

**DEVELOPMENT WORK FOR AN ADVANCED COAL GASIFICATION SYSTEM
FOR
ELECTRIC POWER GENERATION FROM COAL DIRECTED TOWARD
A COMMERCIAL GASIFICATION GENERATING PLANT
PHASE II**

DESIGN REPORT

**VOLUME 2
SECTION 100 — GASIFICATION**

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Under Contract No. E(49-18)-1521

**PREPARED FOR
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION**

**FOSTER WHEELER ENERGY
CORPORATION**

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AREA 100 (GASIFICATION)

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Section 1

INTRODUCTION

SCOPE

The function of Section 100, Gasification, is to produce raw, low-Btu, cooled, high-pressure gas from coal in a two-stage, slagging, entrained-flow gasifier with char recycled to extinction. Section 100 is made up of the following key areas:

- Coal Handling
- Coal Pulverizing and Drying
- High-Pressure Solids Feeding (Petrocarb)
- Coal Gasification
- Slag Handling
- Char Separation, Char Cooling, and Recycle Gas System
- Gas Cooling and Superheated Steam Production
- Gasifier Start-Up System.

The coal handling system, which exists at the South Dakota site, unloads raw coal from rail cars and crushes and transports it to existing coal storage hoppers. Space is provided to stockpile coal.

The coal pulverizing and drying system pulverizes the crushed coal so that it can be readily entrained in the gasifier but will not exceed the fineness limits of the Petrocarb coal feeding system. The system also dries the coal to achieve a zero surface moisture as required by the solids feeding system.

The high-pressure solids feeding system by Petrocarb provides continuous, high-pressure, accurately controlled solid flows of pulverized coal, limestone fluxing agent, and recycled char into the Stage I and Stage II Gasifiers.

The gasification area of Section 100 consists of a two-stage, entrained-flow, high-pressure, slagging, "Bi-Gas" coal gasifier, which receives dry pulverized coal, steam, and air and produces high-temperature, high-pressure, sulfur-containing, low-Btu gas and hot molten slag.

The slag handling system receives the hot, molten slag from the gasifier and cools and frits it so it can be trucked away from the plant.

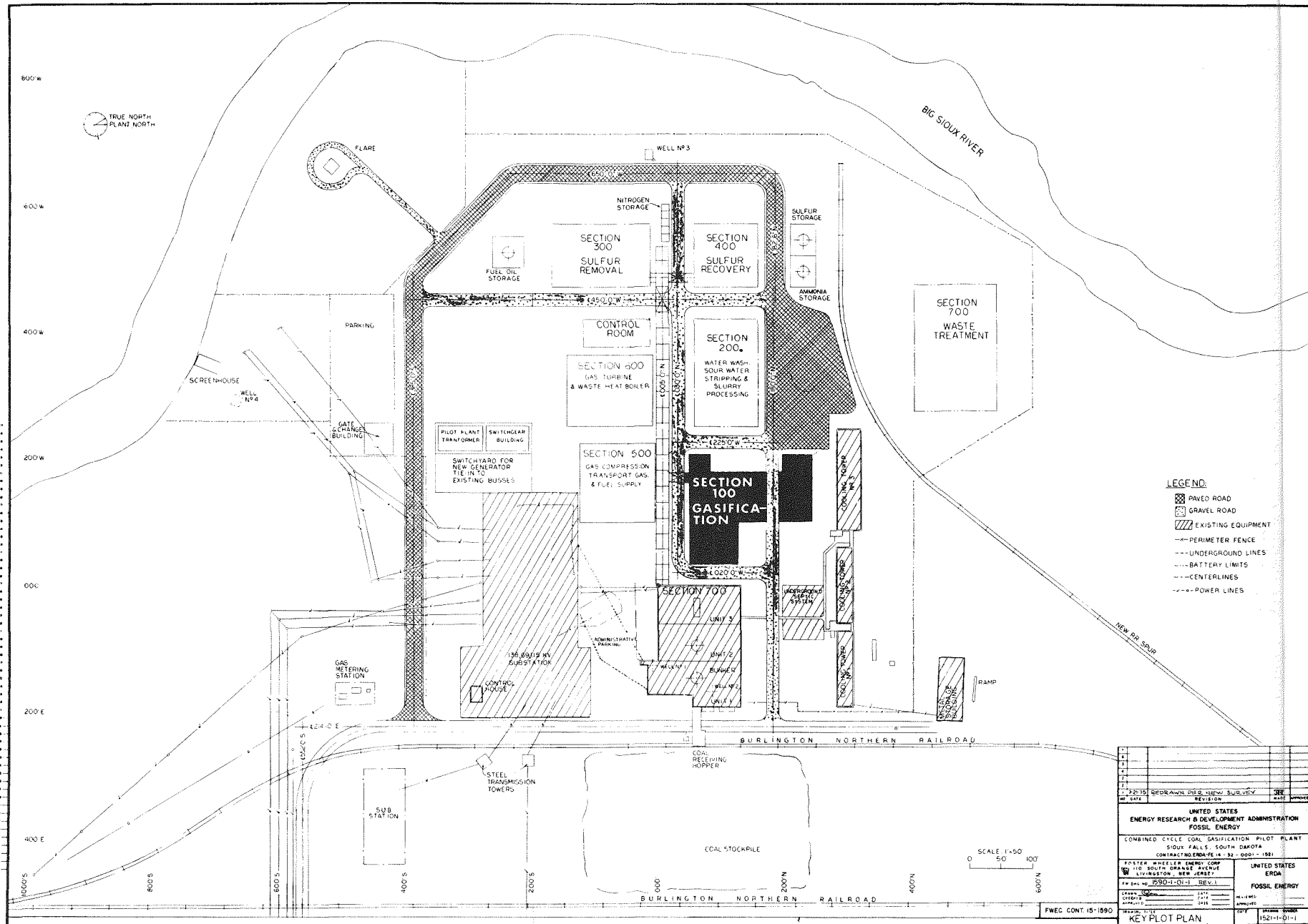
The char separation, char cooling, and recycle gas systems separate the char from the gasifier effluent gas, cool it with recycle gas to a temperature mechanically acceptable to the Petrocarb solids feeding system, and

deliver it to this system for recycle to the gasifier. Low-pressure steam is generated from heat recovered from the recycle gas.

The gas cooling system cools the raw gas before it goes to the gas purification sections and produces superheated, high-pressure steam.

The gasifier start-up system quenches the hot gasifier effluent gas and char produced during start-up of the gasifier. If any char or agglomerated coal has to be blown down from the gasifier, the start-up system will also operate during the normal operation of the gasifier.

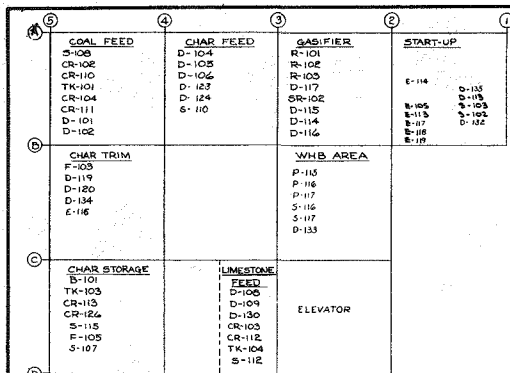
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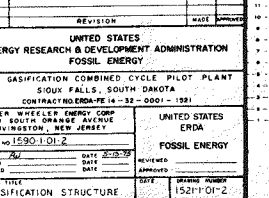
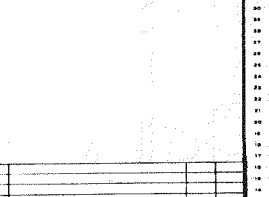
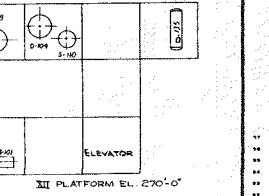
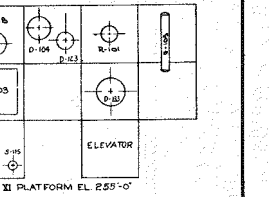
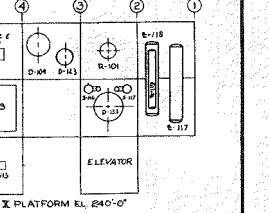
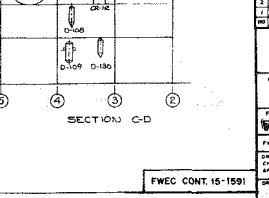
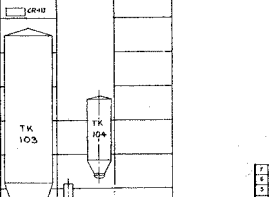
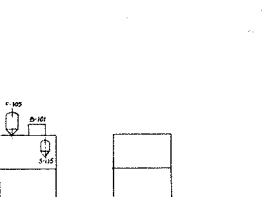
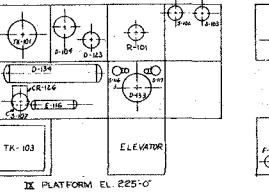
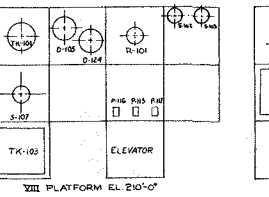
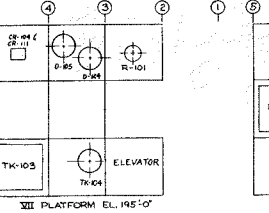
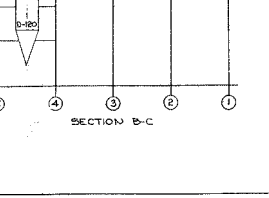
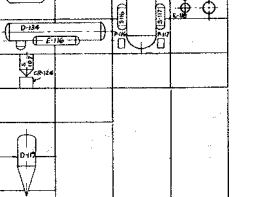
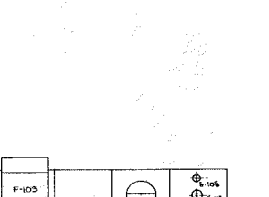
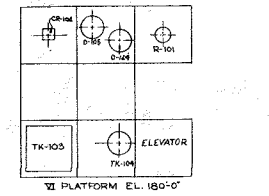
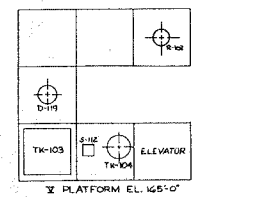
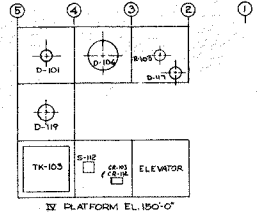
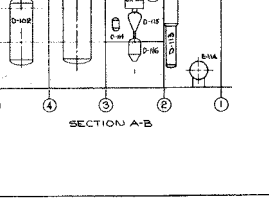
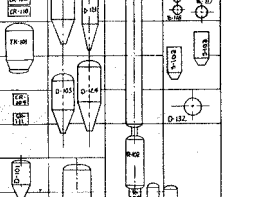
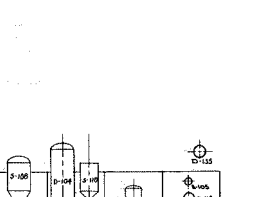
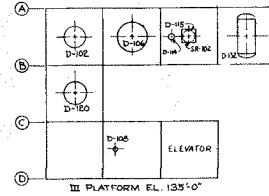
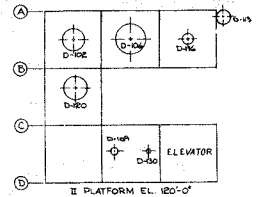
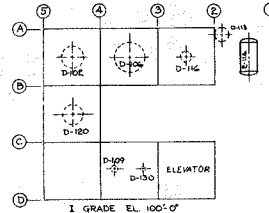
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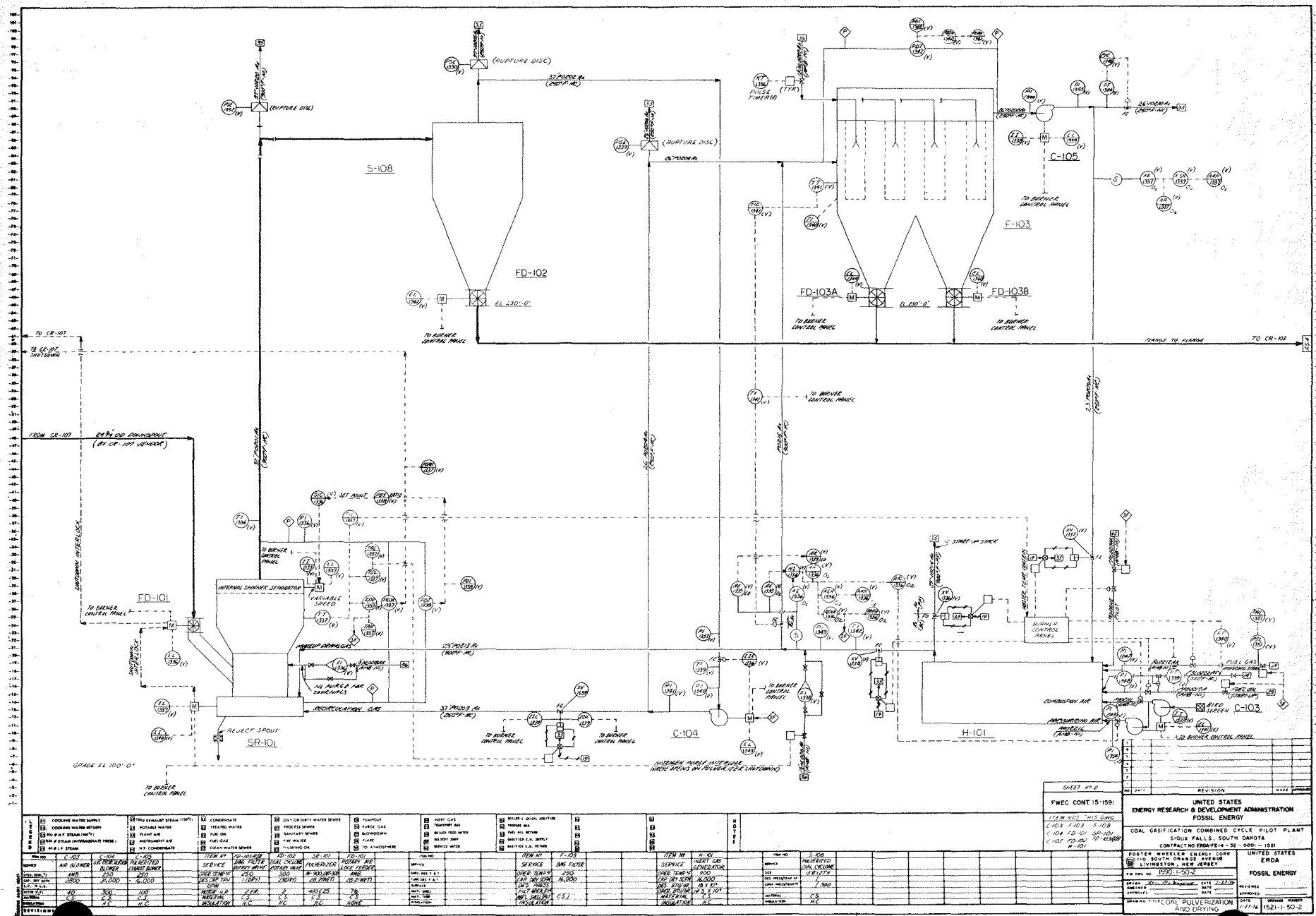
- PAVED ROAD
- GRAVEL ROAD
- EXISTING EQUIPMENT
- PERIMETER FENCE
- UNDERGROUND LINES
- BATTERY LIMITS
- CENTERLINES
- POWER LINES

