PSIG	700		
ELEMENT TYPE			
ELEMENT MATERIAL			
CASE MOUNTING			
RANGE			
O' RANGE PROT. TO *			
CONTROL			
OUTPUT SIGNAL	3-15 PSI		
OUTPUT SIGNAL TO	4PSV-562A, 4PSV-562B		
ACTION	DIRECT		
MODES	PR		
PROCESS CONN. SIZE	1/2 NPT		
PNEUMATIC CONN. SIZE	1/4 NPT		
SUPPLY PRESSURE	20 PSI		
ACCURACY *			
REPEATABILITY *			
DEADBAND *			
M/A STATION	YES		
MANUFACTURER *			
MODEL NO. *			
WEIGHT *			
CATEGORY			
ACCESSORIES			

NOTES: 1. * MANUFACTURER SUPPLIED

REV.	1		2		3		4	
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART A
PRESSURE INDICATORS

CLIENT ERDA
PROJECT AFB STUDY

**PREPARER
SPECIALIST**

INITIAL DATE

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BARBOCK & WILCOX DESIGN

[illegible]

NOTES:

EQUIPMENT COMMON TO
BABCOCK & WILCOX AND FOSTER WHEELER

STONE & WEBSTER ENGINEERING CORPORATION
 TECHNICAL DATA SHEET - PART C
 ELECTRONIC DIFFERENTIAL
 PRESSURE / FLOW TRANSMITTERS

T.D.S. NO. P9

CLIENT **ERDA**
 PROJECT **AFB STUDY**

PREPARER
 SPECIALIST

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GBT **11-15-77**

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EQUIP. NO.	4LIT-2	4LIT-3	4LIT-13	4LIT-12
SERVICE	DEAERATOR STORAGE TANK LEVEL	CONDENSER HOT WELL LEVEL	CONDENSER HOT WELL LEVEL	DEAERATOR LEVEL CONTROL
OPERATING CONDITIONS				
FLUID	WATER	WATER	WATER	WATER
TEMPERATURE °F	300	129	129	300
PRESSURE PSIG	45	30" Hg VAC	30" Hg VAC	45
TEMP. LIMITS				
PRESS. LIMITS				
TYPE	INDICATING	INDICATING	INDICATING	INDICATING
CASE	NEMA-4	NEMA-4	NEMA-4	NEMA-4
MOUNTING				
ELEMENT MATERIAL	316 SS	316 SS	316 SS	316 SS
BODY MATERIAL	304 SS	304 SS	304 SS	304 SS
MAX. PRESSURE RATING	1500	1500	1500	1500
CONNECTIONS	1/2 IN NPT	1/2 IN. NPT	1/2 IN. NPT	1/2 IN. NPT
DIFFERENTIAL RANGE				
OVERRANGE PROTECTION TO				
SPAN LIMITS				
CONDUIT CONN. SIZE	3/4 IN NPT	3/4 IN. NPT	3/4 IN. NPT	3/4 IN NPT
OUTPUT SIGNAL	4-20 MA DC	4-20 MA DC	4-20 MA DC	4-20 MA DC
OUTPUT SIGNAL TO	4LIR-2	4LIR-3	4LIR-13	4LC-24A
ACCESSORIES				
MANUFACTURER *				
MODEL NO. *				
WEIGHT *				
CATEGORY				
NOTES:				
REV.	1	2	3	4

STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART C
ELECTRONIC DIFFERENTIAL
PRESSURE / FLOW TRANSMITTERS

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EQUIP. NO.	4LIT-14A	4LIT-14B		
SERVICE	6" PT LTR DRAIN TANK LEVEL	5" PT LTR DRAIN TANK LEVEL		
OPERATING CONDITIONS				
FLUID	WATER	WATER		
TEMPERATURE °F	200	265		
PRESSURE PSIG	-3	25		
TEMP. LIMITS				
PRESS. LIMITS				
TYPE	INDICATING	INDICATING		
CASE	NEMA-4	NEMA-4		
MOUNTING				
ELEMENT MATERIAL	316SS	316SS		
BODY MATERIAL	304SS	304SS		
MAX. PRESSURE RATING				
CONNECTIONS	1/2 IN. NPT	1/2 IN. NPT		
DIFFERENTIAL RANGE				
OVERRANGE PROTECTION TO				
SPAN LIMITS				
CONDUIT CONN. SIZE	3/4 IN. NPT	3/4 IN. NPT		
OUTPUT SIGNAL	4-20MA DC	4-20MA DC		
OUTPUT SIGNAL TO	4LIR-14A	4LIR-14B		
ACCESSORIES				
MANUFACTURER	*			
MODEL NO.	*			
WEIGHT	*			
CATEGORY				
NOTES:				
REV.	1	2	3	4

STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART C
ELECTRONIC PRESSURE TRANSMITTERS

CLIENT *ERDA*
PROJECT *AFB STUDY*

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EQUIP. NO.	<i>4LIT-7</i>			
SERVICE	<i>COOLING TOWER CIRC WTR LEVEL</i>			
OPERATING CONDITIONS				
FLUID OR GAS	<i>WATER</i>			
TEMPERATURE °F	<i>92</i>			
PRESSURE PSIG	<i>ATMOS</i>			
ELEMENT TYPE				
ELEMENT MATERIAL	<i>316SS</i>			
ENCLOSURE (NEMA TYPE)	<i>NEMA 4</i>			
MOUNTING				
BODY MATERIAL	<i>304SS</i>			
RANGE				
OVERRANGE PROTECTION TO				
SPAN LIMITS				
OUTPUT SIGNAL	<i>4-20 MA DC</i>			
OUTPUT SIGNAL TO	<i>4LR-7, SLCV-18</i>			
PROCESS CONN. SIZE	<i>1/2 IN NPT</i>			
CONDUIT CONN. SIZE	<i>3/4 IN NPT</i>			
ACCURACY				
REPEATIBILITY				
DEADBAND				
ACCESSORIES				
MANUFACTURER	*			
MODEL NO.	*			
WEIGHT	*			
CATEGORY				

NOTES:

STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART C
ELECTRONIC DIFFERENTIAL
PRESSURE / FLOW TRANSMITTERS

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EQUIP. NO.	4FIT-2	4FIT-5	4FIT-6	4FIT-7
SERVICE	FD WTR ECON INLT FLOW	FD WTR ECON. INLT FLOW	FD WTR FLOW TO REHEAT DESPHTRS	FD WTR FLOW TO SPNTR DESPHTRS
OPERATING CONDITIONS				
FLUID	WATER	WATER	WATER	WATER
TEMPERATURE °F	485	485	485	485
PRESSURE PSIG	2900	2900	2900	2900
TEMP. LIMITS				
PRESS. LIMITS				
TYPE	INDICATING	INDICATING	INDICATING	INDICATING
CASE	NEMA-4	NEMA-4	NEMA-4	NEMA-4
MOUNTING				
ELEMENT MATERIAL	316SS	316SS	316SS	316SS
BODY MATERIAL	304SS	304SS	304SS	304SS
MAX. PRESSURE RATING				
CONNECTIONS	1/2 IN NPT	1/2 IN NPT	1/2 IN. NPT	1/2 IN. NPT
DIFFERENTIAL RANGE				
OVERRANGE PROTECTION TO				
SPAN LIMITS				
CONDUIT CONN. SIZE	3/4 NPT	3/4 NPT	3/4 NPT	3/4 NPT
OUTPUT SIGNAL	4-20MA DC	4-20 MA DC	4-20 MA DC	4-20 MA DC
OUTPUT SIGNAL TO	4R-4-1			
ACCESSORIES				
MANUFACTURER *				
MODEL NO. *				
WEIGHT *				
CATEGORY				

NOTES:

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STONE & WEBSTER ENGINEERING CORPORATION
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EQUIP. NO.	4FIT-10	4FIT-14	4FIT-29	4FIT-206
SERVICE	BFP 4-1 RECIRC FLOW CONTROL	START-UP BFP SUCTION FLOW	LP STM FLOW TO BFP TURB	HP STM FLOW TO BFP TURB
OPERATING CONDITIONS				
FLUID	WATER	WATER	STEAM	STEAM
TEMPERATURE °F	300	300	716	1000
PRESSURE PSIG	85	85	155	2520
TEMP. LIMITS				
PRESS. LIMITS				
TYPE	INDICATING	INDICATING	INDICATING	INDICATING
CASE	NEMA-4	NEMA-4	NEMA-4	NEMA-4
MOUNTING				
ELEMENT MATERIAL	316SS	316SS	316SS	316SS
BODY MATERIAL	304SS	304SS	304SS	304SS
MAX. PRESSURE RATING	1500	1500	1500	2000
CONNECTIONS	1/2 IN NPT	1/2 IN NPT	1/2 IN NPT	1/2 IN NPT
DIFFERENTIAL RANGE				
OVERRANGE PROTECTION TO				
SPAN LIMITS				
CONDUIT CONN. SIZE	3/4 NPT	3/4 NPT	3/4 NPT	3/4 NPT
OUTPUT SIGNAL	4-20MA DC	4-20MA DC	4-20MA DC	4-20MA DC
OUTPUT SIGNAL TO	4FI-29, 4CV-5	4FI-41		
ACCESSORIES				
MANUFACTURER *				
MODEL NO. *				
WEIGHT *				
CATEGORY				
NOTES:				
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STONE & WEBSTER ENGINEERING CORPORATION
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ELECTRONIC DIFFERENTIAL
PRESSURE / FLOW TRANSMITTERS

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EQUIP. NO.	<i>4FIT-205</i>	<i>4FIT-15</i>	<i>4FIT-10A</i>	<i>4FIT-26</i>
SERVICE	<i>LP COND SR OPEN LOOP COOL WTR FLOW</i>	<i>COOL TWR MU PP DISCH FLOW</i>	<i>CONDENSATE PPS RECIRC CONTROL</i>	<i>CONDENSATE FLOW</i>
OPERATING CONDITIONS				
FLUID	<i>WATER</i>	<i>WATER</i>	<i>WATER</i>	<i>WATER</i>
TEMPERATURE °F	<i>92</i>	<i>55</i>	<i>130</i>	<i>141</i>
PRESSURE PSIG	<i>43</i>	<i>50</i>	<i>325</i>	<i>325</i>
TEMP. LIMITS				
PRESS. LIMITS				
TYPE	<i>INDICATING</i>	<i>INDICATING</i>	<i>INDICATING</i>	<i>INDICATING</i>
CASE	<i>NEMA-4</i>	<i>NEMA-4</i>	<i>NEMA-4</i>	<i>NEMA-4</i>
MOUNTING				
ELEMENT MATERIAL	<i>316 SS</i>	<i>316 SS</i>	<i>316 SS</i>	<i>316 SS</i>
BODY MATERIAL	<i>304 SS</i>	<i>304 SS</i>	<i>304 SS</i>	<i>304 SS</i>
MAX. PRESSURE RATING	<i>1500</i>	<i>1500</i>	<i>1500</i>	<i>1500</i>
CONNECTIONS	<i>1/2 IN NPT</i>	<i>1/2 IN NPT</i>	<i>1/2 IN NPT</i>	<i>1/2 IN NPT</i>
DIFFERENTIAL RANGE				
OVERRANGE PROTECTION TO				
SPAN LIMITS				
CONDUIT CONN. SIZE	<i>3/4 NPT</i>	<i>3/4 NPT</i>	<i>3/4 NPT</i>	<i>3/4 NPT</i>
OUTPUT SIGNAL	<i>4-20 MA DC</i>	<i>4-20 MA DC</i>	<i>4-20 MA DC</i>	<i>4-20 MA DC</i>
OUTPUT SIGNAL TO			<i>4CV-6</i>	<i>4FRI-26, 4R-3-1</i>
ACCESSORIES				
MANUFACTURER *				
MODEL NO. *				
WEIGHT *				
CATEGORY				

NOTES:

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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART C
ELECTRONIC PRESSURE TRANSMITTERS

CLIENT *ERDA*
PROJECT *AFB STUDY*

PREPARER
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EQUIP. NO.	<i>4PIT-1</i>	<i>4PIT-4</i>	<i>4PIT-9</i>	
SERVICE	<i>MAIN STEAM HEADER PRESS</i>	<i>HP TURB INTERSTAGE PRESS</i>	<i>HOT REHEAT PRESS</i>	
OPERATING CONDITIONS				
FLUID OR GAS	<i>STEAM</i>	<i>STEAM</i>	<i>STEAM</i>	
TEMPERATURE °F	<i>1000</i>		<i>1000</i>	
PRESSURE PSIG	<i>2520</i>		<i>545</i>	
ELEMENT TYPE	<i>INDICATING</i>	<i>INDICATING</i>	<i>INDICATING</i>	
ELEMENT MATERIAL	<i>316 SS</i>	<i>316 SS</i>	<i>316 SS</i>	
ENCLOSURE (NEMA TYPE)	<i>NEMA-4</i>	<i>NEMA-4</i>	<i>NEMA-4</i>	
MOUNTING	<i>PIPE</i>			
BODY MATERIAL				
RANGE PSIG	<i>0 - 3500</i>		<i>0 - 1000</i>	
OVERRANGE PROTECTION TO				
SPAN LIMITS				
OUTPUT SIGNAL	<i>4-20MA DC</i>	<i>4-20MA DC</i>	<i>4-20MA DC</i>	
OUTPUT SIGNAL TO	<i>4PI-10</i>	<i>4PI-23</i>	<i>4PI-12</i>	
PROCESS CONN. SIZE	<i>1/2 NPT</i>	<i>1/2 NPT</i>	<i>1/2 NPT</i>	
CONDUIT CONN. SIZE	<i>3/4 NPT</i>	<i>3/4 NPT</i>	<i>3/4 NPT</i>	
ACCURACY				
REPEATABILITY				
DEADBAND				
ACCESSORIES				
MANUFACTURER	*			
MODEL NO.	*			
WEIGHT	*			
CATEGORY				

NOTES:

REV.	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET-PART C
ELECTRONIC PRESSURE TRANSMITTERS

CLIENT *ERDA*
PROJECT *AFB STUDY*

PREPARER *GBZ* INITIAL *11-15-77*
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EQUIP. NO.		<i>4PIT-57</i>	<i>4PIT-5A</i>	<i>4PIT-5B</i>
SERVICE		<i>MAIN STEAM PRESS</i>	<i>LP(A) TURB EXH PRESS</i>	<i>LP(B) TURB EXH PRESS</i>
OPERATING CONDITIONS				
FLUID OR GAS		<i>STEAM</i>	<i>STEAM</i>	<i>STEAM</i>
TEMPERATURE °F		<i>1000</i>	<i>129</i>	<i>129</i>
PRESSURE PSIG		<i>2520</i>	<i>30" Hg Vac</i>	<i>30" Hg Vac</i>
ELEMENT TYPE				
ELEMENT MATERIAL		<i>316SS</i>	<i>316SS</i>	<i>316SS</i>
ENCLOSURE (NEMA TYPE)		<i>NEMA-4</i>	<i>NEMA-4</i>	<i>NEMA-4</i>
MOUNTING				
BODY MATERIAL		<i>304SS</i>	<i>304SS</i>	<i>304SS</i>
RANGE				
OVERRANGE PROTECTION TO				
SPAN LIMITS				
OUTPUT SIGNAL		<i>4-20MA DC</i>	<i>4-20MA DC</i>	<i>4-20MA DC</i>
OUTPUT SIGNAL TO			<i>4PI-18A</i>	<i>4PI-18B</i>
PROCESS CONN. SIZE		<i>1/2 NPT</i>	<i>1/2 NPT</i>	<i>1/2 NPT</i>
CONDUIT CONN. SIZE		<i>3/4 NPT</i>	<i>3/4 NPT</i>	<i>3/4 NPT</i>
ACCURACY				
REPEATIBILITY				
DEADBAND				
ACCESSORIES				
MANUFACTURER *				
MODEL NO. *				
WEIGHT *				
CATEGORY				

NOTES:

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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET-PART C
ELECTRONIC PRESSURE TRANSMITTERS

CLIENT *ERDA*
PROJECT *AFB STUDY*

PREPARER *EST* INITIAL DATE *11-15-77*
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EQUIP. NO.	<i>4PIT-31</i>	<i>4PIT-32</i>	<i>4PIT-33</i>	<i>4PIT-37</i>
SERVICE	<i>IP THRB EXTR STM PRESS TO 2ND PT HTR</i>	<i>LP THRB EXTR STM PRESS TO DA TANK</i>	<i>IP THRB EXTR STM PRESS</i>	<i>HP THRB EXTR STM PRESS TO 1ST PT HTR</i>
OPERATING CONDITIONS				
FLUID OR GAS	<i>STEAM</i>	<i>STEAM</i>	<i>STEAM</i>	<i>STEAM</i>
TEMPERATURE °F	<i>836</i>	<i>506</i>	<i>716</i>	<i>626</i>
PRESSURE PSIG	<i>250</i>	<i>50</i>	<i>160</i>	<i>572</i>
ELEMENT TYPE				
ELEMENT MATERIAL	<i>316 SS</i>	<i>316 SS</i>	<i>316 SS</i>	<i>316 SS</i>
ENCLOSURE (NEMA TYPE)	<i>NEMA-4</i>	<i>NEMA-4</i>	<i>NEMA-4</i>	<i>NEMA-4</i>
MOUNTING				
BODY MATERIAL	<i>304 SS</i>	<i>304 SS</i>	<i>304 SS</i>	<i>304 SS</i>
RANGE				
OVERRANGE PROTECTION TO				
SPAN LIMITS				
OUTPUT SIGNAL	<i>4-20MA DC</i>	<i>4-20MA DC</i>	<i>4-20MA DC</i>	<i>4-20MA DC</i>
OUTPUT SIGNAL TO				
PROCESS CONN. SIZE	<i>1/2 NPT</i>	<i>1/2 NPT</i>	<i>1/2 NPT</i>	<i>1/2 NPT</i>
CONDUIT CONN. SIZE	<i>3/4 NPT</i>	<i>3/4 NPT</i>	<i>3/4 NPT</i>	<i>3/4 NPT</i>
ACCURACY				
REPEATABILITY				
DEADBAND				
ACCESSORIES				
MANUFACTURER	*			
MODEL NO.	*			
WEIGHT	*			
CATEGORY				

NOTES:

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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET-PART C
ELECTRONIC PRESSURE TRANSMITTERS

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EQUIP. NO.	<i>4PIT-38</i>	<i>4PIT-40</i>	<i>4PIT-305</i>	<i>4PIT-306</i>
SERVICE	<i>IP TURB EXTR STM PRESS TO 2ND PT HTR</i>	<i>IP TURB EXTR STM PRESS TO 3RD PT HTR</i>	<i>IP TURB EXTR STM PRESS TO BFP LP TURB</i>	<i>HP STM PRESS TO BFP HP TURB</i>
OPERATING CONDITIONS				
FLUID OR GAS	<i>STEAM</i>	<i>STEAM</i>	<i>STEAM</i>	<i>STEAM</i>
TEMPERATURE °F	<i>836</i>	<i>710</i>	<i>716</i>	<i>1000</i>
PRESSURE PSIG	<i>250</i>	<i>150</i>	<i>154</i>	<i>2520</i>
ELEMENT TYPE				
ELEMENT MATERIAL	<i>316SS</i>			
ENCLOSURE (NEMA TYPE)	<i>NEMA-4</i>	<i>NEMA-4</i>	<i>NEMA-4</i>	<i>NEMA-4</i>
MOUNTING				
BODY MATERIAL	<i>304SS</i>	<i>304SS</i>	<i>304SS</i>	<i>304SS</i>
RANGE				
OVERRANGE PROTECTION TO				
SPAN LIMITS				
OUTPUT SIGNAL	<i>4-20MA DC</i>	<i>4-20MA DC</i>	<i>4-20MA DC</i>	<i>4-20MA DC</i>
OUTPUT SIGNAL TO				
PROCESS CONN. SIZE	<i>1/2 NPT</i>	<i>1/2 NPT</i>	<i>1/2 NPT</i>	<i>1/2 NPT</i>
CONDUIT CONN. SIZE	<i>3/4 NPT</i>	<i>3/4 NPT</i>	<i>3/4 NPT</i>	<i>3/4 NPT</i>
ACCURACY				
REPEATIBILITY				
DEADBAND				
ACCESSORIES				
MANUFACTURER *				
MODEL NO. *				
WEIGHT *				
CATEGORY				

NOTES:

REV.	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART C
ELECTRONIC PRESSURE TRANSMITTERS

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EQUIP. NO.	4PIT-10	4PIT-11	4PIT-12	4PIT-26
SERVICE	CONDENSATE PUMP 4-1 DISCH PRESS	CONDENSATE PUMP 4-2 DISCH PRESS	BLR BOOSTER FD PUMP SUCTION PRESS	CONDENSATE PUMPS DISCH HDR
OPERATING CONDITIONS				
FLUID OR GAS	WATER	WATER	WATER	WATER
TEMPERATURE °F	129	129	293	129
PRESSURE PSIG	322	322	85	322
ELEMENT TYPE				
ELEMENT MATERIAL	316SS	316SS	316SS	316SS
ENCLOSURE (NEMA TYPE)	NEMA-4	NEMA-4	NEMA-4	NEMA-4
MOUNTING				
BODY MATERIAL	304SS	304SS	304SS	304SS
RANGE				
OVERRANGE PROTECTION TO				
SPAN LIMITS				
OUTPUT SIGNAL	4-20MA DC	4-20MA DC	4-20MA DC	4-20MA DC
OUTPUT SIGNAL TO	4PI-25	4PI-26	4PI-28	
PROCESS CONN. SIZE	1/2 NPT	1/2 NPT	1/2 NPT	1/2 VPT
CONDUIT CONN. SIZE	3/4 NPT	3/4 NPT	3/4 NPT	3/4 NPT
ACCURACY				
REPEATIBILITY				
DEADBAND				
ACCESSORIES				
MANUFACTURER	*			
MODEL NO.	*			
WEIGHT	*			
CATEGORY				

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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET-PART C
ELECTRONIC PRESSURE TRANSMITTERS

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J.O. NO. *12919.02*

EQUIP. NO.	<i>4PIT-39</i>	<i>4PIT-14</i>	<i>4PIT-28</i>	
SERVICE	<i>DEGENERATOR PRESSURE</i>	<i>BLR FD WTR ECON INT PRESS</i>	<i>BFP DISCH PRESS</i>	
OPERATING CONDITIONS				
FLUID OR GAS	<i>STEAM/WATER</i>	<i>WATER</i>	<i>WATER</i>	
TEMPERATURE °F	<i>293</i>	<i>484</i>	<i>299</i>	
PRESSURE PSIG	<i>45</i>	<i>2906</i>	<i>3052</i>	
ELEMENT TYPE				
ELEMENT MATERIAL	<i>316SS</i>	<i>316SS</i>	<i>316SS</i>	
ENCLOSURE (NEMA TYPE)	<i>NEMA - 4</i>	<i>NEMA - 4</i>	<i>NEMA - 4</i>	
MOUNTING				
BODY MATERIAL	<i>304SS</i>	<i>304SS</i>	<i>304SS</i>	
RANGE				
OVERRANGE PROTECTION TO				
SPAN LIMITS				
OUTPUT SIGNAL	<i>4-20 MA DC</i>	<i>4-20 MA DC</i>	<i>4-20 MA DC</i>	
OUTPUT SIGNAL TO		<i>4PI-13</i>	<i>4PI-7, BFP CONT</i>	
PROCESS CONN. SIZE	<i>1/2 NPT</i>	<i>1/2 NPT</i>	<i>1/2 NPT</i>	
CONDUIT CONN. SIZE	<i>3/4 NPT</i>	<i>3/4 NPT</i>	<i>3/4 NPT</i>	
ACCURACY				
REPEATABILITY				
DEADBAND				
ACCESSORIES				
MANUFACTURER	*			
MODEL NO.	*			
WEIGHT	*			
CATEGORY				

NOTES:

REV.	1	2	3	4
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET- PART C
ELECTRONIC PRESSURE TRANSMITTERS

CLIENT *ERDA*
PROJECT *AFB STUDY*

PREPARER
SPECIALIST

INITIAL DATE
GBF *11-15-77*

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EQUIP. NO.	<i>4PIT-41</i>	<i>4PIT-42</i>	<i>4PIT-44A</i>	<i>4PIT-44B</i>
SERVICE	<i>5th PT HTR DRAIN PRESS</i>	<i>6th PT HTR DRAIN PRESS</i>	<i>7th PT HTR 1A SHELL PRESS</i>	<i>7th PT HTR 1B SHELL PRESS</i>
OPERATING CONDITIONS				
FLUID OR GAS	<i>WATER</i>	<i>STEAM/WATER</i>	<i>STEAM/WATER</i>	<i>STEAM/WATER</i>
TEMPERATURE °F	<i>265</i>	<i>199</i>	<i>163</i>	<i>163</i>
PRESSURE PSIG	<i>25</i>	<i>-3</i>	<i>-9</i>	<i>-9</i>
ELEMENT TYPE				
ELEMENT MATERIAL	<i>316SS</i>	<i>316SS</i>	<i>316SS</i>	<i>316SS</i>
ENCLOSURE (NEMA TYPE)	<i>NEMA 4</i>	<i>NEMA 4</i>	<i>NEMA 4</i>	<i>NEMA 4</i>
MOUNTING				
BODY MATERIAL	<i>304SS</i>	<i>304SS</i>	<i>304SS</i>	<i>304SS</i>
RANGE				
OVERRANGE PROTECTION TO				
SPAN LIMITS				
OUTPUT SIGNAL	<i>4-20MA DC</i>	<i>4-20MA DC</i>	<i>4-20MA DC</i>	<i>4-20MA DC</i>
OUTPUT SIGNAL TO				
PROCESS CONN. SIZE	<i>1/2 NPT</i>	<i>1/2 NPT</i>	<i>1/2 NPT</i>	<i>1/2 NPT</i>
CONDUIT CONN. SIZE	<i>3/4 NPT</i>	<i>3/4 NPT</i>	<i>3/4 NPT</i>	<i>3/4 NPT</i>
ACCURACY				
REPEATIBILITY				
DEADBAND				
ACCESSORIES				
MANUFACTURER	*			
MODEL NO.	*			
WEIGHT	*			
CATEGORY				

NOTES:

REV.	1	2	3	4
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET-PART C
ELECTRONIC PRESSURE TRANSMITTERS

CLIENT *ERDA*
PROJECT *AFB STUDY*

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EQUIP. NO.	<i>4PIT-24</i>			
SERVICE	<i>CIRC WTR MU APS DISCH HDR PRESS</i>			
OPERATING CONDITIONS				
FLUID OR GAS	<i>WATER</i>			
TEMPERATURE °F.	<i>55</i>			
PRESSURE PSIG	<i>50</i>			
ELEMENT TYPE				
ELEMENT MATERIAL	<i>316SS</i>			
ENCLOSURE (NEMA TYPE)	<i>NEMA-4</i>			
MOUNTING				
BODY MATERIAL	<i>304SS</i>			
RANGE				
OVERRANGE PROTECTION TO				
SPAN LIMITS				
OUTPUT SIGNAL	<i>4-20 MA DC</i>			
OUTPUT SIGNAL TO				
PROCESS CONN. SIZE	<i>1/2 NPT</i>			
CONDUIT CONN. SIZE	<i>3/4 NPT</i>			
ACCURACY				
REPEATIBILITY				
DEADBAND				
ACCESSORIES				
MANUFACTURER	*			
MODEL NO.	*			
WEIGHT	*			
CATEGORY				

NOTES:

STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART C
ELECTRONIC DIFFERENTIAL
PRESSURE / FLOW TRANSMITTERS

T.D.S. NO. P9
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SPEC. NO.
J.O. NO. 12919.02

CLIENT ERDA
PROJECT AFB STUDY

PREPARER
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INITIAL DATE
GRT 11-15-77

EQUIP. NO.	4PDT-21			
SERVICE	PRESS DIFFER BET BFP DISCH AND ECON INLT			
OPERATING CONDITIONS				
FLUID	WATER			
TEMPERATURE °F				
PRESSURE PSIG				
TEMP. LIMITS	299/484			
PRESS. LIMITS	3052/2906			
TYPE				
CASE	NEMA 4			
MOUNTING				
ELEMENT MATERIAL	316SS			
BODY MATERIAL	304SS			
MAX. PRESSURE RATING				
CONNECTIONS	1/2 NPT			
DIFFERENTIAL RANGE				
OVERRANGE PROTECTION TO				
SPAN LIMITS				
CONDUIT CONN. SIZE	3/4 NPT			
OUTPUT SIGNAL	4-20MA DC			
OUTPUT SIGNAL TO				
ACCESSORIES				
MANUFACTURER	*			
MODEL NO.	*			
WEIGHT	*			
CATEGORY				

NOTES:

REV.	1		2		3		4	
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART C
INDICATING FIELD MOUNTED PNEUMATIC LEVEL CONTROLLER
(DISPLACER OR FLOAT)

CLIENT *ERDA*
 PROJECT *AFB STUDY*

PREPARER
 SPECIALIST

INITIAL DATE
GBZ *11-15-77*

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 J.O. NO. *12919.02*

EQUIP. NO.	<i>4LC-10</i>	<i>4LC-11</i>		
SERVICE	<i>CONDOR HOT WELL LEVEL CONTROL</i>	<i>CONDOR HOT WELL LEVEL CONTROL</i>		
OPERATING CONDITIONS				
LIQUID(S)	<i>STEAM/WATER</i>	<i>STEAM/WATER</i>		
SPECIFIC GRAVITY				
TEMPERATURE F	<i>129</i>	<i>129</i>		
PRESSURE PSIG	<i>30" Hg VAC</i>	<i>30" Hg VAC</i>		
TYPE				
BALL FLOAT TYPE				
BODY CASE MATERIAL				
CONNECTION SIZE & TYPE				
FLOAT MATERIAL				
ROD MATERIAL				
ROD LENGTH				
DISPLACER TYPE				
EXTERNAL OR INTERNAL				
DISPLACER MATERIAL *				
CONNECTION SIZE & TYPE				
TORQUE TUBE MATERIAL				
RANGE				
OVERRANGE PROTECTION TO CONTROL				
OUTPUT SIGNAL	<i>3-15 PSI</i>	<i>3-15 PSI</i>		
OUTPUT SIGNAL TO	<i>4LCV-10A, 10B</i>	<i>4LCV-11A, 11B</i>		
ACTION	<i>REVERSE</i>	<i>REVERSE</i>		
MODES	<i>PR</i>	<i>PR</i>		
SUPPLY PRESSURE	<i>20 PSI</i>	<i>20 PSI</i>		
PNEUMATIC CONNECTION SIZE	<i>1/4 IN</i>	<i>1/4 IN.</i>		
AMBIENT TEMP. LIMITS *				
ACCESSORIES				
MANUFACTURER *				
MODEL NO. *				
WEIGHT *				
CATEGORY				
NOTES: CONTROL ACTION: SPECIFY WHETHER CONTROL OUTPUT INCREASES OR DECREASES FOR MEASURED VARIABLE INCREASE. CONTROL MODES: P-PROPORTIONAL, R-RESET, D-DERIVATIVE.				
REV.	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>

STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART C
INDICATING FIELD MOUNTED PNEUMATIC LEVEL CONTROLLER
(DISPLACER OR FLOAT)

CLIENT *ERDA*
 PROJECT *AFB STUDY*

PREPARER
 SPECIALIST

INITIAL DATE
GAT *11-15-77*

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 J.O. NO. *12919.02*

EQUIP. NO.	<i>4LC-1A</i>	<i>4LC-1B</i>		
SERVICE	<i>15 PT HTR NRML LEVEL CONTROL</i>	<i>15 PT HTR HIGH LEVEL CONTROL</i>		
OPERATING CONDITIONS				
LIQUID(S)	<i>WATER</i>	<i>WATER</i>		
SPECIFIC GRAVITY				
TEMPERATURE F	<i>416</i>	<i>416</i>		
PRESSURE PSIG	<i>572</i>	<i>572</i>		
TYPE				
BALL FLOAT TYPE				
BODY CAGE MATERIAL				
CONNECTION SIZE & TYPE				
FLOAT MATERIAL				
ROD MATERIAL				
ROD LENGTH				
DISPLACER TYPE				
EXTERNAL OR INTERNAL				
DISPLACER MATERIAL				
CONNECTION SIZE & TYPE				
TORQUE TUBE MATERIAL				
RANGE				
OVERRANGE PROTECTION TO CONTROL				
OUTPUT SIGNAL	<i>3-15 PSI</i>	<i>3-15 PSI</i>		
OUTPUT SIGNAL TO	<i>4LCV-1A</i>	<i>4LCV-1B</i>		
ACTION	<i>DIRECT</i>	<i>REVERSE</i>		
MODES	<i>PR</i>	<i>PR</i>		
SUPPLY PRESSURE	<i>20 PSI</i>	<i>20 PSI</i>		
PNEUMATIC CONNECTION SIZE	<i>1/4 IN</i>	<i>1/4 IN</i>		
AMBIENT TEMP. LIMITS				
ACCESSORIES				
MANUFACTURER *				
MODEL NO. *				
WEIGHT *				
CATEGORY				
NOTES: CONTROL ACTION: SPECIFY WHETHER CONTROL OUTPUT INCREASES OR DECREASES FOR MEASURED VARIABLE INCREASE. CONTROL MODES: P-PROPORTIONAL, R-RESET, D-DERIVATIVE.				
REV.	1	2	3	4

STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART C
INDICATING FIELD MOUNTED PNEUMATIC LEVEL CONTROLLER
(DISPLACER OR FLOAT)

CLIENT *ERDA*
 PROJECT *AFB STUDY*

PREPARER
 SPECIALIST

INITIAL DATE

6157 *11-15-77*

T.D.S. NO L5

PAGE

SPEC. NO.