UNITED STATES ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION FOSSIL ENERGY	
COMBINED CYCLE COAL GASIFICATION PILOT PLANT SIOUX FALLS, SOUTH DAKOTA CONTRACTING PERIOD 1-1-80 - 12-31-80	
FOSTER WHEELER ENERGY COMPANY 110 SOUTH DAKOTA AVENUE LIVINGSTON, NEW JERSEY 07033	
FW 152-1-01-1 REV. 1	
KEY PLOT PLAN	
FWEC CONT. 15-1590	
152-1-01-1	



ITEM NO.	DESCRIPTION	BUY LOCATION	SIZE DIA FEET	SIZE O.A.L. FEET	WEIGHT EMPTY TONS	WEIGHT FULL TONS	ELEVATION SUPPORT BOTTOM	ELEVATION TOP
R-101	GASIFIER-STAGE II	E-3-AB	4.5	70				
R-102	GASIFIER-STAGE I	E-3-AB	8.0	84.5				
R-103	SLAG QUENCH VESSEL	E-3-AB	4.5	11				
D-101	COAL STORAGE INJECTOR	4.5-AB	8.0	20				
D-102	COAL PRIMARY INJECTOR	4.5-AB	9.0	30				
D-104	PRIMARY CHAR RECEIVER	34-AB	10.0	5.3				
D-105	PRIMARY CHAR STORAGE INJECTOR	34-AB	10.0	27.5				
D-106	CHAR PRIMARY INJECTOR	34-AB	12.0	54				
D-108	LIMESTONE STORAGE INJECTOR	34-CD	2.0	9				
D-109	LIMESTONE PRIMARY INJECTOR	34-CD	4.0	0				
D-115	CHAR SEAL POT	34-BC	4.5	22				
D-114	SLAG WATER DRUM	E-3-AB	4.0	7.5				
D-115	SLAG STORAGE DRUM	E-3-AB	4.5	4				
D-116	SLAG INJECTOR DRUM	E-3-AB	4.5	10.5				
D-117	SLAG WATER SURGE DRUM	E-3-AB	4.0	7.5				
D-119	CHAR TRIM STORAGE INJECTOR	4.5-BC	7.0	27.5				
D-120	CHAR TRIM PRIMARY INJECTOR	4.5-BC	9.0	33				
S-115	CHAR TRIM CYCLONE	4.5-CD						
D-123	FIRST STAGE CHAR RECEIVER	34-AB	8.0	23				
D-124	FIRST STAGE CHAR STORAGE TANK	34-AB	10.0	31				
D-132	GASIFIER CH. QUENCH DRUM	E-3-AB						
D-133	START UP QUENCH POT	E-3-BC	12.0	40.0				
D-130	LIMESTONE TRANSFER INJECTOR	34-CD	2.0	9				
TK-101	PULVERIZED COAL SURGE BIN	4.5-AB	12.0	23				
TK-103	CHAR STORAGE BIN	4.5-CD	28.0	40				
TK-104	LIMESTONE FEED BIN	34-CD	12.0	40				
E-105	RECYCLE GAS SUCTION COOLER	E-3-AB	1.5	27				
E-113	RECYCLE GAS L.P. EXCHANGER	E-3-AB	2.5	25				
S-114	REGULATING VALVE COOLER	E-3-AB						
F-103	BAG FILTER	4.5-BC						
S-102	FIRST STAGE CHAR REMOVAL CYCLONE	4.5-AB						
S-103	SECOND STAGE CHAR REMOVAL CYCLONE	4.5-AB						
S-107	CHAR TRIM CYCLONE	4.5-CD						
S-108	PULVERIZED COAL CYCLONE	4.5-AB	10.0	24				
S-110	FIRST STAGE RECYCLE GAS CYCLONE	34-AB						
S-112	LIMESTONE RECEIVER	34-CD						
S-114	FLARE GAS DUST COLLECTOR							
CR-102	COAL WEIGH FEEDER	4.5-AB						
CR-103	LIMESTONE FEEDER	34-CD						
CR-104	PULVERIZED COAL FEEDER	4.5-AB						
CR-110	COAL WEIGHER	4.5-AB						
CR-111	COAL SCALPING SCREEN	4.5-AB						
CR-112	LIMESTONE SCALPING SCREEN	34-CD						
CR-113	CHAR TRIM COOLER	4.5-CD						
CR-114	START-UP CHAR SCALPING SCREEN	4.5-BC						
SR-102	SLAG CRUSHER	E-3-AB						
P-117	SECOND START UP PUMP	E-3-BC						
D-135	STEAM DRUM	E-3-AB	12.0	5.5	65.5			
D-134	START UP KNOCK OUT DRUM	E-3-BC	8.0	40.0				
P-115	START UP GAS SCRUBBER PUMP	E-3-BC						
E-116	FIRST START UP PUMP	E-3-BC						
E-117	START UP GAS CONDENSER	E-3-AB	3.0	20				
E-111	PROCESS GAS WASTE HEAT EXCH	E-3-AB	4.7	34				
E-118	STEAM SUPER HEATER	E-3-AB	3.4	30				
E-119	BOILER FEED WATER HEATER	E-3-BC						
F-105	CHAR TRIM BAG FILTER	4.5-CD						
S-116	START UP GAS SCRUBBER FIRST	E-3-BC						
S-117	START UP GAS SCRUBBER SECOND	E-3-BC						
S-101	CHAR FILTER EXHAUST FAN	4.5-CD						





P&ID 1521-1-50-3
PETROCARB - COAL FEED - SHT. 1 of 3

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P&ID 1521-1-50-4
PETROCARB - COAL FEED - SHT. 2 of 3

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P&ID 1521-1-50-5
PETROCARB - COAL FEED - SHT. 3 of 3

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P&ID 1521-1-50-6
PETROCARB - LIMESTONE FEED - SHT. 1 of 3

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P&ID 1521-1-50-7
PETROCARB - LIMESTONE FEED - SHT. 2 of 3

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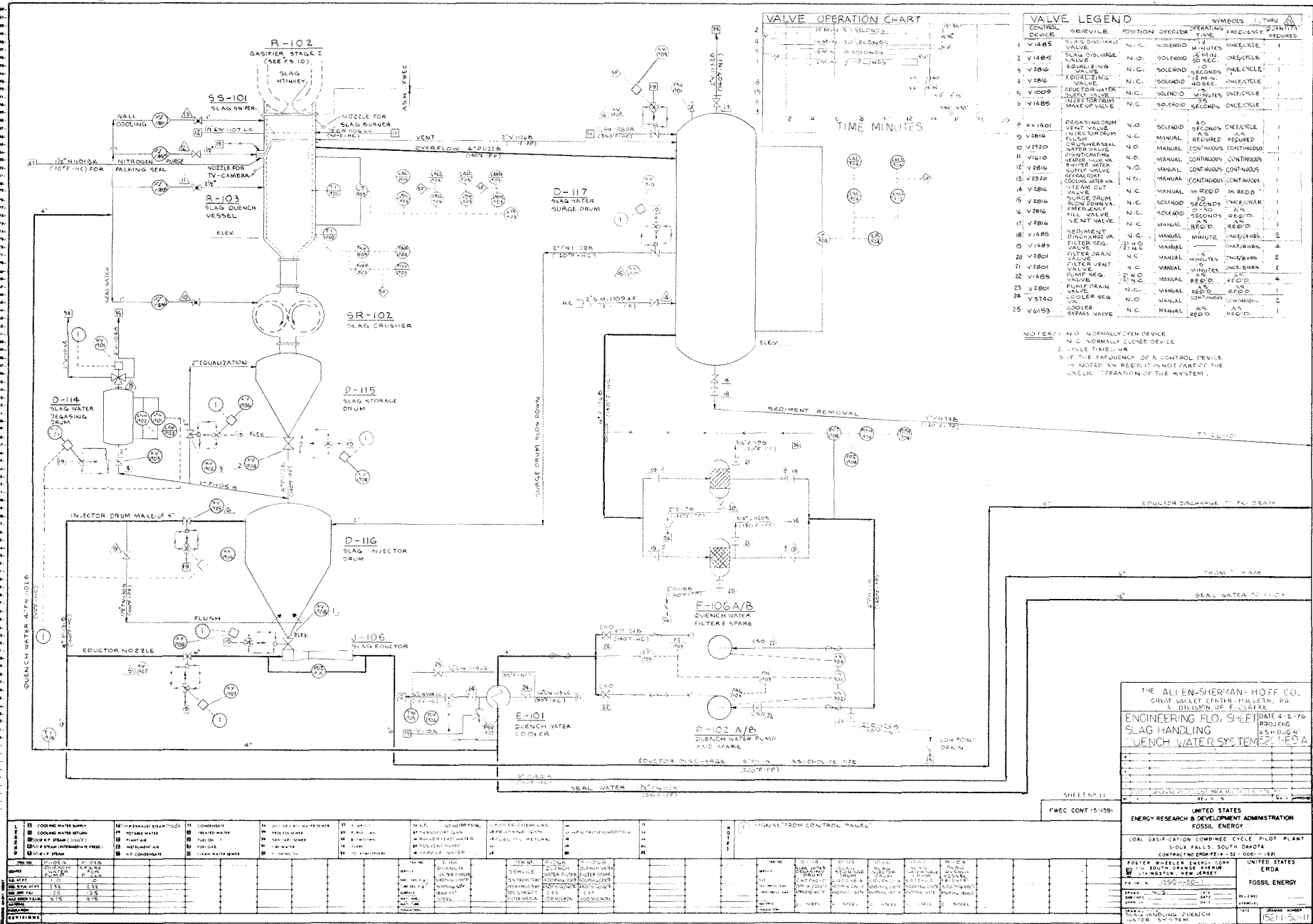
P&ID 1521-1-50-8
PETROCARB - LIMESTONE FEED - SHT. 3 of 3

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02-357-56

[illegible]



VALVE LEGEND			SYMBOLS		TURN
CONTROL	SERVICE	POSITION	OPERATOR	OPERATING TIME	TIME REQUIRED
VV181	SLUDGE MACHINE	N.C.	SCLEND	15 MIN.	OVER 2
SV 125	SLUDGE OF-FRAME	N.C.	SCLEND	33	OVERCLOCK 2
VV109	FLOATING DECK	N.C.	SCLEND	15 MIN.	OVERCLOCK 2
VV100	UPPER DECAINING VALVE	N.C.	MANUAL	15 MIN.	OVERCLOCK 2
VV200	LOWER DECAINING VALVE	N.C.	MANUAL	15 MIN.	OVERCLOCK 2
VV110	HYDROPHOBIC DRAIN	N.C.	SCLEND	RECD	REF 2
VV	WATER FILL	N.O.	MANUAL	CONTINUOUS	CONTINUOUS 1
VV128	EMERGENCY FILL	N.C.	SCLEND	15 MIN.	REF 2
VV300	SLUDGE REMOVAL VALVE	N.O.	SCLEND	RECD	REF 1
VV284	FLUSH VALVE	N.C.	MANUAL	SEED	REF 1
VV281	FLUSH VALVE	N.O.	MANUAL	CONTINUOUS	CONTINUOUS 1
VV270	WATER VALVE	N.O.	MANUAL	CONTINUOUS	CONTINUOUS 1
VV1009	SLUDGE MACHINE VALVE	N.C.	MANUAL	RECD	REF 4

VALVE OPERATION CHART

MINUTES	OPERATION	TIME
3	8 MINUTES	2:10 + 5:00
4	2 HOURS	2:10 + 5:00
5	2 HOURS	2:10 + 5:00
6	2 HOURS	2:10 + 5:00
10	10 MINUTES	2:10 + 5:00

10 MINUTES

NOTES

- 1) NO. NORMALLY OPEN DEVICE
NO. NORMALLY CLOSED DEVICE
- 2) CYCLE TIME : 35 HRS.
- 3) IF THE FREQUENCY OF A CONTROL DEVICE IS NOTED AS REQUIRED IT IS NOT PART OF THE CYCLIC OPERATION OF THE SYSTEM.

LOW PRESSURE MAKE-UP
WATER FROM P-211

SHEET NO. 12

FWEC CONT 15-159

THE ALLEN-SMITH AND MOFF CO.
GREAT VALLEY CENTER - PALM HAVEN, FLA.
A DIVISION OF ECOLIFE

ENGINEERING FLOWSHEET	DATE 4-4
SLAG HANDLING-HYDROBIN	PROJ. NO.
AND CLARIFIER SYSTEM	ASST. PROJ. NO.
	500-10

42376	DELETED PHOTOGRAPH REVD. GENERAL PHOTOGRAPH	16
42376	GENERAL PHOTOGRAPH REVD. PHOTOGRAPH	16

UNITED STATES
ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION
FOSSIL ENERGY