J.O. NO. *12919.02*

EQUIP. NO.	<i>4LC-2A</i>	<i>4LC-2B</i>	<i>4LC-3A</i>	<i>4LC-3B</i>
SERVICE	<i>2ND PT HTR NRML LEVEL CONTROL</i>	<i>2ND PT HTR HIGH LEVEL CONTROL</i>	<i>3RD PT HTR NRML LEVEL CONTROL</i>	<i>3RD PT HTR HIGH LEVEL CONTROL</i>
OPERATING CONDITIONS				
LIQUID(S)	<i>WATER</i>	<i>WATER</i>	<i>WATER</i>	<i>WATER</i>
SPECIFIC GRAVITY				
TEMPERATURE F	<i>376</i>	<i>376</i>	<i>306</i>	<i>306</i>
PRESSURE PSIG	<i>250</i>	<i>250</i>	<i>150</i>	<i>150</i>
TYPE				
BALL FLOAT TYPE				
BODY CAGE MATERIAL				
CONNECTION SIZE & TYPE				
FLOAT MATERIAL				
ROD MATERIAL				
ROD LENGTH				
DISPLACER TYPE				
EXTERNAL OR INTERNAL				
DISPLACER MATERIAL				
CONNECTION SIZE & TYPE				
TORQUE TUBE MATERIAL				
RANGE				
OVERRANGE PROTECTION TO CONTROL				
OUTPUT SIGNAL	<i>3-15 PSI</i>	<i>3-15 PSI</i>	<i>3-15 PSI</i>	<i>3-15 PSI</i>
OUTPUT SIGNAL TO	<i>4LCV-2A</i>	<i>4LCV-2B</i>	<i>4LCV-3A</i>	<i>4LCV-3B</i>
ACTION	<i>DIRECT</i>	<i>REVERSE</i>	<i>DIRECT</i>	<i>REVERSE</i>
MODES	<i>PR</i>	<i>PR</i>	<i>PR</i>	<i>PR</i>
SUPPLY PRESSURE	<i>20 PSI</i>	<i>20 PSI</i>	<i>20 PSI</i>	<i>20 PSI</i>
PNEUMATIC CONNECTION SIZE	<i>1/4 IN</i>	<i>1/4 IN</i>	<i>1/4 IN</i>	<i>1/4 IN</i>
AMBIENT TEMP. LIMITS				
ACCESSORIES				
MANUFACTURER *				
MODEL NO. *				
WEIGHT *				
CATEGORY				

NOTES:

CONTROL ACTION: SPECIFY WHETHER CONTROL OUTPUT INCREASES OR DECREASES FOR MEASURED VARIABLE INCREASE.

CONTROL MODES: P-PROPORTIONAL, R-RESET, D-DERIVATIVE.

REV.	1		2		3		4	
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET- PART C
INDICATING FIELD MOUNTED PNEUMATIC LEVEL CONTROLLER
(DISPLACER OR FLOAT)

CLIENT ERDA
 PROJECT AFB STUDY

PREPARER
 SPECIALIST

INITIAL DATE
GBZ 11-15-97

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 PAGE
 SPEC. NO.
 J.O. NO. 12919.02

EQUIP. NO.	<u>4LC-5A</u>	<u>4LC-5B</u>		
SERVICE	<u>5 LB PT HTR DEN</u> <u>RCVR NRML LEVEL</u> <u>CONTROL</u>	<u>5 LB PT HTR DEN</u> <u>RCVR HIGH LEVEL</u> <u>CONTROL</u>		
OPERATING CONDITIONS				
LIQUID(S)	<u>WATER</u>	<u>WATER</u>		
SPECIFIC GRAVITY				
TEMPERATURE F	<u>266</u>	<u>266</u>		
PRESSURE PSIG	<u>25</u>	<u>25</u>		
TYPE				
BALL FLOAT TYPE				
BODY CAGE MATERIAL				
CONNECTION SIZE & TYPE				
FLOAT MATERIAL				
ROD MATERIAL				
ROD LENGTH				
DISPLACER TYPE				
EXTERNAL OR INTERNAL				
DISPLACER MATERIAL				
CONNECTION SIZE & TYPE				
TORQUE TUBE MATERIAL				
RANGE				
OVERRANGE PROTECTION TO CONTROL				
OUTPUT SIGNAL	<u>3-15 PSI</u>	<u>3-15 PSI</u>		
OUTPUT SIGNAL TO	<u>4LCV-5A</u>	<u>4LCV-5B</u>		
ACTION	<u>DIRECT</u>	<u>REVERSE</u>		
MODES	<u>PR</u>	<u>PR</u>		
SUPPLY PRESSURE	<u>20 PSI</u>	<u>20 PSI</u>		
PNEUMATIC CONNECTION SIZE	<u>1/4 IN</u>	<u>1/4 IN</u>		
AMBIENT TEMP. LIMITS				
ACCESSORIES				
MANUFACTURER *				
MODEL NO. *				
WEIGHT *				
CATEGORY				

NOTES:

CONTROL ACTION: SPECIFY WHETHER CONTROL OUTPUT INCREASES OR DECREASES FOR MEASURED VARIABLE INCREASE.

CONTROL MODES: P-PROPORTIONAL, R-RESET, D-DERIVATIVE.

REV.	1		2		3		4	
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART C
INDICATING FIELD MOUNTED PNEUMATIC LEVEL CONTROLLER
(DISPLACER OR FLOAT)

CLIENT **ERDA**
 PROJECT **AFB STUDY**

PREPARER
 SPECIALIST

INITIAL DATE

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J.O. NO. **12919.02**

EQUIP. NO.	4LC-6A	4LC-6B		
SERVICE	6 1/2 PT HTR DRAIN RCVR NORMAL LEVEL CONTROL	6 1/2 PT HTR DRAIN RCVR HIGH LEVEL CONTROL		
OPERATING CONDITIONS				
LIQUID(S)	WATER	WATER		
SPECIFIC GRAVITY				
TEMPERATURE F	136	136		
PRESSURE PSIG				
TYPE				
BALL FLOAT TYPE				
BODY CAGE MATERIAL				
CONNECTION SIZE & TYPE				
FLOAT MATERIAL				
ROD MATERIAL				
ROD LENGTH				
DISPLACER TYPE				
EXTERNAL OR INTERNAL				
DISPLACER MATERIAL				
CONNECTION SIZE & TYPE				
TORQUE TUBE MATERIAL				
RANGE				
OVERRANGE PROTECTION TO CONTROL				
OUTPUT SIGNAL	3-15 PSI	3-15 PSI		
OUTPUT SIGNAL TO	4LCV-6A	4LCV-6B		
ACTION	DIRECT	REVERSE		
MODES	PR	PR		
SUPPLY PRESSURE	20 PSI	20 PSI		
PNEUMATIC CONNECTION SIZE	1/4 IN	1/4 IN		
AMBIENT TEMP. LIMITS				
ACCESSORIES				
MANUFACTURER *				
MODEL NO. *				
WEIGHT *				
CATEGORY				

NOTES:

CONTROL ACTION: SPECIFY WHETHER CONTROL OUTPUT INCREASES OR DECREASES FOR MEASURED VARIABLE INCREASE.

CONTROL MODES: P-PROPORTIONAL, R-RESET, D-DERIVATIVE.

REV.	1		2		3		4	
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART C
INDICATING FIELD MOUNTED
PRESSURE CONTROLLER

CLIENT **ERDA**
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EQUIP. NO.	4PC-1 *	4PC-6A	4PC-6B
SERVICE	MAIN STEAM OUTLET HDR PSV CONT	CONDENSATE PUMP 1A SEAL WATER PRESS CONT	CONDENSATE PUMP 1B SEAL WATER PRESS CONT
OPERATING CONDITIONS			
TEMPERATURE F°	1000	129	129
PRESSURE PSIG	2620		
ELEMENT TYPE			
ELEMENT MATERIAL			
CASE MOUNTING			
RANGE			
O' RANGE PROT. TO *			
CONTROL			
OUTPUT SIGNAL	3-15 PSI	3-15 PSI	3-15 PSI
OUTPUT SIGNAL TO	4PSV-1, 4PSV-2	4PRV-6A	4PRV-6B
ACTION	DIRECT	REVERSE	REVERSE
MODES	PR	PR	PR
PROCESS CONN. SIZE	1/2 NPT	1/2 NPT	1/2 NPT
PNEUMATIC CONN. SIZE	1/4 NPT	1/4 NPT	1/4 NPT
SUPPLY PRESSURE	20 PSI	20 PSI	20 PSI
ACCURACY *			
REPEATABILITY *			
DEADBAND *			
M/A STATION	YES	YES	YES
MANUFACTURER *			
MODEL NO. *			
WEIGHT *			
CATEGORY			
ACCESSORIES			

NOTES: 1 * MANUFACTURER SUPPLIED

REV.	1	2	3	4
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART C
INDICATING FIELD MOUNTED
PRESSURE CONTROLLER

CLIENT ERDA
PROJECT AFB STUDY

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EQUIP. NO.	4PC-51		
SERVICE	CIRC WTR MAKE-UP PUMP DISCH PRESS CONT		
OPERATING CONDITIONS			
TEMPERATURE F°	55		
PRESSURE PSIG	50		
ELEMENT TYPE			
ELEMENT MATERIAL			
CASE MOUNTING			
RANGE			
O' RANGE PROT. TO			
CONTROL			
OUTPUT SIGNAL	3-15 PSI		
OUTPUT SIGNAL TO	4PCV-51		
ACTION			
MODES	PR		
PROCESS CONN. SIZE	1/2 NPT		
PNEUMATIC CONN. SIZE	1/4 NPT		
SUPPLY PRESSURE	20 PSI		
ACCURACY			
REPEATABILITY			
DEADBAND			
M/A STATION	YES		
MANUFACTURER *			
MODEL NO. *			
WEIGHT *			
CATEGORY			
ACCESSORIES			

NOTES:

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J.O. NO. 12919.02

4

STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART C
LEVEL SWITCHES
BALL FLOAT OR DISPLACER TYPE

CLIENT *ERDA*
 PROJECT *AFB STUDY*

PREPARER
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INITIAL DATE
GBZ *11-15-77*

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 J.O. NO. *12919.02*

EQUIP. NO.	<i>4LS-88A</i>	<i>4LS-88B</i>	<i>4LS-89A</i>	<i>4LS-89B</i>
SERVICE	<i>COLD REHT STM DRAIN</i>	<i>COLD REHT STM DRAIN</i>	<i>COLD REHT STM DRAIN</i>	<i>COLD REHT STM DRAIN</i>
FLUID	<i>WATER</i>	<i>WATER</i>	<i>WATER</i>	<i>WATER</i>
SPECIFIC GRAVITY				
RANGE				
OPERATING PRESSURE	<i>585 PSIG</i>	<i>585 PSIG</i>	<i>585 PSIG</i>	<i>585 PSIG</i>
OPERATING TEMPERATURE °F	<i>486</i>	<i>486</i>	<i>486</i>	<i>486</i>
AMBIENT TEMP. LIMITS				
BALL FLOAT TYPE				
BODY/CAGE MAT'L.				
CONN. LOCATION				
CONN. SIZE & TYPE				
FLOAT MAT'L.				
ROD MAT'L.				
ROD LENGTH				
DISPLACER TYPE				
EXTERNAL OR INTERNAL				
DISPLACER DIAMETER				
DISPLACER MAT'L.				
CONN. - SIZE & RATING				
CONN. LOC.				
TORQUE TUBE MAT'L.				
SWITCH				
TYPE	<i>DPST</i>	<i>DPST</i>	<i>SPST</i>	<i>SPST</i>
ENCLOSURE				
CONDUIT CONN.				
FORM				
NO. SWITCHES				
RESISTIVE LOAD				
MAKE 120 VAC/125 VDC				
BREAK 120 VAC/125 VDC				
INDUCTIVE LOAD AT .026 L/R				
MAKE 120 VAC/125 VDC				
BREAK 120 VAC/125 VDC				
MAX. CARRYING CURRENT				
MIN. DIFFERENTIAL				
DIFFERENTIAL				
SET POINT - INCR/DECR				
MANUFACTURER	*			
MODEL NO.	*			
WEIGHT	*			
CATEGORY				
NOTES:				
REV.	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>

STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART C
LEVEL SWITCHES
BALL FLOAT OR DISPLACER TYPE

CLIENT ERDA
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PREPARER
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INITIAL DATE
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T.D.S. NO L1
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 SPEC. NO.
 J.O. NO. 129/9.02

EQUIP. NO.	<u>4LS-4A</u>	<u>4LS-4B</u>	<u>4LS-12A</u>	<u>4LS-12B</u>
SERVICE	<u>DA STORAGE TK LEVEL</u>	<u>DA STORAGE TK LEVEL</u>	<u>CONDOR HOT WELL LEVEL</u>	<u>CONDOR HOT WELL LEVEL</u>
FLUID	<u>WATER</u>	<u>WATER</u>	<u>WATER</u>	<u>WATER</u>
SPECIFIC GRAVITY				
RANGE				
OPERATING PRESSURE	<u>45 PSIG</u>	<u>45 PSIG</u>	<u>129</u>	<u>129</u>
OPERATING TEMPERATURE °F	<u>294</u>	<u>294</u>	<u>30" Hg VAC</u>	<u>30" Hg VAC</u>
AMBIENT TEMP. LIMITS				
BALL FLOAT TYPE				
BODY / CAGE MAT'L.				
CONN. LOCATION				
CONN. SIZE & TYPE				
FLOAT MAT'L.				
ROD MAT'L.				
ROD LENGTH				
DISPLACER TYPE				
EXTERNAL OR INTERNAL				
DISPLACER DIAMETER				
DISPLACER MAT'L.				
CONN. - SIZE & RATING				
CONN. LOC.				
TORQUE TUBE MAT'L.				
SWITCH				
TYPE				
ENCLOSURE				
CONDUIT CONN.				
FORM				
NO. SWITCHES				
RESISTIVE LOAD				
MAKE 120VAC / 125 VDC				
BREAK 120 VAC / 125 VDC				
INDUCTIVE LOAD AT .026 L/R				
MAKE 120 VAC / 125 VDC				
BREAK 120 VAC / 125 VDC				
MAX. CARRYING CURRENT				
MIN. DIFFERENTIAL				
DIFFERENTIAL				
SET POINT - INCR/DECR				
MANUFACTURER *				
MODEL NO. *				
WEIGHT *				
CATEGORY				
NOTES:				
REV.	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>

STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART C
LEVEL SWITCHES
BALL FLOAT OR DISPLACER TYPE

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EQUIP. NO.	4LS-40A	4LS-40B	4LS-41	4LS-49
SERVICE	DA STORAGE TK LEVEL	DA STORAGE TK LEVEL	DA STORAGE TK LEVEL	DA STORAGE TK LEVEL
FLUID	WATER	WATER	WATER	WATER
SPECIFIC GRAVITY				
RANGE				
OPERATING PRESSURE	45 PSIG	45 PSIG	45 PSIG	45 PSIG
OPERATING TEMPERATURE °F	294	294	294	294
AMBIENT TEMP. LIMITS				
BALL FLOAT TYPE				
BODY/CAGE MAT'L.				
CONN. LOCATION				
CONN. SIZE & TYPE				
FLOAT MAT'L.				
ROD MAT'L.				
ROD LENGTH				
DISPLACER TYPE				
EXTERNAL OR INTERNAL				
DISPLACER DIAMETER				
DISPLACER MAT'L.				
CONN. - SIZE & RATING				
CONN. LOC.				
TORQUE TUBE MAT'L.				
SWITCH				
TYPE				
ENCLOSURE				
CONDUIT CONN.				
FORM				
NO. SWITCHES				
RESISTIVE LOAD				
MAKE 120 VAC/125 VDC				
BREAK 120 VAC/125 VDC				
INDUCTIVE LOAD AT .026 L/R				
MAKE 120 VAC/125 VDC				
BREAK 120 VAC/125 VDC				
MAX. CARRYING CURRENT				
MIN. DIFFERENTIAL				
DIFFERENTIAL				
SET POINT - INCR/DECR				
MANUFACTURER *				
MODEL NO. *				
WEIGHT *				
CATEGORY				
NOTES:				
REV.	1	2	3	4

STONE & WEBSTER ENGINEERING CORPORATION
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LEVEL SWITCHES
BALL FLOAT OR DISPLACER TYPE

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EQUIP. NO.	<i>4LS-90</i>		<i>4LS-1A</i>	<i>4LS-1B</i>
SERVICE	<i>DA STORAGE TK LEVEL</i>		<i>1ST PT HTR LEVEL</i>	<i>1ST PT HTR HIGH LEVEL</i>
FLUID	<i>WATER</i>		<i>WATER</i>	<i>WATER</i>
SPECIFIC GRAVITY				
RANGE				
OPERATING PRESSURE	<i>45 PSIG</i>		<i>572 PSIG</i>	<i>572 PSIG</i>
OPERATING TEMPERATURE °F	<i>294</i>		<i>416</i>	<i>416</i>
AMBIENT TEMP. LIMITS				
BALL FLOAT TYPE				
BODY/CAGE MAT'L.				
CONN. LOCATION				
CONN. SIZE & TYPE				
FLOAT MAT'L.				
ROD MAT'L.				
ROD LENGTH				
DISPLACER TYPE				
EXTERNAL OR INTERNAL				
DISPLACER DIAMETER				
DISPLACER MAT'L.				
CONN. - SIZE & RATING				
CONN. LOC.				
TORQUE TUBE MAT'L.				
SWITCH				
TYPE				
ENCLOSURE				
CONDUIT CONN.				
FORM				
NO. SWITCHES				
RESISTIVE LOAD				
MAKE 120VAC/125 VDC				
BREAK 120 VAC/125 VDC				
INDUCTIVE LOAD AT .026 L/R				
MAKE 120 VAC/125 VDC				
BREAK 120 VAC/125 VDC				
MAX. CARRYING CURRENT				
MIN. DIFFERENTIAL				
DIFFERENTIAL				
SET POINT - INCR/DECR				
MANUFACTURER *				
MODEL NO. *				
WEIGHT *				
CATEGORY				
NOTES:				
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TECHNICAL DATA SHEET - PART C
LEVEL SWITCHES
BALL FLOAT OR DISPLACER TYPE

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EQUIP. NO.	<i>4LS-1C</i>	<i>4LS-2A</i>	<i>4LS-2B</i>	<i>4LS-2C</i>
SERVICE	<i>1ST PT HTR EXTN HI LEVEL</i>	<i>2ND PT HTR LEVEL</i>	<i>2ND PT HTR HIGH LEVEL</i>	<i>2ND PT HTR EXTN HIGH LEVEL</i>
FLUID	<i>WATER</i>	<i>WATER</i>	<i>WATER</i>	<i>WATER</i>
SPECIFIC GRAVITY				
RANGE				
OPERATING PRESSURE	<i>572 PSIG</i>	<i>250 PSIG</i>	<i>250 PSIG</i>	<i>250 PSIG</i>
OPERATING TEMPERATURE °F	<i>416</i>	<i>376</i>	<i>376</i>	<i>376</i>
AMBIENT TEMP. LIMITS				
BALL FLOAT TYPE				
BODY/CAGE MAT'L.				
CONN. LOCATION				
CONN. SIZE & TYPE				
FLOAT MAT'L.				
ROD MAT'L.				
ROD LENGTH				
DISPLACER TYPE				
EXTERNAL OR INTERNAL				
DISPLACER DIAMETER				
DISPLACER MAT'L.				
CONN. - SIZE & RATING				
CONN. LOC.				
TORQUE TUBE MAT'L.				
SWITCH				
TYPE				
ENCLOSURE				
CONDUIT CONN.				
FORM				
NO. SWITCHES				
RESISTIVE LOAD				
MAKE 120 VAC/125 VDC				
BREAK 120 VAC/125 VDC				
INDUCTIVE LOAD AT .026 L/R				
MAKE 120 VAC/125 VDC				
BREAK 120 VAC/125 VDC				
MAX. CARRYING CURRENT				
MIN. DIFFERENTIAL				
DIFFERENTIAL				
SET POINT - INCR/DECR				
MANUFACTURER *				
MODEL NO. *				
WEIGHT *				
CATEGORY				

NOTES:

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LEVEL SWITCHES
BALL FLOAT OR DISPLACER TYPE

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EQUIP. NO.	<i>4LS-3A</i>	<i>4LS-3B</i>	<i>4LS-3C</i>	<i>4LS-5A</i>
SERVICE	<i>288 PT HTR LEVEL</i>	<i>380 PT HTR HIGH LEVEL</i>	<i>380 PT HTR EXTREM HIGH LEVEL</i>	<i>512 PT HTR DRN RCVR LEVEL</i>
FLUID	<i>WATER</i>	<i>WATER</i>	<i>WATER</i>	<i>WATER</i>
SPECIFIC GRAVITY				
RANGE				
OPERATING PRESSURE	<i>150 PSIG</i>	<i>150 PSIG</i>	<i>150 PSIG</i>	<i>25 PSIG</i>
OPERATING TEMPERATURE °F	<i>306</i>	<i>306</i>	<i>306</i>	<i>266</i>
AMBIENT TEMP. LIMITS				
BALL FLOAT TYPE				
BODY / CAGE MAT'L.				
CONN. LOCATION				
CONN. SIZE & TYPE				
FLOAT MAT'L.				
ROD MAT'L.				
ROD LENGTH				
DISPLACER TYPE				
EXTERNAL OR INTERNAL				
DISPLACER DIAMETER				
DISPLACER MAT'L.				
CONN. - SIZE & RATING				
CONN. LOC.				
TORQUE TUBE MAT'L.				
SWITCH				
TYPE				
ENCLOSURE				
CONDUIT CONN.				
FORM				
NO. SWITCHES				
RESISTIVE LOAD				
MAKE 120 VAC / 125 VDC				
BREAK 120 VAC / 125 VDC				
INDUCTIVE LOAD AT .026 L/R				
MAKE 120 VAC / 125 VDC				
BREAK 120 VAC / 125 VDC				
MAX. CARRYING CURRENT				
MIN. DIFFERENTIAL				
DIFFERENTIAL				
SET POINT - INCR/DECR				
MANUFACTURER	<i>*</i>			
MODEL NO.	<i>*</i>			
WEIGHT	<i>*</i>			
CATEGORY				
NOTES:				
REV.	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>

STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART C
LEVEL SWITCHES
BALL FLOAT OR DISPLACER TYPE

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EQUIP. NO.	<i>4LS-5B</i>	<i>4LS-5C</i>	<i>4LS-6A</i>	<i>4LS-6B</i>
SERVICE	<i>5 1/2 PT HTR DRN RCVR HIGH LEVEL</i>	<i>5 1/2 PT HTR LEVEL</i>	<i>6 1/2 PT HTR DRN RCVR LEVEL</i>	<i>6 1/2 PT HTR DRN RCVR HIGH LEVEL</i>
FLUID				
SPECIFIC GRAVITY				
RANGE				
OPERATING PRESSURE	<i>25 PSIG</i>	<i>25 PSIG</i>	<i>11 PSIA</i>	<i>11 PSIA</i>
OPERATING TEMPERATURE	<i>266</i>	<i>266</i>	<i>200</i>	<i>200</i>
AMBIENT TEMP. LIMITS				
BALL FLOAT TYPE				
BODY/CAGE MAT'L.				
CONN. LOCATION				
CONN. SIZE & TYPE				
FLOAT MAT'L.				
ROD MAT'L.				
ROD LENGTH				
DISPLACER TYPE				
EXTERNAL OR INTERNAL				
DISPLACER DIAMETER				
DISPLACER MAT'L.				
CONN. - SIZE & RATING				
CONN. LOC.				
TORQUE TUBE MAT'L.				
SWITCH				
TYPE				
ENCLOSURE				
CONDUIT CONN.				
FORM				
NO. SWITCHES				
RESISTIVE LOAD				
MAKE 120 VAC / 125 VDC				
BREAK 120 VAC / 125 VDC				
INDUCTIVE LOAD AT .026 L/R				
MAKE 120 VAC / 125 VDC				
BREAK 120 VAC / 125 VDC				
MAX. CARRYING CURRENT				
MIN. DIFFERENTIAL				
DIFFERENTIAL				
SET POINT - INCR/DECR				
MANUFACTURER *				
MODEL NO. *				
WEIGHT *				
CATEGORY				
NOTES:				
REV.	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>

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LEVEL SWITCHES
BALL FLOAT OR DISPLACER TYPE

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EQUIP. NO.	<i>4LS-6C</i>	<i>4LS-7A</i>	<i>4LS-7B</i>	<i>4LS-7C</i>
SERVICE	<i>6th PT HTR LEVEL</i>	<i>7th PT HTR 1A HIGH LEVEL</i>	<i>7th PT HTR 1A LEVEL</i>	<i>7th PT HTR 1B HIGH LEVEL</i>
FLUID	<i>WATER</i>	<i>WATER</i>	<i>WATER</i>	<i>WATER</i>
SPECIFIC GRAVITY				
RANGE				
OPERATING PRESSURE	<i>11 PSIA</i>	<i>5 PSIA</i>	<i>5 PSIA</i>	<i>5 PSIA</i>
OPERATING TEMPERATURE °F	<i>216</i>	<i>163</i>	<i>163</i>	<i>163</i>
AMBIENT TEMP. LIMITS				
BALL FLOAT TYPE				
BODY/CAGE MAT'L.				
CONN. LOCATION				
CONN. SIZE & TYPE				
FLOAT MAT'L.				
ROD MAT'L.				
ROD LENGTH				
DISPLACER TYPE				
EXTERNAL OR INTERNAL				
DISPLACER DIAMETER				
DISPLACER MAT'L.				
CONN. - SIZE & RATING				
CONN. LOC.				
TORQUE TUBE MAT'L.				
SWITCH				
TYPE				
ENCLOSURE				
CONDUIT CONN.				
FORM				
NO SWITCHES				
RESISTIVE LOAD				
MAKE 120 VAC/125 VDC				
BREAK 120 VAC/125 VDC				
INDUCTIVE LOAD AT .026 L/R				
MAKE 120 VAC/125 VDC				
BREAK 120 VAC/125 VDC				
MAX. CARRYING CURRENT				
MIN. DIFFERENTIAL				
DIFFERENTIAL				
SET POINT - INCR/DECR				
MANUFACTURER	*			
MODEL NO.	*			
WEIGHT	*			
CATEGORY				
NOTES:				
REV.	1	2	3	4

STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART C
LEVEL SWITCHES
BALL FLOAT OR DISPLACER TYPE

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EQUIP. NO.	4LS-7D			
SERVICE	7 1/2 PT HTR IB LEVEL			
FLUID	WATER			
SPECIFIC GRAVITY				
RANGE				
OPERATING PRESSURE	5 PSIA			
OPERATING TEMPERATURE °F	163			
AMBIENT TEMP. LIMITS				
BALL FLOAT TYPE				
BODY/CAGE MAT'L.				
CONN. LOCATION				
CONN. SIZE & TYPE				
FLOAT MAT'L.				
ROD MAT'L.				
ROD LENGTH				
DISPLACER TYPE				
EXTERNAL OR INTERNAL				
DISPLACER DIAMETER				
DISPLACER MAT'L.				
CONN. - SIZE & RATING				
CONN. LOC.				
TORQUE TUBE MAT'L.				
SWITCH				
TYPE				
ENCLOSURE				
CONDUIT CONN.				
FORM				
NO. SWITCHES				
RESISTIVE LOAD				
MAKE 120 VAC/125 VDC				
BREAK 120 VAC/125 VDC				
INDUCTIVE LOAD AT .026 L/R				
MAKE 120 VAC/125 VDC				
BREAK 120 VAC/125 VDC				
MAX. CARRYING CURRENT				
MIN. DIFFERENTIAL				
DIFFERENTIAL				
SET POINT - INCR/DECR				
MANUFACTURER *				
MODEL NO. *				
WEIGHT *				
CATEGORY				

NOTES:

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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET-PART C
ELECTRONIC RECEIVER INDICATORS

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GENERAL SPECIFICATIONS	
INPUT SIGNAL	<i>4-20MA DC</i>
INPUT IMPEDANCE	
ACCURACY	<i>1% SPAN</i>
POWER SUPPLY	<i>N/A</i>
ENVIRONMENTAL TEMPERATURE LIMITS	
CASE MATERIAL	<i>LATER</i>
CASE FINISH	
CHASSIS MATERIAL	
SCALE LENGTH	
MOUNTING	<i>↓</i>
MANUFACTURER	*
MODEL NO.	*
WEIGHT	*

EQUIP. NO.	SERVICE	TYPE	SCALE RANGE	RACK	ASSOC TRANS
<i>4FRI-26</i>	<i>CONDENSATE FLOW</i>	<i>VERT SCALE</i>	<i>0-7000 GPM</i>	<i>MN. CONT BD.</i>	<i>4FIT-26</i>
<i>4FI-29</i>	<i>BFP RECIRC FLOW</i>	<i>VERT SCALE</i>		<i>MN. CONT BD.</i>	<i>4FIT-10</i>
<i>4FI-41</i>	<i>START-UP BFP RECIRC FLOW</i>	<i>VERT SCALE</i>	<i>0-3000 GPM</i>	<i>MN. CONT. BD.</i>	<i>4FIT-14</i>

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STONE & WEBSTER ENGINEERING CORPORATION
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ELECTRONIC RECEIVER INDICATORS

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GENERAL SPECIFICATIONS

INPUT SIGNAL	4-20MA DC
INPUT IMPEDANCE	
ACCURACY	1% SPAN
POWER SUPPLY	
ENVIRONMENTAL TEMPERATURE LIMITS	
CASE MATERIAL	LATER
CASE FINISH	
CHASSIS MATERIAL	
SCALE LENGTH	
MOUNTING	
MANUFACTURER	*
MODEL NO.	*
WEIGHT	*

EQUIP. NO.	SERVICE	TYPE	SCALE RANGE	RACK	ASSOC TRANS
4PI-10	MAIN STEAM PRESS	VERT SCALE	0-3500 PSIG	MN CONT BD.	4PIT-1
4PI-12	REHTR OUTLT STM PRESS	VERT SCALE	0-1000 PSIG	MN CONT BD.	4PIT-9
4PI-23	HP TURB INTERSTAGE PRESS	VERT SCALE		MN CONT BD.	4PIT-4
4PI-47	SUPHTR OUTLT PRESS	VERT SCALE	0-3500 PSIG	MN CONT BD.	4PIT-29
4PI-93	COLD REHEAT STM PRESS	VERT SCALE	0-800 PSIG	MN CONT BD.	4PIT-30
4PI-18A	CONDSR 4-1 VACUUM	VERT SCALE	0-30" Hg Vac	MN CONT BD.	4PIT-5A
4PI-18B	CONDSR 4-2 VACUUM	VERT SCALE	0-30" Hg Vac	MN CONT BD.	4PIT-5B

NOTES:

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STONE & WEBSTER ENGINEERING CORPORATION
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ELECTRONIC RECEIVER INDICATORS

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GENERAL SPECIFICATIONS

INPUT SIGNAL	<i>4-20 MA DC</i>
INPUT IMPEDANCE	
ACCURACY	<i>1% SPAN</i>
POWER SUPPLY	
ENVIRONMENTAL TEMPERATURE LIMITS	
CASE MATERIAL	<i>LATER</i>
CASE FINISH	
CHASSIS MATERIAL	
SCALE LENGTH	
MOUNTING	
MANUFACTURER	*
MODEL NO.	*
WEIGHT	*

EQUIP. NO.	SERVICE	TYPE	SCALE RANGE	RACK	ASSOC TRANS
<i>4PI-25</i>	<i>CONDENSATE PP 4-1 DISCH PRESS</i>	<i>VERT SCALE</i>	<i>0-400 PSIG</i>		<i>4PIT-10</i>
<i>4PI-26</i>	<i>CONDENSATE PP 4-2 DISCH PRESS</i>	<i>VERT SCALE</i>	<i>0-400 PSIG</i>		<i>4PIT-11</i>
<i>4PI-28</i>	<i>BFP Suction PRESS</i>	<i>VERT SCALE</i>	<i>0-150 PSIG</i>		<i>4PIT-12</i>
<i>4PI-7</i>	<i>BFP DISCH PRESS</i>	<i>VERT SCALE</i>			<i>4PIT-28</i>
<i>4PI-13</i>	<i>FWTR BLOW INLT PRESS</i>	<i>VERT SCALE</i>	<i>0-3500 PSIG</i>		<i>4PIT-14</i>

NOTES:

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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET- PART C
PRESSURE INDICATORS

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COMMON FOR BARCOCK & WILCOX AND FOSTER WHEELER

EQUIP. NO.	SERVICE	RANGE PSIG	OPER. TEMP. °F	OPER. PRESS. PSIG	FLUID	ELEMENT MATERIAL	DIAL SIZE IN.	MANUFACTURER TYPE OR MODEL *
4PI-19	MN STM LINE PRESS	0-5000	1000	2520	STEAM	316SS	4.5	
4PI-166	COLD REHT PRESS	0-1000	628	600	STEAM	316SS	4.5	
4PI-167	HOT REHT PRESS	0-1000	1000	525	STEAM	316SS	4.5	
4PI-4	3RD PT LITR SHELL	30" Hg Vac to 300 PSIG	500	150	STEAM	316SS	4.5	
4PI-17	CONDR 4-1 VACUUM	30" Hg Vac to 1 PSIG	129	28.5" Hg Vac	STEAM	316SS	4.5	
4PI-29	BFP SUCTION PRESS	0-400	294	85	WATER	316SS	4.5	
4PI-77A	COND PP 4-1 SUCTION PRESS	30" Hg to 60 PSIG	129		WATER	316SS	4.5	
4PI-77B	COND PP 4-2 SUCTION PRESS	30" Hg to 60 PSIG	129		WATER	316SS	4.5	
4PI-82A	COND PP 4-1 STUFFING BOX PRESS	0-30	129		WATER	316SS	4.5	
4PI-82B	COND PP 4-2 STUFFING BOX PRESS	0-30	129		WATER	316SS	4.5	
4PI-91	COND PP 4-1 DISCH PRESS	0-600	129	320	WATER	316SS	4.5	

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PRESSURE INDICATORS

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EQUIP. NO.	SERVICE	RANGE PSIG	OPER. TEMP.	OPER. PRESS.	FLUID	ELEMENT MATERIAL	DIAL SIZE IN.	MANUFACTURER TYPE OR MODEL *
4PI-92	COND. PP 4CP-1B DISCH PRESS	0-600	129	322	WATER	316 SS	4.5	
4PDI-23	BFP SUCT STRNR DIFF PRESS	0-100	299	3052	WATER	316 SS	4.5	
4PI-32	BFP DISCH PRESS	0-3600	299	3052	WATER	316 SS	4.5	
4PDI-34	BOOSTER BFP SUCT STRNR	0-100	299	3052	WATER	316 SS	4.5	
4PI-33	ECON FW INLT PRESS	0-3500	485	2900	WATER	316 SS	4.5	
4PI-34	SUPPLY DESUPPLIES BFP SUPP PRESS	0-3500	485	2900	WATER	316 SS	4.5	
4PI-35	RENT DESUPPLIES BFP SUPP PRESS	0-3500	485	2900	WATER	316 SS	4.5	
4PI-36	RENT DESUPPLIES BFP SUPP PRESS	0-3500	485	2900	WATER	316 SS	4.5	
4PI-182	FD WTR HTS INLT PRESS	0-3500	485	2900	WATER	316 SS	4.5	
4PI-301	MU PP BFWSH STRNR INLT PRESS	0-100	55	50	WATER	316 SS	4.5	
4PI-302	MU PP BFWSH STRNR INLT PRESS	0-100	55	50	WATER	316 SS	4.5	
4PDI-25A	COND PP1A SUCT STRNR DIFF PRESS	30" Hg Vac - 10 PSIG	129	28.5" Hg Vac	WATER	316 SS	4.5	
4PDI-25B	COND PP1B SUCT STRNR DIFF PRESS	30" Hg Vac - 10 PSIG	129	28.5" Hg Vac	WATER	316 SS	4.5	

NOTES:

REVISION	1		2		3		4	
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART C
DIFFERENTIAL PRESSURE OR
FLOW INDICATORS / SWITCHES

CLIENT *ERDA*
PROJECT *AFB STUDY*

PREPARER
SPECIALIST

INITIAL DATE
GBF *11-15-77*

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PAGE
SPEC. NO.
J.O. NO. *12919.02*

EQUIP. NO.	<i>4PDS-25A</i>	<i>4PDS-25B</i>	<i>4PDIS-51</i>	<i>4PDIS-52</i>
SERVICE	<i>COND PP 1A SHAFT SEAL WTR FLT DIFF</i>	<i>COND PP 1B SHAFT SEAL WTR FLT DIFF</i>	<i>MU PP BACKWASH STRNR DIFF PRESS</i>	<i>CIRC WTR SCREEN DIFF PRESS</i>
OPERATING CONDITIONS				
FLUID	<i>WATER</i>	<i>WATER</i>	<i>WATER</i>	<i>WATER</i>
TEMPERATURE °F	<i>129</i>	<i>129</i>	<i>55</i>	<i>55</i>
PRESSURE PSIG	<i>322</i>	<i>322</i>	<i>50</i>	<i>50</i>
RANGE DIFFERENTIAL PSIG	<i>2-15</i>	<i>2-15</i>		
OVERRANGE PROTECTION TO SCALE PSIG	<i>0-30</i>	<i>0-30</i>		
SET POINT - INCR/DECR	<i>INCR</i>	<i>INCR</i>	<i>INCR</i>	<i>INCR</i>
CONSTRUCTION				
CHAMBER RATING PSIG	<i>1500</i>	<i>1500</i>	<i>1500</i>	<i>1500</i>
CHAMBER MAT'L.				
BELLOWS MAT'L.				
TORQUE TUBE MAT'L				
CONN.'S SIZE	<i>1/2 NPT</i>	<i>1/2 NPT</i>	<i>1/2 NPT</i>	<i>1/2 NPT</i>
SWITCH				
TYPE				
ENCLOSURE				
CONDUIT CONN. SIZE				
FORM				
NO. OF SWITCHES				
RESISTIVE LOAD				
MAKE 120VAC/125VDC				
BREAK 120VAC/125VDC				
INDUCTIVE LOAD AT .026L/R				
MAKE 120VAC/125VDC				
BREAK 120VAC/125VDC				
MAX. CARRYING CURRENT				
MIN. DIFFERENTIAL				
RESET DIFFERENTIAL	<i>Less than 50% Range</i>			
MANUFACTURER *				
MODEL NO. *				
WEIGHT *				
CATEGORY				
NOTES:				
REV.	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>

STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET-PART C
PRESSURE SWITCHES

CLIENT **ERDA**
PROJECT **AFB STUDY**

PREPARER
SPECIALIST

INITIAL DATE
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EQUIP. NO.	4PS-32	4PS-33	4PS-14A	4PS-14B
SERVICE	COND POL DEMIN INLT PRESS-START SDRY COND PP	COND POL DEMIN INLT PRESS	CIRC WTR MU PPS DISCH HDR	CIRC WTR MU PPS DISCH HDR
OPERATING CONDITIONS				
FLUID	WATER	WATER	WATER	WATER
TEMPERATURE °F	129	129	55	55
PRESSURE PSIG	322	322	60	50
PRESSURE CONN. SIZE	1/2 NPT	1/2 NPT	1/2 NPT	
ELEMENT TYPE	BOURDON	BOURDON	BOURDON	BOURDON
ELEMENT MATERIAL	316SS	316SS	316SS	316SS
RANGE PSIG	0-600	0-600		
OVERRANGE PROTECTION TO PSIG	900	900		
SETPOINT- INCR/DECR				
SWITCH				
TYPE				
ENCLOSURE				
CONDUIT CONN.				
FORM				
NO. SWITCHES				
RESISTIVE LOAD				
MAKE 120 VAC / 125 VDC				
BREAK 120 VAC / 125 VDC				
INDUCTIVE LOAD AT .026 L/R				
MAKE 120 VAC / 125 VDC				
BREAK 120 VAC / 125 VDC				
MAX. CARRYING CURRENT				
MIN. DIFFERENTIAL				
RESET DIFFERENTIAL Δ	*			
MANUFACTURER	*			
MODEL NO.	*			
WEIGHT	*			
CATEGORY				

NOTES:

REFER TO T.D.S NO. SW 1 FOR GUIDE IN DETERMINING CONTACT RATINGS.
Δ DIFFERENCE BETWEEN ACTUATION AND REACTUATION POINT
EXAMPLE: IF SWITCH IS SET FOR HIGH ALARM CONTACT CLOSURE
AT 600 PSI; WHAT IS PRESSURE DROP NECESSARY
TO OPEN CONTACTS.

REV.	1	2	3	4
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET-PART C
PRESSURE SWITCHES

CLIENT *ERDA*
PROJECT *AFB STUDY*

PREPARER
SPECIALIST

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EQUIP. NO.	<i>4PS-36A</i>	<i>4PS-36B</i>	<i>4PS-139</i>	<i>4PS-140</i>
SERVICE	<i>VAC PRI PP 1A SUCTION</i>	<i>VAC PRI PP 1B SUCTION</i>	<i>COOL TWR LEVEL LOW</i>	<i>COOL TWR LEVEL HIGH</i>
OPERATING CONDITIONS				
FLUID	<i>WATER/AIR</i>	<i>WATER/AIR</i>	<i>WATER</i>	<i>WATER</i>
TEMPERATURE °F	<i>129</i>	<i>129</i>		
PRESSURE PSIG	<i>30" H₂O - 15PSIG</i>	<i>30" H₂O - 15PSIG</i>	<i>0-60" H₂O</i>	<i>0-60" H₂O</i>
PRESSURE CONN. SIZE	<i>1/2 NPT</i>	<i>1/2 NPT</i>	<i>1/2 NPT</i>	<i>1/2 NPT</i>
ELEMENT TYPE				
ELEMENT MATERIAL				
RANGE				
OVERRANGE PROTECTION TO				
SETPOINT - INCR/DECR				
SWITCH				
TYPE				
ENCLOSURE				
CONDUIT CONN.				
FORM				
NO. SWITCHES				
RESISTIVE LOAD				
MAKE 120 VAC / 125 VDC				
BREAK 120 VAC / 125 VDC				
INDUCTIVE LOAD AT .026 L/R				
MAKE 120 VAC / 125 VDC				
BREAK 120 VAC / 125 VDC				
MAX. CARRYING CURRENT				
MIN. DIFFERENTIAL				
RESET DIFFERENTIAL Δ	*			
MANUFACTURER	*			
MODEL NO.	*			
WEIGHT	*			
CATEGORY				

NOTES:

REFER TO T.D.S NO. SW 1 FOR GUIDE IN DETERMINING CONTACT RATINGS.

Δ DIFFERENCE BETWEEN ACTUATION AND REACTUATION POINT

EXAMPLE: IF SWITCH IS SET FOR HIGH ALARM CONTACT CLOSURE
AT 600 PSI; WHAT IS PRESSURE DROP NECESSARY
TO OPEN CONTACTS.

REV.	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET- PART C
MULTIPOINT RECORDERS

CLIENT *ERDA*
PROJECT *AFB STUDY*

PREPARER
SPECIALIST

INITIAL DATE
GB7 *11-15-77*

T.D.S. NO. R2A
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EQUIP. NO.	<i>4R-1</i>	<i>4R-3</i>	<i>4R-4</i>
SERVICE	<i>MAIN STM & REHEAT</i>	<i>CONDENSATE</i>	<i>BOILER FEED</i>
LOCATION			
CALIBRATED RANGE			
CHART			
RANGE			
WIDTH	<i>12 IN</i>	<i>12 IN</i>	<i>12 IN</i>
NUMBER			
SPEED	<i>1 IN. / HR</i>	<i>1 IN. / HR</i>	<i>1 IN. / HR</i>
NUMBER OF POINTS			
TYPE RECORD			
PRINT SPEED			
BALANCE SPEED			
ACCURACY	<i>.25%</i>	<i>.25%</i>	<i>.25%</i>
SENSITIVITY	<i>.05%</i>	<i>.05%</i>	<i>.05%</i>
DEAD BAND			
ATTACHMENTS			
NO. H ALARM			
TYPE			
NO. L ALARM			
TYPE			
CONTACT RATING			
T/C FAIL-SAFE	<i>DOWNSCALE</i>	<i>DOWNSCALE</i>	<i>DOWNSCALE</i>
POWER SUPPLY	<i>120V AC</i>	<i>120V AC</i>	<i>120V AC</i>
CASE COLOR			
MANUFACTURER *			
MODEL NO. *			
WEIGHT *			

ACCESSORIES: FURNISH MONTHS SUPPLY OF CHARTS & INK FOR EACH RECORDER.

NOTES:

STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET-PART C
MULTIPOINT RECORDERS

CLIENT *ERDA*
PROJECT *AFB STUDY*

PREPARER
SPECIALIST

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EQUIP. NO.	<i>4R-5</i>	<i>4R-8</i>	<i>4R-9</i>
SERVICE	<i>MAIN STEAM + REHEAT</i>	<i>MAIN STEAM + REHEAT</i>	<i>MAIN STEAM + REHEAT</i>
LOCATION			
CALIBRATED RANGE			
CHART			
RANGE			
WIDTH	<i>12 IN</i>	<i>12 IN</i>	<i>12 IN</i>
NUMBER			
SPEED	<i>1 IN / HR</i>	<i>1 IN / HR</i>	<i>1 IN / HR</i>
NUMBER OF POINTS			
TYPE RECORD			
PRINT SPEED			
BALANCE SPEED			
ACCURACY	<i>.25%</i>	<i>.25%</i>	<i>.25%</i>
SENSITIVITY	<i>.05%</i>	<i>.05%</i>	<i>.05%</i>
DEAD BAND			
ATTACHMENTS			
NO. H ALARM			
TYPE			
NO. L ALARM			
TYPE			
CONTACT RATING			
T/C FAIL-SAFE			
POWER SUPPLY			
CASE COLOR			
MANUFACTURER *			
MODEL NO. *			
WEIGHT *			
ACCESSORIES: FURNISH MONTHS SUPPLY OF CHARTS & INK FOR EACH RECORDER.			
NOTES:			
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WEBSTER ENGI. RING CORPORATION
TECHNICAL DATA SHEET - PART C
MULTIPOINT RECORDER
POINT IDENTIFICATION LIST

CLIENT **ERDA**
PROJECT **AFB**

**PREPARER
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WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET-PART C
MULTIPOINT RECORDER
POINT IDENTIFICATION LIST

CLIENT. ERDA
PROJECT AFB STUDY

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INPUT SOURCE - SPECIFY INPUT SOURCE SIGNAL. IF TC, GIVE CALIB. CURVE. EXS: TC-E, RTD, 0-20MV, ETC.

NOTES :

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WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET-PART C
MULTIPOINT RECORDER
POINT IDENTIFICATION LIST

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PROJECT AFB STUDY

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WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET-PART C
MULTIPOINT RECORDER
POINT IDENTIFICATION LIST

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PROJECT AFB STUDY

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WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET-PART C
MULTIPOINT RECORDER
POINT IDENTIFICATION LIST

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WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET-PART C
MULTIPOINT RECORDER
POINT IDENTIFICATION LIST

**PREPARER
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CLIENT ERDA
PROJECT AFB STUDY

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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART C
ORIFICE PLATES

CLIENT *ERDA*
PROJECT *AFB STUDY*

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GBZ *11-15-77*

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SPEC. NO.
J.O. NO. *12919.02*

EQUIP. NO.	<i>4RO-90</i>	<i>4RO-33</i>	<i>4RO-205</i>
SERVICE	<i>THROTTLE VV STEM LEAK-OFF</i>	<i>CLNG TWR MK UP PP DISCH</i>	<i>OPEN LOOP CLNG WTR SUPP</i>
PIPE SIZE AND CLASS			
PIPE I.D.			
TYPE TAPS	<i>FLANGE</i>		
FLANGE RATING	<i>for 100lb circle</i>		
PLATE MATERIAL	<i>304 SS or 316 SS</i>		
PLATE THICKNESS	<i>1/8" up to 12" line size 3/16"</i>		
BORE			
d/D <i>1/2 3/4 1 1 1/2</i>	<i>APPROX. /</i>	<i>APPROX. /</i>	<i>/</i>
METER DIFFERENTIAL	<i>NORMAL: 100 IN H₂O</i>		
FLUID			
MINIMUM FLOW			
NORMAL FLOW			
MAXIMUM FLOW			
SP. GR. OR M.W.			
OPERATING PRESS.			
OPERATING TEMP.			
MANUFACTURER *			

EQUIP. NO.			
SERVICE			
PIPE SIZE AND CLASS			
PIPE I.D.			
TYPE TAPS			
FLANGE RATING			
PLATE MATERIAL			
PLATE THICKNESS			
BORE			
d/D	<i>/</i>	<i>/</i>	<i>/</i>
METER DIFFERENTIAL			
FLUID			
MINIMUM FLOW			
NORMAL FLOW			
MAXIMUM FLOW			
SP. GR. OR M.W.			
OPERATING PRESS.			
OPERATING TEMP.			
MANUFACTURER *			

REV.	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET-PART C
VENTURI FLOW ELEMENT

CLIENT ERDA
PROJECT AFB STUDY

PREPARER
SPECIALIST

INITIAL DATE
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SPEC. NO.
J.O. NO. 12919.02

EQUIP. NO.	4R0-206	4R0-43	4R0-43A	4R0-42
SERVICE	MN STM TO BFP HP TURB	BOOSTER BFP SUCTION	COND POL DEMIN OUTLT	FD WTR ECON INLT
OPERATING CONDITIONS				
FLUID	STEAM	WATER	WATER	WATER
PRESSURE PSIA	175	63	336	3271
TEMPERATURE °F	725	296	132	485
SPECIFIC GRAVITY				
METER DIFFERENTIAL				
FLOW AT MAX. DIFF.				
FLOW - NORMAL				
PIPE SIZE AND I.D.				
TAP LOCATIONS				
TAP SIZE				
d/D AND BORE				
TUBE MATERIAL				
LINER MATERIAL				
END TO END DIM.				
ACCURACY				
MANUFACTURER *				
MODEL NO. *				
WEIGHT *				
CATEGORY				

NOTES:

REV.	1		2		3		4	
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET-PART C
VENTURI FLOW ELEMENT

CLIENT *ERDA*
PROJECT *AFB STUDY*

PREPARER
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EQUIP. NO.	<i>4R0-46</i>	<i>4R0-47</i>		
SERVICE	<i>BFP DISCH TO REHEAT DESUPHTRS</i>	<i>BFP DISCH TO SUPHTR DESUPHTRS</i>		
OPERATING CONDITIONS				
FLUID	<i>WATER</i>	<i>WATER</i>		
PRESSURE PSIA	<i>3421</i>	<i>3421</i>		
TEMPERATURE °F	<i>301</i>	<i>301</i>		
SPECIFIC GRAVITY				
METER DIFFERENTIAL				
FLOW AT MAX. DIFF.				
FLOW - NORMAL				
PIPE SIZE AND I.D.				
TAP LOCATIONS				
TAP SIZE				
d/D AND BORE				
TUBE MATERIAL				
LINER MATERIAL				
END TO END DIM.				
ACCURACY				
MANUFACTURER *				
MODEL NO. *				
WEIGHT *				
CATEGORY				

NOTES:

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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET-PART C
RESISTANCE TEMPERATURE DETECTOR
AND THERMOWELL ASSEMBLIES

CLIENT *ERDA*
PROJECT *AFB STUDY*

PREPARER
SPECIALIST

INITIAL DATE
GBZ *11-15-77*

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EQUIP. NO.	SERVICE/RANGE	THERMOWELL			PIPE		MAXIMUM DESIGN REQ.		
		S & W DWG NO.	MAT'L	"U" LGTH.	SIZE	WALL THK.	TEMP. F	PRESS PSIG	VEL. FPS
<i>4RTD-13</i>	<i>COLD REHEAT STM</i>	<i>MP-1051-7,8,9,10</i>							
<i>4RTD-5</i>	<i>HP TURB EXT STM TO 1ST PT HTR</i>	<i>EM-103A</i>							
<i>4RTD-3</i>	<i>HP COND SR SHELL</i>	<i>EM-104A</i>							
<i>4RTD-4</i>	<i>LP COND SR SHELL</i>	<i>EM-104A</i>							
<i>4RTD-6</i>	<i>5TH PT HTR OUTLT</i>	<i>EM-104A</i>							
<i>4RTD-8</i>	<i>BOOST BFP SUCT</i>	<i>EM-104A</i>							
<i>4RTD-24</i>	<i>GLND STM COND SR OUTLT</i>	<i>EM-104A</i>							
<i>4RTD-27</i>	<i>5TH PT HTR INLT</i>	<i>EM-104A</i>							
<i>4RTD-32</i>	<i>BOOST BFP SUCT</i>	<i>EM-104A</i>							
RTD TYPE:		<i>3 WIRE PLC.</i>							
HEAD									
EXTENSION NIPPLES & UNION									
CONDUIT CONN. SIZE		<i>3/4 IN.</i>							
MANUFACTURER*									
NOTES:									
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET-PART C
RESISTANCE TEMPERATURE DETECTOR
AND THERMOWELL ASSEMBLIES

CLIENT *ERDA*
PROJECT *AFB STUDY*

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J.O. NO. *12919.02*

EQUIP. NO.	SERVICE/RANGE	THERMOWELL			PIPE		MAXIMUM DESIGN REQ.		
		S & W DWG NO.	MAT'L	"U" LGTH.	SIZE	WALL THK.	TEMP. F	PRESS PSIG	VEL. FPS
4RTD-9	FD WTR HTR 4EH-6 INLT	EM-105A							
4RTD-10	FD WTR HTRS OUTLET HDR	EM-105A							
4RTD-31	FD WTR HTR 4EH-7 INLT	EM-105A							
4RTD-17	1ST PT HTR TO 2ND PT HTR	EM-106A							
4RTD-18	2ND PT HTR TO 3RD PT HTR	EM-106A							
4RTD-20	3RD PT HTR TO DA TK	EM-106A							
4RTD-21	5TH PT HTR DRNS TO DRN RCVR	EM-106A							
4RTD-22	6TH PT HTR DRNS TO DRN TK	EM-106A							
RTD TYPE:									
HEAD									
EXTENSION NIPPLES & UNION									
CONDUIT CONN. SIZE									
MANUFACTURER*									
NOTES:									
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET-PART C
RESISTANCE TEMPERATURE DETECTOR
AND THERMOWELL ASSEMBLIES

CLIENT *ERDA*
 PROJECT *AFB STUDY*

PREPARER
 SPECIALIST

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EQUIP. NO.	SERVICE/RANGE	THERMOWELL			PIPE		MAXIMUM DESIGN REQ.		
		S & W DWG NO.	MAT'L	"U" LGTH.	SIZE	WALL THK.	TEMP. F	PRESS PSIG	VEL. FPS
4RTD-23A	7 ¹ / ₂ PT HTR 1A LOOP SEAL <i>DRN</i>	EM-106A							
4RTD-23B	7 ¹ / ₂ PT HTR 1B LOOP SEAL <i>DRN</i>	EM-106A							
4RTD-48A	6 ¹ / ₂ PT HTR DRN CLR TO CONDSE	EM-106A							
4RTD-48B	5 ¹ / ₂ PT HTR DRN CLR TO CONDSE	EM-106A							
4RTD-101A	HP CONDSE CIRC WTR OUTLT	EM-110A							
4RTD-101B	HP CONDSE CIRC WTR OUTLT	EM-110A							
4RTD-102A	LP CONDSE CIRC WTR INLT	EM-110A							
4RTD-102B	LP CONDSE CIRC WTR INLT	EM-110A							
RTD TYPE:									
HEAD									
EXTENSION NIPPLES & UNION									
CONDUIT CONN. SIZE									
MANUFACTURER*									
NOTES:									
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET-PART C
THERMOCOUPLES WITH THERMOWELLS