COAL GASIFICATION COMBINED CYCLE PILOT PLAN
SIOUX FALLS, SOUTH DAKOTA
CONTRACT NO ERDA-FE14-32-G001-1921

FOSTER WHEELER ENERGY CORP 110 SOUTH ORANGE AVENUE LIVINGSTON, NEW JERSEY	UNITED STATES EROA
1550-1-50-12	FOSSIL ENERGY

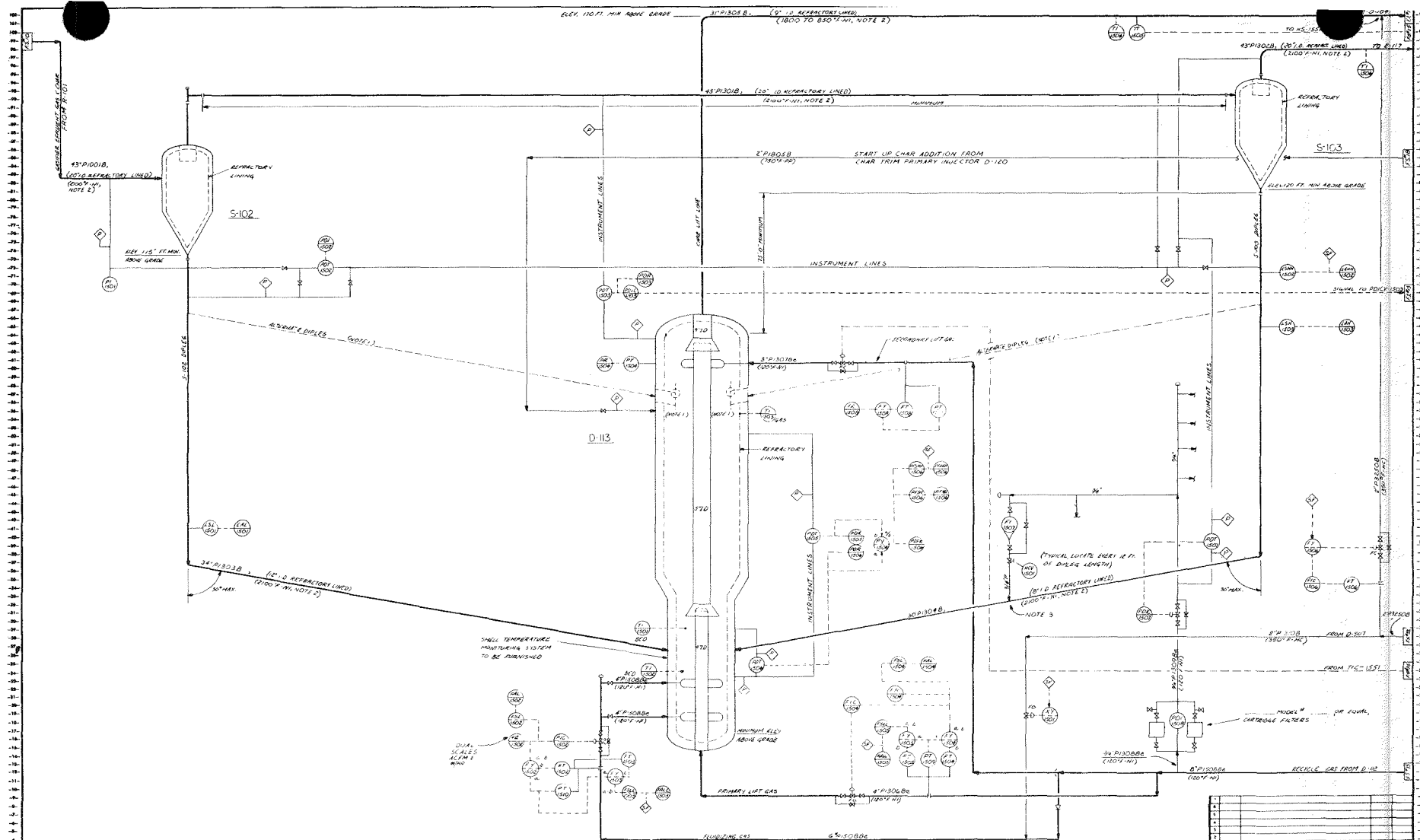
DRAWN	DATE	REVISED
CHECKED	DATE	
APPROVED	SIGNATURE	APPROVED
DRAWING NO.	TITLE	DRAWING NUMBER

SLAG HANDLING - HYDROLYSIS AND CLARIFIER SYSTEM

① SIGNAL FROM CONTROL PANEL

[illegible]

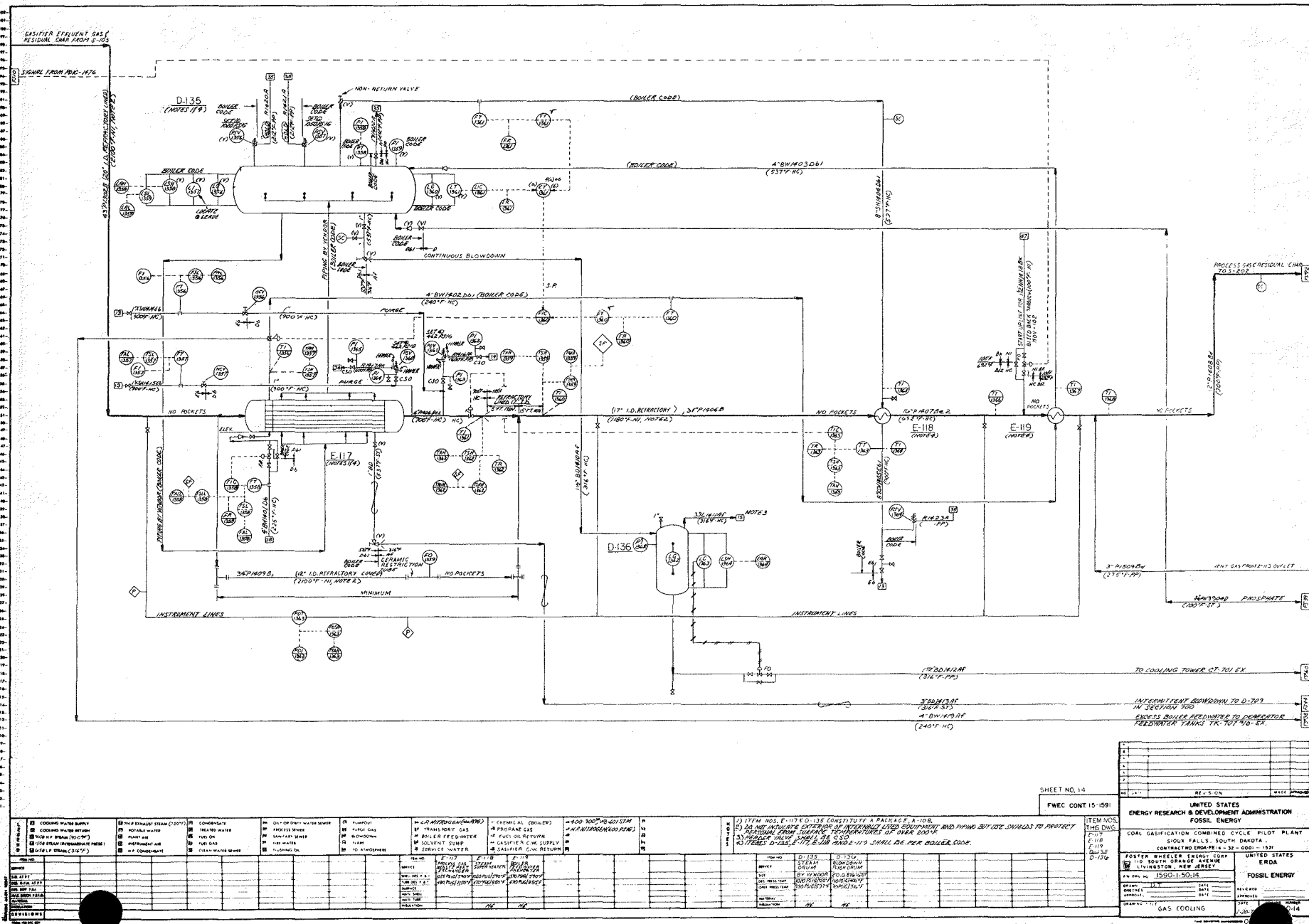
THE PRICE IS \$68

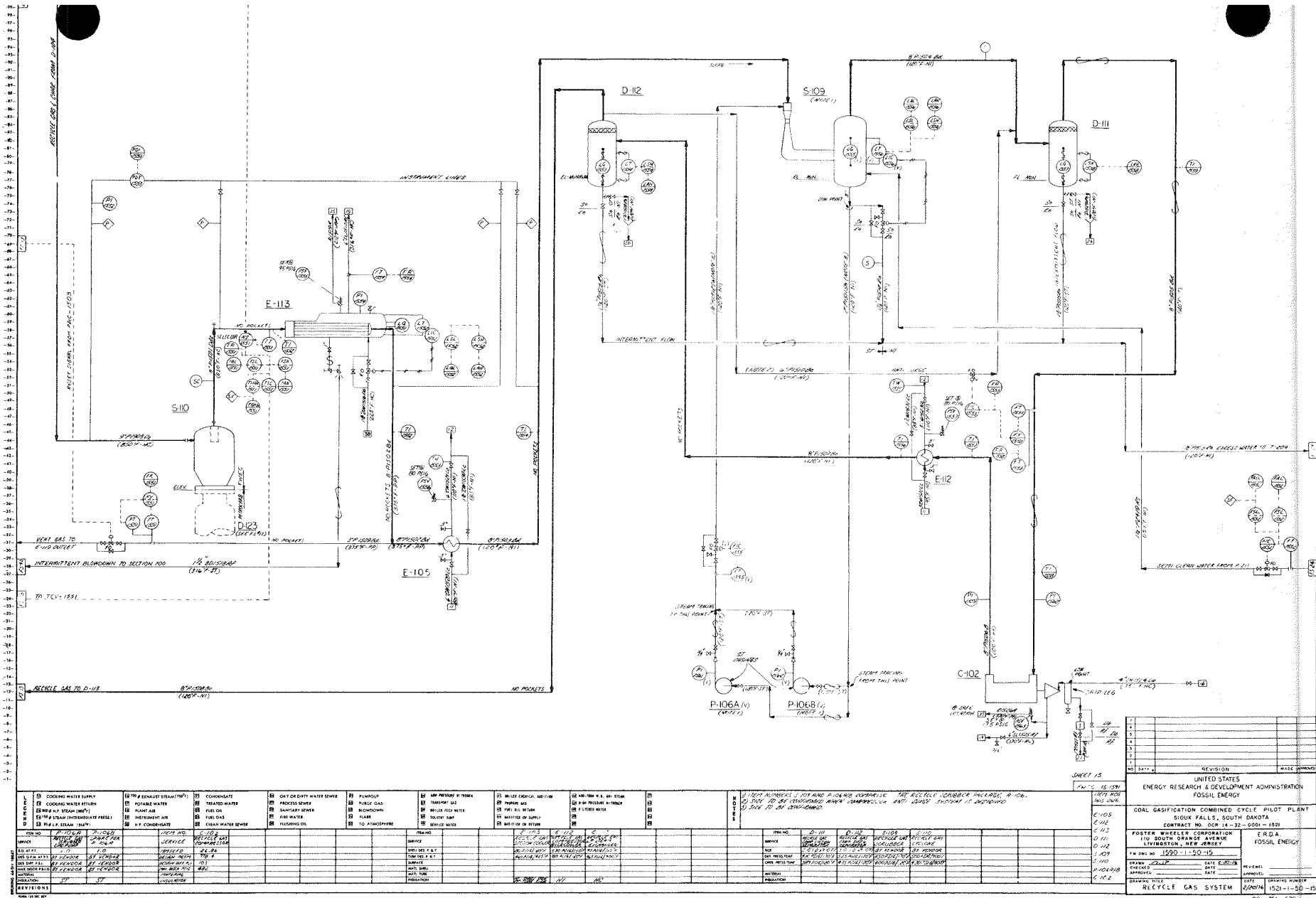
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SHEET NO. 13

FWC CONT. 15-1591

UNITED STATES ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION OFFICE OF COAL RESEARCH	
COAL GASIFICATION COMBINED CYCLE PILOT PLANT SIOUX FALLS, SOUTH DAKOTA CONTRACT NO. GCR-44-38-0000-1321	
FOSTER WHEELER ENERGY CORP. 110 SOUTH ORANGE AVENUE LIVINGSTON, NEW JERSEY	UNITED STATES ERDA
FW DDC NO. <u>1590-150-13</u>	
OFFICE OF COAL RESEARCH	
DRAWN <u>GER</u> DATE	REVIEWED
CHECKED <u>GER</u> DATE	APPROVED
APPROVED: DATE	APPROVED
DRAWING TITLE (CHAR SEPARATION & COOLING)	DATE <u>1/10/76</u> DRAWING NUMBER <u>1521-150-13</u>





P&ID 1521-1-50-16
PETROCARB - CHAR RECYCLE - SHT. 1 of 3

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P&ID 1521-1-50-17
PETROCARB - CHAR RECYCLE - SHT. 2 of 3

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P&ID 1521-1-50-18
PETROCARB - CHAR RECYCLE - SHT. 3 of 3

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P&ID 1521-1-50-19
PETROCARB - CHAR ADDITION - SHT. 1 of 3

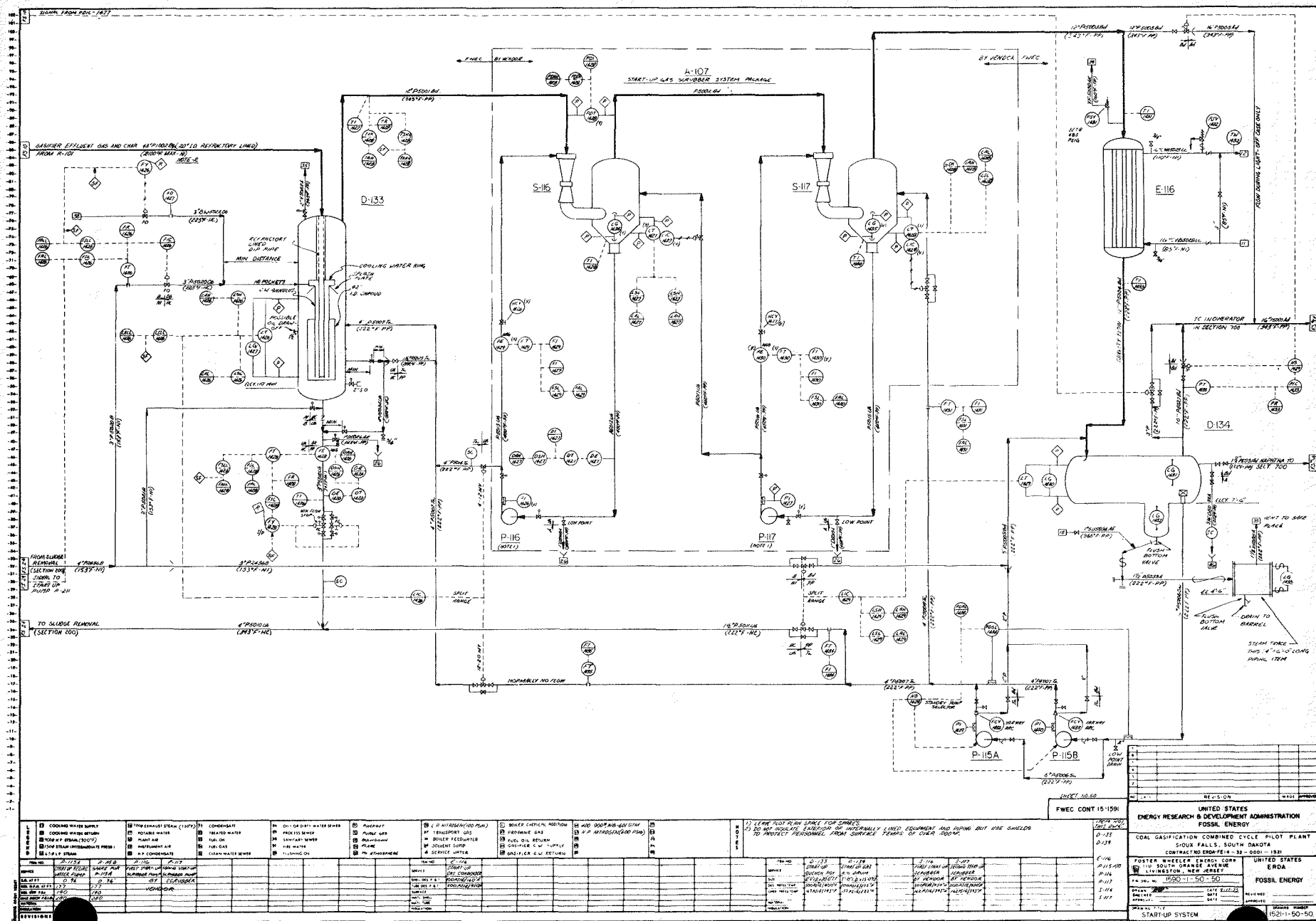
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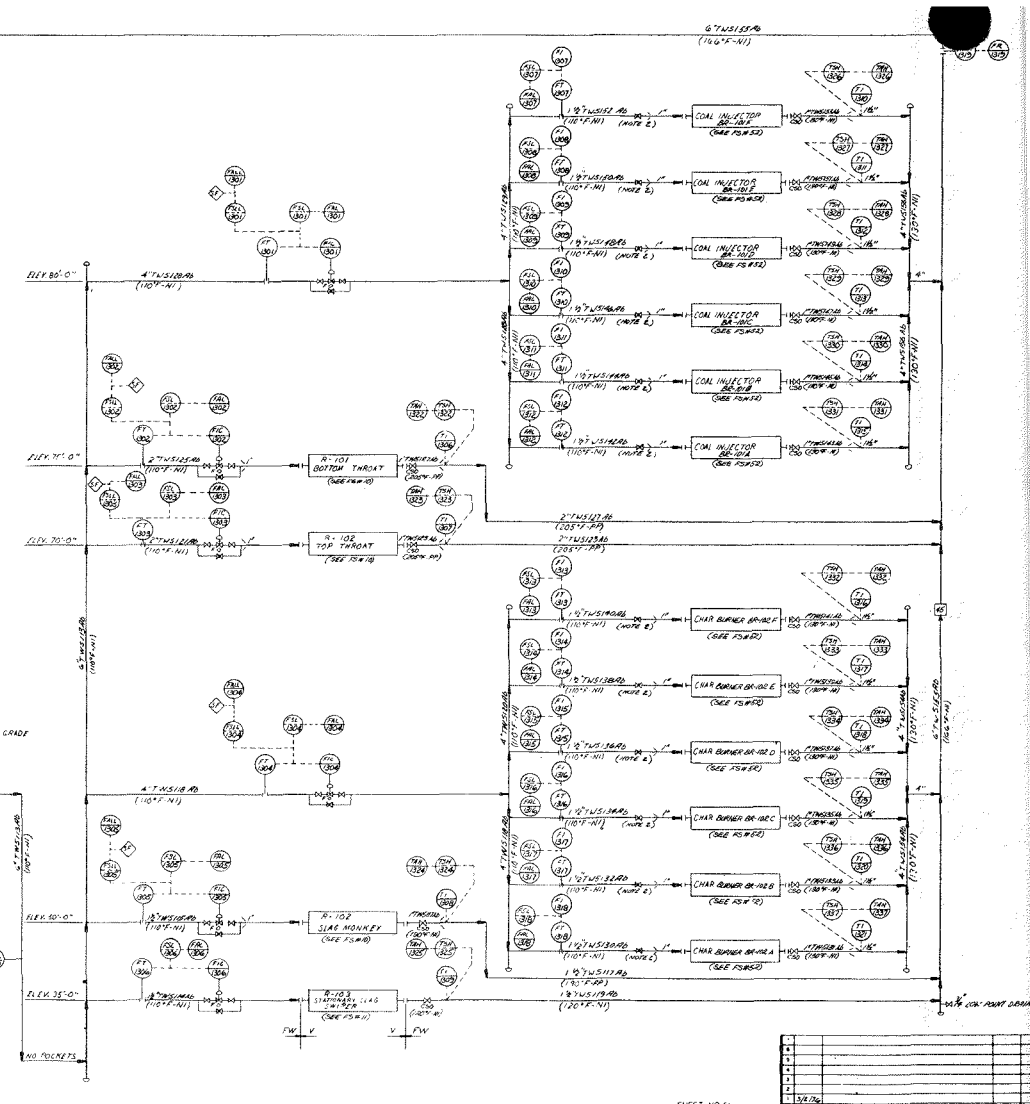
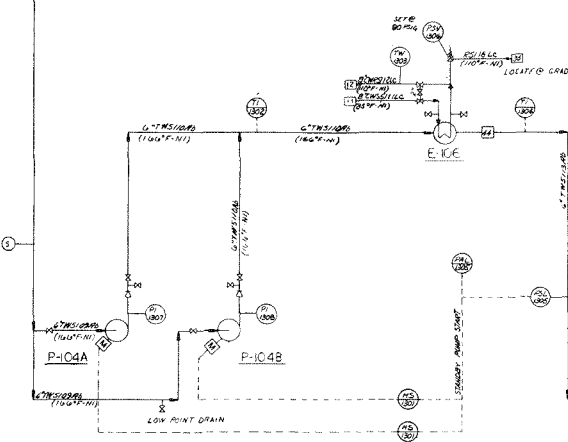
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PETROCARB - CHAR ADDITION - SHT. 2 of 3

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P&ID 1521-50-21
PETROCARB - CHAR ADDITION - SHT. 3 of 3

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of N. Y. C.





SHEET NO. 51		7/27/76		REVISION		PAGE	
FWC CONT. IS (150)		NO		DATE		NO	
UNITED STATES ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION OFFICE OF COAL RESEARCH							
COAL GASIFICATION COMBINED CYCLE PILOT PLANT SIOUX FALLS, SOUTH DAKOTA CONTRACT NO. DCR 14-A-32-0000 - 150							
PORTER WHEELER ENERGY CORP. 1000 WEST 10TH AVENUE LIVINGSTON, NEW JERSEY				UNITED STATES ERDA			
FBI REG NO. 1501-1-50 SI				OFFICE OF COAL RESEARCH			
PROJECT NO.		DATE		REVISED			
DRAWING NO.		DATE		DRAWN			
APPROVED		BY		CHECKED			
DRAWING TITLE				DATE		DRAWING NUMBER	
GASIFIER COOLING WATER SYSTEM				7/29/76		1501-50-SI	

[illegible]

FOSTER WHEELER CORP. PROCESS PLANTS DIVISION			CONTRACT NO: 15-1591 SECTION: 100		LINE CLASSIFICATION LIST				FLOWSHEET NUMBER CF-751-562 FS-1521-1-50-2		REV	BY	PAGE 1
REVISION	0	1	2	3	4	5	6	7	8	9	10		
DATE													
LINE NUMBER			LINE EXTREMITIES		OPERATING		DESIGN		INSULATION		PLAN OR ISO. DRAWING NO.	PIPE WALL TKN.	REMARKS
SIZE	SERIAL	SPEC	FROM	TO	TEMP °F	PRESS PSIG	TEMP °F	PRESS PSIG	TYPE	TKN.			
37"	P 0201	AX	SR-101	S-108	300	2" WC			HC			3/8"	FIP N.E.P.I. - 60
37"	P 0202	AX	S-108	C-104	250	4" WC			HC			3/8"	" " "
37"	P 0203	AX	C-104	SR-101	250	20" WC			HC			3/8"	" " "
26"	P 0204	AX	37" P0203 AX	F-103	250	20"			NI			3/8"	" " "
37"	V 0205	AX	PSE-1350	35	250	ATM			NI				
26"	V 0206	AX	PSE-1339	35	250	ATM			NI				
1 1/2"	NL 0207	AK	36	F-103	100	100			NI				
26"	P 0208	AX	F-103	C-105	250	16" WC			HC			3/8"	FIP N.E.P.I. - 60
26" / 23"	P 0209	AX	C-105	H-101	250	20" WC			HC			3/8"	FIP N.E.P.I. - 60
26"	V 0210	AX	26" P0209 AX	35	250	ATM			NI				
	PA 0211	L	C-103	H-101	AMB	45 WC			NI				
	FG 0212	AK	24	H-101	225	40			ST				
29"	P 0213	KX	H-101	SR-101	900	20 WC			HC				
29"	V 0214	KX/A	29" P0213 KX	35	900	ATM			PP				
	P 0215	KX/A	29" P0213 KX	26" P0204 AX	900	20" WC			HC				SIZE BY VENDOR
1 1/2"	NL 0216	AK	36	29" P0214	100	100			NI				
1"	FO 0217	A	23	H-101	100	125			NI				
1 1/2"	NL 0218	AK	36	SR-101	100	100			NI				
1"	PG 0219	AK	42	H-101	50	90			NI				
37"	V 0220	AX	PSE-1352	35	250	ATM			NI				
	PA 0221	L	C-103	H-101	AMB	45 WC			NI				
1"	SL 0222	AF	14	H-101	520	150			HC				

F. W. ENERGY CORP. PROCESS PLANTS DIVISION				CONTRACT NO: 15-1591 SECTION: 100		LINE CLASSIFICATION LIST				FLOWSHEET NUMBER Coal Feeding Sys. F.S. #5			REV	BY	PAGE 1								
REVISION		0		1		2		3		4		5		6		7		8		9		10	
DATE																							
LINE NUMBER				LINE EXTREMITIES				OPERATING		DESIGN		INSULATION		PLAN OR ISO. DRAWING NO.		PIPE WALL TKN.		REMARKS					
SIZE	SERIAL	SPEC	FROM	TO	TEMP °F	PRESS PSIG	TEMP °F	PRESS PSIG	TYPE	TKN.													
3	TG	0501	D	67G3205D	1TG0502Ba	350	850		HC														
					1TG0503Ba	350	850		HC														
					1TG0504Ba	350	850		HC														
					1TG0505Ba	350	850		HC														
					1TG0506Ba	350	850		HC														
					1TG0507Ba	350	850		HC														
1	TG	0502	Ba	3TG0501D	1 ¹ P0511Ba	350	450		HC														
1	TG	0503	Ba		1 ¹ P0515Ba	350	450		HC														
1	TG	0504	Ba		1 ¹ P0516Ba	350	450		HC														
1	TG	0505	Ba		1 ¹ P0517Ba	350	450		HC														
1	TG	0506	Ba		1 ¹ P0518Ba	350	450		HC														
1	TG	0507	Ba		1 ¹ P0519Ba	350	450		HC														
1	TG	0508	Ba	3TG0522D	D-102	350	450		HC														
1	TG	0509	Ba		D-102	350	450		HC														
1	TG	0510	Ba		D-102	350	450		HC														
1	TG	0511	Ba		D-102	350	450		HC														
1	TG	0512	Ba		D-102	350	450		HC														
1	TG	0513	Ba		D-102	350	450		HC														
1 ¹ / ₂	P	0514	Ba	D-102	BR-101A	350	450		HC														
1 ¹ / ₂	P	0515	Ba	D-102	BR-101B	350	450		HC														
1 ¹ / ₂	P	0516	Ba	D-102	BR-101C	350	450		HC														
1 ¹ / ₂	P	0517	Ba	D-102	BR-101D	350	450		HC														
1 ¹ / ₂	P	0518	Ba	D-102	BR-101E	350	450		HC														
1 ¹ / ₂	P	0519	Ba	D-102	BR-101F	350	450		HC														
1	N	0520	AK	36	D-102	100	100		NL														
1	N	0521	AK	36	PT-	100	100		NL														
3	TG	0572	D	4TG3205D	1TG0508Ba	350	850		HC														
					1TG0509Ba	350	850		HC														
					1TG0510Ba	350	850		HC														
					1TG0511Ba	350	850		HC														
					1TG0512Ba	350	850		HC														
					1TG0513Ba	350	850		HC														
4	P	0523	B	XCV1009	FSL	300			HC														
3	VF	0524	AK	D-102	34	300	10		NL														

[illegible]

FOSTER WHEELER CORP. PROCESS PLANTS DIVISION			CONTRACT NO: 15-1591 SECTION: 100		LINE CLASSIFICATION LIST				FLOWSHEET NUMBER 1521-1-50-8			REV 0	BY A.T.	PAGE 1
REVISION	0	1	2	3	4	5	6	7	8	9	10			
DATE	5/1/76													
LINE NUMBER			LINE EXTREMITIES		OPERATING		DESIGN		INSULATION		PLAN OR ISO. DRAWING NO.	PIPE WALL TKN.	REMARKS	
SIZE	SERIAL	SPEC	FROM	TO	TEMP °F	PRESS PSIG	TEMP °F	PRESS PSIG	TYPE	TKN.				
3/4"	A 0801	Ba	2"A0906Ba -	HEADER	110	570			NI					
1/2"	A 0802	Ba	3/4"A0801Ba -	3/8"P0814Ba	110	570			NI					
1/2"	A 0803	Ba	" " " -	3/8"P0815Ba	110	570			NI					
1/2"	A 0804	Ba	" " " -	3/8"P0816Ba	110	570			NI					
1/2"	A 0805	Ba	" " " -	3/8"P0817Ba	110	570			NI					
1/2"	A 0806	Ba	" " " -	3/8"P0818Ba	110	570			NI					
1/2"	A 0807	Ba	" " " -	3/8"P0819Ba	110	570			NI					
1/2"	A 0808	Ba	1/2"A0820Ba -	D-109	110	570			NI					
1/2"	A 0809	Ba	" " " -	D-109	110	570			NI					
1/2"	A 0810	Ba	" " " -	D-109	110	570			NI					
1/2"	A 0811	Ba	" " " -	D-109	110	570			NI					
1/2"	A 0812	Ba	" " " -	D-109	110	570			NI					
1/2"	A 0813	Ba	" " " -	D-109	110	570			NI					
3/8"	P 0814	Ba	D-109 -	BR-102A	110	570			NI					
3/8"	P 0815	Ba	D-109 -	BR-102B	110	570			NI					
3/8"	P 0816	Ba	D-109 -	BR-102C	110	570			NI					
3/8"	P 0817	Ba	D-109 -	BR-102D	110	570			NI					
3/8"	P 0818	Ba	D-109 -	BR-102E	110	570			NI					
3/8"	P 0819	Ba	D-109 -	BR-102F	110	570			NI					
1/2"	A 0820	Ba	3/4"A0906Ba -	HEADER	110	570			NI					
2"	V 0821	Ba-A	D-109 -	S-112	110	570			NI					
1"	V 0822	Ba-A	2"V0821B -	2"V0821A	110	570			NI					
	R 0823	A	PSV-1016 -	35	110	0			NI					