CLIENT **ERDA**
PROJECT **AFB STUDY**

PREPARER **BBF** INITIAL DATE **11-15-77**
SPECIALIST

T.D.S. NO. T3
PAGE
SPEC. NO.
J.O. NO. **12919.02**

EQUIP. NO.	SERVICE / RANGE	THERMOWELL			PIPE		MAXIMUM DESIGN REQ.		
		S & W DWG NO.	MAT'L	"U" LGTH.	SIZE	WALL THK.	TEMP. F	PRESS PSIG	VEL. FPS
4TR-109A	MN STM OUTLT HDR	MP-1051-7,8,9,10			13 1/2" ID	3 1/8"	0-1500		
4TR-109B	MN STM OUTLT HDR	"			13 1/2" ID	3 1/8"	0-1500		
4TR-110	HOT REHEAT OUTLT HDR	"			33" ID	1 1/2"	0-1500		
4TR-113	MN STM LINE	"			17.5" ID	4"	0-1500		
4TR-136	HOT REHEAT STM	"			33" ID	1 1/2"	0-1500		
4TR-143	MN STM LINE	"			17.5" ID	4"	0-1500		
4TR-145	HOT REHEAT OUTLT	"			30" ID	1 1/2"	0-1500		
4TR-146	HOT REHEAT OUTLT	"			30" ID	1 1/2"	0-1500		
CALIBRATION TYPE									
HEAD									
EXTENSION NIPPLES & UNION									
CONDUIT CONN. SIZE									
MANUFACTURER *									
NOTES:									
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART C
THERMOCOUPLES WITH THERMOWELLS

CLIENT *ERDA*
PROJECT *AFB STUDY*

PREPARER *GB7* INITIAL *GB7* DATE *11-15-77*
SPECIALIST

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EQUIP. NO.	SERVICE / RANGE	THERMOWELL			PIPE		MAXIMUM DESIGN REQ.		
		S & W DWG NO.	MAT'L	"U" LGTH.	SIZE	WALL THK.	TEMP. F	PRESS PSIG	VEL. FPS
<i>4TR-121</i>	<i>IP TURB EXT STM TO 2ND PT HTR</i>	<i>EM-103A</i>			<i>10"</i>				
<i>4TR-122</i>	<i>LP TURBS EXT STM TO DATA</i>	<i>EM-103A</i>							
<i>4TR-123A</i>	<i>IP EXT STM</i>	<i>EM-103A</i>							
<i>4TR-123B</i>	<i>LP (B) TURB EXT STM TO DATA</i>	<i>EM-103A</i>							
<i>4TR-124</i>	<i>LP (A) TURB EXT STM TO 6TH PT HTR</i>	<i>EM-103A</i>							
<i>4TR-125</i>	<i>LP (B) TURB EXT STM TO 7TH PT HTR</i>	<i>EM-103A</i>							
<i>4TR-126</i>	<i>LP (A) TURB EXT STM TO 7TH PT HTR</i>	<i>EM-103A</i>							
<i>4TR-127</i>	<i>LP (B) TURB EXT STM TO 5TH PT HTR</i>	<i>EM-103A</i>							
<i>4TR-138</i>	<i>IP TURB EXT STM TO 2ND PT HTR</i>	<i>EM-103A</i>							
CALIBRATION TYPE									
HEAD									
EXTENSION NIPPLES & UNION									
CONDUIT CONN. SIZE									
MANUFACTURER *									
NOTES:									
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THERMOCOUPLES WITH THERMOWELLS

CLIENT ERDA
PROJECT AFB STUDY

PREPARER	GBZ	11-15-77
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET- PART C
FILLED SYSTEM TEMPERATURE SWITCHES

CLIENT *ERDA*
PROJECT *AFB STUDY*

PREPARED BY *087* INITIAL *087* DATE *11-15-77*
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EQUIP. NO.	<i>4TS-10A</i>	<i>4TS-10B</i>		
SERVICE	<i>LP(A) TURB EXH TEMP</i>	<i>LP(B) TURB EXH TEMP</i>		
FLUID	<i>STEAM</i>	<i>STEAM</i>		
MAX. PRESS. PSIG	<i>30" Hg Vac-5 PSIG</i>	<i>30" Hg Vac-5 PSIG</i>		
MAX. TEMP. F				
MAX. VELOCITY FPS				
THERMAL ELEMENT				
CLASS				
CONN. SIZE				
OVERRANGE PROT.				
BULB LENGTH				
BULB DIAM.				
BULB MAT'L.				
CAPILLARY LGTH.				
CAPILLARY TYPE (ARMOR)				
SWITCH				
TYPE				
ENCLOSURE				
CONDUIT CONN.				
FORM				
NO. SWITCHES				
RESISTIVE LOAD				
MAKE 120VAC/125VDC				
BREAK 120VAC/125VDC				
INDUCTIVE LOAD AT .026 L/R				
MAKE 120VAC/125VDC				
BREAK 120VAC/125VDC				
MAX. CARRYING CURRENT				
MIN. DIFFERENTIAL				
RESET DIFFERENTIAL				
SET POINT = INCR/DECR				
THERMOWELL				
"U" LENGTH				
MATERIAL				
WALL THICKNESS				
MANUFACTURER *				
MODEL NO. *				
WEIGHT *				
CATEGORY				

NOTES:

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TECHNICAL DATA SHEET- PART C
THERMOWELLS

CLIENT ERDA
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EQUIP. NO.	SERVICE OR LOCATION	S & W DWG. NO.	LENGTH "U" (IF REQ'D.)	MATERIAL	PIPE		DESIGN REQUIREMENTS		
					SIZE	WALL THK.	TEMP. °F	PRESS PSIG	VEL. FPS
4TW-1A	COLD REHEAT STA	EM-102A							
4TW-1B	COLD REHEAT STA	EM-102A							
4TW-2A	MN STM LINE	EM-102A							
4TW-2B	MN STM LINE	EM-102A							
4TW-3A	HOT REHEAT STM	EM-102A							
4TW-3B	HOT REHEAT STM	EM-102A							
4TW-38 *	THROTTLE LEAK OFF DEN	EM-102A							
4TW-56A	MN STM HDR	EM-102A							
4TW-56B	MN STM HDR	EM-102A							
4TW-57	COLD REHEAT INLT	EM-102A							
4TW-58	HOT REHEAT OUTLT	EM-102A							
MANUFACTURER:									
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STONE & WEBSTER ENGINEERING CORPORATION
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EQUIP. NO.	SERVICE OR LOCATION	S & W DWG. NO.	LENGTH "U" (IF REQ'D.)	MATERIAL	PIPE		DESIGN REQUIREMENTS		
					SIZE	WALL THK.	TEMP. OF	PRESS PSIG	VEL. FPS
4TW-4	IP TURB EXT STM TO 2ND PT HTR	EM-103A							
4TW-5	LP TURB EXT STM TO DA TK	EM-103A							
4TW-6A	IP TURB EXT STM TO DA TK	EM-103A							
4TW-6B	LP (B) EXT STM TO DA TK	EM-103A							
4TW-28	HP TURB EXT STM TO 1ST PT HTR	EM-103A							
4TW-29	IP TURB EXT STM TO 2ND PT HTR	EM-103A							
4TW-30	EXT STM SHPP TO DA TK	EM-103A							
4TW-31	IP TURB EXT STM TO 3RD PT HTR	EM-103A							
4TW-35B	72 PT HTR DRN	EM-103A							
4TW-101	IP TURB EXT STM TO BFP LP TURB	EM-103A							
4TW-102	MN STM TO BFP HP TURB	EM-103A							

MANUFACTURER:

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THERMOWELLS

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THERMOWELLS

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EQUIP. NO.	SERVICE OR LOCATION	S & W DWG. NO.	LENGTH "U" (FREQ'D.)	MATERIAL	PIPE		DESIGN REQUIREMENTS		
					SIZE	WALL THK.	TEMP. °F	PRESS PSIG	VEL. FPS
		<i>EM-105A</i>							
<i>4TW-13A</i>	<i>FD WTR HTR INLT 4EH-7</i>								
<i>4TW-13B</i>	<i>FD WTR HTR OUTLT 4EH-6</i>	<i>EM-105A</i>							
<i>4TW-14A</i>	<i>FD WTR HTR OUTLT 4EH-5</i>	<i>EM-105A</i>							
<i>4TW-14B</i>	<i>FD WTR HTR INLT 4EH-6</i>	<i>EM-105A</i>							
<i>4TW-15A</i>	<i>FD WTR HTRS OUTLT HDB</i>	<i>EM-105A</i>							
<i>4TW-15B</i>	<i>FD WTR HTRS OUTLT HDB</i>	<i>EM-105A</i>							
<i>4TW-32</i>	<i>FD WTR HTR INLT 4EH-5</i>	<i>EM-105A</i>							
<i>4TW-70</i>	<i>FD WTR HTR INLT 4EH-5</i>	<i>EM-105A</i>							
MANUFACTURER:									
NOTES:									
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET- PART C
THERMOCOUPLES WITH THERMOWELLS

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EQUIP. NO.	SERVICE / RANGE	THERMOWELL			PIPE		MAXIMUM DESIGN REQ.		
		S & W DWG NO.	MAT'L	"U" LGTH.	SIZE	WALL THK.	TEMP. F	PRESS PSIG	VEL. FPS
4TW-21	1 st PT HTR TO 2 nd PT HTR	EM-106A							
4TW-22	2 nd PT HTR TO 3 rd PT HTR	EM-106A							
4TW-24	3 rd PT HTR TO DTK	EM-106A							
4TW-25	5 th PT HTR DRN	EM-106A							
4TW-26	6 th PT HTR DRN	EM-106A							
4TW-27A	7 th PT HTR 1A LOOP SEAL DRN	EM-106A							
4TW-27B	7 th PT HTR 1B LOOP SEAL DRN	EM-106A							
4TW-71A	6 th PT HTR DRN CLR DRN TO CO4SR	EM-106A							
4TW-71B	5 th PT HTR DRN CLR TO CO4SR	EM-106A							
CALIBRATION TYPE									
HEAD									
EXTENSION NIPPLES & UNION									
CONDUIT CONN. SIZE									
MANUFACTURER *									
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STONE & WEBSTER ENGINEERING CORPORATION
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THERMOCOUPLES WITH THERMOWELLS

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EQUIP. NO.	SERVICE / RANGE	THERMOWELL			PIPE		MAXIMUM DESIGN REQ.		
		S & W DWG NO.	MAT'L	"U" LGTH.	SIZE	WALL THK.	TEMP. F	PRESS PSIG	VEL. FPS
4TW-19A	HP COND SR CIRC WTR OUTLT	EM-110A							
4TW-19B	HP COND SR CIRC WTR OUTLT	EM-110A							
4TW-19C	HP COND SR CIRC WTR OUTLT	EM-110A							
4TW-20A	HP COND SR CIRC WTR OUTLT	EM-110A							
4TW-20B	HP COND SR CIRC WTR OUTLT	EM-110A							
4TW-20C	HP COND SR CIRC WTR OUTLT	EM-110A							
4TW-41	HP COND SR CIRC WTR INLT	EM-110A							
4TW-42	LP COND SR CIRC WTR INLT	EM-110A							
CALIBRATION TYPE									
HEAD									
EXTENSION NIPPLES & UNION									
CONDUIT CONN. SIZE									
MANUFACTURER *									
NOTES:									
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THERMOCOUPLES WITH THERMOWELLS

CLIENT ERDA
PROJECT AFB STUDY

PREPARER	837	11-15-77
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EQUIP. NO.	SERVICE / RANGE	THERMOWELL			PIPE		MAXIMUM DESIGN REQ.		
		S & W DWG NO.	MAT'L	"U" LGTH.	SIZE	WALL THK.	TEMP. F	PRESS PSIG	VEL. FPS
4TW-63A	CLNG TWR CIRC WTR INLT	EM-110A							
4TW-63B	CLNG TWR CIRC WTR INLT	EM-110A							
4TW-63C	CLNG TWR CIRC WTR INLT	EM-110A							
4TW-64A	CLNG TWR CIRC WTR OUTLT	EM-110A							
4TW-64B	CLNG TWR CIRC WTR OUTLT	EM-110A							
4TN-64C	CLNG TWR CIRC WTR OUTLT	EM-110A							
CALIBRATION TYPE									
HEAD									
EXTENSION NIPPLES & UNION									
CONDUIT CONN. SIZE									
MANUFACTURER *									
NOTES:									
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET-PART C
CONTROL VALVE

CLIENT ERDA
PROJECT AFB STUDY

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EQUIP. NO 4LLV-10A		No. REQ'D 1		FSK-EM-104A	
SERVICE CONDENSATE MAKE-UP		ASME CODE		CLASS	
		S & W CATEGORY			
SHUT-OFF PSIA 100		LOCATION: AT CONDENSER			
LINE SIZE/SCHED 2" / 80		DESIGN PRESS 20 PSIA		TEMP 95 °F	
SIZING DATA		MINIMUM		NORMAL	
INLET PSIA				15	
OUTLET PSIA				3.5" H/g	
SP. GR. OR (MW)				.995	
FLOW RATE				65 GPM	
TEMP °F				95	
C _v REQUIRED				17.8	
C _v ACTUAL *				PLANT LINE NO.	
FLUID		WATER			
S & W SEAT LEAK CLASS		CLASS 2			
BODY-FORM *				ACCESSORIES	
-SIZE (IN.) *				AIR SET (W/GAGE) YES-2	
-ANSI RATING/CONN		1		LUBRICATOR (W/ISOL. VALVE) NO	
MATERIAL (ASTM)-BODY		CS		HANDWHEEL YES	
-BONNET		CS		POSITIONER YES	
TRIM-CHARACTERISTIC		= 90		MFG/MODEL * 1	
-NO. PORTS		ONE		INPUT/OUTPUT 3-15 1*	
-PORT SIZE (IN)		FULL PORT		TRANSDUCER	
-MATERIAL-PLUG *				MFG/MODEL * 1	
-SEAT *				INPUT/OUTPUT 4-20MA / 3-15	
GUIDE *				CONNS-ELEC/PNEU. 1/2" NPT 1/4" NPT	
BONNET		FLANGED/REGULAR		SOLENOID VALVE TYPE 3-WAY	
PACKING		TEFLON V-RING		MFG./MODEL *	
BACK SEAT		NO		ENERGIZE TO CLOSE / VALVE	
LEAK-OFF CONN.		NO		SOL. COIL ENCL. NEMA 4	
ACTION-AIR TO		CLOSE		ELECT. CONNS. NEMA 1/2"	
FLOW-TENDS TO		OPEN		BODY CONNS. 1/4" NPT	
ACTUATOR-TYPE *				LIMIT SWITCH YES	
-SIZE *				MFG/MODEL *	
-STROKE IN. *				OPEN POSITION 2 SPDT	
AIR TO ACTUATOR *				CLOSE POSITION 2 SPDT	
CALC NOISE (dBA) *				ENCLOSURE NEMA 4	
VELOCITY (FPS) *				CONDUIT SIZE 1/2"	
MANUFACTURER *				SEISMIC DATA REQUIRED NO	
MODEL NO. *				WEIGHT (NET) *	

NOTES: 1, * INDICATES INFORMATION TO BE SUPPLIED BY MFG

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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET-PART C
CONTROL VALVE

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PROJECT AFB STUDY

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EQUIP. NO 4LCV-10B		No. REQ'D 1		FSK-EM-104A	
SERVICE CONDENSATE EMERG MAKE-UP		ASME CODE		CLASS	
S & W CATEGORY					
SHUT-OFF PSIA		LOCATION: AT CONDENSER			
LINE SIZE/SCHED		DESIGN PRESS.		TEMP.	
SIZING DATA	MINIMUM	NORMAL		MAXIMUM	
INLET PSIA		17.5			
OUTLET PSIA		35" HG			
SP. GR. OR (MW)		.995			
FLOW RATE		1100 GPM			
TEMP °F		95			
Cv REQUIRED		275			
Cv ACTUAL *		PLANT LINE NO.			
FLUID	WATER				
S & W SEAT LEAK CLASS	CLASS 2				
BODY-FORM *		ACCESSORIES			
-SIZE (IN.) *		AIR SET (W/GAGE)		YES-2	
-ANSI RATING/CONN *	1	LUBRICATOR (W/ISOL. VALVE)		NO	
MATERIAL (ASTM)-BODY	CS	HANDWHEEL		YES	
-BONNET	CS	POSITIONER		YES	
TRIM-CHARACTERISTIC	20	MFG/MODEL *		1	
-NO. PORTS	ONE	INPUT/OUTPUT		3-15 1 *	
-PORT SIZE (IN)	FULL PORT	TRANSDUCER		YES	
-MATERIAL-PLUG *		MFG/MODEL *		1	
-SEAT *		INPUT/OUTPUT		4-20MA 1 3-15	
GUIDE *		CONNS-ELEC/PNEU.		1/2" NPT 1/4" NPT	
BONNET	FLANGED/METAL	SOLENOID VALVE TYPE		3-WAY	
PACKING	TEFLON V-RING	MFG./MODEL *			
BACK SEAT	NO	ENERGIZE TO		OPEN 1 VALVE	
LEAK-OFF CONN.	NO	SOL. COIL ENCL.		NEMA 4	
ACTION-AIR TO	OPEN	ELECT. CONNS.		NEMA 1/2"	
FLOW-TENDS TO	OPEN	BODY CONNS.		1/4" NPT	
ACTUATOR-TYPE *		LIMIT SWITCH		YES	
-SIZE *		MFG/MODEL *			
-STROKE IN.		OPEN POSITION		2 SPDT	
AIR TO ACTUATOR *		CLOSE POSITION		2 SPDT	
CALC. NOISE (dBA) *		ENCLOSURE		NEMA 4	
VELOCITY (FPS) *		CONDUIT SIZE		1/2"	
MANUFACTURER *		SEISMIC DATA REQUIRED		NO	
MODEL NO. *		WEIGHT (NET) *			

NOTES: 1, * INDICATES INFORMATION TO BE SUPPLIED BY MFG

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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET-PART C
CONTROL VALVE

CLIENT **ERDA**
PROJECT **AFB STUDY**

PREPARER
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EQUIP. NO ALCV-3-1, ALCV-3-2		No. REQ'D 2		FSK-EM-104A	
SERVICE DEAERATOR LEVEL CONTROL		ASME CODE		CLASS	
S & W CATEGORY					
SHUT-OFF PSIA 548		LOCATION: AT DEAERATOR			
LINE SIZE/SCHED	18" / Ex STR	DESIGN: PRESS. 548 PSIA TEMP. 263°F			
SIZING DATA	MINIMUM	NORMAL		MAXIMUM	
INLET PSIA				344	
OUTLET PSIA				63	
SP. GR. OR (MW)				.936	
FLOW RATE				3390 GPM	
TEMP °F				263	
C _v REQUIRED				195	
C _v ACTUAL	*	PLANT LINE NO.			
FLUID	WATER				
S & W SEAT LEAK CLASS	CLASS 2				
BODY-FORM	*	ACCESSORIES			
-SIZE (IN.)	*	AIR SET (W/GAGE)		YES-2	
-ANSI RATING/CONN	*	LUBRICATOR (W/ISOL. VALVE)		NO	
MATERIAL (ASTM)-BODY	CS	HANDWHEEL		YES	
-BONNET	CS	POSITIONER		YES	
TRIM-CHARACTERISTIC	= 90	MFG/MODEL		* 1	
-NO. PORTS	ONE	INPUT/OUTPUT		3-15 1*	
-PORT SIZE (IN)	FULL PORT	TRANSDUCER		YES	
-MATERIAL-PLUG	*	MFG/MODEL		* 1	
-SEAT	*	INPUT/OUTPUT		4-20MA / 3-15	
GUIDE	*	CONNS-ELEC/PNEU.		1/2" NPT / 1/4" NPT	
BONNET	FLANGED/INTEGRAL	SOLENOID VALVE TYPE		3-WAY	
PACKING	TEFLON V-RING	MFG./MODEL		* 	
BACK SEAT	NO	ENERGIZE TO		OPEN / VALVE	
LEAK-OFF CONN.	NO	SOL. COIL ENCL.		NEMA 4	
ACTION-AIR TO	OPEN	ELECT. CONNS.		1/2"	
FLOW-TENDS TO	OPEN	BODY CONNS.		1/4" NPT	
ACTUATOR-TYPE	*	LIMIT SWITCH		YES	
-SIZE	*	MFG/MODEL		* 	
-STROKE IN.	*	OPEN POSITION		2 SPDT	
AIR TO ACTUATOR	*	CLOSE POSITION		2 SPDT	
CALC. NOISE (dBA)	*	ENCLOSURE		NEMA 4	
VELOCITY (FPS)	*	CONDUIT SIZE		1/2"	
MANUFACTURER	*	SEISMIC DATA REQUIRED		NO	
MODEL NO.	*	WEIGHT (NET)		* 	

NOTES: 1. * INDICATES INFORMATION TO BE SUPPLIED BY MFG

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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET- PART C
CONTROL VALVE

CLIENT ERDA
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EQUIP. NO 4LCV-11A		No. REQ'D 1		FSK-EM-104A	
SERVICE CONDENSATE DRAW-OFF		ASME CODE		CLASS	
S & W CATEGORY					
SHUT-OFF PSIA 548		LOCATION: AT CONDENSER			
LINE SIZE/SCHED 2" / 80		DESIGN: PRESS. 548		TEMP. 263 °F	
SIZING DATA		MINIMUM		NORMAL	
				MAXIMUM	
INLET PSIA		192			
OUTLET PSIA		20			
SP. GR. OR (MW)		.983			
FLOW RATE		65 GPM			
TEMP °F		141			
C _v REQUIRED		4.91			
C _v ACTUAL *		PLANT LINE NO.			
FLUID WATER					
S & W SEAT LEAK CLASS CLASS 2					
BODY-FORM *		ACCESSORIES			
-SIZE (IN.) *		AIR SET (W/GAGE)		YES-2	
-ANSI RATING/CONN *		LUBRICATOR (W/ISOL. VALVE)		NO	
MATERIAL (ASTM)-BODY CS		HANDWHEEL		YES	
-BONNET CS		POSITIONER		YES	
TRIM-CHARACTERISTIC = 90		MFG/MODEL *		1	
-NO. PORTS ONE		INPUT/OUTPUT		3-15 1X	
-PORT SIZE (IN) FULL PORT		TRANSDUCER		YES	
-MATERIAL-PLUG *		MFG/MODEL *		1	
-SEAT *		INPUT/OUTPUT		4-20MA 13-15	
GUIDE *		CONNS-ELEC/PNEU.		1/2" NPT 1 1/4" NPT	
BONNET FLANGED/MATERIAL		SOLENOID VALVE TYPE		3-WAY	
PACKING TEFLON V-RING		MFG./MODEL *			
BACK SEAT NO		ENERGIZE TO		OPEN 1 VALVE	
LEAK-OFF CONN. NO		SOL. COIL ENCL.		NEMA-4	
ACTION-AIR TO OPEN		ELECT. CONNS.		NEMA 1/2"	
FLOW-TENDS TO OPEN		BODY CONNS.		1/4" NPT	
ACTUATOR-TYPE *		LIMIT SWITCH			
-SIZE *		MFG/MODEL *			
-STROKE IN. *		OPEN POSITION		2 SPDT	
AIR TO ACTUATOR *		CLOSE POSITION		2 SPDT	
CALC. NOISE (dBA) *		ENCLOSURE		NEMA 4	
VELOCITY (FPS) *		CONDUIT SIZE		1/2"	
MANUFACTURER *		SEISMIC DATA REQUIRED		NO	
MODEL NO. *		WEIGHT (NET) *			

NOTES: 1. * INDICATES INFORMATION TO BE SUPPLIED BY MFG

REV	1		2		3		4	
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART C
CONTROL VALVE

CLIENT **ERDA**
PROJECT **AFB STUDY**

PREPARER
SPECIALIST

INITIAL DATE
GBF **11-15-77**

T.D.S. NO. VI
PAGE
SPEC. NO.
J.O. NO. **12919.02**

EQUIP. NO 4LCV-11B		No. REQ'D 1		FSK-EM-104A	
SERVICE CONDENSATE BLOWDOWN VALVE		ASME CODE		CLASS	
		S & W CATEGORY			
SHUT-OFF PSIA 548		LOCATION: AT CONDENSER			
LINE SIZE/SCHED 2"/80		DESIGN PRESS. 548		TEMP. 263	
SIZING DATA		MINIMUM		NORMAL	
				MAXIMUM	
INLET PSIA				192	
OUTLET PSIA				14.7	
SP. GR. OR (MW)				.983	
FLOW RATE				65 GPM	
TEMP °F				141	
C _v REQUIRED				4.84	
C _v ACTUAL *				PLANT LINE NO.	
FLUID		WATER			
S & W SEAT LEAK CLASS		CLASS 2			
BODY-FORM *				ACCESSORIES	
-SIZE (IN.) *				AIR SET (W/GAGE)	
-ANSI RATING/CONN *		1		LUBRICATOR (W/ISOL. VALVE)	
MATERIAL (ASTM)-BODY		CS		HANDWHEEL	
-BONNET		CS		POSITIONER	
TRIM-CHARACTERISTIC		= 90		MFG/MODEL *	
-NO. PORTS		ONE		INPUT/OUTPUT	
-PORT SIZE (IN.)		FULL PORT		TRANSDUCER	
-MATERIAL-PLUG *				MFG/MODEL *	
-SEAT *				INPUT/OUTPUT	
GUIDE *				CONNS-ELEC/PNEU.	
BONNET		FLANGED/INTEGRAL		SOLENOID VALVE TYPE	
PACKING		TEFLON V-RING		MFG./MODEL *	
BACK SEAT		NO		ENERGIZE TO	
LEAK-OFF CONN.		NO		SOL. COIL ENCL.	
ACTION-AIR TO		OPEN		ELECT. CONNS.	
FLOW-TENDS TO		OPEN		BODY CONNS.	
ACTUATOR-TYPE *				LIMIT SWITCH	
-SIZE *				MFG/MODEL *	
-STROKE IN. *				OPEN POSITION	
AIR TO ACTUATOR *				CLOSE POSITION	
CALC. NOISE (dBA) *				ENCLOSURE	
VELOCITY (FPS) *				CONDUIT SIZE	
MANUFACTURER *				SEISMIC DATA REQUIRED	
MODEL NO. *				WEIGHT (NET) *	

NOTES: 1. * INDICATES INFORMATION TO BE SUPPLIED BY MFG.

REV	1		2		3		4	
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART C
CONTROL VALVE

CLIENT ERDA
PROJECT AFB STUDY

PREPARER
SPECIALIST

INITIAL DATE

697 11-15-77

T.D.S. NO. VI

PAGE

SPEC. NO.