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F. W. ENERGY CORP. PROCESS PLANTS DIVISION				CONTRACT NO: 15-1591 SECTION: 100		LINE CLASSIFICATION LIST				FLOWSHEET NUMBER Slag Handling F.S.-11			REV	BY	PAGE																		
REVISION	0			1			2			3			4			5			6			7			8			9			10		
DATE																																	
LINE NUMBER				LINE EXTREMITIES				OPERATING		DESIGN		INSULATION		PLAN OR ISO. DRAWING NO.		PIPE WALL TKN.		REMARKS															
SIZE	SERIAL	SPEC		FROM	TO			TEMP °F	PRESS PSIG	TEMP °F	PRESS PSIG	TYPE	TKN.																				
1½	N	1101	BK	36	R-103			100	500			HC																					
4	RN	1102	B	E-101	R-103, SR-102			90	150			HC																					
2	V	1103	A	D-114	34			140	200			N1																					
2	V	1101	A	D-114	35			140	200			N1																					
2	P	1105	A	D-115	D-114; D-116			140	450			PP																					
1½	CW	1106	LC	11	R-103			85	75			N1																					
1½	CW	1107	LC	R-103	12			110	75			N1																					
2	PW	1108	B	D-117	D-116			140	450			HC																					
2	SM	1109	Af	Coupling	D-117			406	250			HC																					
1	V	1110	A	PSV1902	35			150	150			N1																					
5	P	1111	A	J-106	TK-105A/B			200	450			PP																					
1½	PW	1112	B	E-101	P-103			200	500			PP																					
6	CW	1113	Lc	11	E-101			85	55			HC																					
6	CW	1114	Lc	E-101	12			110	55			HC																					
1½	CW	1115	LC	6" CW 1113Lc	6" CW 1114LC			85	55			HC																					
4	P	1116	B	D-117	F-106A/B			140	450			HC																					
2	D	1117	B	F-106A	26			140	450			PP																					
2	D	1118	B	F-106B	26			140	450			PP																					
3/4	V	1119	B	F-106A	35			140	450			PP																					
3/4	V	1120	B	F-106B	35			140	450			PP																					
4	P	1123	B	F-106A/B	P-102A/B			140	450			PP																					
4	P	1124	B	P-102A/B	E-101			140	575			HC																					
2	D	1125	B	4P1123B	25			140	450			N1																					
2	V	1126	B	R-103	D-117			140	450			PP																					
4	P	1127	B	R-103	D-117			140	450			PP																					
1½	BW	1128	Db	38	D-117			350	1200			HC																					
8	P	1129	B	D-115	D-116			450	140			PP																					
1½	PW	1130	B	4P1131B	D-116			100	450			PP																					
4																																	

[illegible]

FOSTER WHEELER CORP. PROCESS PLANTS DIVISION			CONTRACT NO: 1591 SECTION: 100		LINE CLASSIFICATION LIST		FLOWSHEET NUMBER 1521-1-50-14		REV 0	BY A.T.	PAGE		
REVISION	0	1	2	3	4	5	6	7	8	9	10		
DATE	5/1/76												
LINE NUMBER			LINE EXTREMITIES		OPERATING		DESIGN		INSULATION		PLAN OR ISO. DRAWING NO.	PIPE WALL TKN.	REMARKS
SIZE	SERIAL	SPEC	FROM	TO	TEMP °F	PRESS PSIG	TEMP °F	PRESS PSIG	TYPE	TKN.			
4"	BW 1401	Db	[38]	E-117	225	1200	350		HC				Part per boiler code
4"	BW 1402	Db1	E-117	E-119	240	935			HC				Per boiler code
4"	BW 1403	Db1	E-119	D-135	537	930			HC				Per boiler code
8"	SH 1404	Db1	D-135	E-118	537	930			HC				Per boiler code
8"	XSH 1405	Eb	E-118	[13]	900	900			HC				Part per boiler code
16"	31 P 1406	Be2 B	E-117	E-118	700	418			HC				Part 17" I.D. Refractory Lined
16"	P 1407	Be2	E-118	E-119	692	406			HC				
12"	P 1408	Bd	E-119	S-202	300	394			PP				
34"	P 1409	B	43" P1302 B	31" P1406 B	2100	430			* NI				12" I.D. Refractory Lined
1 1/2"	BD 1410	Db1 Af	D-135	D-136	537	930			HC				
3"	SL 1411	Af	D-136	[15]	316	65			HC				
1 1/2"	BD 1412	Af	D-136	CT-701 EX.	316	65			PP				
1 1/2"	BD 1413	Db1 Af	E-117	D-709	537	935			ST				
1"	XSH 1414	Eb Db	[13]	-16" P1406 Be2	900	900			HC				
1"	XSH 1415	Eb Db	[13]	-16" P1406 Be2	900	900			HC				
	R 1416	AK	PSV-1361	[34]	600	10			PP				
	R 1417	AK	PSV-1360	[34]	600	10			PP				
1 1/2"	NH 1418	Bd2 BK	[47]	-16" P1407 Bd2	692	406			HC PP				
4"	BW 1419	Af	4" BW1402 Db1	TK-707A/B EX	240	10			HC				
	R 1420	A	PSV-1356	[35]	212	0			PP				
	R 1421	A	PSV-1357	[35]	212	0			PP				
1"	V 1422	Db1 A	D-135	[35]	537	930			HC PP				
	R 1423	A	PSV-1364	[35]		0			PP				

* Use shields to protect personnel from surface temperatures of over 200°F.

FORM NO. 135-56B

FOSTER WHEELER CORP. PROCESS PLANTS DIVISION				CONTRACT NO: 15-1591 SECTION: 100		LINE CLASSIFICATION LIST		FLOWSHEET NUMBER 1521-1-50-13		REV 0	BY A.T.	PAGE		
REVISION	0	1	2	3	4	5	6	7	8	9	10			
DATE	5/1/76													
LINE NUMBER				LINE EXTREMITIES		OPERATING		DESIGN		INSULATION		PLAN OR ISO. DRAWING NO.	PIPE WALL TKN.	REMARKS
SIZE	SERIAL	SPEC	FROM	TO	TEMP °F	PRESS PSIG	TEMP °F	PRESS PSIG	TYPE	TKN.				
8"	P 1501	Dd2	S-110	E-113	250	431			HC					
3"	P 1502	Bd	E-113	E-105	375	420			PP					
8"	P 1503	Bd	E-105	S-109	120	409			NI					
8"	P 1504	Bd	S-109	D-111	120	385			NI					
8"	P 1505	Bd	D-111	C-102	120	385			ST					
8"	P 1506	B	C-102	E-112	200	482			PP					
8"	P 1507	Be	E-112	D-112	120	470			NI					
8"	P 1508	Be	D-112	D-113	120	470			NI					
3"	P 1509	Bd	8" P1502 Bd	12" P1408 Bd	375	420			PP					
6"	P 1510	Be	8" P1508 Be	8" P-1504 Bd	120	470			NI				Size to be confirmed	
3"	P 1511	Sh	S-109	P-106A+B	120	409			NI/ST				" " " "	
1 1/2"	P 1512	Sh	P-106A+B	S-109	120				NI/ST				" " " "	
1 1/2"	P 1513	Sh/Rh	D-112	T-204	120	470/56			ST/NI					
1 1/2"	P 1514	Sh/Rh	3" P1511 Sh	1 1/2" P1513 Rh	120	409/70			NI					
1 1/2"	P 1515	Sh/Rh	D-111	1 1/2" P1513 Rh	120	385/70			ST					
1 1/2"	BW 1516	Db	[38]	E-113	225	1200	350		HC					
6"	SL 1517	Af	E-113	[15]	150	316			HC					
1 1/2"	BD 1518	Af	E-113	SECTION 700	150	316			ST					
	R 1519	A	PSV-1555	[35]	316	0			PP					
6"	CW 1520	Lc	[11]	E-105	85	100			NI					
6"	CW 1521	Lc	E-105	[12]	110	90			NI					
3"	CW 1522	Lc	[11]	E-112	85	100			NI					
3"	CW 1523	Lc	E-112	[12]	110	90			NI					
4"	SH 1524	Db	[18]	C-102	750	700			HC					
6"	SL 1525	Af	C-102	[14]	370	150			HC					
	R 1526	A	PSV-1563	[35]	370	0			PP					
1"	C 1527	Db/Af	4" SH 1524 Db	[21]	750/370	700/65			HC					
1"	D 1528	Sh/Rh	1 1/2" P1513 Sh	[26]	120	470/0			ST/NI					
1"	D 1529	Sh/Rh	1 1/2" P1515 Sh	[26]	120	385/0			ST/NI					
1 1/2"	CW 1530	Lc	6" CW1520 Lc	6" CW1521 Lc	85	100			NI					
1"	CW 1531	Lc	3" CW1522 Lc	3" CW1523 Lc	85	100			NI					

PROCESS PLANTS DIVISION				SECTION: 100		LIST		Char Recycle Sys. F.S. 18														
REVISION	0		1		2		3		4		5		6		7		8		9		10	
DATE																						
LINE NUMBER				LINE EXTREMITIES				OPERATING		DESIGN		INSULATION		PLAN OR ISO. DRAWING NO.		PIPE WALL TKN.		REMARKS				
SIZE	SERIAL	SPEC	FROM	TO	TEMP °F	PRESS PSIG	TEMP °F	PRESS PSIG	TYPE	TKN.												
3	TG	1801	D	FS-5	1TG1802Ba	350	800		HC													
					1TG1803Ba	350	800		HC													
					1TG1804Ba	350	800		HC													
					1TG1805Ba	350	800		HC													
					1TG1806Ba	350	800		HC													
					1TG1807Ba	350	800		HC													
1	TG	1802	Ba	3TG1801D	1½P1808Ba	350	550		HC													
1	TG	1803	Ba		1½P1809Ba	350	550		HC													
1	TG	1804	Ba		1½P1810Ba	350	550		HC													
1	TG	1805	Ba		1½P1811Ba	350	550		HC													
1	TG	1806	Ba		1½P1812Ba	350	550		HC													
1	TG	1807	Ba		1½P1813Ba	350	550		HC													
1½	P	1808	Ba	1TG1802Ba	FS-52	350	550		HC													
1½	P	1809	Ba	1TG1803Ba	FS-52	350	550		HC													
1½	P	1810	Ba	1TG1804Ba	FS-52	350	550		HC													
1½	P	1811	Ba	1TG1805Ba	FS-52	350	550		HC													
1½	P	1812	Ba	1TG1806Ba	FS-52	350	550		HC													
1½	P	1813	Ba	1TG1807Ba	FS-52	350	550		HC													
3	TG	1814	D	67G3502D	1½TG1815Ba	350	800		HC													
					1½TG1816Ba	350	800		HC													
					1½TG1817Ba	350	800		HC													
					1½TG1818Ba	350	800		HC													
					1½TG1819Ba	350	800		HC													
					1½TG1820Ba	350	800		HC													
1½	TG	1815	Ba	3TG1814	D-106	350	550		HC													
1½	TG	1816	Ba		D-106	350	550		HC													
1½	TG	1817	Ba		D-106	350	550		HC													
1½	TG	1818	Ba		D-106	350	550		HC													
1½	TG	1819	Ba		D-106	350	550		HC													
1½	TG	1820	Ba		D-106	350	550		HC													
18	P	1821	D2	D-106	FS-16	800	550		PP													
8	P	1822	D2	XCV-1130	FS-16	800	550		PP													
1½	N	1823	AK	36	D-106	100	100		N1													
3	VF	1824	AK	PSV-1035	34	350	10		N1													

F. W. ENERGY CORP. PROCESS PLANTS DIVISION				CONTRACT NO: 15-1591		LINE CLASSIFICATION LIST				FLOWSHEET NUMBER				REV	BY	PAGE																	
SECTION: 100				1521-1-50-19 F.S. 19																													
REVISION	0			1			2			3			4			5			6			7			8			9			10		
DATE																																	
LINE NUMBER				LINE EXTREMITIES				OPERATING		DESIGN		INSULATION		PLAN OR ISO. DRAWING NO.		PIPE WALL TKN.		REMARKS															
SIZE	SERIAL	SPEC	FROM	TO		TEMP °F	PRESS PSIG	TEMP °F	PRESS PSIG	TYPE	TKN.																						
2"	N	1901	Ak	N ₂ Header	P1915A	100	100			N1																							
"	P	1902	A	F-105	B-101	-	-																										
"	P	1903	A	B-101	Atmos	-	-																										
4"	P	1904	A	F-105	P-1905A																												
4"	P	1905	A	S-115	8" P-1905A																												
2"	CWS	1906	Lc	CWS Header	CR-113	85	75			N1																							
2"	CWS	1907	Lc	CR-113	CWR Header	110	75			N1																							
8"	P	1908	A	CR-113	TK-103																												
"	VA	1909	A	TK-103	Atmos																												
14"	P	1910	A	TK-103	EJ-10																												
1 1/2"	N	1911	Ak	N ₂ Header	P1910A	100	100			N1																							
"	P	1912	A		To Disposal																												
4"	P	1913	A	Char Addition	S-107																												
"	P	1914	A	Char Truck	TK-103																												
4"	P	1915	A	S-115	F-105																												

[illegible]

FOSTER WHEELER CORP. PROCESS PLANTS DIVISION			CONTRACT NO: 15-1571		LINE CLASSIFICATION LIST				FLOWSHEET NUMBER			REV	BY	PAGE
			SECTION: 1st						OP-751-602, FS-1521-1-50-20				NLS	1
REVISION	0		1	2	3	4	5	6	7	8	9	10		
DATE														
LINE NUMBER			LINE EXTREMITIES			OPERATING		DESIGN		INSULATION		PLAN OR ISO. DRAWING NO.	PIPE WALL TKN.	REMARKS
SIZE	SERIAL	SPEC	FROM	TO		TEMP °F	PRESS PSIG	TEMP °F	PRESS PSIG	TYPE	TKN.			
12"	P 5001	Bd	D-133	S-116		343	450			PP				PRESSURE RASD ON/DC14 OPERATING PRESSURE OF CASIFILE
	P 5002	Bd	S-116	S-117		343	450			PP				
12"	P 5003	L1	S-117	E-116		343	450			PP				
12"	P 5004	Bd	E-116	D-134		222	450			PP				
12"/16"	P 5005	KA	12" P5003 Bd	F.S. S4		343	450			PP				
6"	P 5006	Sn	D-134	P-115A/E		222	450		485	PP				
4"	P 5007	Ta	P-115A/E	D-133		222	591		629	PP				
4"	P 5008	Ta	4" P5007 Ta	S-117		222	591			PP				
2 1/3"	P 5009	Ta/Bd	P-115A/E	12" P5008 Bd		222	591			PP				
3 1/4"	P 5010	Uh	D-133	4" P2414 AS		343	450			HC				
1 1/2"	P 5011	F/L	4" P5007 Ta	4" P5010 Uh		222	591			PP				
	P 5012	Uh	S-116 (common)	P-116		450	591			PP				
	P 5013	Uh	P-116	S-116 (common)		450	591			PP				* BY VENDOR
A"	P 5014	Uh/Ta	P5012 Uh	4" P5007 Ta		222	591			PP				
	P 5015	Uh	S-117 (common)	P-117		450	591			PP				
	P 5016	Uh	P-117	S-117 (common)		450	591			PP				
	P 5017	Uh	P5016 Uh	S-116		450	591			PP				* BY VENDOR
1"	D 5018	A	P5012 Uh	26		450	0			PP				* BY VENDOR
1"	D 5019	A	P5015 Uh	26		450	0			PP				
3"	P 5020	B/L	4" P2436 B	D-133		153	468			N1/Hc				
2"	P 5021	B/Uh	4" P2436 B	3" P5010 Uh		153	468			N1/Hc				
3"	BW 5022	D6	1381	3" P5010 D6		225	1200			HC				
2"	V 5023	A	D-133	35		343	0			PP				
1"	P 5024	Uh	D-132	3" P5010 Uh		343	450			HC				
1 1/2"	P 5025	Ta/Uh	4" P5007 Ta	4" P5024 Uh		222	591			PP/Hc				
1"	D 5026	Uh/AK	3" P5010 Uh	1261		343	0			PP				
12"/16"	P 5027	Bd	D-134	16" P5005 Bd		222	450			PP				
16"	OS 5028	Lo	111	P-116		85	75			N1				
16"	OS 5029	Lo	B-116	112		110	75			N1				
	VF 5030	AK	PSV-1431	39		160	10			PP				
1 1/2"	P 5031	Bd	D-134			AMB	450			N1				
3 1/4"	D 5032	A	D-134	1261		AMB	0			N1				
1 1/2"	P 5033	A	D-134	TO BARREL		AMB	0			N1				
1"	SW 5034	N	115	1 1/2" P5011		365	65			HC				

FOSTER WHEELER CORP. PROCESS PLANTS DIVISION			CONTRACT NO: <u>15-1591</u> SECTION: <u>100</u>		LINE CLASSIFICATION LIST				FLOWSHEET NUMBER <u>OP-151-603, 15-1521, 15-50-51</u>			REV	BY	PAGE
REVISION	0	1	2	3	4	5	6	7	8	9	10			
DATE														
LINE NUMBER			LINE EXTREMITIES		OPERATING		DESIGN		INSULATION		PLAN OR ISO. DRAWING NO.	PIPE WALL TKN.	REMARKS	
SIZE	SERIAL	SPEC	FROM	TO	TEMP °F	PRESS PSIG	TEMP °F	PRESS PSIG	TYPE	TKN.				
1 1/2"	BW 5101	DB	<u>138</u>	2" BW 5102A	225	1200			PP					
2"	BW 5102	AF	1 1/2" 5101 DB	D-132	225	25			PP					
1 1/2"	NL 5103	AK	<u>136</u>	6" NL 5104 AK	100	100			NI					
6"	NL 5104	AK	D-132	8" VF 5105 AK	166	25			NI					
8"	VF 5105	AK	1 1/2" VF 5106 AK	<u>137</u>	166				NI					
1 1/2"	VF 5106	AK	6" NL 5104 AK	8" VF 5105 AK	166				NI					
2"	SL 5107	AF	<u>115</u>	D-132	307	65			HC					
1 1/2"	CL 5108	AF	D-132	<u>121</u>	307	65			PP					
6"	BW 5109	AF	D-132	P-104A/B	116	25			NI					
6"	BW 5110	AF	P-104A/B	E-106	166	110			NI					
DELETED														
6"	BW 5113	AF	E-106	1 1/2" BW 5129A	110				NI					
1 1/2"	BW 5114	AF	6" BW 5113A	R-103	110				NI					
1 1/2"	BW 5115	AF	6" BW 5113A	1" BW 5116 AF	110				NI					
1"	BW 5116	AF	1 1/2" BW 5115 AF	R-102	110				NI					
1"	BW 5117	AF	R-102	1 1/2" BW 5118 AF	190				NI					
1 1/2"	BW 5118	AF	1" BW 5117 AF	6" BW 5115 AF	166				NI					
1 1/2"	BW 5119	AF	R-103	6" BW 5115 AF	120				NI					
4"	BW 5120	AF	6" BW 5113 AF	1 1/2" BW 5120 AF	110				NI					
2"	BW 5121	AF	6" BW 5113 AF	1" BW 5122 AF	110				NI					
1"	BW 5122	AF	2" BW 5121 AF	R-102	110				NI					
1"	BW 5123	AF	R-102	2" BW 5124 AF	205				PP					
2"	BW 5124	AF	1" BW 5123 AF	6" BW 5115 AF	205				PP					
2"	BW 5125	AF	6" BW 5113 AF	1" BW 5126 AF	110				NI					
1"	BW 5126	AF	2" BW 5125 AF	R-101	110				NI					
1"	BW 5127	AF	R-101	2" BW 5128 AF	205				PP					
2"	BW 5128	AF	1" BW 5127 AF	6" BW 5115 AF	205				PP					
2"	BW 5129	AF	6" BW 5113 AF	4" BW 5142 AF	110				NI					
1 1/2"	BW 5142	AF	4" BW 5129 AF	1" BW 5116 AF	110				NI					
1"	BW 5143	AF	1 1/2" BW 5142 AF	6" BW 5115 AF	110				NI					
1"	BW 5144	AF	6" BW 5113 AF	1 1/2" BW 5143 AF	131				NI					
1 1/2"	BW 5145	AF	1" BW 5144 AF	4" BW 5180 AF	130				NI					
1 1/2"	BW 5146	AF	1" BW 5144 AF	2" BW 5116 AF	110				NI					
1"	BW 5147	AF	1 1/2" BW 5146 AF	6" BW 5115 AF	110				NI					

FOSTER WHEELER CORP. PROCESS PLANTS DIVISION			CONTRACT NO: 15-1541 SECTION: 100		LINE CLASSIFICATION LIST		FLOWSHEET NUMBER OP-751-603, F5-1521-1-50-51		REV	BY	PAGE		
REVISION	0	1	2	3	4	5	6	7	8	9	10		
DATE													
LINE NUMBER			LINE EXTREMITIES		OPERATING		DESIGN		INSULATION		PLAN OR ISO. DRAWING NO.	PIPE WALL TKN.	REMARKS
SIZE	SERIAL	SPEC	FROM	TO	TEMP °F	PRESS PSIG	TEMP °F	PRESS PSIG	TYPE	TKN.			
1"	BN 5171	AF	COAL INJ. #2	1 1/2" BN 5171 AF	130				N/I				
1 1/2"	BN 5145	AF	1" BN 5171 AF	4" BN 5180 AF	130				N/I				
1 1/2"	BN 5144	AF	4" BN 5129 AF	1" BN 5172 AF	110				N/I				
1"	BN 5172	AF	1 1/2" BN 5146 AF	COAL INJ. #3	110				N/I				
1"	BN 5173	AF	COAL INJ. #3	1 1/2" BN 5147 AF	130				N/I				
1 1/2"	BN 5147	AF	1" BN 5173 AF	4" BN 5180 AF	130				N/I				
1 1/2"	BN 5143	AF	4" BN 5129 AF	1" BN 5174 AF	110				N/I				
1"	BN 5174	AF	1 1/2" BN 5148 AF	COAL INJ. #4	110				N/I				
1"	BN 5175	AF	COAL INJ. #4	1 1/2" BN 5149 AF	130				N/I				
1 1/2"	BN 5149	AF	1" BN 5175 AF	4" BN 5180 AF	130				N/I				
1 1/2"	BN 5136	AF	4" BN 5129 AF	1" BN 5176 AF	110				N/I				
1"	BN 5176	AF	1 1/2" BN 5150 AF	COAL INJ. #5	110				N/I				
1"	BN 5177	AF	COAL INJ. #5	1 1/2" BN 5151 AF	130				N/I				
1 1/2"	BN 5151	AF	1" BN 5177 AF	4" BN 5180 AF	130				N/I				
1 1/2"	BN 5152	AF	4" BN 5129 AF	1" BN 5178 AF	110				N/I				
1"	BN 5178	AF	1 1/2" BN 5152 AF	COAL INJ. #6	110				N/I				
1"	BN 5179	AF	COAL INJ. #6	1 1/2" BN 5153 AF	130				N/I				
1 1/2"	BN 5153	AF	1" BN 5179 AF	4" BN 5180 AF	130				N/I				
1 1/2"	BN 5130	AF	4" BN 5120 AF	1" BN 5154 AF	110				N/I				
1"	BN 5154	AF	1 1/2" BN 5130 AF	COAL INJ. #1	110				N/I				
1"	BN 5157	AF	COAL INJ. #1	1 1/2" BN 5131 AF	130				N/I				
1 1/2"	BN 5131	AF	1" BN 5157 AF	4" BN 5180 AF	130				N/I				
1 1/2"	BN 5132	AF	4" BN 5120 AF	1" BN 5158 AF	110				N/I				
1"	BN 5158	AF	1 1/2" BN 5132 AF	COAL INJ. #2	110				N/I				
1"	BN 5159	AF	COAL INJ. #2	1 1/2" BN 5133 AF	130				N/I				
1 1/2"	BN 5133	AF	1" BN 5159 AF	4" BN 5180 AF	130				N/I				
1 1/2"	BN 5134	AF	4" BN 5120 AF	1" BN 5160 AF	110				N/I				
1"	BN 5160	AF	1 1/2" BN 5134 AF	COAL INJ. #3	110				N/I				
1"	BN 5161	AF	COAL INJ. #3	1 1/2" BN 5161 AF	130				N/I				
1 1/2"	BN 5135	AF	1" BN 5161 AF	4" BN 5180 AF	130				N/I				
1 1/2"	BN 5136	AF	4" BN 5120 AF	1" BN 5162 AF	110				N/I				
1"	BN 5162	AF	1 1/2" BN 5136 AF	COAL INJ. #4	110				N/I				
1"	BN 5163	AF	COAL INJ. #4	1 1/2" BN 5163 AF	130				N/I				
1 1/2"	BN 5137	AF	1" BN 5163 AF	4" BN 5180 AF	130				N/I				

FOSTER WHEELER CORP. PROCESS PLANTS DIVISION				CONTRACT NO: 15-1591 SECTION: 106		LINE CLASSIFICATION LIST				FLOWSHEET NUMBER OP-15-1591-FS-106-1-50-71		REV	BY	PAGE
REVISION	0	1	2	3	4	5	6	7	8	9	10			
DATE														
LINE NUMBER	LINE EXTREMITIES			OPERATING		DESIGN		INSULATION		PLAN OR ISO. DRAWING NO.	PIPE WALL TKN.	REMARKS		
SIZE	SERIAL	SPEC	FROM	TO	TEMP °F	PRESS PSIG	TEMP °F	PRESS PSIG	TYPE	TKN.				
1 1/2"	BN 5138	AF	4" BN 5120 AF	1" BN 5164 AF	110				NI					
1"	BN 5167	AF	1 1/2" BN 5138 AF	Char Inj. #5	110				NI					
1"	BN 5165	AF	Char Inj. #4	1 1/2" BN 5139 AF	130				NI					
1 1/2"	BN 5139	AF	1" BN 5165 AF	4" BN 5154 AF	130				NI					
1 1/2"	BN 5141	AF	4" BN 5154 AF	1" BN 5163 AF	110				NI					
1"	BN 5164	AF	1 1/2" BN 5138 AF	Char. Inj. #6	110				NI					
1"	BN 5167	AF	Char Inj. #6	1 1/2" BN 5141 AF	130				NI					
1 1/2"	BN 5141	AF	1" BN 5167 AF	4" BN 5158 AF	130				NI					
4"	BN 5158	AF	Char Inj. #5	6" BN 5155 AF	166				NI					
4"	BN 5180	AF	Char Inj. #6	6" BN 4355 AB	166				NI					
6"	BN 5155	AF	HEADER	D-132	166				NI					
8"	CWS 5181	LC	11	E-106	85	75			NI					
8"	CWR 5182	LC	E-106	12	110	75			NI					
	R 5183	LC	8" CWR 5182 LC	35	110	0			NI					

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FOSTER WHEELER CORP. PROCESS PLANTS DIVISION			CONTRACT NO: 15-1591 SECTION: 100		LINE CLASSIFICATION LIST		FLOWSHEET NUMBER 1521-1-50-52		REV 0	BY A.T	PAGE		
REVISION	0	1	2	3	4	5	6	7	8	9	10		
DATE	5/1/76												
LINE NUMBER			LINE EXTREMITIES		OPERATING		DESIGN		INSULATION		PLAN OR ISO. DRAWING NO.	PIPE WALL TKN.	REMARKS
SIZE	SERIAL	SPEC	FROM	TO	TEMP °F	PRESS PSIG	TEMP °F	PRESS PSIG	TYPE	TKN.			
3" 6"	XSH 5201	Eb	[13]	- HEADER	900	900			HC				
6"	SM 5202	Bb/Eb	[14]	- 6" XSH 5201 Eb	400	250	400	490	HC				
2"	XSH 5203	Eb	6" XSH 5201 Eb	- BR-101A	900	900	900	490	HC				
2"	XSH 5204	Eb	6" XSH 5201 Eb	- BR-101B	900	900	900	490	HC				
2"	XSH 5205	Eb	6" XSH 5201 Eb	- BR-101C	900	900	900	490	HC				
2"	XSH 5206	Eb	6" XSH 5201 Eb	- BR-101D	900	900	900	490	HC				
2"	XSH 5207	Eb	6" XSH 5201 Eb	- BR-101E	900	900	900	490	HC				
2"	XSH 5208	Eb	6" XSH 5201 Eb	- BR-101F	900	900	900	490	HC				
4"	XSH 5209	Eb	[13]	- HEADER	900	900			HC				
2" 3"	XSH 5210	Eb	4" XSH 5210 Eb	- BR-102A	900	900	900	496	HC				
2" 3"	XSH 5211	Eb	4" XSH 5210 Eb	- BR-102B	900	900	900	496	HC				
2" 3"	XSH 5212	Eb	4" XSH 5210 Eb	- BR-102C	900	900	900	496	HC				
2" 3"	XSH 5213	Eb	4" XSH 5210 Eb	- BR-102D	900	900	900	496	HC				
2" 3"	XSH 5214	Eb	4" XSH 5210 Eb	- BR-102E	900	900	900	496	HC				
2" 3"	XSH 5215	Eb	4" XSH 5210 Fb	- BR-102F	900	900	900	496	HC				
3" 2"	A 5216	D	8" A 3119 D	- BR-102A	800	496			HC				
3" 2"	A 5217	D	8" A 3119 D	- BR-102B	800	496			HC				
3" 2"	A 5218	D	8" A 3119 D	- BR-102C	800	496			HC				
3" 2"	A 5219	D	8" A 3119 D	- BR-102D	800	496			HC				
3" 2"	A 5220	D	8" A 3119 D	- BR-102E	800	496			HC				
3" 2"	A 5221	D	8" A 3119 D	- BR-102F	800	496			HC				
2"	A 5222	D/Eb	3" A 5216 D	- 3" XSH 5210 Eb	800	496			HC				
2"	A 5223	D/Eb	3" A 5217 D	- 3" XSH 5211 Eb	800	496			HC				
2"	A 5224	D/Eb	3" A 5218 D	- 3" XSH 5212 Eb	800	496			HC				
2"	A 5225	D/Eb	3" A 5219 D	- 3" XSH 5213 Eb	800	496			HC				
2"	A 5226	D/Eb	3" A 5220 D	- 3" XSH 5214 Eb	800	496			HC				
2"	A 5227	D/Eb	3" A 5221 D	- 3" XSH 5215 Eb	800	496			HC				
1"	NH 5228	BK/D	[47]	- 8" A 3119 D	100	600			NI				
1 1/2"	PG 5229	AK	[42]	- HEADER	50	90			ST				
1" 1 1/2"	PG 5230	AK/D	1 1/2" PG-5229 AK	- BR-102A	50/850	75/496			ST/NI/PP				
1" 1 1/2"	PG 5231	AK/D	1 1/2" PG-5229 AK	- BR-102C	50/850	75/496			ST/NI/PP				
1" 1 1/2"	PG 5232	AK/D	1 1/2" PG-5229 AK	- BR-102E	50/850	75/496			ST/NI/PP				
1 1/2"	A 5233	A/AK	3" A 3129 A	- 1 1/2" PG 5230 AK	120	100			NI				
1 1/2"	A 5234	A/AK	3" A 3129 A	- 1 1/2" PG 5231 AK	120	100			NI				