J.O. NO. 12919.02

EQUIP. NO. <u>ALCV-56A, ALCV-56B</u>		No. REQ'D <u>2</u>		FSK- <u>EM-110A</u>	
SERVICE <u>VAC PUMP 1A RESERVOIR LEVEL</u>		ASME CODE		CLASS	
<u>VAC PUMP 1B RESERVOIR LEVEL</u>		S & W CATEGORY			
SHUT-OFF PSIA		LOCATION: <u>AT CONDENSER</u>			
LINE SIZE/SCHED		DESIGN PRESS. <u>15 PSIG</u>		TEMP. <u>95° F</u>	
SIZING DATA	MINIMUM	NORMAL		MAXIMUM	
INLET PSIA		<u>15 PSIG</u>			
OUTLET PSIA		<u>1" Hg</u>			
SP. GR. OR (MW)		<u>.994</u>			
FLOW RATE		<u>20 GPM</u>			
TEMP °F		<u>95</u>			
C _v REQUIRED		<u>3.77</u>			
C _v ACTUAL	*	PLANT LINE NO.			
FLUID	<u>WATER</u>				
S & W SEAT LEAK CLASS	<u>CLASS 2</u>				
BODY-FORM	*	ACCESSORIES			
-SIZE (IN.)	*	AIR SET (W/GAGE)		<u>YES-2</u>	
-ANSI RATING/CONN	*	LUBRICATOR (W/ISOL. VALVE)		<u>NO</u>	
MATERIAL (ASTM)-BODY	<u>CS</u>	HANDWHEEL		<u>YES</u>	
-BONNET	<u>CS</u>	POSITIONER		<u>YES</u>	
TRIM-CHARACTERISTIC	<u>= 90</u>	MFG/MODEL		* <u>1</u>	
-NO. PORTS	<u>ONE</u>	INPUT/OUTPUT		<u>3-15 1*</u>	
-PORT SIZE (IN)	<u>FULL PORT</u>	TRANSDUCER		<u>YES</u>	
-MATERIAL-PLUG	*	MFG/MODEL		* <u>1</u>	
-SEAT	*	INPUT/OUTPUT		<u>4-20 MA / 3-15</u>	
GUIDE	*	CONNS-ELEC/PNEU.		<u>1/2" NPT 1 1/4" NPT</u>	
BONNET	<u>FLANGED/STANDARD</u>	SOLENOID VALVE TYPE		<u>3-WAY</u>	
PACKING	<u>TEFLON V-RING</u>	MFG./MODEL		* <u></u>	
BACK SEAT	<u>NO</u>	ENERGIZE TO		<u>OPEN / 1 VALVE</u>	
LEAK-OFF CONN.	<u>NO</u>	SOL. COIL ENCL.		<u>NEMA 4</u>	
ACTION-AIR TO	<u>OPEN</u>	ELECT. CONNS.		<u>1/2"</u>	
FLOW-TENDS TO	<u>OPEN</u>	BODY CONNS.		<u>1/4" NPT</u>	
ACTUATOR-TYPE	*	LIMIT SWITCH		<u>YES</u>	
-SIZE	*	MFG/MODEL		* <u></u>	
-STROKE IN.	*	OPEN POSITION		<u>2 SPDT</u>	
AIR TO ACTUATOR	*	CLOSE POSITION		<u>2 SPDT</u>	
CALC. NOISE (dBA)	*	ENCLOSURE		<u>NEMA 4</u>	
VELOCITY (FPS)	*	CONDUIT SIZE		<u>1/2"</u>	
MANUFACTURER	*	SEISMIC DATA REQUIRED		<u>NO</u>	
MODEL NO.	*	WEIGHT (NET)		* <u></u>	

NOTES: 1. * INDICATES INFORMATION TO BE SUPPLIED BY MFG

REV	1		2		3		4	
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET- PART C
CONTROL VALVE

CLIENT ERDA
PROJECT AFB STUDY

PREPARER
SPECIALIST

INITIAL DATE
GBZ 11-15-77

T.D.S. NO. VI
PAGE
SPEC. NO.
J.O. NO. 12919.02

EQUIP. NO 4LCV-18		No. REQ'D 1		FSK-EM-110	
SERVICE COOLING TOWER MAKE-UP		ASME CODE		CLASS	
		S & W CATEGORY			
SHUT-OFF PSIA 65 PSIG		LOCATION: COOLING TOWER			
LINE SIZE/SCHED	20" / 151	DESIGN PRESS. 65 PSIG		TEMP. 92°F	
SIZING DATA		MINIMUM		NORMAL	
				MAXIMUM	
INLET PSIA		50			
OUTLET PSIA		14.7			
SP. GR. OR (MW)		.995			
FLOW RATE		9000 GPM			
TEMP °F		92°F			
C _v REQUIRED		1511			
C _v ACTUAL *		PLANT LINE NO.			
FLUID	WATER				
S & W SEAT LEAK CLASS	CLASS 2				
BODY-FORM *		ACCESSORIES			
-SIZE (IN.) *		AIR SET (W/GAGE)		YES-2	
-ANSI RATING/CONN *	1	LUBRICATOR (W/ISOL. VALVE)		NO	
MATERIAL (ASTM)-BODY	CS	HANDWHEEL		YES	
-BONNET	CS	POSITIONER		YES	
TRIM-CHARACTERISTIC	= 90	MFG/MODEL *		1	
-NO. PORTS	ONE	INPUT/OUTPUT		3-15 1X	
-PORT SIZE (IN)	FULL PORT	TRANSDUCER		YES	
-MATERIAL-PLUG *		MFG/MODEL *		1	
-SEAT *		INPUT/OUTPUT		4-20MA 13-15	
GUIDE *		CONNS-ELEC/PNEU.		1/2" NPT 1 1/4" NPT	
BONNET	FLANGED/INTERNAL	SOLENOID VALVE TYPE		3-WAY	
PACKING	TEFLON V-RING	MFG./MODEL *			
BACK SEAT	NO	ENERGIZE TO		OPEN VALVE	
LEAK-OFF CONN.	NO	SOL. COIL ENCL.		NEMA 4	
ACTION-AIR TO	OPEN	ELECT. CONNS.		1/2"	
FLOW-TENDS TO	OPEN	BODY CONNS.		1/4" NPT	
ACTUATOR-TYPE *		LIMIT SWITCH		YES	
-SIZE *		MFG/MODEL *			
-STROKE IN. *		OPEN POSITION		2 SPDT	
AIR TO ACTUATOR *		CLOSE POSITION		2 SPDT	
CALC. NOISE (dBA) *		ENCLOSURE		NEMA 4	
VELOCITY (FPS) *		CONDUIT SIZE		1/2"	
MANUFACTURER *		SEISMIC DATA REQUIRED		NO	
MODEL NO. *		WEIGHT (NET) *			

NOTES: 1. * INDICATES INFORMATION TO BE SUPPLIED BY MFG

REV	1		2		3		4	
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART C
CONTROL VALVE

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PROJECT AFB STUDY

PREPARER
SPECIALIST

INITIAL DATE
237 11-15-77

T.D.S. NO. VI
PAGE
SPEC. NO.
J.O. NO. 12919.02

EQUIP. NO 4 CV-95		No. REQ'D 1		FSK-EM-110A	
SERVICE COOLING TOWER BLOWDOWN		ASME CODE		CLASS	
SHUT-OFF PSIA 56 PSIG		S & W CATEGORY			
LINE SIZE/SCHED 10" / CL 151		LOCATION: AT COOLING TOWER		DESIGN: PRESS. 56 PSIG TEMP. 92°F	
SIZING DATA		MINIMUM		NORMAL	
INLET PSIA		43 PSIG		MAXIMUM	
OUTLET PSIA		39 PSIG			
SP. GR. OR (MW)		.995			
FLOW RATE		2040 GPM			
TEMP °F		92°F			
Cv REQUIRED		507.45			
Cv ACTUAL *		PLANT LINE NO.			
FLUID		WATER			
S & W SEAT LEAK CLASS		CLASS 2			
BODY-FORM *		ACCESSORIES			
-SIZE (IN.) *		AIR SET (W/GAGE)		YES-2	
-ANSI RATING/CONN *		LUBRICATOR (W/ISOL. VALVE)		NO	
MATERIAL (ASTM)-BODY		HANDWHEEL		YES	
-BONNET		POSITIONER		YES	
TRIM-CHARACTERISTIC		MFG/MODEL *		/	
-NO. PORTS		INPUT/OUTPUT		3-15 / *	
-PORT SIZE (IN)		TRANSDUCER		YES	
-MATERIAL-PLUG *		MFG/MODEL *		/	
-SEAT *		INPUT/OUTPUT		4-20MA / 3-15	
GUIDE *		CONNS-ELEC/PNEU.		1/2" NPT 1/4" NPT	
BONNET		SOLENOID VALVE TYPE		3-WAY	
PACKING		MFG./MODEL *			
BACK SEAT		ENERGIZE TO		OPEN / VALVE	
LEAK-OFF CONN.		SOL. COIL ENCL.		NEMA 4	
ACTION-AIR TO		ELECT. CONNS.		1/2"	
FLOW-TENDS TO		BODY CONNS.		1/4" NPT	
ACTUATOR-TYPE *		LIMIT SWITCH		YES	
-SIZE *		MFG/MODEL *			
-STROKE IN. *		OPEN POSITION		2 SPDT	
AIR TO ACTUATOR		CLOSE POSITION		2 SPDT	
CALC. NOISE (dBA) *		ENCLOSURE		NEMA 4	
VELOCITY (FPS) *		CONDUIT SIZE		1/2"	
MANUFACTURER *		SEISMIC DATA REQUIRED		NO	
MODEL NO. *		WEIGHT (NET) *			

NOTES: 1. * INDICATES INFORMATION TO BE SUPPLIED BY MFG

REV	1		2		3		4	
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STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART C
CONTROL VALVE

CLIENT ERDA
PROJECT AFB STUDY

PREPARER
SPECIALIST

INITIAL DATE
GBF 11-15-77

T.D.S. NO. VI
PAGE
SPEC. NO.
J.O. NO. 12919.02

EQUIP. NO 4CV-301A, 4CV-301B		No. REQ'D 2		FSK-EM-110A	
SERVICE VAC PPS 1A, 1B. SUCTION		ASME CODE		CLASS	
		S & W CATEGORY			
SHUT-OFF PSIA		LOCATION: AT CONDENSER			
LINE SIZE/SCHED		DESIGN PRESS.	TEMP.		
SIZING DATA	MINIMUM	NORMAL	MAXIMUM		
INLET PSIA		11N Hg			
OUTLET PSIA		14.7			
SP. GR. OR (MW)		.0750 #/ft ³			
FLOW RATE		504 #/hr			
TEMP °F		71.5°F			
C _v REQUIRED		31.62			
C _v ACTUAL *		PLANT LINE NO.			
FLUID	AIR				
S & W SEAT LEAK CLASS	CLASS 2				
BODY-FORM *		ACCESSORIES			
-SIZE (IN.) *		AIR SET (W/GAGE)		YES-2	
-ANSI RATING/CONN *	1	LUBRICATOR (W/ISOL. VALVE)		NO	
MATERIAL (ASTM)-BODY	CS	HANDWHEEL		YES	
-BONNET	CS	POSITIONER		YES	
TRIM-CHARACTERISTIC	= 90	MFG/MODEL *		1	
-NO. PORTS	ONE	INPUT/OUTPUT		3-15 / *	
-PORT SIZE (IN)	FULL PORT	TRANSDUCER		YES	
-MATERIAL-PLUG *		MFG/MODEL *		1	
-SEAT *		INPUT/OUTPUT		4-20 MA / 3-15	
GUIDE *		CONNS-ELEC/PNEU.		1/2" NPT / 1/4" NPT	
BONNET	FLANGED/INTERFACED	SOLENOID VALVE TYPE		3-WAY	
PACKING	TEFLON V-RING	MFG./MODEL *			
BACK SEAT	NO	ENERGIZE TO		OPEN / VALVE	
LEAK-OFF CONN.	NO	SOL. COIL ENCL.		NEMA 4	
ACTION-AIR TO	OPEN	ELECT. CONNS.		NEMA 1/2"	
FLOW-TENDS TO	CLOSE	BODY CONNS.		1/4" NPT	
ACTUATOR-TYPE *		LIMIT SWITCH		YES	
-SIZE *		MFG/MODEL *			
-STROKE IN. *		OPEN POSITION		2 SPDT	
AIR TO ACTUATOR *		CLOSE POSITION		2 SPDT	
CALC. NOISE (dBA) *		ENCLOSURE		NEMA 4	
VELOCITY (FPS) *		CONDUIT SIZE		1/2"	
MANUFACTURER *		SEISMIC DATA REQUIRED		NO	
MODEL NO. *		WEIGHT (NET) *			

NOTES: 1. * INDICATES INFORMATION TO BE SUPPLIED BY MFG

REV	1		2		3		4	
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APPENDIX IIIA-E
INSTRUMENT SCHEDULE

PART A - Babcock & Wilcox Equipment

PART B - Equipment Common to
Babcock & Wilcox and Foster Wheeler

BABCOCK & WILCOX EQUIPMENT

REVISIONS			
NO.	DESCRIPTION	DATE	APPROVAL

STONE AND WEBSTER

DESIGNED BY FRED HOLLS	570 MW FLUID BED BOILER FLOW SCHEMATIC	THE MARCOX & WILCOX CO. POWER EQUIPMENT GROUP
CHECKED BY		
APPROVED BY		
DATE		
ES-261		
SCALE	1/4"	
250370 E 0		

This drawing was prepared as an integral part of the contract for the design and construction of the 570 MW Fluid Bed Boiler. It is the property of Stone and Webster Engineering Corporation and is not to be distributed outside the project without the written consent of Stone and Webster Engineering Corporation. It is to be used only for the purpose for which it was prepared and is not to be used for any other purpose without the written consent of Stone and Webster Engineering Corporation.

REVISIONS		
NO.	DESCRIPTION	DATE

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STONE & WEBSTER

DESIGNED BY CHECKED BY APPROVED BY DATE 11-28-77 ES-261	ARRGT CARBON BURN-UP BED	THIS DRAWING IS THE PROPERTY OF THE BARCOCK & WILCOX CO. IT IS TO BE KEPT IN THE COMPANY'S FILES AND NOT TO BE LOANED, REPRODUCED, COPIED, OR IN ANY MANNER DISCLOSED TO THE PUBLIC OR USED FOR ANY PURPOSE OTHER THAN THAT FOR WHICH IT WAS PREPARED WITHOUT THE WRITTEN PERMISSION OF THE BARCOCK & WILCOX CO.
SCALE 1/8" = 1'-0"	250374 E 0	REV.

REVISIONS		
NO.	DESCRIPTION	DATE

PLAN VIEW

FRONT VIEW

SIDE ELEVATION

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STONE & WEBSTER

DESIGNED BY	FRED HOLLIS
DRAWN BY	
CHECKED BY	
APPROVED BY	
DATE	10-12-77
ES-261	

LAYOUT CBB
FEED SYSTEM

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250371	E O

SCALE 3/32" = 1'-0"

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STONE & WEBSTER

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SOLIDS STORAGE TANK
PRECIP TO CBB AND
MIXING BUSTLE

DATE OF E.P.	DATE OF APPROVAL	DATE OF ISSUE
1-1-77	1-1-77	1-1-77
1-1-77	1-1-77	1-1-77

250372E-0

VIEW A-A

VIEW B-B

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THE BAKER & WILSON CO.			
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LAYOUT OF IN-BED SURFACES			
Drawn by E.H.	Checked by E.H.	Scale 1/4" = 1'-0"	Date 10-1-33
ES-261	250373 E-0

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not to be loaned to any other person or organization. It is to be
destroyed when it is no longer needed. It is to be kept in a safe
place and not to be loaned to any other person or organization.
ARRGT. OF REINJECTION
SYSTEM-PRECIP TO CBB.
PLAN SECTION A-A
DESIGNED BY F.H. DATE 11-1-57
CHECKED BY J.H. DATE 11-1-57
15-281 39161 F-0

Diagram illustrating a detail tube support. The diagram shows a horizontal tube with a seal plate and a 3" SCH 80 P. (pipe) connected to a COAL PIPE. The diagram is labeled "DETAIL TUBE SUPPORT".

A cross-sectional diagram of a well casing. It shows a vertical pipe labeled 'WELL TUBES' at the top. A 'SEAL PLATE' is shown as a horizontal disc within the pipe. The casing is labeled 'CASING'. A 'COIL PIPE' is shown as a separate pipe running parallel to the casing. The diagram illustrates the connection between the casing and the coil pipe.

A schematic diagram of a bed support structure. It shows a vertical support rod passing through a rectangular bed support frame. A coal pipe is positioned to the right of the support rod. At the bottom, a horizontal shaft's lug is welded to the coal pipe. Labels with arrows point to the following components: BED (top horizontal line), SUPPORT ROD (vertical line), BED SUPPORT (rectangular frame), COAL PIPE (vertical line on the right), and SHAFT'S LUG WELDED TO PIPE (bottom horizontal line).

"C" DETAIL TUBE SUPPORT

STONE & WILSTER

THE BARBERS & MILLERS CO.

LAY OUT OF BED SUPPORT
2 COTAL FIRE LOCATION
FOR MAIN BED LOUER

DATE: 10-26-77
BY: [signature]
CHECKED BY: [signature]

10-26-77
ES-261

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STONE & WEBSTER THE BARCOCK & WILCOX CO. 1500 N. 10TH ST. S.W. ALBUQUERQUE, N.M. 87102	
PROJECT OF REINJECTION SYSTEM PRECIPITATOR TO MAIN SECTION B-1	
DRAWN BY J. L. P.	CHECKED BY J. L. P.
DATE 39162 F-0

This drawing was prepared as a part of work done by the Stone & Webster Engineering Corporation, for the United States Atomic Energy Commission, under contract with the United States Atomic Energy Commission, for the purpose of providing a design for the construction of a carbon burn-out system. The design is based on the data furnished by the client and is subject to change without notice.

STONE & WEBSTER

ES-261		SECTIONAL SIDE VIEW	
DATE	10/1/50	BY	W. J. F.
CHECKED		APPROVED	
ES-261		SECTIONAL SIDE VIEW

250399E

REVISIONS			
NO.	DESCRIPTION	DATE	APPROVAL

F-24.

T.V.A.

DESIGNED BY E.E. PINSKE	ARRGT SIDE VIEW TVA A.F.B.	<small>THE ENGINEERING & ARCHITECTURE CO. 1000 MARKET STREET SAN FRANCISCO, CALIF. 94102</small>
CHECKED BY	ES-241	
APPROVED BY	200 MW UNIT	
DATE	SCALE 1/8" = 1'-0"	
250399E		0

REVISIONS			
NO.	DESCRIPTION	DATE	APPROVAL

PLAN SECTION "A-A"

T. V. A.

DESIGNED BY DRAWN BY CHECKED BY DATE ES-241	APPROVED BY DATE 12-1-77	T. V. A. ARRG PLAN SECTION "A-A" IVA A. F. B. 200 MW UNIT	THE BARCOCK & WILCOX CO. ENGINEERING GROUP 250391 E 0
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STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHEET I-1
PRESSURE INDICATORS - PI

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4PI-513	Turbine Bypass Desup Spray	Boiler Feed	later	EM-105	N/A	later	N/A
4PI-515	Turbine Bypass Desup Supply	Boiler Feed	later	EM-105	N/A	later	N/A
4PI-519	RHTR Cool Outlet Stm Desup Spray	Boiler Feed	later	EM-105	N/A	later	N/A
4PI-522	RHTR Cool Outlet Stm Desup Supply	Boiler Feed	later	EM-105	N/A	later	N/A
4PI-527	RHTR Cool Intl Stm Desup Spray	Boiler Feed	later	EM-105	N/A	later	N/A
4PI-530	RHTR Cool Intl Stm Desup Supply	Boiler Feed	later	EM-105	N/A	later	N/A
4PI-69	Phosphate Feed Pump Disch	Chemical Feed	later	EM-119A	N/A	later	N/A
4PI-70	Caustic Feed Pump Disch	Chemical Feed	later	EM-119A	N/A	later	N/A

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDY

INSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGN

SHEET I-2
PRESSURE INDICATING TRANSMITTERS - PIT
PRESSURE CONTROLLERS - PC

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagram</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4PIT-510	Desup Spray Supply	Boiler Feed	later	EM-105A	later	later	4PCV-510, 4SUV-510
4PC-562	Hot Reheat Outlet Header	Main Steam	later	EM-102A	later	later	4PSV-562A 4PSV-562B

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK AND WILCOX DESIGNSHEET IV-1
FLOW INDICATING TRANSMITTERS - FIT

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc. Instr.</u>
4FIT-516	Turb. Bypass Desup.	Boiler Feed	later	EM-105A	later	later	4RO-516
4FIT-523	Rhtr. Cooling Outlet Steam Desup. Spray	Boiler Feed	later	EM-105A	later	later	4RO-523
4FIT-531	Rhtr. Cooling Inlet Steam Desup. Spray	Boiler Feed	later	EM-105A	later	later	4RO-531
*4FIT-638A	CBB Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-638A
*4FIT-638B	CBB Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-638B
*4FIT-638C	CBB Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-638C
*4FIT-638D	CBB Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-638D
*4FIT-639A	CBB Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-639A
*4FIT-639B	CBB Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-639B
*4FIT-639C	CBB Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-639C
*4FIT-639D	CBB Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-639D
*4FIT-640A	Main Bed Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-640A
*4FIT-640B	Main Bed Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-640B
*4FIT-640C	Main Bed Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-640C
*4FIT-640D	Main Bed Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-640D

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDY

INSTRUMENT LIST - PART A
BABCOCK AND WILCOX DESIGN

SHEET IV-2
FLOW INDICATING TRANSMITTERS - FIT

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc. Instr.</u>
*4FIT-640E	Main Bed Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-640E
*4FIT-641A	Main Bed Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-641A
*4FIT-641B	Main Bed Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-641B
*4FIT-641C	Main Bed Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-641C
*4FIT-641D	Main Bed Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-641D
*4FIT-641E	Main Bed Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-641E
*4FIT-642A	Main Bed Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-642A
*4FIT-642B	Main Bed Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-642B
*4FIT-642C	Main Bed Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-642C
*4FIT-642D	Main Bed Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-642D
*4FIT-642E	Main Bed Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-642E
*4FIT-643A	Main Bed Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-643A
*4FIT-643B	Main Bed Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-643B
*4FIT-643C	Main Bed Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-643C
*4FIT-643D	Main Bed Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-643D

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02
ERDA AFB STUDY

INSTRUMENT LIST - PART C
COMMON TO BABCOCK & WILCOX, FOSTER WHEELER

SHEET VI-1
MULTIPOINT INDICATORS - 4R

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4R-1 PT-1	HP Turb Interstate Press	Main Stm & Reheat		EM-102A	Later	Later	4PIT-45
4R-3 PT-1	Condensate Flow	Condensate		EM-104A	Later	Later	FIT-26
PT-2	Da Tk Lvl	Condensate		EM-104A	Later	Later	4LIT-2
4R-4 PT-1	Econ Inlet Flow	Boiler Feed		EM-105A	Later	Later	4FIT-2
PT-2	Mn Stm Press			EM-102A	Later	Later	4PIT-1
4R-5 PT-1	Hot Reheat Outlt Temp	Mn Steam & Reheat		EM-102A	Later	Later	4TT-3
4R-8 PT-1	Suphtr Outlt Temp	Mn Steam & Reheat		EM-102A	Later	Later	4TT-1
4R-9 PT-1	Hot Reheat Temp	Mn Steam & Reheat		EM-102A	Later	Later	4TT-3

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02
ERDA AFB STUDY

INSTRUMENT LIST - PART C
COMMON TO BABCOCK & WILCOX, POSTER WHEELER

SHEET VI-2
CONDUCTIVITY MEASURING DEVICES - CR

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4CR-101	Cond Pps Disch Conductvty	Condensate		EM-104A	Later	Later	4CT-101
*4CR-102	Cond Pps Disc Conductvty	Condensate		EM-104A	Later	Later	4CT-102

*By Mfg.

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02
ERDA AFB STUDYINSTRUMENT LIST - PART C
COMMON TO BABCOCK & WILCOX, FOSTER WHEELERSHEET VI-3
CONDUCTIVITY TRANSMITTERS - CT

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4CT-101	Cond Pp Disch Conductvty	Condensate		EM-104A	Later	Later	4CR-101, Comptr
*4CT-102	Cond Pp Disch Conductvty	Condensate		EM-104A	Later	Later	4CR-102, Comptr
*4CT-113A	Condsr Hot Well Conductvty Before Cation Exch	Condensate		EM-104A	Later	Later	4RCR-113
*4CT-113B	Condsr Hot Well Conductvty After Cation Exch	Condensate		EM-104A	Later	Later	4RCR-113

*By Mfg.

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02
ERDA AFB STUDY

INSTRUMENT LIST - PART C
COMMON TO BABCOCK & WILCOX, FOSTER WHEELER

SHEET VI-4
DIAPHRAGM OPERATED VALVES - CV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4CV-82	Desuperhtr FSH-1 Stop Vlv	Boiler Feed		EM-105A	Later	Later	4SOV-82
4CV-12	Reht Desuperhtr Stop Vlv	Boiler Feed		EM-105A	Later	Later	4SOV-9

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02
ERDA AFB STUDYINSTRUMENT LIST - PART C
COMMON TO BABCOCK & WILCOX, FOSTER WHEELERSHEET V-7
SAFETY VALVES - SV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4SV-65B	Cond Pmp 1B Suct	Condensate		EM-104A	N/A	Later	N/A
4SV-204	Drn Clr DC-2 Cond Outlt	Condensate		EM-104A	N/A	Later	N/A
4SV-205	BFP Suct	Condensate		EM-104A	N/A	Later	N/A
4SV-206	Start-up Pd Pmp Suct	Condensate		EM-104A	N/A	Later	N/A
4SV-63	1st Pt Htr	Boiler Feed		EM-105A	N/A	Later	N/A
4SV-207	3rd Pt Htr	Boiler Feed		EM-105A	N/A	Later	N/A
4SV-208	2nd Pt Htr	Boiler Feed		EM-105A	N/A	Later	N/A

STONE & WEBSTER ENGINEERING CORPORATION
TECHNICAL DATA SHEET - PART A
ELECTRONIC PRESSURE TRANSMITTERS

CLIENT ERDA
PROJECT AFB STUDY

PREPARER
SPECIALIST

INITIAL DATE
GBF 11-30-77

T.D.S. NO. PIO
PAGE
SPEC. NO.
J.O. NO. 12919.02A

BABCOCK & WILCOX DESIGN

EQUIP. NO.	4PIT-510			
SERVICE	DESUP. SPRAY WTR SUPP PRESS			
OPERATING CONDITIONS				
FLUID OR GAS	WATER			
TEMPERATURE °F	304			
PRESSURE PSIG	1000			
ELEMENT TYPE	INDICATING			
ELEMENT MATERIAL	316SS			
ENCLOSURE (NEMA TYPE)	NEMA-4			
MOUNTING				
BODY MATERIAL				
RANGE				
OVERRANGE PROTECTION TO				
SPAN LIMITS				
OUTPUT SIGNAL	4-20MA DC			
OUTPUT SIGNAL TO	4PCV-510			
PROCESS CONN. SIZE	1/2 NPT			
CONDUIT CONN. SIZE	3/4 NPT			
ACCURACY				
REPEATIBILITY				
DEADBAND				
ACCESSORIES				
MANUFACTURER *				
MODEL NO. *				
WEIGHT *				
CATEGORY				

NOTES:

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02
ERDA AFB STUDYINSTRUMENT LIST - PART C
COMMON TO BABCOCK & WILCOX, FOSTER WHEELERSHEET V-5
NONRETURN VALVES - NRV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4NRV-1	HP Turb Ext Stm to 1st Pt Htr	Ext Stm		EM-103A	Later	Later	4SOV-28, 4LS-1B, Turb Trip
4NRV-2	IP Turb Ext Stm to 2nd Pt Htr	Ext Stm		EM-103A	Later	Later	4SOV-29, 4LS-2B, Turb Trip
4NRV-3	LP Turbs Ext Stm to DA	Ext Stm		EM-103A	Later	Later	Turb Trip
4NRV-4	IP Turb Ext Stm	Ext Stm		EM-103A	Later	Later	4SOV-31, 4LS-4B, Turb Trip
4NRV-5	HP Turb Ext Stm to Aux Stm	Ext Stm		EM-103A	Later	Later	Turb Trip
4NRV-6	Ext Stm to DA	Ext Stm		EM-103A	Later	Later	4SOV-62, 4LS-3B, Turb Trip
4NRV-7	LP Turb Ext Stm to DA	Ext Stm		EM-103A	Later	Later	Turb Trip
4NRV-51	IP Turb Ext Stm to 3rd Pt Htr	Ext Stm		EM-103A	Later	Later	
4NRV-52	IP Turb Ext Stm to BFP LP Turb	Ext Stm		EM-103A	Later	Later	4SOV-302

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02
ERDA AFB STUDY

INSTRUMENT LIST - PART C
COMMON TO BABCOCK & WILCOX, FOSTER WHEELER

SHEET V-6
SAFETY VALVES - SV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4SV-1*	Roof Header	Main Stm	Set 3265 Psig	EM-102A	Later	Later	N/A
4SV-2*	Roof Header	Main Stm	Set 3265 Psig	EM-102A	Later	Later	N/A
4SV-3*	Roof Header	Main Stm	Set 3365 Psig	EM-102A	Later	Later	N/A
4SV-4*	Roof Header	Main Stm	Set 3315	EM-102A	Later	Later	N/A
4SV-5*	Roof Header	Main Stm	Set 3315 Psig	EM-102A	Later	Later	N/A
4SV-6*	Roof Header	Main Stm	Set 3365 Psig	EM-102A	Later	Later	N/A
4SV-7*	Cold Reheat	Mn Stm & Reheat	Set 730 Psig	EM-102A	Later	Later	N/A
4SV-8*	Cold Reheat	Mn Stm & Reheat	Set 735 Psig	EM-102A	Later	Later	N/A
4SV-9*	Cold Reheat	Mn Stm & Reheat	Set 740 Psig	EM-102A	Later	Later	N/A
4SV-10*	Cold Reheat	Mn Stm & Reheat	Set 745	EM-102A	Later	Later	N/A
4SV-11*	Hot Reheat Outlt	Mn Stm & Reheat	Set 630	EM-102A	Later	Later	N/A
4SV-12*	Hot Reheat Outlt	Mn Stm & Reheat	Set 630	EM-102A	Later	Later	N/A
4SV-13*	Cold Reheat	Mn Stm & Reheat	Set 745	EM-102A	Later	Later	N/A
4SV-14*	Mn Stm Outlt	Mn Stm & Reheat	Set 3060	EM-102A	Later	Later	N/A
4SV-203*	Cold Reheat	Mn Stm & Reheat	Set 725	EM-102A	Later	Later	N/A
4PSV-1*	Mn Stm Hdr to Atmos	Mn Stm & Reheat		EM-102A	Later	Later	4PC-1
4PSV-2*	Mn Stm Hdr to Atmos	Mn Stm & Reheat		EM-102A	Later	Later	4PC-1
4SV-21	Cond Drawoff LCV Outlt	Condensate		EM-104A	Later	Later	N/A
4SV-54	Glnd Stm Condsr Cond Outlt	Condensate		EM-104A	Later	Later	N/A
4SV-56	7th Pt Htr Cond	Condensate		EM-104A	Later	Later	N/A
4SV-58	5th Pt Htr Cond	Condensate		EM-104A	Later	Later	N/A
4SV-65A	Cond Pmp 1A Suct	Condensate		EM-104A	Later	Later	N/A

*By Equip Mfr

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02
ERDA AFB STUDYINSTRUMENT LIST - PART C
COMMON TO BABCOCK & WILCOX, FOSTER WHEELERSHEET V-3
MOTOR-OPERATED VALVES - MOV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4MOV-62	Start-up Recirc Line Shutoff	Boiler Feed		EM-105A	Later	Later	
4MOV-63	Start-up BFP Disch to BFP	Boiler Feed		EM-105A	Later	Later	
4MOV-16A	Circ Wtr Pp 1A Disch	Circ Wtr, Condsr Air Rmvl		EM-110A	Later	Later	
4MOV-16B	Circ Wtr Pp 1B Disch	Circ Wtr, Condsr Air Rmvl		EM-110A	Later	Later	
4MOV-37A	Clng Twr Circ Wtr Inlt	Circ Wtr, Condsr Air Rmvl		EM-110A	Later	Later	
4MOV-37B	Clng Twr Circ Wtr Inlt	Circ Wtr, Condsr Air Rmvl		EM-110A	Later	Later	
4MOV-114	Clng Twr Mkup Pmp Bkwsh Strnr Disch	Circ Wtr, Condsr Air Rmvl		EM-110A	Later	Later	
4MOV-115	Clng Twr Mkup Pmp Disch Vlv	Circ Wtr, Condsr		EM-110A	Later	Later	

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02
ERDA AFB STUDY

INSTRUMENT LIST - PART C
COMMON TO BABCOCK & WILCOX, FOSTER WHEELER

SHEET V-4
SOLENOID OPERATED VALVES - SOV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4SOV-25*	AS to CV-1 Equalizer Vlv For Comb Intr & RH Stop Valve CRV-2	Mn Stm & Reheat		EM-102A	Later	Later	4CV-1
4SOV-28	HP Turb Ext Stm to 1st Pt Htr, NRV-1	Ext Stm		EM-103A	Later	Later	NRV-1
4SOV-29	IP Turb Ext Stm to 2nd Pt Htr, NRV-2	Ext Stm		EM-103A	Later	Later	NRV-2
4SOV-31	IP Turb Ext Stm, NRV-4	Ext Stm		EM-103A	Later	Later	NRV-4
4SOV-62	Ext Stm to DA Tk, NRV-6	Ext Stm		EM-103A	Later	Later	NRV-6
4SOV-302	IP Turb Ext Stm to BFP LP Turb, NRV-52	Ext Stm		EM-103A	Later	Later	NRV-52
4SOV-9	BFP Disch to Reheat Desuphtr Hdr	Boiler Feed		EM-105A	Later	Later	4CV-12
4SOV-82	BFP Disch to Suphtr Desuphtr Hdr	Boiler Feed		EM-105A	Later	Later	4CV-82
4SOV-301A	Vac Pri Pmp Suct Vlv CV-301A	Circ Wtr, Condsr Air Rmvl		EM-110A	Later	Later	4CV-301A
4SOV-301B	Vac Pri Pmp Suct Vlv CV-301B	Circ Wtr, Condsr		EM-110A	Later	Later	4CV-301B