OWNER		PROJECT		SECTION		EQUIPMENT LIST		TYPE		NIT	
PROCESS		NITS DIVISION		15-1591		100		COAL GASIFICATION PROJECT		1	
CUSTOMER				REVISION		1/14/76		1		2	
LOCATION				DATE		3/25/75		4/18/75		6/18/75	
CLASS		ITEM NO.		DESCRIPTION		FD #		REQ'N. NO.		P.O. NO.	
REACTORS		R-101		Gasifier - Stage II				1121-A			
		R-102		Gasifier - Stage I				1121-A			
DRUMS		D-101 *		Coal Storage Injector						In Pkg. A-102	
		D-102 *		Coal Primary Injector						In Pkg. A-103	
		D-104 *		Primary Char Receiver						In Pkg. A-102	
		D-105 *		Primary Char Storage Inj.						In Pkg. A-102	
		D-106 *		Char Primary Injector						In Pkg. A-102	
		D-108 *		Limestone Storage Inj.						In Pkg. A-102	
		D-109 *		Limestone Primary Inj.						In Pkg. A-102	
		D-111		Recycle Gas Comp. Suction Sep.				1131-A			
		D-112		Recycle Gas Comp. Discharge Sep.				1131-E			
		E-113		Char Seal Pot				1131-B			
		D-114 *		Slag Water Disengaging Drum						In Pkg. A-105	
		D-115 *		Slag Storage Drum						In Pkg. A-105	
		D-116 *		Slag Injector Drum						In Pkg. A-105	
		D-117 *		Slag Water Surge Drum						In Pkg. A-105	
		D-119 *		Char Trim Storage Inj.						In Pkg. A-102	
		D-120 *		Char Trim Primary Inj.						In Pkg. A-102	
		D-123 *		1st Stage Char Receiver						In Pkg. A-102	
		D-124 *		1st Stage Char Storage Inj.						In Pkg. A-102	
		D-130 *		Limestone Transfer Inj.						In Pkg. A-102	
		D-131		Slipstream Air Separator				1131-D			
		D-132		Gasifier C.W. Surge Drum				1131-Q			
		D-133		Start-Up Quench Pot				1131-R			
		D-134		Start-Up KO Drum				1131-S			
		D-135 *		Steam Drum						In Pkg. A-108	
		D-136		Blow Down Flash Drum							

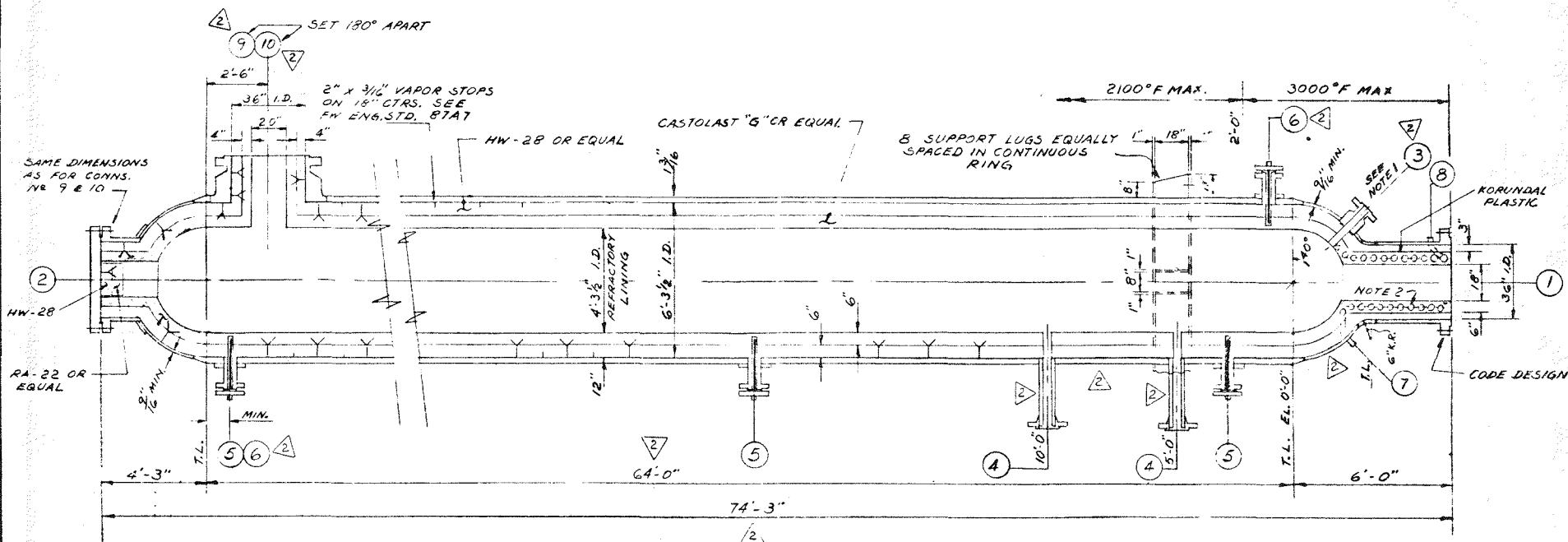
FUEL PROCESSING CORPORATION		CONTRACT	SECTION	EQUIPMENT LIST		TYPE OF UNIT					OF
PROCESS		15-1591	100			COAL GASIFICATION PROJECT					17
CUSTOMER				REVISION	AS TO	1	2	3	4	5	
LOCATION				DATE		1/14/76	3/25/75	4/18/75	6/18/75	9/2/75	12/2/75
CLASS	ITEM NO.	DESCRIPTION		FD #	REQ'N. NO.	P.O. NO.	ELEVATION				
TANKS	TK-101 *	Pulverized Coal Surge Bin							In Pkg. A-103		
	TK-103 *	Char Storage Bin							In Pkg. A-103		
	TK-104 *	Limestone Storage Bin							In Pkg. A-103		
	TK-105A *	Slag Hydrobin							In Pkg. A-105		
	TK-105B *	Slag Hydrobin							In Pkg. A-105		
	TK-111	EK - Coal Storage Hopper									
	TK-113	EK - Coal Unloading Hopper									
	TK-114 *	Pulverized Feed Hopper							In Pkg. A-104		
EXCHANGERS	E-101 *	Quench Water Cooler							In Pkg. A-105		
	E-105	Recycle Gas Suction Cooler			1211-J						
	E-106	Gasifier C.W. Cooler			1211-D						
	E-112	Recycle Gas Comp. Aft. Cooler			1211-F						
	E-113	Recycle Gas LP Stm. Exch.			1211-G						
	E-115	Slipstream Air Cooler			1221-A						
	E-116	Start-Up Gas Condenser			1211-K						
	E-117 *	Waste Heat Exchanger							In Pkg. A-103		
	E-118	Steam Superheater			1211-AA						
	E-119	Boiler Feed Water Preheater			1211-AB						
PUMPS											
	P-101A *	Transport Water Pump							In Pkg. A-105		
	P-101B *	Transport Water Pump Spare							In Pkg. A-105		
	P-102A *	Quench Water Pump							In Pkg. A-105		
	P-103A *	Slag Slurry Pump							In Pkg. A-105		
	P-103B *	Slag Slurry Pump Spare							In Pkg. A-105		
	P-104A	Gasifier C.W. Pump			1311-A						
	P-104B	Gasifier C.W. Pump Spare			1311-A						
	P-106A *	Recycle Gas Scrub. Circ. Pump							In Pkg. A-106		
	P-106B *	Recycle Gas Scrubber Pump Spare							In Pkg. A-106		
	P-115AB	Start-Up Recirc. Water Pump/Spare			1311-W						
	P-116 *	First Start-Up Pump							In Pkg. A-107		
	P-117 *	Second Start-Up Pump							In Pkg. A-107		

FW	RCY	POR	DN	CON	T	SEC	EQUIPMENT LIST				OF		PAG	1
PROCESS	3	DIVISION	15-1591	100			COAL GASIFICATION PROJECT							
CUSTOMER	ERDA-EE					REVISION	X9X 6	1	2	3	4	5		
LOCATION	SIOUX FALLS, SOUTHE DAKOTA					DATE	1/14/76	4/18/75	6/18/75	9/2/75	2/15/75	12/11/75		
CLASS	ITEM NO.	DESCRIPTION				FD #	REQ'N. NO.	P.O. NO.	ELEVATION					
COMPRESSORS	C-102	Recycle Gas Compressor					1321-A							
SOLIDS HANDLING	CR-102 *	Dry Coal Screw Conv.									In Pkg. A-103			
	CR-103 *	Limestone Feeder									In Pkg. A-103			
	CR-104 *	Coal Screw Feeder									In Pkg. A-103			
	CR-107	Coal Distribution Conveyor					1351-E							
	CR-108	Freight Elevator					1493-A							
	CR-110 *	Coal Wash Element									In Pkg. A-103			
	CR-111 *	Coal Scalping Screen									In Pkg. A-103			
	CR-112 *	Limestone Scalping Screen									In Pkg. A-103			
	CR-113 *	Char Trim Cooler									In Pkg. A-103			
	CR-119	EX - Coal Apron Feeder												
	CR-120	EX - Transfer Conveyor												
	CR-121	EX - Coal Elevator												
	CR-122	EX - Upper Coal Conveyor												
	CR-123	EX - Coal Stg. Hopper FD Conv.												
	CR-125	EX - Front End Loader												
	CR-126 *	Start-Up Char Scalping Screen									In Pkg. A-103			
	S-102 *	1st Stage Char Removal Cycl.									In Pkg. A-102			
	S-103 *	2nd Stage Char Removal Cycl.									In Pkg. A-102			
	S-107 *	Char Trim Receiver Collector									In Pkg. A-103			
	S-108 *	Pulverized Coal Cyclone									In Pkg. A-101			
MISC.	S-110 *	1st Stage Recycle Gas Cycl.									In Pkg. A-102			
	S-112 *	Limestone Receiver Collector									In Pkg. A-103			
	S-115 *	Char Trim Cyclone									In Pkg. A-103			
	B-101 *	Char Filter Exhaust Fan									In Pkg. A-103			
	C-103 *	Air Blower									In Pkg. A-101			
	C-104 *	Gas Recirculation Blower									In Pkg. A-101			
	C-105 *	Pulverized Exhaust Blower									In Pkg. A-101			
	CI-101 *	Slag Water Clarifier									In Pkg. A-105			
	F-103 *	Bag Filter									In Pkg. A-101			
	F-105 *	Char Trim Bag Filter									In Pkg. A-103			

FW		PROCESS		CONTRACT		SECTION		EQUIPMENT LIST		COAL GASIFICATION PROJECT					
S DIVISION		15-1591		100											
CUSTOMER		ERDA-EE		REVISION		8 6		1		2		3		5	
LOCATION		SIOUX FALLS, SOUTH DAKOTA		DATE		1/14/76		4/18/75		6/18/75		9/2/75		2/15/76	
CLASS	ITEM NO.	DESCRIPTION		FD #	REQ'N. NO.	P.O. NO.	ELEVATION								
MISC. (Cont'd)	F-106A/B	Slag Water Filter & Spare							In Pkg. A-105						
	F-107A/B	Coal Dust Filter & Spare			1349-C										
	F-108A/B	Flame Dust Filter & Spare			1349-D										
PACKAGE UNITS	FD-101	Rotary Air Lock Feeder							In Pkg. A-105						
	E-101	Inert Gas Generator							In Pkg. A-105						
	J-106	Slag Drum Eductor							In Pkg. A-105						
	MOV-102	Reactor Valve			1626-A										
	MOV-103	Reactor Valve			1626-A										
	R-103	Slag Quench Vessel							In Pkg. A-105						
	SR-101	Pulverizer							In Pkg. A-105						
	SR-102	Slag Crusher							In Pkg. A-105						
	SR-103	Fly - Coal Crusher													
	A-101	Slagstream Air Dryer Pkg.			1313-A										
	A-102	Char Recovery Cyclones			1343-D										
	S-102	1st Stage Char Removal Cycl.													
	S-103	2nd Stage Char Removal Cycl.													
	S-110	1st Stage Recycle Gas Cycl.													
	A-103	Solids Feeding System			1351-A										
	D-101	Coal Storage Injector													
	D-102	Coal Primary Injector													
	D-104	Primary Char Receiver													
	D-105	Primary Char Storage Inj.													
	D-106	Char Primary Injector													
	D-108	Limestone Storage Inj.													
	D-109	Limestone Primary Inj.													
	D-119	Char Trim Storage Inj.													
	D-120	Char Trim Primary Inj.													
	D-123	1st Stage Char Receiver													
	D-124	1st Stage Char Storage Inj.													
	D-130	Limestone Transfer Inj.													
	TK-101	Pulverized Coal Surge Bin													
	TK-103	Char Storage Bin													
	TK-104	Limestone Storage Bin													
CR-102	Pulv. Coal Screw Conv.														