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02
ERDA AFB STUDY

INSTRUMENT LIST - PART C
COMMON TO BABCOCK & WILCOX, POSTER WHEELER

SHEET V-1
CONTROL VALVES - CV, CRV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4CV-1*	Equalizer Valve for Comb Intercept & RH Stop Valve CRV-2	Mn Stm & Reheat		EM-102A	Later	Later	4SOV-25*
4CV-32*	IP Turb Blowdown to Cond	Mn Stm & Reheat		EM-102A	Later	Later	
4CV-33*	Mn Stm Blowdown to Cond	Mn Stm & Reheat		EM-102A	Later	Later	
4CV-79*	HP Turb Heating Stm Block Vlv	Mn Stm & Reheat		EM-102A	Later	Later	
4CRV-1*	Comb Inter & RH Stop Vlv	Mn Stm & Reheat		EM-102A	Later	Later	
4CRV-2*	Comb Inter & RH Stop Vlv	Mn Stm & Reheat		EM-102A	Later	Later	
4CV-23*	7th Pt Htr Drn	Ext Stm		EM-103A	Later	Later	
4CV-6*	Cond Recirc to Condsr	Condensate		EM-104A	Later	Later	
4CV-5	Mn Fd Pmp Recirc to DA Tk	Boiler Feed		EM-105A	Later	Later	
4CV-11	Blr Fd Pmp Disch to Reheat Desuphtrs	Boiler Feed		EM-105A	Later	Later	
4CV-14	Start Up Fd Pmp Recirc to DA Tk	Boiler Feed		EM-105A	Later	Later	
4CV-95	Cling Twr Blowdown Vlv	Circ Wtr, Cond Air Rmvl		EM-110A	Later	Later	
4CV-301A	Vac Pmp 1A Suct Vlv	Circ Wtr, Cond Air Rmvl		EM-110A	Later	Later	4SOV-301A
4CV-301B	Vac Pmp 1B Suct Vlv	Circ Wtr, Cond Air Rmvl		EM-110A	Later	Later	4SOV-301B

*BY Equip Mfr

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02
ERDA AFB STUDY

INSTRUMENT LIST - PART C
COMMON TO BABCOCK & WILCOX, FOSTER WHEELER

SHEET V-2
MOTOR-OPERATED VALVES - MOV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4MOV-5	Main Stm Hdr Isol	Mn Stm & Reheat		EM-102A	Later	Later	
4MOV-10	Main Stm Drn to Condsr	Mn Stm & Reheat		EM-102A	Later	Later	
4MOV-20	Main Stm to Blow-off Tank	Mn Stm & Reheat		EM-102A	Later	Later	
4MOV-21	HP Turb Ext Stm to 1st Pt Htr	Ext Stm		EM-103A	Later	Later	
4MOV-22	IP Turb Ext Stm to 2nd Pt Htr	Ext Stm		EM-103A	Later	Later	
4MOV-23	LP Turb Ext Stm to DA	Ext Stm		EM-103A	Later	Later	
4MOV-24	HP Turb Ext Stm to Aux Stm	Ext Stm		EM-103A	Later	Later	
4MOV-25	IP Turb Ext Stm to 3rd Pt Htr	Ext Stm		EM-103A	Later	Later	
4MOV-116	IP Turb Ext Stm to BFP LP Turb	Ext Stm		EM-103A	Later	Later	
4MOV-117	Mn Stm Supp to BFP HP Turb	Ext Stm		EM-103A	Later	Later	
4MOV-1A	Cond Pmp 1A Disch Vlv	Condensate		EM-104A	Later	Later	
4MOV-1B	Cond Pmp 1B Disch Vlv	Condensate		EM-104A	Later	Later	
4MOV-39A	DA Tk Lvl Cont	Condensate		EM-104A	Later	Later	
4MOV-39B	DA Tk Lvl Cont Bypass	Condensate		EM-104A	Later	Later	
4MOV-40	DA Tk Dump to Condsr	Condensate		EM-104A	Later	Later	
4MOV-47	Condsr Neck Htrs Inlt	Condensate		EM-104A	Later	Later	
4MOV-49	Condsr Neck Htrs Bypass	Condensate		EM-104A	Later	Later	
4MOV-51	Condsr Neck Htrs Outlt	Condensate		EM-104A	Later	Later	
4MOV-2	Start-up BFP Disch to Fdwtr Htrs	Boiler Feed		EM-105A	Later	Later	
4MOV-3	BFP Disch	Boiler Feed		EM-105A	Later	Later	
4M 3	Blr Fill From Cond Pmps	Boiler Feed		EM-105A	Later	Later	

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02
ERDA AFB STUDY

INSTRUMENT LIST - PART C
COMMON FOR BABCOCK AND WILCOX, FOSTER WHEELER

SHEET IV-3
FLOW CONTROLLERS - FIC

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4FIC-1	Ammonia Feed to Condenser Hotwell	Chemical Feed	Later	EN-119	Later	Later	N/A

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02
ERDA AFB STUDYINSTRUMENT LIST - PART C
COMMON FOR BABCOCK AND WILCOX, FOSTER WHEELERSHEET IV-4
RESTRICTION ORIFICE - RO

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4RO-90	Mn Stm Heat-up	Mn Stm and Reheat		EM-102A	N/A	Later	N/A
4RO-206	Mn Stm Supp to BFP HP Turb	Ext Stm		EM-103A	N/A	Later	4FIT-206
4RO-43	Booster BFP Suct	Condensate		EM-104A	N/A	Later	4FIT-10
4RO-43A	Cond Pul Demin Outlt	Condensate		EM-104A	N/A	Later	4FIT-10A, 4FIT-26
4RO-2	BFP Warm-up Suct Inlt	Boiler Feed		EM-105A	N/A	Later	
4RO-42	Econ Fd Wtr Inlt	Boiler Feed		EM-105A	N/A	Later	4FIT-2, 4FIT-5
4RO-46	BFP Disch to Reheat Desuphtrs	Boiler Feed		EM-105A	N/A	Later	4FIT-6
4RO-47	BFP Disch to Suphtr Desuphtrs	Boiler Feed		EM-105A	N/A	Later	4FIT-7
4RO-33	Clng Twr Mkup Pmps Disch	Circ Wtr, Condsr Air Rmvl		EM-110A	N/A	Later	4FIT-15
4RO-205	Open Loop Cooling Water Supply	Circ Wtr, Condsr Air Rmvl		EM-110A	N/A	Later	4FIT-205

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02
ERDA AFB STUDYINSTRUMENT LIST - PART C
COMMON FOR BABCOCK AND WILCOX, FOSTER WHEELERSHEET IV-1
FLOW INDICATORS - FI

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4FRI-26	Condensate Flow	Condensate		EM-104A	Later	Later	4FIT-26
4FI-29	BFP Recirc Control	Condensate		EM-104A	Later	Later	4FIT-10
4FI-41	Startup BFP Recirc Control	Condensate		EM-104A	Later	Later	4FIT-14

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02
ERDA AFB STUDYINSTRUMENT LIST - PART C
COMMON FOR BABCOCK AND WILCOX, FOSTER WHEELERSHEET IV-2
FLOW TRANSMITTERS - FIT

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4FIT-206	Mn Stm Supp to BFP Ep Turb	Ext Stm		EM-103A	Later	Later	Comptr
4FIT-29	LP Stm Flow to BFP Turb	Ext Stm		EM-103A	Later	Later	
4FIT-10	BFP 4-1 Recirc Cont	Condensate		EM-104A	Later	Later	4FI-29, 4CV-5
4FIT-10A	Cond Pp Recirc Cont	Condensate		EM-104A	Later	Later	4CV-6
4FIT-26	Condensate Flow	Condensate		EM-104A	Later	Later	4FRI-26, 4R-3-1
4FIT-14	Startup BFP Suct Flw	Condensate		EM-104A	Later	Later	FI-41
4FIT-2	Pd Wtr Econ Inlt Flow	Boiler Feed		EM-105A	Later	Later	4R-4-1, Comptr
4FIT-5	Pd Wtr Econ Inlt Flow	Boiler Feed		EM-105A	Later	Later	
4FIT-6	Pd Wtr to Reheat Desuphtrs	Boiler Feed		EM-105A	Later	Later	Comptr
4FIT-7	Pd Wtr to Suphtr Desuphtrs	Boiler Feed		EM-105A	Later	Later	Comptr
4FIT-15	Clng Twr Mkup Pump Disch	Circ Wtr Condsr Air Rmvl		EM-110A	Later	Later	Acid Pd Cont Pnl
4FIT-205	LP Condsr Open Loop Clng Wtr Supp	Circ Wtr Condsr Air Rmvl		EM-110A	Later	Later	

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02
ERDA AFB STUDYINSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELERSHEET III-5
LEVEL CONTROLLERS - LC

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4LC-10	HP Condsr	Condensate		EM-104A	Later	Later	4LCV-10A, 10B
4LC-11	HP Condsr Lvl Hot Well	Condensate		EM-104A	Later	Later	4LCV-11A, 11B
4LC-1A	1st Pt Htr Lvl Lower Half	Heater Drains		EM-106A	Later	Later	4LCV-1A
4LC-1B	1st Pt Htr Lvl Upper Half	Heater Drains		EM-106A	Later	Later	4LCV-1B
4LC-2A	2nd Pt Htr Lower Half	Heater Drains		EM-106A	Later	Later	4LCV-2A
4LC-2B	2nd Pt Htr Upper Half	Heater Drains		EM-106A	Later	Later	4LCV-2B
4LC-3A	2rd Pt Htr	Heater Drains		EM-106A	Later	Later	4LCV-3A
4LC-3B	3rd Pt Htr	Heater Drains		EM-106A	Later	Later	4LCV-3B
4LC-5A	5th Pt Htr Drn Rcvr Lower Half	Heater Drains		EM-106A	Later	Later	4LCV-5A
4LC-5B	5th Pt Htr Drn Rcvr Upper Half	Heater Drains		EM-106A	Later	Later	4LCV-5B
4LC-6A	6th Pt Htr Drn Rcvr	Heater Drains		EM-106A	Later	Later	4LCV-6A
4LC-6B	6th Pt Htr Drn Rcvr	Heater Drains		EM-106A	Later	Later	4LCV-6B

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J.O.NO. 12919.02
ERDA AFB STUDYINSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELERSHEET III-6
LEVEL CONTROL VALVES - LCV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4LCV-3-1	Da Lvl Cont	Condensate		EM-104A	Later	Later	4LIT-12
4LCV-3-2	Da Lvl Cont	Condensate		EM-104A	Later	Later	4LIT-12
4LCV-10A	Cond Makeup	Condensate		EM-104A	Later	Later	4LC-10A
4LCV-10B	Cond Emerg Makeup	Condensate		EM-104A	Later	Later	4LC-10B
4LCV-11A	Cond Draw-off	Condensate		EM-104A	Later	Later	4LC-11
4LCV-11B	Cond Blowdown Vlv	Condensate		EM-104A	Later	Later	4LC-11
4LCV-1A	1st Pt Htr Drns to 2nd Pt Htr	Heater Drains		EM-106A	Later	Later	4LC-1A
4LCV-1B	1st Pt Htr Drns to Condsr	Heater Drains		EM-106A	Later	Later	4LC-1B
4LCV-2A	2nd Pt Htr Drns to 3rd Pt Htr	Heater Drains		EM-106A	Later	Later	4LC-2A
4LCV-2B	2nd Pt Htr Drns to Condsr	Heater Drains		EM-106A	Later	Later	4LC-2B
4LCV-3A	3rd Pt Htr Drns to Deaerator	Heater Drains		EM-106A	Later	Later	4LC-3A
4LCV-3B	3rd Pt Htr Drns to Condsr	Heater Drains		EM-106A	Later	Later	4LC-3B
4LCV-5A	5th Pt Htr Drns to Condsr	Heater Drains		EM-106A	Later	Later	4LC-5A
4LCV-5B	5th Pt Htr Drn Rcvr Drns to Condsr	Heater Drains		EM-106A	Later	Later	4LC-5B
4LCV-6A	6th Pt Htr Drn Clr Drns to Condsr	Heater Drains		EM-106A	Later	Later	4LC-6A
4LCV-6B	6th Pt Htr Drn Rcvr Drns to Condsr	Heater Drains		EM-106A	Later	Later	4LC-6B
4LCV-18	Circ Wtr Clng Wtr Makeup	Circ Wtr, Cond Air Rmvl		EM-110A	Later	Later	4LIT-7
4LCV-56A	Vac Pmp 1A Reservoir Lvl Cont	Circ Wtr, Cond Air Rmvl		EM-110A	Later	Later	
4LCV-56B	Vac Pmp 1B Reservoir Lvl Cont	Circ Wtr, Cond Air Rmvl		EM-110A	Later	Later	

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J.O.NO. 12919.02
ERDA AFB STUDYINSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELERSHEET III-3
LEVEL SWITCHES - LS

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4LS-83A	Cold Reheat Drns to Cond	Mn Stm & Reheat		EM-102A	Later	Later	
4LS-88B	Cold Reheat Drns to Cond	Mn Stm & Reheat		EM-102A	Later	Later	
4LS-89A	Cold Reheat Drns to Cond	Mn Stm & Reheat		EM-102A	Later	Later	
4LS-89B	Cold Reheat Drns to Cond	Mn Stm & Reheat		EM-102A	Later	Later	
4LS-4A	Da Lvl	Condensate		EM-104A	Later	Later	
4LS-4B	Da Lvl	Condensate		EM-104A	Later	Later	4NRV-6
4LS-12A	HP Condsr Lvl	Condensate		EM-104A	Later	Later	
4LS-12B	HP Condsr Lvl	Condensate		EM-104A	Later	Later	
4LS-40A	Da Lvl	Condensate		EM-104A	Later	Later	4MOV-40
4LS-40B	Da Lvl	Condensate		EM-104A	Later	Later	4MOV-40
4LS-41	Da Lvl	Condensate		EM-104A	Later	Later	SBFP
4LS-49	Da Lvl	Condensate		EM-104A	Later	Later	
4LS-90	Da Lvl	Condensate		EM-104A	Later	Later	
4LS-1A	1st Pt Htr	Heater Drains		EM-106A	Later	Later	
4LS-1B	1st Pt Htr	Heater Drains		EM-106A	Later	Later	
4LS-1C	1st Pt Htr	Heater Drains		EM-106A	Later	Later	
4LS-2A	2nd Pt Htr	Heater Drains		EM-106A	Later	Later	
4LS-2B	2nd Pt Htr	Heater Drains		EM-106A	Later	Later	
4LS-2C	2nd Pt Htr	Heater Drains		EM-106A	Later	Later	
4LS-3A	3rd Pt Htr	Heater Drains		EM-106A	Later	Later	
4LS-3B	3rd Pt Htr	Heater Drains		EM-106A	Later	Later	
4LS-3C	3rd Pt Htr	Heater Drains		EM-106A	Later	Later	
4LS-5A	5th Pt Htr	Heater Drains		EM-106A	Later	Later	
4LS-5B	5th Pt Htr	Heater Drains		EM-106A	Later	Later	

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02
ERDA AFB STUDYINSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELERSHEET III-4
LEVEL SWITCHES - LS

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4LS-5C	5th Pt Htr	Heater Drains	Later	EM-106A	Later	Later	
4LS-6A	6th Pt Htr Drn Tk Lvl Lower Half	Heater Drains	Later	EM-106A	Later	Later	
4LS-6B	6th Pt Htr Drn Tk Lvl Upper Half	Heater Drains	Later	EM-106A	Later	Later	
4LS-6C	6th Pt Htr	Heater Drains	Later	EM-106A	Later	Later	
4LS-7A	7th Pt Htr 1A Hi Lvl	Heater Drains	Later	EM-106A	Later	Later	
4LS-7B	7th Pt Htr 1A NWL	Heater Drains	Later	EM-106A	Later	Later	
4LS-7C	7th Pt Htr 1B Hi Lvl	Heater Drains	Later	EM-106A	Later	Later	
4LS-7D	7th Pt Htr 1B NWL	Heater Drains		EM-106A	Later	Later	
4LS-27	Hydrazine Feed Tank Low Level	Chemical Feed	Later	EM-119A	Later	Later	

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02
ERDA AFB STUDYINSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELERSHEET 111-1
LEVEL TRANSMITTERS - LIT

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4LIT-2	Da Tk Lvl	Condensate		EM-104A	Later	Later	4LIR-2, 4R-3-2
4LIT-3	LP Condsr Shell Lvl	Condensate		EM-104A	Later	Later	4LIR-3, Comptr
4LIT-12	Da Tk Lvl Cont	Condensate		EM-104A	Later	Later	4LC-28A
4LIT-13	HP Condsr Shell Lvl	Condensate		EM-104A	Later	Later	4LIR-13, Comptr
4LIT-14A	6th Pt Htr Drn Tk Lvl	Heater Drains		EM-106A	Later	Later	4LIR-14A
4LIT-14B	5th Pt Htr Drn Tk Lvl	Heater Drains		EM-106A	Later	Later	4LIR-14B
4LIT-7	Clng Twr Cir Wtr Lvl	Circ Wtr Condsr Air Rmvl		EM-110A	Later	Later	4LIR-7, 4LCV-18

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02
ERDA AFB STUDYINSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELERSHEET III-2
LEVEL INDICATING RECEIVERS - LIR

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4LIR-2	Da Stg Tk Lvl	Condensate		EM-104A	Later	Later	4LIT-2
4LIR-3	Condsr Hot Well Lvl	Condensate		EM-104A	Later	Later	4LIT-3
4LIR-13	Condsr Hot Well Lvl	Condensate		EM-104A	Later	Later	4LIT-13
4LIR-14A	6th Pt Htr Drn Rcvr Lvl	Heater Drains		EM-106A	Later	Later	4LIT-14A
4LIR-14B	5th Pt Htr Drn Rcvr Lvl	Heater Drains		EM-106A	Later	Later	4LIT-14B
4LIR-7	Clng Twr Circ Wtr Lvl	Circ Wtr Condsr Air Rmvl		EM-110A	Later	Later	4LIT-7

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J.O.N.O. 12919.02
ERDA AFB STUDYINSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELER TEMPERATURE INDICATING RECEIVERS - TIR SHEET II-3

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4TIR-1	Mn Stm Temp	Mn Stm & Reheat		EM-102A	Later	Later	4TR-143, 4TT-1
4TIR-3	Hot Reheat Outlet Hdr	Mn Stm & Reheat		EM-102A	Later	Later	4TR-145, 4TT-3
4TIR-5	Econ Fd Wtr Inlet	Mn Stm & Reheat		EM-102A	Later	Later	4TT-5

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J.O.NO. 12919.02
ERDA AFB STUDYINSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELER RESISTANCE TEMPERATURE DETECTORS - RTD

SHEET II-11

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4RTD-13	Cold Reheat Line	Mn Stm & Reheat		EM-102A	Later	Later	Comptr
4RTD-5	Hp Turb Ext Stm to 1st Pt Htr	Ext Stm		EM-103A	Later	Later	Comptr
4RTD-3	Hp Condsr Shell	Condensate		EM-104A	Later	Later	Comptr
4RTD-4	Lp Condsr Shell	Condensate		EM-104A	Later	Later	Comptr
4RTD-6	5th Pt Htr Outlet	Condensate		EM-104A	Later	Later	Comptr
4RTD-8	Boost BFP Suct	Condensate		EM-104A	Later	Later	Comptr
4RTD-24	Glnd Stm Cond Outlet	Condensate		EM-104A	Later	Later	Comptr
4RTD-27	5th Pt Htr Inlet	Condensate		EM-104A	Later	Later	Comptr
4RTD-32	Boost BFP Suct	Condensate		EM-104A	Later	Later	Comptr
4RTD-9	Fd Wtr Htr 4EH-6 Hdr	Boiler Feed		EM-105A	Later	Later	Comptr
4RTD-10	Fd Wtr Htrs Outlet Hdr	Boiler Feed		EM-105A	Later	Later	Comptr
4RTD-31	Fd Wtr Htrs Inlet Hdr	Boiler Feed		EM-105A	Later	Later	Comptr
4RTD-17	1st Pt Htr to 2nd Pt Htr	Heater Drains		EM-106A	Later	Later	Comptr
4RTD-18	2nd Pt Htr to 3rd Pt Htr	Heater Drains		EM-106A	Later	Later	Comptr
4RTD-20	3rd Pt Htr to Da Tk	Heater Drains		EM-106A	Later	Later	Comptr
4RTD-21	5th Pt Htr Drns to Drn Rcvr	Heater Drains		EM-106A	Later	Later	Comptr
4RTD-22	6th Pt Htr Drns to Drn Tk	Heater Drains		EM-106A	Later	Later	Comptr
4RTD-23A	7th Pt Htr (1A) Loop Seal Drn	Heater Drains		EM-106A	Later	Later	Comptr
4RTD-23B	7th Pt Htr (1B) Loop Seal Drn	Heater Drains		EM-106A	Later	Later	Comptr
4RTD-48A	6th Pt Htr Drn Clr Drns to Cond	Heater Drains		EM-106A	Later	Later	Comptr

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02
ERDA AFB STUDY

INSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELER RESISTANCE TEMPERATURE DETECTORS - RTD

SHEET II-12

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4RTD-48B	5th Pt Htr Dm Clr to Condsr	Heater Drains		EM-106A	Later	Later	Comptr
4RTD-101A	Hp Condsr Circ Wtr Outlet	Circ Wtr, Condsr Air Rmvl		EM-110A	Later	Later	Comptr
4RTD-101B	Hp Condsr Circ Wtr Outlet	Circ Wtr, Condsr Air Rmvl		EM-110A	Later	Later	Comptr
4RTD-102A	Lp Condsr Circ Wtr Inlet	Circ Wtr, Condsr Air Rmvl		EM-110A	Later	Later	Comptr
4RTD-102B	Lp Condsr Circ Wtr Inlet	Circ Wtr, Condsr Air Rmvl		EM-110A	Later	Later	Comptr

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02
ERDA AFB STUDYINSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELERSHEET II-9
THERMOCOUPLES - TR

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4TR-110	Hot Reheat Outlet Hdr	Mn Stm & Reheat		EM-102A	Later	Later	Comptr
4TR-109	Mn Stm Outlet Hdr	Mn Stm & Reheat		EM-102A	Later	Later	Comptr
4TR-113	Mn Stm Line	Mn Stm & Reheat		EM-102A	Later	Later	Comptr
4TR-136	Hot Reheat Stm Line	Mn Stm & Reheat		EM-102A	Later	Later	Comptr
4TR-143	Mn Stm Line	Mn Stm & Reheat		EM-102A	Later	Later	4TIR-1, 4R-8-1
4TR-145	Hot Reheat Outlet Hdr	Mn Stm & Reheat		EM-102A	Later	Later	4TIR-3, 4R-5-1, 4R-9-1
4TR-121	Ip Turb Ext Stm to 2nd Pt Htr	Ext Stm		EM-103A	Later	Later	Comptr
4TR-122	Lp Turb Ext Stm to Da Tk	Ext Stm		EM-103A	Later	Later	Comptr
4TR-123A	Ip Ext Stm	Ext Stm		EM-103A	Later	Later	Comptr
4TR-123B	Lp(B) Turb Ext Stm to Da Tk	Ext Stm		EM-103A	Later	Later	Comptr
4TR-124	Lp(A) Turb Ext Stm to 6th Pt Htr	Ext Stm		EM-103A	Later	Later	Comptr
4TR-125	Lp(B) Turb Ext Stm to 7th Pt Htr	Ext Stm		EM-103A	Later	Later	Comptr
4TR-126	Lp(A) Turb Ext Stm to 7th Htr	Ext Stm		EM-103A	Later	Later	Comptr
4TR-127	Lp(B) Turb Ext Stm to 5th Pt Htr	Ext Stm		EM-103A	Later	Later	Comptr
4TR-138	Ip Turb Ext Stm to 2nd Pt Htr	Ext Stm		EM-103A	Later	Later	Comptr
4TR-139	Ext Stm to Da Tk	Ext Stm		EM-103A	Later	Later	Comptr
4TR-140	Ip Turb Ext Stm to 3rd Pt Htr	Ext Stm		EM-103A	Later	Later	Comptr

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02
ERDA AFB STUDYINSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELERSHEET II-10
THERMOCOUPLES - TR

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4TR-501	Ip Turb Ext Stm to BFP Lp Turb	Ext Sm		EM-103A	Later	Later	Comptr
4TR-502	Mn Stm Supp to Hp BFP turb	Ext Stm		EM-103A	Later	Later	Comptr
4TR-106	Fd Wtr to Econ	Boiler Feed		EM-105A	Later	Later	Comptr
4TR-135	Fd Wtr to Reheat Desup Htrs	Boiler Feed		EM-105A	Later	Later	Comptr

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02
ERDA AFB STUDY

INSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELER

SHEET II-7
TEST WELLS - TW

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
		Air Rmvl					
4TW-64C	Clng Twr Circ Wtr Outlet	Circ Wtr, Condsr Air Rmvl		EM-110A	N/A	Later	

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02
ERDA AFB STUDY

INSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELER

SHEET II-8
TEMPERATURE SWITCHES - TS

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4TS-10A	Lp (A) Turb Exh Temp	Ext Stm		EM-103A	Later	Later	
4TS-10B	Lp (B) Turb Exh Temp	Ext Stm		EM-103A	Later	Later	

STONE & WEBSTER ENGINEERING CORP.

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ERDA AFB STUDYINSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, POSTER WHEELERSHEET II-5
TEST WELLS - TW

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
	Lp Turb						
4TW-102	Mn Stm to BFP Hp Turb	Ext Stm		EM-103A	N/A	Later	
4TW-8	6th Htr Cond Inlet	Condensate		EM-104A	N/A	Later	
4TW-9	5th Htr Cond Inlet	Condensate		EM-104A	N/A	Later	
4TW-10	5th Htr Cond Outlet	Condensate		EM-104A	N/A	Later	
4TW-12	Da Tk Outlet	Condensate		EM-104A	N/A	Later	
4TW-16	Cond Pol Demin Inlet	Condensate		EM-104A	N/A	Later	
4TW-55A	Deaerator	Condensate		EM-104A	N/A	Later	
4TW-55B	Deaerator	Condensate		EM-104A	N/A	Later	
4TW-103	GlnD Stm Cond Outlet	Condensate		EM-104A	N/A	Later	
4TW-13A	Fd Wtr Htr Inlet 4EH-7	Boiler Feed		EM-105A	N/A	Later	
4TW-13B	Fd Wtr Htr Outlet 4EH-6	Boiler Feed		EM-105A	N/A	Later	
4TW-14A	Fd Wtr Htr Outlet 4EH-5	Boiler Feed		EM-105A	N/A	Later	
4TW-14B	Fd Wtr Htr Inlet 4EH-6	Boiler Feed		EM-105A	N/A	Later	
4TW-15A	Fd Wtr Htrs Outlet Hdr	Boiler Feed		EM-105A	N/A	Later	
4TW-15B	Fd Wtr Htrs Outlet Hdr	Boiler Feed		EM-105A	N/A	Later	
4TW-32	Fd Wtr Htr 4EH-5 Inlet	Boiler Feed		EM-105A	N/A	Later	
4TW-70	Fd Wtr Htr 4EH-5 Inlet	Boiler Feed		EM-105A	N/A	Later	
4TW-21	1st Htr to 2nd Pt Htr	Heater Drains		EM-106A	N/A	Later	
4TW-22	2nd Pt Htr to 3rd Pt Htr	Heater Drains		EM-106A	N/A	Later	
4TW-24	3rd Pt Htr to Da Tk	Heater Drains		EM-106A	N/A	Later	
4TW-25	5th Pt Htr Drn	Heater Drains		EM-106A	N/A	Later	
4TW-26	6th Pt Htr Drns	Heater Drains		EM-106A	N/A	Later	

STONE & WEBSTER ENGINEERING CORP.

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ERDA AFB STUDY

INSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELER

SHEET II-6
TEST WELLS - TW

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4TW-27A	7th Pt Htr 1A Loop Seal Drn	Heater Drains		EM-106A	N/A	Later	
4TW-27B	7th Pt Htr 1B Loop Seal Drn	Heater Drains		EM-106A	N/A	Later	
4TW-71A	6th Pt Htr Drn Clr Drns to Condsr	Heater Drains		EM-106A	N/A	Later	
4TW-71B	5th Pt Htr Drn Clr to Condsr	Heater Drains		EM-106A	N/A	Later	
4TW-19A	Hp Condsr Circ Wtr Outlet	Circ Wtr, Condsr Air Rmvl		EM-110A	N/A	Later	
4TW-19B	Hp Condsr Circ Wtr Outlet	Circ Wtr, Condsr Air Rmvl		EM-110A	N/A	Later	
4TW-19C	Hp Condsr Circ Wtr Outlet	Circ Wtr, Condsr Air Rmvl		EM-110A	N/A	Later	
4TW-20A	Hp Condsr Circ Wtr Outlet	Circ Wtr, Condsr Air Rmvl		EM-110A	N/A	Later	
4TW-20B	Hp Condsr Circ Wtr Outlet	Circ Wtr, Condsr Air Rmvl		EM-110A	N/A	Later	
4TW-20C	Ep Condsr Circ Wtr Outlet	Circ Wtr, Condsr Air Rmvl		EM-110A	N/A	Later	
4TW-41	Lp Condsr Circ Wtr Inlet	Circ Wtr, Condsr Air Rmvl		EM-110A	N/A	Later	
4TW-42	Lp Condsr Circ Wtr Inlet	Circ Wtr, Condsr Air Rmvl		EM-110A	N/A	Later	
4TW-63A	Cling Twr Circ Wtr Inlet	Circ Wtr, Condsr Air Rmvl		EM-110A	N/A	Later	
4TW-63B	Cling Twr Circ Wtr Inlet	Circ Wtr, Condsr Air Rmvl		EM-110A	N/A	Later	
4TW-64A	Cling Twr Circ Wtr Outlet	Circ Wtr, Condsr Air Rmvl		EM-110A	N/A	Later	
4TW-64B	Cling Twr Circ Wtr Outlet	Circ Wtr, Condsr		EM-110A	N/A	Later	

STONE & WEBSTER ENGINEERING CORP.

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INSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELER

SHEET II-4
TEST WELLS - TW

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4TW-1A	Cold Reheat	Main Stm & Reheat		EM-102A	N/A	Later	
4TW-1B	Cold Reheat	Main Stm & Reheat		EM-102A	N/A	Later	
4TW-2A	Mn Stm Hdr	Main Stm & Reheat		EM-102A	N/A	Later	
4TW-2B	Mn Stm Hdr	Main Stm & Reheat		EM-102A	N/A	Later	
4TW-3A	Hot Reheat	Main Stm & Reheat		EM-102A	N/A	Later	
4TW-3B	Hot Reheat	Main Stm & Reheat		EM-102A	N/A	Later	
4TW-38*	Stm Drain	Main Stm & Reheat		EM-102A	N/A	Later	
4TW-56	Mn Stm Outlet Hdr	Main Stm & Reheat		EM-102A	N/A	Later	
4TW-57A	Cold Reheat Desup Outlet	Main Stm & Reheat		EM-102A	N/A	Later	
4TW-58	Hot Reheat Outlet	Main Stm & Reheat		EM-102A	N/A	Later	
4TW-4	ID Turb Ext Stm to 2nd Dt Htr	Ext Stm		EM-103A	N/A	Later	
4TW-5	Lp Turb Ext Stm to Da Tk	Ext Stm		EM-103A	N/A	Later	
4TW-6A	Ip Turb Ext Stm Hdr	Ext Stm		EM-103A	N/A	Later	
4TW-6B	Lp (B) Ext Stm to Da Tk	Ext Stm		EM-103A	N/A	Later	
4TW-28	HP Turb Ext Stm to 1st Pt Htr	Ext Stm		EM-103A	N/A	Later	
4TW-29	Ip Turb Ext Stm to 2nd Pt Htr	Ext Stm		EM-103A	N/A	Later	
4TW-30	Ext Stm to Da Tk	Ext Stm		EM-103A	N/A	Later	
4TW-31	Ip Turb Ext Stm to 3rd Pt Htr	Ext Stm		EM-103A	N/A	Later	
4TW-35B	7th Pt Htr Drn	Ext Stm		EM-103A	N/A	Later	
4TW-101	Ip Turb Ext Stm to BFP	Ext Stm		EM-103A	N/A	Later	

*By Instrument Manufacturer

STONE & WEBSTER ENGINEERING CORP.

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INSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELER

SHEET 11-1
TEMPERATURE TRANSMITTERS - TT

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4TT-1	Super Ht Outlet	Main Steam		EM-102A	Later	Later	4TIR-1, 4R-8-1
4TT-3	Hot Reheat	Main Steam		EM-102A	Later	Later	4TIR-3, 4R-5-1, 4R-9-1
4TT-5	Economizer Inlet Hdr	Boiler Feed		EM-105A	Later	Later	4TIR-5

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INSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELER

SHEET II-2
TEMPERATURE CONTROL VALVES - CV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4CV-11	Reheat Desuperheater Temp Control Valve	Boiler Feed		EM-105A	Later	Later	
4CV-13	Superheater Desuper- heater FSH-1	Boiler Feed		EM-105A	Later	Later	

STONE & WEBSTER ENGINEERING CORP.

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INSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELER

SHEET I-11
PRESSURE CONTROL VALVES - PCV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4PCV-51	Cling Twr Mkup Pmp Min Disch Press	Circ Wtr, Condsr Air Rmvl		EM-110A	Later	Later	4PC-51

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ERDA AFB STUDYINSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELERSHEET III-7
LEVEL GAGES - LG

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4LG-10A	LP Condsr Shell	Condensate		EM-104A	N/A	Later	
4LG-10B	LP Condsr Shell	Condensate		EM-104A	N/A	Later	
4LG-11A	HP Condsr Shell	Condensate		EM-104A	N/A	Later	
4LG-11B	HP Condsr Shell	Condensate		EM-104A	N/A	Later	
4LG-25*	Da Tk	Condensate		EM-104A	N/A	Later	
4LG-1*	1st Pt Htr	Heater Drains		EM-106A	N/A	Later	
4LG-2*	2nd Pt Htr	Heater Drains		EM-106A	N/A	Later	
4LG-4*	3rd Pt Htr	Heater Drains		EM-106A	N/A	Later	
4LG-5	5th Pt Htr Drn Tk	Heater Drains		EM-106A	N/A	Later	
4LG-6	6th Pt Htr Drn Tk	Heater Drains		EM-106A	N/A	Later	
4LG-7A	7th Pt Htr 1A	Heater Drains		EM-106A	N/A	Later	
4LG-7B	7th Pt Htr 1B	Heater Drains		EM-106A	N/A	Later	
4LG-50A	7th Pt Htr 1A Loop Seal Drn	Heater Drains		EM-106A	N/A	Later	
4LG-50B	7th Pt Htr 1B Loop Seal Drn	Heater Drains		EM-106A	N/A	Later	
4LG-3A	Vac Pmp Outlet Reservoir Separator	Circ Wtr Air Rmvl		EM-110A	N/A	Later	
4LG-3B	Vac Pmp Outlet Reservoir Separator	Circ Wtr Air Rmvl		EM-110A	N/A	Later	
4LG-18A*	Hydrazine Feed Tank	Chemical Feed		EM-119A	N/A	Later	
4LG-18B*	Hydrazine Feed Tank	Chemical Feed		EM-119A	N/A	Later	

*By Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02
ERDA AFB STUDY

INSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELER PRESSURE DIFFERENTIAL SWITCHES - PDS,
PDIS

SHEET I-9

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4PDS-25A	Cond Pmp 1A Shaft Seal Wtr Flt Diff	Condensate	2-15 Psig	EM-104A	Later	Later	
4PDS-25B	Cond Pmp 1B Shaft Seal Wtr Flt Diff	Condensate	2-15 Psig	EM-104A	Later	Later	
4PDIS-51	Circ Wtr Mkup Pmp Backwsh Strmr	Circ Wtr, Condsr Air Rmvl		EM-110A	Later	Later	
4PDIS-52	Circ Wtr Screenwell Screen Diff	Circ Wtr, Condsr Air Rmvl		EM-110A	Later	Later	

STONE & WEBSTER ENGINEERING CORP.

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INSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELER

SHEET I-10
PRESSURE REGULATING VALVES - PRV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4PRV-6A	Cond Pmp 1A Shaft Sealing	Condensate	Later	EM-104A	Later	Later	4PC-6A
4PRV-6B	Cond Pmp 1B Shaft Sealing	Condensate	Later	EM-104A	Later	Later	4PC-6B
4PRV-25A	Ammonia Cyl No. 1 Outlet	Chem Feed	Later	EM-119A	Later	Later	N/A
4PRV-25B	Ammonia Cyl No. 2 Outlet	Chem Feed	Later	EM-119A	Later	Later	N/A
4PRV-25C	Ammonia Cyl No. 3 Outlet	Chem Feed	Later	EM-119A	Later	Later	N/A
4PRV-38	Instr Air Supply	Cond Pol		EM-128A			

STONE & WEBSTER ENGINEERING CORP.

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ERDA AFB STUDYINSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELERSHEET I-7
PRESSURE CONTROLLERS - PC

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4PC-1	Mn St Outlt Hdr	Mn Stm & Reheat		EM-102A	Later	Later	4PSV-1, 4PSV-2
4PC-6A	Cond Pp 1A Seal Wtr Press	Condensate		EM-104A	Later	Later	4PRV-6A
4PC-6B	Cond Pp 1B Seal Water Press	Condensate		EM-104A	Later	Later	4PRV-6B
4PC-51	Circ Wtr Mkup Pmp Disch Press Cont	Circ Wtr, Condsr Air Rmvl		EM-110A	Later	Later	4PCV-51

STONE & WEBSTER ENGINEERING CORP.

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ERDA AFB STUDYINSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELERSHEET I-8
PRESSURE SWITCHES - PS

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4PS-32	Cond Pol Demin Inlt	Condensate		EM-104A	Later	Later	
4PS-33	Cond Pol Demin Inlt	Condensate		EM-104A	Later	Later	
4PS-14A	Cir Wtr Mkup Pmps Disch Hdr	Circ Wtr, Condsr Air Rmvl	0-60 Psig	EM-110A	Later	Later	
4PS-14B	Cir Wtr Mkup Pmps Disch Hdr	Circ Wtr, Condsr Air Rmvl	0-60 Psig	EM-110A	Later	Later	
4PS-36A	Vac Pri Pmp 1A Suct	Circ Wtr, Condsr Air Rmvl	30 In. Hg - 15 Psig	EM-110A	Later	Later	
4PS-36B	Vac Pri Pmp 1B Suct	Circ Wtr, Condsr Air Rmvl	30 In. Hg - 15 Psig	EM-110A	Later	Later	
4PS-139	Clng Twr Lvl Low	Circ Wtr, Condsr Air Rmvl	0-60 In. H2O	EM-110A	Later	Later	
4PS-140	Clng Twr Lvl Hi	Circ Wtr, Condsr Air Rmvl	0-60 In. H2O	EM-110A	Later	Later	

STONE & WEBSTER ENGINEERING CORP.

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ERDA AFB STUDY

INSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELER PRESSURE DIFFERENTIAL TRANSMITTERS - PDT

SHEET I-5

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4PDT-21	Press Diff Bet BFP and Econ Inlt	Boiler Feed		EM-105A	Later	Later	

STONE & WEBSTER ENGINEERING CORP.

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ERDA AFB STUDY

INSTRUMENT LIST - PART C
COMMON FOR BAEBOCK & WILCOX, FOSTER WHEELER PRESSURE DIFFERENTIAL INDICATORS - PDI

SHEET I-6

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4PDI-23	BFP Suct Str Diff Press	Condensate		EM-104A	N/A	Later	N/A
4PDI-25A	Cond Pp 1A Suct Strnr Diff	Condensate		EM-104A	N/A	Later	N/A
4PDI-25B	Cond Pp 1B Suct Strnr Diff	Condensate		EM-104A	N/A	Later	N/A
4PDI-34	Booster BFP Suct Str Diff Press	Condensate		EM-104A	N/A	Later	N/A

STONE & WEBSTER ENGINEERING CORP.

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ERDA AFB STUDYINSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELERSHEET I-3
PRESSURE TRANSMITTERS - PIT

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4PIT-1	Mn Stm Hdr Press	Mn Stm & Reheat		EM-102A	Later	Later	4PI-10, 4R-4-2, Comptr
4PIT-4	HP Turb Intrstage Press	Mn Stm & Reheat		EM-102A	Later	Later	4PI-23
4PIT-9	Hot Reheat Press	Mn Stm & Reheat		EM-102A	Later	Later	4PI-12, Comptr
4PIT-13*	Turb Stm Chest Press	Mn Stm & Reheat		EM-102A	Later	Later	Comptr
4PIT-21	Cold Reheat Press	Mn Stm & Reheat		EM-102A	Later	Later	
4PIT-29	Mn Stm Hdr Press	Mn Stm & Reheat		EM-102A	Later	Later	4PI-47, Comptr
4PIT-30	Cold Reheat Press	Mn Stm & Reheat		EM-102A	Later	Later	4PI-93, Comptr
4PIT-45	HP Turb Interstage Press	Mn Stm & Reheat		EM-102A	Later	Later	4R-1-1
4PIT-49*	HP Turb Interstage Press	Mn Stm & Reheat		EM-102A	Later	Later	
4PIT-57	Mn Stm Hdr Press	MN Stm & Reheat		EM-102A	Later	Later	
4PIT-5A	LP (A) Turb Exh Press	Ext Stm	0-30 In. Hg	EM-103A	Later	Later	4PI-18A, Comptr
4PIT-5B	LP (B) Turb Exh Press	Ext Stm	0-30 In. Hg	EM-103A	Later	Later	4PI-18B, Comptr
4PIT-31	IP Turb Exh Stm to 2nd Pt Htr Press	Ext Stm	30 In. Hg to 300 Psig	EM-103A	Later	Later	Comptr
4PIT-32	LP Turbs Ext Stm to DA Tk Press	Ext Stm	30 In. Hg to 200 Psig	EM-103A	Later	Later	Comptr
4PIT-33	IP Turb Ext Stm Press	Ext Stm	30 In. Hg to 100 Psig	EM-103A	Later	Later	Comptr
4PIT-37	HP Turb Ext Stm to 1st Pt Htr Press	Ext Stm		EM-103A	Later	Later	Comptr
4PIT-38	IP Turb Ext Stm to 2nd Pt Htr	Ext Stm	-15 to +200 Psig	EM-103A	Later	Later	Comptr

*By Equip Mfr

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02
ERDA AFB STUDYINSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELERSHEET I-4
PRESSURE TRANSMITTERS - PIT

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4PIT-40	IP Turb Ext Stm to 3rd Pt Htr	Ext Stm	-15 to +100 Psig	EM-103A	Later	Later	Comptr
4PIT-305	IP Turb Ext Stm to BFP LP Turb	Ext Stm		EM-103A	Later	Later	Comptr
4PIT-306	Mn Stm Supp to BFP HP Turb	Ext Stm		EM-103A	Later	Later	Comptr
4PIT-10	Cond Pmp 1A Disch	Condensate		EM-104A	Later	Later	4PI-25, Comptr
4PIT-11	Cond Pmp 1B Disch	Condensate		EM-104A	Later	Later	4PI-26, Comptr
4PIT-12	Boost Pd Pmp Suct	Condensate		EM-104A	Later	Later	4PI-28, Comptr
4PIT-26	Cond Pmps Common Disch	Condensate		EM-104A	Later	Later	Comptr
4PIT-39	DA Press	Condensate	-15 to +200 Psig	EM-104A	Later	Later	Comptr
4PIT-14	Fdwtr Econ Inlt Press	Boiler Feed		EM-105A	Later	Later	4PI-13, Comptr
4PIT-28	BFP Disch Press	Boiler Feed		EM-105A	Later	Later	4PI-7, Comptr, BFPT Cont
4PIT-41	5th Pt Htr Drn	Heater Drains	-15 to +30 Psig	EM-106A	Later	Later	Comptr
4PIT-42	6th Pt Htr Drn	Heater Drains	-15 to +15 Psig	EM-106A	Later	Later	Comptr
4PIT-44A	7th Pt Htr (1A) Shell	Heater Drains	-15 to +15 Psig	EM-106A	Later	Later	Comptr
4PIT-44B	7th Pt Htr (1B) Shell	Heater Drains	-15 to +15 Psig	EM-106A	Later	Later	Comptr
4PIT-24	Circ Wtr Mk-up Pps Disch Hdr	Circ Wtr	0-60	EM110A	Later	Later	?

STONE & WEBSTER ENGINEERING CORP.

J.O.N.O. 12919.02
ERDA AFB STUDYINSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELERSHEET 1-1
PRESSURE INDICATORS - PI

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4PI-10	Mn Stm Press	Mn Stm & Reheat		EM-102A	Later	Later	4PIT-1
4PI-12	Rehtr Outlt Stm Press	Mn Stm & Reheat		EM-102A	Later	Later	4PIT-9
4PI-19	Mn Stm Hdr	Mn Stm & Reheat		EM-102A	N/A	Later	N/A
4PI-23	HP Turb Interstage Press	Mn Stm & Reheat		EM-102A	Later	Later	4PIT-4
4PI-47	Mn Stm Press At Suphtr Outlt	Mn Stm & Reheat		EM-102A	Later	Later	4PIT-29
4PI-93	Cold Reheat Stm	Mn Stm & Reheat		EM-102A	Later	Later	4PIT-30
4PI-166	Cold Reheat Stm	Mn Stm & Reheat		EM-102A	N/A	Later	N/A
4PI-167	Hot Reheat Stm	Mn Stm & Reheat		EM-102A	N/A	Later	N/A
4PI-8	3rd Pt Htr	Extraction Stm	30 In. Hg to 100 Psig	EM-103A	N/A	Later	N/A
4PI-17	Condsr 4-1 Vacuum	Extraction Stm	0-30 In. Hg	EM-103A	N/A	Later	N/A
4PI-18A	Condsr 4-1 Vacuum	Extraction Stm		EM-103A	Later	Later	4PIT-5A
4PI-18B	Condsr 4-2 Vacuum	Extraction Stm		EM-103A	Later	Later	4PIT-5B
4PI-25	Cond Pp 1A Disch	Condensate		EM-104A	Later	Later	4PIT-10
4PI-26	Cond Pp 1B Disch	Condensate		EM-104A	Later	Later	4PIT-11
4PI-28	BFP Suct Hdr	Condensate		EM-104A	Later	Later	4PIT-12
4PI-29	Booster BFP Disch	Condensate		EM-104A	N/A	Later	N/A
4PI-77A	Cond Pp 1A Suct	Condensate	30 In. Hg to 60 Psig	EM-104A	N/A	Later	N/A
4PI-77B	Cond Pp 1B Suct	Condensate	30 In. Hg to 60 Psig	EM-104A	N/A	Later	N/A
4PI-82A	Cond Pp 1A Stuffing Box	Condensate	0-30 Psig	EM-104A	N/A	Later	N/A
4PI-82B	Cond Pp 1B Stuffing Box	Condensate	0-30 Psig	EM-104A	N/A	Later	N/A
4PI-91	Cond Pp 1A Disch	Condensate		EM-104A	N/A	Later	N/A
4PI-92	Cond Pp 1B Disch	Condensate		EM-104A	N/A	Later	N/A

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02
ERDA AFB STUDYINSTRUMENT LIST - PART C
COMMON FOR BABCOCK & WILCOX, FOSTER WHEELERSHEET I-2
PRESSURE INDICATORS - PI

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4PI-7	BFP Disch	Boiler Feed		EM-105A	Later	Later	4PIT-28
4PI-13	Econ Fdwtr Inlt	Boiler Feed		EM-105A	Later	Later	4PIT-14
4PI-32	BFP Disch	Boiler Feed		EM-105A	N/A	Later	N/A
4PI-33	Econ Fdwtr Inlt	Boiler Feed		EM-105A	N/A	Later	N/A
4PI-34	BFP Disch to Suphtr Desuphtrs	Boiler Feed		EM-105A	N/A	Later	N/A
4PI-35	BFP Disch to Reheat Desuphtrs	Boiler Feed		EM-105A	N/A	Later	N/A
4PI-36	BFP Disch to Reheat Desuphtrs	Boiler Feed		EM-105A	N/A	Later	N/A
4PI-182	Fdwtr Htrs Inlt	Boiler Feed		EM-105A	N/A	Later	N/A
4PI-301	Mkup Pp Bkwsh Strnr Inlt	Circ Wtr, Condsr Air Rmvl		EM-110A	N/A	Later	N/A
4PI-302	Mkup Pp Bkwsh Strnr Outlt	Circ Wtr, Condsr Air Rmvl		EM-110A	N/A	Later	N/A
4PI-71	Hydrazine Fd Pmp Disch	Chemical Feed		EM-119A	N/A	Later	N/A
4PI-196	Ammonia Supply Header	Chemical Feed		EM-119A	N/A	Later	N/A

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHEET VI-23
CYLINDER OPERATED VALVES - COV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4COV-579B	Pressure Conveyor Line Isolation Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-579B
*4COV-580A	Pressure Conveyor Line Isolation Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-580A
*4COV-580B	Pressure Conveyor Line Isolation Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-580B
*4COV-581	Silo Inlet Valve	Fly Ash Collection	Later	EM-120C	Later	Later	4SOV-581
*4COV-582A	Vacuum Pump Inlet Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-582A
*4COV-582B	Vacuum Pump Inlet Valve	Fly Ash Collection	Later	EM-120C	Later	Later	4SOV-582B
*4COV-583	Vacuum Pump Inlet Crossover Valve	Fly Ash Collection	Later	EM-120C	Later	Later	4SOV-583

*Supplied by Equipment Manufacturer

EQUIPMENT COMMON TO
BABCOCK & WILCOX AND FOSTER WHEELER

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHEET VI-21
CYLINDER OPERATED VALVES - COV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4COV-567	CBC Dust Hopper Header Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-567
*4COV-568A	CBC Dust Hopper Header Isolation Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-568A
*4COV-568B	CBC Dust Hopper Header Isolation Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-568B
*4COV-569A	Vacuum Chamber Inlet Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-569A
*4COV-569B	Vacuum Chamber Inlet Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-569B
*4COV-570A	Pressure Blower Disch.	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-570A
*4COV-570B	Pressure Blower Disch.	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-570B
*4COV-571	Pressure Blower Disch.	Fly Ash Collection	Later	EM-120C	Later	Later	4SOV-571
*4COV-572A	Material Handling Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-572A
*4COV-572B	Material Handling Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-572B
*4COV-572C	Material Handling Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-572C
*4COV-572D	Material Handling Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-572D
*4COV-573A	Material Handling Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-573A
*4COV-573B	Material Handling Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-573B

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDY

INSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGN

SHEET VI-22
CYLINDER OPERATED VALVES - COV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4COV-573C	Material Handling Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-573C
*4COV-573D	Material Handling Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-573D
*4COV-574A	Material Handling Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-574A
*4COV-574B	Material Handling Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-574A
*4COV-574C	Material Handling Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-574C
*4COV-574D	Material Handling Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-574D
*4COV-575A	CBC Hot Precip Hopper Isolation Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-575A
*4COV-575B	CBC Hot Precip Hopper Isolation Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-575B
*4COV-575C	CBC Hot Precip Hopper Isolation Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-575C
*4COV-576A	Air Preheater Hopper Isolation Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-576A
*4COV-576B	Air Preheater Hopper Isolation Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-576B
*4COV-577	Stack Hopper Isolation Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-577
*4COV-578	Air Preheater/Stack Hopper Header Isolation Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-578
*4COV-579A	Pressure Conveyor Line Isolation Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-579A

*Supplied by Equipment Manufacturer

J. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHEET -- 19
CYLINDER OPERATED VALVES - COV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4COV-543B	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-543B
*4COV-543C	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-543C
*4COV-543D	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-543D
*4COV-543E	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-543E
*4COV-543F	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-543F
*4COV-543G	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-543G
*4COV-543H	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-543H
*4COV-543J	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-543J
*4COV-543K	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-543K
*4COV-543L	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-543L
*4COV-543M	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-543M
*4COV-543N	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-543N
*4COV-543P	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-543P
*4COV-543Q	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-543Q
*4COV-543R	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-543R

*Supplied by Equipment Manufacturer

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J.O.NO. 12919.02A
ERDA AFB STUDY

INSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGN

SHEET VI-20
CYLINDER OPERATED VALVES - COV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4COV-544A	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-544A
*4COV-544B	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-543B
*4COV-545A	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-545A
*4COV-545B	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-545B
*4COV-546A	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-546A
*4COV-546B	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-546B
*4COV-547A	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-547A
*4COV-547B	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-547B
*4COV-564A	CBC Dust Hopper Isolation Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-564A
*4COV-564B	CBC Dust Hopper Isolation Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-564B
*4COV-564C	CBC Dust Hopper Isolation Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-564C
*4COV-565	CBC Dust Hopper Header Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-565
*4COV-566A	CBC Dust Hopper Isolation Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-566A
*4COV-566B	CBC Dust Hopper Isolation Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-566B
*4COV-566C	CBC Dust Hopper Isolation Valve	Fly Ash Collection & Disposal	Later	EM-120C	Later	Later	4SOV-566C

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.C.No. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHEET 7
CYLINDER OPERATED VALVES - COV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4COV-541D	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-541D
*4COV-541E	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-541E
*4COV-541F	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-541F
*4COV-541G	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-541G
*4COV-541H	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-541H
*4COV-541J	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-541J
*4COV-541K	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-541A
*4COV-541L	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-541L
*4COV-541M	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-541M
*4COV-541N	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-541N
*4COV-541P	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-541P
*4COV-541Q	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-541Q
*4COV-541R	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-541R
*4COV-542A	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-542A
*4COV-542B	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-542B

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STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDY

INSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGN

SHEET VI-18
CYLINDER OPERATED VALVES - COV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4COV-542C	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-542C
*4COV-542D	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-542D
*4COV-542E	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-542E
*4COV-542F	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-542F
*4COV-542G	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-542G
*4COV-542H	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-542H
*4COV-542J	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-542J
*4COV-542K	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-542K
*4COV-542L	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-542L
*4COV-542M	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-542M
*4COV-542N	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-542N
*4COV-542P	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-542P
*4COV-542Q	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-542Q
*4COV-542R	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-542R
*4COV-543A	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-543A

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHEET VI-15
CYLINDER OPERATED VALVES - COV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4COV-605A	Bed Material Disposal Valve	Bed Material Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-605A
*4COV-605B	Bed Material Disposal Valve	Bed Material Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-605B
*4COV-606A	Bed Material Disposal Valve	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-606A
*4COV-606B	Bed Material Disposal Valve	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-606B
*4COV-607A	Bed Material Disposal Valve	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-607A
*4COV-607B	Bed Material Disposal Valve	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-607B
*4COV-608A	Silo Inlet Valve	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-608A
*4COV-608B	Silo Inlet Valve	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-608B
*4COV-540A	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-540A
*4COV-540B	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-540B
*4COV-540C	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-540C
*4COV-540D	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-540D

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDY

INSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGN

SHEET VI-16
CYLINDER OPERATED VALVES - COV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4COV-540E	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-540E
*4COV-540F	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-540F
*4COV-540G	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-540G
*4COV-540H	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-540H
*4COV-540J	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-540J
*4COV-540K	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-540A
*4COV-540L	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-540L
*4COV-540M	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-540M
*4COV-540N	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-540N
*4COV-540P	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-540P
*4COV-540Q	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-540Q
*4COV-540R	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-540R
*4COV-541A	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-541A
*4COV-541B	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-541B
*4COV-541C	Material Handling Valve	Carbon Collection & Reinjection	Later	EM-120B	Later	Later	4SOV-541C

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHEET VI-13
CYLINDER OPERATED VALVES - COV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4COV-599J	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-599J
*4COV-599K	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-599K
*4COV-599L	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-599L
*4COV-599M	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-599M
*4COV-600A	Bed Material Makeup Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-600A
*4COV-600B	Bed Material Makeup Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-600B
*4COV-601A	Bed Material Isolation Valve	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-601A
*4COV-601B	Bed Material Isolation Valve	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-601B
*4COV-602A	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-602A
*4COV-602B	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-602B
*4COV-602C	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-602C

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHEET VI-14
CYLINDER OPERATED VALVES - COV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4COV-602D	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-602D
*4COV-602E	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-602E
*4COV-602F	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-602F
*4COV-603A	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-603A
*4COV-603B	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-603B
*4COV-603C	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-603C
*4COV-603D	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-603A
*4COV-603E	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-603D
*4COV-603F	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-603E
*4COV-604A	Bed Material Disposal Valve	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-604A
*4COV-604B	Bed Material Disposal Valve	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-604B

*Supplied by Equipment Manufacturer

J. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHEET 11-11
CYLINDER OPERATED VALVES - COV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4COV-597A	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-597A
*4COV-597B	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-597B
*4COV-598A	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-598A
*4COV-598B	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-598B
*4COV-598C	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-598C
*4COV-598D	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-598D
*4COV-598E	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-598E
*4COV-598F	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-598F
*4COV-598G	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-598G
*4COV-598H	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-598H
*4COV-598J	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-598J

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDY

INSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGN

SHEET VI-12
CYLINDER OPERATED VALVES - COV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem./Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4COV-598K	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-598K
*4COV-598L	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-598L
*4COV-598M	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-598M
*4COV-599A	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-599A
*4COV-599B	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-599B
*4COV-599C	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-599C
*4COV-599D	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-599D
*4COV-599E	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-599E
*4COV-599F	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-599F
*4COV-599G	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-599G
*4COV-599H	Air Lock Valves	Bed Letdown Transfer & Disposal System	Later	EM-120A	Later	Later	4SOV-599H

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHEET VI-9
POWER OPERATED DAMPERS - PSD

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4PSD-629B	Air Preheater Outlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4MOV-629B
*4PSD-629C	Air Preheater Outlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4MOV-629C
*4PSD-629D	Air Preheater Outlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4MOV-629D
*4PSD-630A	Primary Air Fan Inlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Later
*4PSD-630B	Primary Air Fan Inlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Later
*4PSD-631A	Primary Air Fan Outlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Later
*4PSD-631B	Primary Air Fan Outlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Later

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHEET VI-10
UNIT DRIVE - 4U
MOTOR OPERATED DRIVE - MOV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4U-621A	FD Fan Inlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4PCD-622A
*4U-621B	FD Fan Inlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4PCD-622B
*4U-632A	Tempering Air Fan	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4PCD-633A
*4U-632B	Tempering Air Fan	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4PCD-633B
*4U-634A	Primary Air Fan	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4PCD-634A
*4U-634B	Primary Air Fan	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4PCD-634B
*4MOV-623A	Air Preheater Inlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4PSD-623A
*4MOV-623B	Air Preheater Inlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4PSD-623B
*4MOV-623C	Air Preheater Inlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4PSD-623C
*4MOV-623D	Air Preheater Inlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4PSD-623D
*4MOV-629A	Air Preheater Outlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4PSD-629A
*4MOV-629B	Air Preheater Outlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4PSD-629B
*4MOV-629C	Air Preheater Outlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4PSD-629C
*4MOV-629D	Air Preheater Outlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4PSD-629D

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STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHEET VI-7
POWER OPERATED CONTROL DAMPERS - PCD

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4PCD-620E	Main Bed Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-622A	FD Fan Inlet Vane	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4U-621A
*4PCD-622B	FD Fan Inlet Vane	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4U-621B
*4PCD-633A	Tempering Air Fan	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4U-632A
*4PCD-633B	Tempering Air Fan	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4U-632A
*4PCD-635A	Primary Air Fan	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4U-634A
*4PCD-635B	Primary Air Fan	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4U-634B
*4PCD-636A	CBB Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-636B	CBB Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-636C	CBB Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-636D	CBB Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-637A	CBB Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-637B	CBB Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-637C	CBB Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-637D	CBB Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDY

INSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGN

SHEET VI-8
POWER OPERATED DAMPERS - PSD

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elen/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4PSD-623A	Air Preheater Inlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4MOV-623A
*4PSD-623B	Air Preheater Inlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4MOV-623B
*4PSD-623C	Air Preheater Inlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4MOV-623B
*4PSD-623D	Air Preheater Inlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4MOV-623B
*4PSD-624A	ID Fan Inlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Later
*4PSD-624B	ID Fan Inlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Later
*4PSD-625A	ID Fan Outlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Later
*4PSD-625B	ID Fan Outlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Later
*4PSD-626A	FD Fan Disch	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Later
*4PSD-626B	FD Fan Disch	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Later
*4PSD-627A	Temp Fan 4-1 Inlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Later
*4PSD-627B	Temp Fan 4-2 Inlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Later
*4PSD-628A	Temp Fan 4-1 Outlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Later
*4PSD-628B	Temp Fan 4-2 Outlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Later
*4PSD-629A	Air Preheater Outlet	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	4MOV-629A

*Supplied by Equipment Manufacturer

J.(12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHEET --
POWER OPERATED CONTROL DAMPERS - PCD

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4PCD-615C	CBB Reinjection Mixing Bustle Temp. Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-615D	CBB Reinjection Mixing Bustle Temp. Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-615E	CBB Reinjection Mixing Bustle Temp. Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-615F	CBB Reinjection Mixing Bustle Temp. Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-615G	CBB Reinjection Mixing Bustle Temp. Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-615H	CBB Reinjection Mixing Bustle Temp. Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-616A	Main Bed Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-616B	Main Bed Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-616C	Main Bed Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-616D	Main Bed Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-616E	Main Bed Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-617A	Main Bed Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-617B	Main Bed Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-617C	Main Bed Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-617D	Main Bed Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl

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STONE & WEESTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHEET VI-6
POWER OPERATED CONTROL DAMPERS - PCD

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4PCD-617E	Main Bed Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-618A	Main Bed Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-618B	Main Bed Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-618C	Main Bed Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-618D	Main Bed Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-618E	Main Bed Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-619A	Main Bed Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-619B	Main Bed Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-619C	Main Bed Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-619D	Main Bed Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-619E	Main Bed Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-620A	Main Bed Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-620B	Main Bed Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-620C	Main Bed Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-620D	Main Bed Undergrid Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHEET VI-3
POWER OPERATED CONTROL DAMPERS - PCD

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4PCD-611L	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-611M	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-611N	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-611P	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-611Q	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-611R	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-611S	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-611T	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-611U	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-611V	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-612A	Start-up Compartment Tempering Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-612B	Start-up Compartment Tempering Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-612C	Start-up Compartment Tempering Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-612D	Start-up Compartment Tempering Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-612E	Start-up Compartment Tempering Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDY

INSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGN

SHEET VI-4
POWER OPERATED CONTROL DAMPERS - PCD

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4PCD-613A	Start-up Compartment Tempering Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-613B	Start-up Compartment Tempering Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-613C	Start-up Compartment Tempering Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-613D	Start-up Compartment Tempering Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-613E	Start-up Compartment Tempering Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-614A	CB3 Reinjection Mixing Bustle Temp. Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-614B	CB3 Reinjection Mixing Bustle Temp. Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-614C	CB3 Reinjection Mixing Bustle Temp. Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-614D	CB3 Reinjection Mixing Bustle Temp. Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-614E	CB3 Reinjection Mixing Bustle Temp. Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-614F	CB3 Reinjection Mixing Bustle Temp. Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-614G	CB3 Reinjection Mixing Bustle Temp. Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-614H	CB3 Reinjection Mixing Bustle Temp. Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-615A	CB3 Reinjection Mixing Bustle Temp. Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-615B	CB3 Reinjection Mixing Bustle Temp. Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.N.O. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHEET VI-1
POWER OPERATED CONTROL DAMPERS - PCD

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4PCD-610A	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-610B	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-610C	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-610D	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-610E	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-610F	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-610G	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-610H	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-610J	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-610K	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-610L	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-610M	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-610N	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-610P	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-610Q	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHEET VI-2
POWER OPERATED CONTROL DAMPERS - PCD

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4PCD-610R	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-610S	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-610T	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-610U	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-610V	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-611A	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-611B	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-611C	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-611D	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-611E	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-611F	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-611G	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-611H	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-611J	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl
*4PCD-611K	Main Bed Tempering Air Damper	Combustion Air & Flue Gas	Later	EM-115A	Later	Later	Blr Contrl

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHEET V-15
SOLENOID OPERATED VALVES - SOV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4SOV-543K	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-543K
*4SOV-543L	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-543L
*4SOV-543M	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-543M
*4SOV-543N	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-543N
*4SOV-543P	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-543P
*4SOV-543Q	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-543Q
*4SOV-543R	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-543R
*4SOV-544A	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-544A
*4SOV-544B	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-544B
*4SOV-545A	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-545A
*4SOV-545B	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-545B

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHEET V-16
SOLENOID OPERATED VALVES - SOV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4SOV-546A	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-546A
*4SOV-546B	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-546B
*4SOV-547A	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-547A
*4SOV-547B	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-547B
*4SOV-564A	CBC Dust Hopper Isolation Valve	Fly Ash Collection and Disposal	later	EM-120C	later	later	4COV-564A
*4SOV-564B	CBC Dust Hopper Isolation Valve	Fly Ash Collection and Disposal	later	EM-120C	later	later	4COV-564B
*4SOV-564C	CBC Dust Hopper Isolation Valve	Fly Ash Collection and Disposal	later	EM-120C	later	later	4COV-564C
*4SOV-565	CBC Dust Hopper Header Valve	Fly Ash Collection and Disposal	later	EM-120C	later	later	4COV-565
*4SOV-566A	CBC Dust Hopper Isolation Valve	Fly Ash Collection and Disposal	later	EM-120C	later	later	4COV-566A
*4SOV-566B	CBC Dust Hopper Isolation Valve	Fly Ash Collection and Disposal	later	EM-120C	later	later	4COV-566B
*4SOV-566C	CBC Dust Hopper Isolation Valve	Fly Ash Collection and Disposal	later	EM-120C	later	later	4COV-566C
*4SOV-567	CBC Dust Hopper Header Valve	Fly Ash Collection and Disposal	later	EM-120C	later	later	4COV-567
*4SOV-568A	CBC Dust Hopper Header Isolation Valve	Fly Ash Collection and Disposal	later	EM-120C	later	later	4COV-568A

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHEET V-13
SOLENOID OPERATED VALVES - SOV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4SOV-542D	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-542D
*4SOV-542E	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-542E
*4SOV-542F	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-542F
*4SOV-542G	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-542G
*4SOV-542H	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-542H
*4SOV-542J	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-542J
*4SOV-542K	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-542K
*4SOV-542L	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-542L
*4SOV-542M	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-542M
*4SOV-542N	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-542N
*4SOV-542P	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-542P

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STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDY

INSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGN

SHEET V-14
SOLENOID OPERATED VALVES - SOV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4SOV-542Q	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-542Q
*4SOV-542R	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-542R
*4SOV-543A	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-543A
*4SOV-543B	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-543B
*4SOV-543C	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-543C
*4SOV-543D	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-543D
*4SOV-543E	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-543E
*4SOV-543F	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-543F
*4SOV-543G	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-543G
*4SOV-543H	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-543H
*4SOV-543J	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-543J

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STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHE -11
SOLENOID OPERATED VALVES - SOV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4SOV-540P	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-540P
*4SOV-540Q	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-540Q
*4SOV-540R	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-540R
*4SOV-541A	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-541A
*4SOV-541B	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-541B
*4SOV-541C	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-541C
*4SOV-541D	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-541D
*4SOV-541E	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-541E
*4SOV-541F	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-541F
*4SOV-541G	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-541G
*4SOV-541H	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-541H

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STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHEET V-12
SOLENOID OPERATED VALVES - SOV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4SOV-541J	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-541J
*4SOV-541K	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-541K
*4SOV-541L	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-541L
*4SOV-541M	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-541M
*4SOV-541N	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-541N
*4SOV-541P	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-541P
*4SOV-541Q	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-541Q
*4SOV-541R	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-541R
*4SOV-542A	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-542A
*4SOV-542B	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-542B
*4SOV-542C	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-542C

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STONE & WEBSTER ENGINEERING CORP.

J.0000. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHEET V-9
SOLENOID OPERATED VALVES - SOV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4SOV-604B	Bed Material Disposal Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-604B
*4SOV-605A	Bed Material Disposal Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-605A
*4SOV-605B	Bed Material Disposal Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-605B
*4SOV-606A	Bed Material Disposal Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-606A
*4SOV-606B	Bed Material Disposal Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-606B
*4SOV-607A	Bed Material Disposal Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-607A
*4SOV-607B	Bed Material Disposal Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-607B
*4SOV-608A	Silo Inlet Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-608A
*4SOV-608B	Silo Inlet Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-608B
*4SOV-540A	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-540A
*4SOV-540B	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-540B

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STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDY

INSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGN

SHEET V-10
SOLENOID OPERATED VALVES - SOV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4SOV-540C	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-540C
*4SOV-540D	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-540D
*4SOV-540E	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-540E
*4SOV-540F	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-540F
*4SOV-540G	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-540G
*4SOV-540H	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-540H
*4SOV-540J	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-540J
*4SOV-540K	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-540K
*4SOV-540L	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-540L
*4SOV-540M	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-540M
*4SOV-540N	Material Handling Valve	Carbon Collection and Rejection	later	EM-120B	later	later	4COV-540N

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STONE & WEBSTER ENGINEERING CORP.

J.C 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSheet J-7
SOLENOID OPERATED VALVES - SOV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4SOV-599J	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-599J
*4SOV-599K	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-599K
*4SOV-599L	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-599L
*4SOV-599M	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-599M
*4SOV-600A	Bed Material Makeup Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-600A
*4SOV-600B	Bed Material Makeup Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-600B
*4SOV-601A	Bed Material Isolation Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-601A
*4SOV-601B	Bed Material Isolation Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-601B
*4SOV-602A	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-602A
*4SOV-602B	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-602B

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDY

INSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGN

SHEET V-8
SOLENOID OPERATED VALVES - SOV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4SOV-602C	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-602C
*4SOV-602D	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-602D
*4SOV-602E	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-602E
*4SOV-602F	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-602F
*4SOV-603A	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-603A
*4SOV-603B	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-603B
*4SOV-603C	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-603C
*4SOV-603D	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-603D
*4SOV-603E	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-603E
*4SOV-603F	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-603F
*4SOV-604A	Bed Material Disposal Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-604A

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSheet V-5
SOLENOID OPERATED VALVES - SOV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4SOV-597A	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-597A
*4SOV-597B	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-597B
*4SOV-598A	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-598A
*4SOV-598B	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-598B
*4SOV-598C	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-598C
*4SOV-598D	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-598D
*4SOV-598E	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-598E
*4SOV-598F	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-598F
*4SOV-598G	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-598G
*4SOV-598H	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-598H
*4SOV-598J	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-598J

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDY

INSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGN

SHEET V-6
SOLENOID OPERATED VALVES - SOV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4SOV-598K	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-598K
*4SOV-598L	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-598L
*4SOV-598M	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-598M
*4SOV-599A	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-599A
*4SOV-599B	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-599B
*4SOV-599C	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-599C
*4SOV-599D	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-599D
*4SOV-599E	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-599E
*4SOV-599F	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-599F
*4SOV-599G	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-599G
*4SOV-599H	Air Lock Valve	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	4COV-599H

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDY

INSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGN

SHEET V-3
SAFETY VALVES - SV
RELIEF VALVES - RV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4SV-67	Phosphate Feed Pump Disch.	Chemical Feed	later	EM-119	N/A	later	N/A
4SV-68	Caustic Feed Pump Disch.	Chemical Feed	later	EM-119	N/A	later	N/A
*4SV-501	Boiler Drum	Main Steam	later	EM-10 2A	N/A	later	N/A
*4SV-502	Cold Reheat	Main Steam	later	EM-10 2A	N/A	later	N/A
*4RV-595A	Blower Disch.	Bed Letdown, Transfer, & Disposal System	later	EM-120A	N/A	later	N/A
*4RV-595B	Blower Disch.	Bed Letdown, Transfer, & Disposal System	later	EM-120A	N/A	later	N/A
*4RV-595C	Blower Disch.	Bed Letdown, Transfer, & Disposal System	later	EM-120A	N/A	later	N/A
*4RV-609A	Silo Inlet Relief	Bed Letdown, Transfer, & Disposal System	later	EM-120A	N/A	later	N/A
*4RV-609B	Silo Inlet Relief	Bed Letdown, Transfer, & Disposal System	later	EM-120A	N/A	later	N/A
*4RV-586A	Hot Precip. Blower Disch.	Fly Ash Collection & Disposal	later	EM-120C	N/A	later	N/A
*4RV-586B	Hot Precip. Blower Disch.	Fly Ash Collection & Disposal	later	EM-120C	N/A	later	N/A
*4RV-587A	Dust Collector Press Blower Disch.	Fly Ash Collection & Disposal	later	EM-120C	N/A	later	N/A
*4RV-587B	Dust Collector Press Blower Disch.	Fly Ash Collection & Disposal	later	EM-120C	N/A	later	N/A

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDY

INSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGN

SHEET V-4
NONRETURN VALVES - NRV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4NRV-563	HP Turb. Exhaust	Main Steam	later	EM-102A	later	later	4SOV-563

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STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHEET V-1
SOLENOID OPERATED VALVES - SOV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4SOV-503A	Start-up Bypass Valve	Main Steam	later	EM-102A	later	later	4CV-503A,EHC
4SOV-503B	Start-up Bypass Valve	Main Steam	later	EM-102A	later	later	4CV-503B,EHC
4SOV-503C	Start-up Bypass Valve	Main Steam	later	EM-102A	later	later	4CV-503C,EHC
4SOV-560A	HP Turb. Bypass	Main Steam	later	EM-102A	later	later	4CV-560A BLR Cont.
4SOV-560B	HP Turb. Bypass	Main Steam	later	EM-102A	later	later	4CV-560B BLR Cont.
4SOV-560C	HP Turb. Bypass	Main Steam	later	EM-102A	later	later	4CV-560C BLR Cont.
4SOV-560D	HP Turb. Bypass	Main Steam	later	EM-102A	later	later	4CV-560D BLR Cont.
4SOV-561A	LP Turb. Bypass	Main Steam	later	EM-102A	later	later	4CV-561A BLR Cont.
4SOV-561B	LP Turb. Bypass	Main Steam	later	EM-102A	later	later	4CV-561B BLR Cont.
4SOV-561C	LP Turb. Bypass	Main Steam	later	EM-102A	later	later	4CV-561C BLR Cont.
4SOV-561D	LP Turb. Bypass	Main Steam	later	EM-102A	later	later	4CV-561D BLR Cont.
4SOV-563	HP Turb. Exhaust	Main Steam	later	EM-102A	later	later	4NRV-563
4SOV-510	Desup. Spray Supply	Boiler Feed	later	EM-105	later	later	4PCV-510, 4PIT-510
4SOV-512	Turb. Bypass Desup.	Boiler Feed	later	EM-105	later	later	4CV-512, 4TR-512
4SOV-514	Desup. Wtr. Iso. Valve	Boiler Feed	later	EM-105	later	later	4CV-514
4SOV-518A	Rhtr. Cooling Outlet Steam Desup. Spray	Boiler Feed	later	EM-105	later	later	4CV-518A

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDY

INSTRUMENT LIST - PART A
EABCOCK & WILCOX DESIGN

SHEET V-2
SOLENOID OPERATED VALVES - SOV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4SOV-518B	Rhtr. Cooling Outlet Steam Desup. Spray	Boiler Feed	later	EM-105	later	later	4CV-518B
4SOV-520	Rhtr. Cooling Outlet Steam Desup. Spray	Boiler Feed	later	EM-105	later	later	4CV-520
4SOV-526	Rhtr. Cooling Inlet Steam Desup.	Boiler Feed	later	EM-105	later	later	4CV-526
4SOV-528	Rhtr. Cooling Inlet Steam Desup.	Boiler Feed	later	EM-105	later	later	4CV-528

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STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK AND WILCOX DESIGNSHEET IV-5
FLOW INDICATING TRANSMITTERS - FIT

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc. Instr.</u>
*4FE-642D	Main Bed Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-642D
*4FE-642E	Main Bed Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-642E
*4FE-643A	Main Bed Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-643A
*4FE-643B	Main Bed Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-643B
*4FE-643C	Main Bed Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-643C
*4FE-643D	Main Bed Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-643D
*4FE-643E	Main Bed Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-643E
*4FE-644A	Main Bed Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-644A
*4FE-644B	Main Bed Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-644B
*4FE-644C	Main Bed Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-644C
*4FE-644D	Main Bed Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-644D
*4FE-644E	Main Bed Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-644E
*4RO-591A	High Pressure Conveyor Line	Fly Ash Collection & Disposal	later	EM-120C	later	later	N/A
*4RO-591B	High Pressure Conveyor Line	Fly Ash Collection & Disposal	later	EM-120C	later	later	N/A
*4RO-592A	Secondary Collector Equalizing Line	Fly Ash Collection & Disposal	later	EM-120C	later	later	N/A

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDY

INSTRUMENT LIST - PART A
BABCOCK AND WILCOX DESIGN

SHEET IV-6
FLOW INDICATING TRANSMITTERS - FIT

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc. Instr.</u>
*4RO-592B	Secondary Collector Equalizing Line	Fly Ash Collection & Disposal	later	EM-120C	later	later	N/A
*4RO-593A	Secondary Collector Equalizing Line	Fly Ash Collection & Disposal	later	EM-120C	later	later	N/A
*4RO-593B	Secondary Collector Equalizing Line	Fly Ash Collection & Disposal	later	EM-120C	later	later	N/A

*Supplied by Equipment Manufacturer

.....O. 12919.02A
ERDA AFB STUDY

INSTRUMENT LIST - PART A
BABCOCK AND WILCOX DESIGN

Sheet IV-3
FLOW INDICATING TRANSMITTERS - FIT

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc. Instr.</u>
*4FIT-643E	Main Bed Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-643E
*4FIT-644A	Main Bed Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-644A
*4FIT-644B	Main Bed Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-644B
*4FIT-644C	Main Bed Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-644C
*4FIT-644D	Main Bed Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-644D
*4FIT-644E	Main Bed Undergrid Air Flow	Combustion Air & Flue Gas	later	EM-115A	later	later	4FE-644E
4RO-516	Turb. Bypass Desup.	Boiler Feed	later	EM-105A	later	later	4FIT-516
4RO-523	RHTR Cooling Outlet Steam Desup. Htr. Spray	Boiler Feed	later	EM-105A	later	later	4FIT-523
4RO-531	RHTR Cooling Inlet Steam Desup. Htr. Spray	Boiler Feed	later	EM-105A	later	later	4FIT-531
*4FE-638A	CBB Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-638A
*4FE-638B	CBB Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-638B
*4FE-638C	CBB Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-638C
*4FE-638D	CBB Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-638D
*4FE-639A	CBB Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-639A
*4FE-639B	CBB Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-639B

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.C2A
ERDA AFB STUDY

INSTRUMENT LIST - PART A
BABCOCK AND WILCOX DESIGN

SHEET IV-4
FLOW INDICATING TRANSMITTERS - FIT

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc. Instr.</u>
*4FE-639C	CBB Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-639C
*4FE-639D	CBB Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-639D
*4FE-640A	Main Bed Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-640A
*4FE-640B	Main Bed Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-640B
*4FE-640C	Main Bed Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-640C
*4FE-640D	Main Bed Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-640D
*4FE-640E	Main Bed Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-640E
*4FE-641A	Main Bed Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-641A
*4FE-641B	Main Bed Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-641B
*4FE-641C	Main Bed Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-641C
*4FE-641D	Main Bed Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-641D
*4FE-641E	Main Bed Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-641E
*4FE-642A	Main Bed Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-642A
*4FE-642B	Main Bed Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-642B
*4FE-642C	Main Bed Undergrid Damper	Combustion Air & Flue Gas	later	EM-115A	later	later	4FIT-642C

*Supplied by Equipment Manufacturer

J..... 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHE II-1
LEVEL GAGES - LG

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4LG-26A	Mixing Tank	Chemical Feed	Later	EM-119A	N/A	Later	N/A
*4LG-26B	Mixing Tank	Chemical Feed	Later	EM-119A	N/A	Later	N/A
*4LG-14A	Phosphate Feed Tank	Chemical Feed	Later	EM-119A	N/A	Later	N/A
*4LG-14B	Phosphate Feed Tank	Chemical Feed	Later	EM-119A	N/A	Later	N/A
*4LG-15A	Caustic Feed Tank	Chemical Feed	Later	EM-119A	N/A	Later	N/A
*4LG-15B	Caustic Feed Tank	Chemical Feed	Later	EM-119A	N/A	Later	N/A

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDY

INSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGN

SHEET III-2
LEVEL SWITCHES - LS

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4LS-42	Mixing Tank Low Level	Chemical Feed	Later	EM-119A	Later	Later	
*4LS-33	Phosphate Feed Tank High Level	Chemical Feed	Later	EM-119A	Later	Later	
*4LS-34	Phosphate Feed Tank Low Level	Chemical Feed	Later	EM-119A	Later	Later	
*4LS-35	Caustic Feed Tank High Level	Chemical Feed	Later	EM-119A	Later	Later	
*4LS-36	Caustic Feed Tank Low Level	Chemical Feed	Later	EM-119A	Later	Later	

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STONE & WEBSTER ENGINEERING CORP.

J.O.No. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHEET II-3
THERMOCOUPLES

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4TR-504	Turbine Bypass	Main Steam	Later	EM-102A	N/A	Later	4TT-504, 4CV-512
4TR-518A	Rhtr Cool Outlet Desup Stm Temp	Main Steam	Later	EM-102A	Later	Later	4TT-518A, 4CV-518A
4TR-518B	Rhtr Cool Outlet Desup Stm Temp	Main Steam	Later	EM-102A	Later	Later	4TT-518B, 4CV-518B
4TR-517	Desup Water	Boiler Feed	Later	EM-105A	N/A	Later	Later
4TR-525	Rhtr Cool Outlet Stm Desup	Boiler Feed	Later	EM-105A	N/A	Later	Later
4TR-533	Rhtr Cool Inlt Stm Desup	Boiler Feed	Later	EM-105A	N/A	Later	Later

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STONE & WEBSTER ENGINEERING CORP.

J.O. No. 12919.02A
ERDA AFB STUDY

INSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGN

SHEET II-4
TEMPERATURE CONTROL VALVES - TCV,CV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4CV-512	Turb Bypass Desup	Boiler Feed	Later	EM-105A	Later	Later	4TR-504, 4TT-504
4CV-518A	Rhtr Cool Outlet Stm Desup Spray	Boiler Feed	Later	EM-105A	Later	Later	4TW-58, 4TT-518A
4CV-518B	Rhtr Cool Outlet Stm Desup Spray	Boiler Feed	Later	EM-105A	Later	Later	4TW-58, 4TT-518B
4CV-526	Rhtr Cool Inlt Stm Desup Spray	Boiler Feed	Later	EM-105A	Later	Later	4TW-57, 4TT-526

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.No. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHEET I-3
PRESSURE SWITCHES - PS

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagram</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4PS-595A	Blower Disch	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	later
*4PS-595B	Blower Disch	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	later
*4PS-595C	Blower Disch	Bed Letdown, Transfer and Disposal System	later	EM-120A	later	later	later
*4PS-584A	Hot Precip Press Blower Disch	Fly Ash Collection and Disposal	later	EM-120C	later	later	later
*4PS-584B	Hot Precip Press Blower Disch	Fly Ash Collection and Disposal	later	EM-120C	later	later	later
*4PS-585A	Dust Collector Press Blow Disch	Fly Ash Collection and Disposal	later	EM-120C	later	later	later
*4PS-585B	Dust Collector Press Blow	Fly Ash Collection and Disposal	later	EM-120C	later	later	later

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.No. 12919.02A
ERDA AFB STUDY

INSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGN

SHEET I-4
PRESSURE REGULATING VALVES - PRV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagram</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4PRV-588A	Vacuum Chamber Equalizing Valve	Fly Ash Collection and Disposal	later	EM-120C	later	later	N/A
*4PRV-588B	Vacuum Chamber Equalizing Valve	Fly Ash Collection and Disposal	later	EM-120C	later	later	N/A
*4PRV-589A	Secondary Collector Equalizing Valve	Fly Ash Collection and Disposal	later	EM-120C	later	later	N/A
*4PRV-589B	Secondary Collector Equalizing Valve	Fly Ash Collection and Disposal	later	EM-120C	later	later	N/A
*4PRV-590A	Secondary Collector Equalizing Valve	Fly Ash Collection and Disposal	later	EM-120C	later	later	N/A
*4PRV-590B	Secondary Collector Equalizing Valve	Fly Ash Collection and Disposal	later	EM-120C	later	later	N/A

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDY

INSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGN

SHEET I-6
CONTROL VALVES - CV

<u>Mark Number</u>		<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4CV-503A	Start-up Bypass	Main Steam	later	EM-102A	later	later	4SOV-503A, EHC
4CV-503B	Start-up Bypass	Main Steam	later	EM-102A	later	later	4SOV-503B, EHC
4CV-503C	Start-up Bypass	Main Steam	later	EM-102A	later	later	4SOV-503C, EHC
4PCV-560A	RHTR Cool INLT CONT VLV	Main Steam	later	EM-102A	later	later	4SOV-560A, BLR Cont
4PCV-560B	RHTR Cool INLT CONT VLV	Main Steam	later	EM-102A	later	later	4SOV-560B, BLR Cont
4PCV-560C	RHTR Cool INLT CONT VLV	Main Steam	later	EM-102A	later	later	4SOV-560C, BLR Cont
4PCV-560D	RHTR Cool INLT CONT VLV	Main Steam	later	EM-102A	later	later	4SOV-560D, BLR Cont
4PCV-561A	RHTR Cool OUTLT CONT VLV	Main Steam	later	EM-102A	later	later	4SOV-560A, BLR Cont
4PCV-561B	RHTR Cool OUTLT CONT VLV	Main Steam	later	EM-102A	later	later	4SOV-560B, BLR Cont
4PCV-561C	RHTR Cool OUTLT CONT VLV	Main Steam	later	FM-102A	later	later	4SOV-560C, BLR Cont
4PCV-561D	RHTR Cool OUTLT CONT VLV	Main Steam	later	EM-102A	later	later	4SOV-560D, BLR Cont
4PVC-510	Desup Spray Supply	Boiler Feed	later	EM-105A	later	later	4SOV-510, 4PIT-510
4CV-514	Desup Spray Supply Isolation Valve	Boiler Feed	later	EM-105A	later	later	4SOV-514
4CV-520	Rhtr Cool Outlet Steam Desup Iso Valve	Boiler Feed	later	EM-105A	later	later	4SOV-520
4CV-528	Rhtr Cool Inlet Steam Desup Iso Valve	Boiler Feed	later	EM-105A	later	later	4SOV-528

STONE & WEBSTER ENGINEERING CORP

NO. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGN-----T I-5
POWER SAFETY VALVES - PSV

<u>Mark Number</u>		<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4PSV-562A	Hot Reheat Hdr	Main Steam	later	EM-102A	later	later	4PC-562
4PSV-562B	Hot Reheat Hdr	Main Steam	later	EM-102A	later	later	4PC-562

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDY

INSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGN

SHEET II-1
TEMPERATURE TRANSMITTERS - TT

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4TT-504	Turbine Bypass Desup Spray	Main Steam	Later	EM-102A	Later	Later	4TR-504, 4CV-512
4TT-518A	Rhtr Cool Outlet Stm Desup Spray	Main Steam		EM-102A	Later	Later	4TR-518A 4CV-518A
4TT-518B	Rhtr Cool Outlet Stm Desup Spray	Main Steam		EM-102A	Later	Later	4TR-518B 4CV-518B
4TT-526	Rhrt Cool Inlt Stm Desup Spray	Main Steam		EM-102A	Later	Later	4TW-57, 4CV-526

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDY

INSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGN

SHEET II-2
TEMPERATURE INDICATING RECEIVERS

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
4TIR-504	Turbine Bypass Steam Temp	Main Steam	Later	EM-102A	Later	Later	4TR-504, 4CV-512
4TIR-526	Rhtr Cool Inlt Stm	Main Steam	Later	EM-102A	Later	Later	4TW-57, 4CV-526

*Supplied by Equipment Manufacturer

STONE & WEBSTER ENGINEERING CORP.

J.O.NO. 12919.02A
ERDA AFB STUDYINSTRUMENT LIST - PART A
BABCOCK & WILCOX DESIGNSHEET V-17
SOLENOID OPERATED VALVES - SOV

<u>Mark Number</u>	<u>Service</u>	<u>System</u>	<u>Range/Size</u>	<u>Flow Diagram</u>	<u>Elem/Logic Diagrams</u>	<u>Mfr Model & Order No.</u>	<u>Assoc Instr</u>
*4SOV-568B	CBC Dust Hopper Header Isolation Valve	Fly Ash Collection and Disposal	later	EM-120C	later	later	4COV-568B
*4SOV-569A	Vacuum Chamber Inlet Valve	Fly Ash Collection and Disposal	later	EM-120C	later	later	4COV-569A
*4SOV-569B	Vacuum Chamber Inlet Valve	Fly Ash Collection and Disposal	later	EM-120C	later	later	4COV-569B
*4SOV-570A	Pressure Blower Disch.	Fly Ash Collection and Disposal	later	EM-120C	later	later	4COV-570A
*4SOV-570B	Pressure Blower Disch.	Fly Ash Collection and Disposal	later	EM-120C	later	later	4COV-570B
*4SOV-571	Pressure Blower Disch. Crossover	Fly Ash Collection and Disposal	later	EM-120C	later	later	4COV-571
*4SOV-580A	Pressure Conveyor Line Isolation Valve	Fly Ash Collection and Disposal	later	EM-120C	later	later	4COV-580A
*4SOV-580B	Pressure Conveyor Line Isolation Valve	Fly Ash Collection and Disposal	later	EM-120C	later	later	4COV-580B
*4SOV-581	Silo Inlet Valve	Fly Ash Collection and Disposal	later	EM-120C	later	later	4COV-581
*4SOV-582A	Vacuum Pump Inlet Valve	Fly Ash Collection and Disposal	later	EM-120C	later	later	4COV-582A
*4SOV-582B	Vacuum Pump Inlet Valve	Fly Ash Collection and Disposal	later	EM-120C	later	later	4COV-582B
*4SOV-583	Vacuum Pump Inlet Crossover Valve	Fly Ash Collection and Disposal	later	EM-120C	later	later	4COV-583

*Supplied by Equipment Manufacturer