FW	ERG	RPO	ICN	CO	ST	SE	N	EQUIPMENT LIST				PE	O	IT	PA	UF	ET
PROCESS		S DIVISION		15-1591		100		COAL GASIFICATION PROJECT									
CUSTOMER	ERDA-FE				REVISION	XXX 6		1	2	3	4	5					
LOCATION	STONY MOUNTAINS, SOUTH DAKOTA				DATE	1/14/76	4/18/75	6/18/75	9/2/75	2/15/76	12/11/76						
CLASS	ITEM NO.	DESCRIPTION			FD	REQ'N. NO.	P.O. NO.	ELEVATION									
PACKAGE UNITS (Cont'd)	CR-103	Limestone Feeder															
	CR-104	Coal Screw Feeder															
	CR-110	Coal Weigh Element															
	CR-111	Coal Scalping Screen															
	CR-112	Limestone Scalping Screen															
	CR-113	Char Trim Cooler															
	CR-126	Start-Up Char Scalping Screen															
	S-107	Char Trim Receiver Collector															
	S-112	Limestone Receiver Collector															
	S-115	Char Trim Cyclone															
	B-101	Char Filter Exhaust Fan															
	E-105	Char Trim Bag Filter															
	A-104	Coal Pulverization & Drying				1351-B											
	FD-101	Rotary Air Lock Feeder															
	SR-101	Pulverizer															
	H-101	Inert Gas Generator															
	C-103	Air Blower															
	C-104	Gas Recirculation Blower															
	S-108	Pulverized Coal Cyclone															
	F-103	Bag Filter															
	C-105	Pulverized Exhaust Blower															
	TK-114	Pulverized Feed Hopper															
	A-105	Slag Handling System				1351-D											
	R-103	Slag Quench Vessel															
	D-114	Slag Water Disengaging Drum															
	D-115	Slag Storage Drum															
	D-116	Slag Injector Drum															
	D-117	Slag Water Surge Drum															
	TK-105A	Slag Hydrobin															
	TK-105B	Slag Hydrobin															
	P-101A	Transport Water Pump															
	P-101B	Transport Water Pump Spare															
	P-102A	Quench Water Pump															
	P-102B	Quench Water Pump Spare															

CUSTOMER		LOCATION		REVISION	DATE	1	2	3	4	5
ERDA-EE		SIOUX FALLS, SOUTH DAKOTA		XXX6	1/14/76	4/18/75	6/18/75	9/2/75	9/15/75	12/11/75
CLASS	ITEM NO.	DESCRIPTION	FD #	REQ'N. NO.	P.O. NO.	ELEVATION				
PACKAGE UNITS (Cont'd)	P-103A	Slag Slurry Pump								
	P-103B	Slag Slurry Pump Spare								
	E-101	Quench Water Cooler								
	CL-101	Slag Water Clarifier								
	J-106	Slag Drum Eductor								
	SR-102	Slag Crusher								
	F-106A	Slag Water Filter								
	F-106B	Slag Water Filter Spare								
	A-106	Recycle Scrubber		1343-B						
	S-109	Recycle Gas Scrubber								
	P-106A	Recycle Gas Scrub. Circ. Pump								
	P-106B	Recycle Gas Scrubber Pump Spare								
	A-107	Start-Up Scrubber Pkg.		1349-A						
	S-116	First Start-Up Scrubber								
	S-117	Second Start-Up Scrubber								
	P-116	First Start-Up Scrubber Pump								
	A-108	Waste Heat Exchanger		1252-B						
	D-135	Steam Drum								
	E-117	Waste Heat Exchanger								



NOTES

- 1- 40° ANGLE CAN ONLY BE CONSIDERED TENTATIVE, PENDING OUTCOME OF COLD FLOW MODEL STUDIES. THIS APPLIES TO CONN. # 3 ONLY.
- 2- WATER COOLING COIL, 1 1/8" DIA. 8 GAGE, 1 1/4 CR. 1/2 MO. PIPE.
- 3- FLUID TEMPERATURE POINTS BETWEEN REACTOR AXIS & REFRACTORY WALL TO BE SHOWN LATER.

DESIGN OF THIS ITEM OR SYSTEM IS TENTATIVE SUBJECT TO DEVELOPMENTAL WORK IN PROGRESS OR ANTICIPATED. PRIOR TO PURCHASE DESIGN SHOULD BE REVIEWED WITH FWEC TO INCORPORATE DEVELOPMENTAL RESULTS.



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REFERENCE DRAWINGS, REQUISITIONS, STANDARDS

OP-754-755
OP-754-756

REV'D AS SHOWN		DATE	BY
AS INDICATED		DATE	BY
REVISION		DATE	BY
UNITED STATES ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION FOSSIL ENERGY			
COAL GASIFICATION COMBINED CYCLE PILOT PLANT SIOUX FALLS, SOUTH DAKOTA CONTRACTING ORDER NO. 16-32-0001-1521			
FOSTER WHEELER ENERGY CORP. 110 SOUTH ORANGE AVENUE LIVINGSTON, NEW JERSEY		UNITED STATES ERDA FOSSIL ENERGY	
PROJECT NO. OP-754-754-2		DATE 5/2/75	
DRAWING TITLE GASIFIER STAGE II (R-101)		APPROVED DATE	
FWEC CONT. 15-1591		REQ. N 1591-1121-A	

NOTES

- 1- SHELL TEMPERATURE TO BE MONITORED WITH "TEMPILLAC" DEVICE OR EQUAL
- 2- THE BOTTOM AREA OF R-101 SHOULD BE COVERED WITH KIDDE ELEMENTS OR EQUAL.

RELEASES

DWG. REV.	DATE	ISSUED FOR
	DATE OF ORDER	(A) PURCHASE SHELL AND HEAD MATERIAL PREPARE BUT DO NOT SUBMIT SHOP DETAIL DRAWINGS.
		(B) ISSUE CHECKED FOSTER WHEELER DRAWING. PURCHASE ALL OTHER MATERIALS, FINALIZE AND SUBMIT CHECKED SHOP DETAIL DRAWING WITHIN ONE WEEK OF RELEASE DATE. PROCEED WITH COMPLETE FABRICATION.
		(C) VENDOR'S DRAWING RETURNED
		(D) FIELD CONSTRUCTION
		(E)

NOZZLE CHART

CORR. NO.	SIZE	USAS. RATING	SERVICE	NO. REQD.
1	36" ID	CODE DESIGN	GAS INLET	1
2	36" ID	"	MANWAY	1
3	6"	600# RF	INJECTORS (FOAM)	4
4	3"	"	CHAR WITHDRAWAL	2
5	SEE DETAIL	"	T ₁ & T ₂ (FLUID)	LATER
6	"	"	PDI	2
7	1 1/2"	"	WATER INTO COIL	1
8	1 1/2"	"	" OUT OF COIL	1
9	36" ID	"	PROCESS GAS OUT	1
10	36" ID	"	START UP GAS OUT	1

* THE 600# RF IS TOTAL PRESSURE DROP ACROSS R-101 & R-102

DESIGN OF THIS ITEM OR SYSTEM IS TENTATIVE SUBJECT TO DEVELOPMENTAL WORK IN PROGRESS OR ANTICIPATED. PRIOR TO PURCHASE, DESIGN SHOULD BE REVIEWED WITH FWEC TO INCORPORATE DEVELOPMENTAL RESULTS.

1-420% AS INDICATED	GE
1-224% AS INDICATED	GE
1-224% AS INDICATED	GE

REFERENCE DRAWINGS, REQUISITIONS, STANDARDS

OP-754-754 ; 1590-1041 ; 1590-100B
50A2 ; 52C4 ; 83A1 ; 87A7, 04-34-756

VESSEL DATA

1	ITEM NO:	R-101	NO. REQ'D:	ONE
2	SERVICE:	GASIFIER STAGE II		
3				
4	DIAMETER: INSIDE	6'-3 1/2"		
5	TANGENT LENGTH:	61'-3"		
6	OPR. PRESSURE:	NORM.:	440	PSI G
7	ABOVE LIQUID LEVEL MAX.:			PSI
8	DESIGN PRESSURE:	500 PSI G		
9	OPR. LIQUID HOLD-UP PRESS:	PSI		
10	OPR. PRESS. DROP THRU VESSEL:	6.0 PSI		
11	MAX. RELIEVING PRESS. @ TOP NO.:	PSI		
12	MAX. OPR. TEMPERATURE:	3000°F AT BTM; 2100°F TOP		
13	DESIGN TEMPERATURE:	650°F		
14	SPECIFIC GRAVITY (PROCESS FLUID):			
15	CODE: ASME SECT VII DIV. 1	STAMPED: YES		
16	P.W.M.T.: FOR CODE: YES	FOR PROCESS: -		
17	RADIOGRAPHED:	FULL		
18	JOINT EFFICIENCY:	1.00		
19	CORROSION ALLOWANCE: SHELLS:	HEADS:		
20	MATL. SHELL:	SA-387-22CL.2		
21	MATL. HEADS:			
22	MATL. SUPPORTS:	SA-285-C		
23	TYPE OF HEADS:	HEMISPHERICAL		
24	EXTERNAL BOLTING:	SA 193-B7 & SA-194-2H		
25	INTERNAL BOLTING:			
26	GASKETS:	SPIRAL WOUND S/S & ASBESTOS		
27	BOLT HOLES:	STRADDLE VESSEL CENTERLINE		
28	PAINT:	SHOP COAT SUPPORT RING		
29	INSULATION:	NONE		
30	SHIPMENT:	ONE PIECE		
31				
32	EMPTY WGT.:	83000	LBS	
33	WATER WGT.:		LBS	
34	TRAYS WGT.:		LBS	
35	INSULATION WGT. (INT.):	150000	LBS	
36	GRUNITE WGT.:		LBS	
37	OPR. LIQUID WGT.:		LBS	
38				
39	BULK AXIAL GAS FLOW VELOCITY:	8.0 FT/SEC		
40				
41	HYDROTEST: SHOP:	FIELD:	PSI	
42	GAGE LOCATION:			
43	MAX. ALLOW. PRESS. (HEAT & COLD):	PSI		

UNITED STATES
ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION
FOSSIL ENERGY

COAL GASIFICATION COMBINED CYCLE PILOT PLANT
SIOUX FALLS, SOUTH DAKOTA
CONTRACT NO. ERDA-FE 14-32-0001-1531

FOSTER WHEELER ENERGY CORP
100 SOUTH ORANGE AVENUE
LIVINGSTON, NEW JERSEY

UNITED STATES
ERDA
FOSSIL ENERGY

FW Dwg. NO. OP-754-755-2

DRAWN: GE
CHECKED: GE
APPROVED: GE

REVIEWED: GE
APPROVED: GE

DRAWING TITLE
GASIFIER STAGE II (R-101)

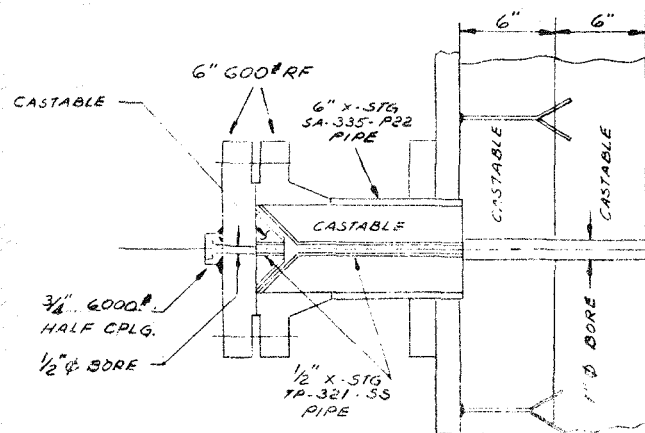
DRAWING NUMBER

FWEC CONT. 15-1591

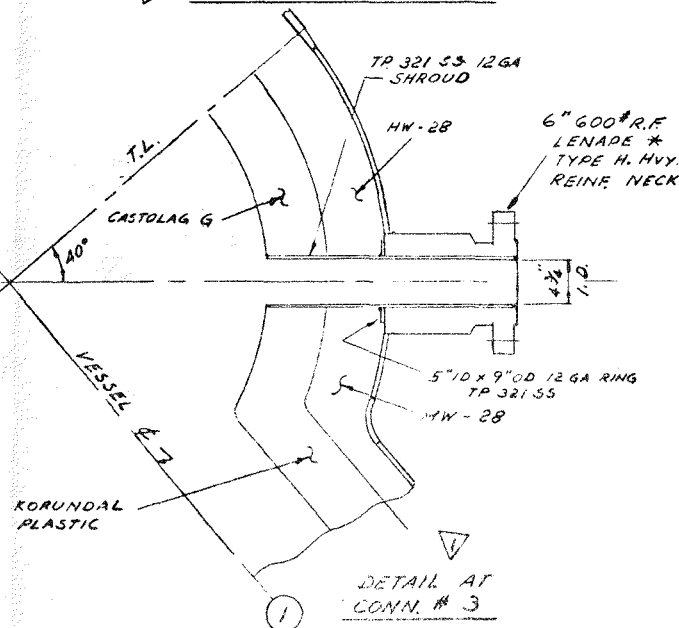
REQ'N NO 1591-1121-A



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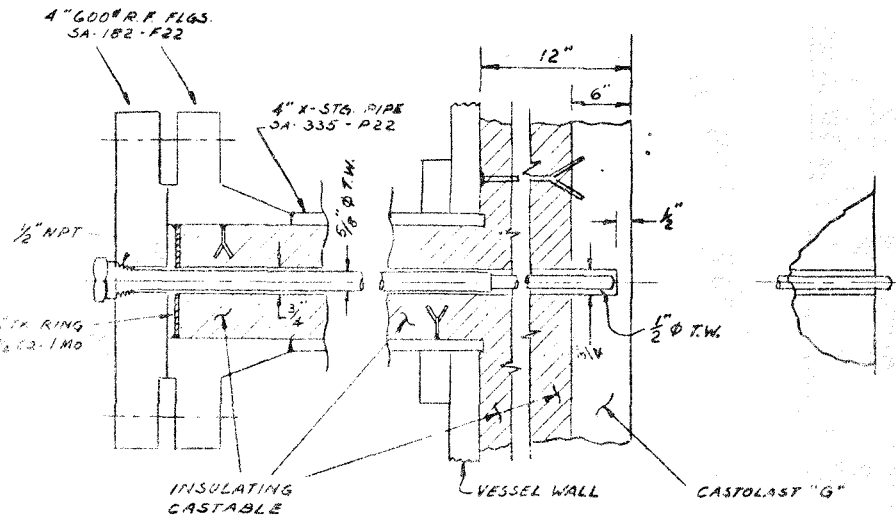


DETAIL OF CONN. NO 6



DETAIL AT CONN. NO 3

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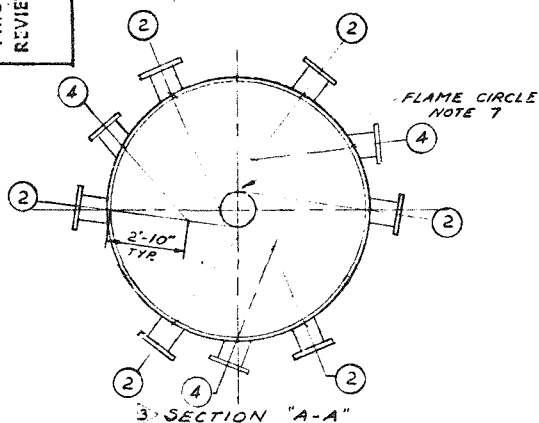


DETAIL AT CONNECTION NO 5

DESIGN OF THIS ITEM OR SYSTEM IS TENTATIVE SUBJECT TO DEVELOPMENTAL WORK IN PROGRESS OR ANTICIPATED. PRIOR TO PURCHASE DESIGN SHOULD BE REVIEWED WITH FWEC TO INCORPORATE DEVELOPMENTAL RESULTS.

UNITED STATES ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION FOSSIL ENERGY	
COAL GASIFICATION COMBINED CYCLE PILOT PLANT SIOUX FALLS, SOUTH DAKOTA CONTRACT NO. ERDA-FE14-32-0001-1571	
FOSTER WHEELER ENERGY CORP 25412 SOUTH ORANGE AVENUE NEW JERSEY	UNITED STATES ERDA FOSSIL ENERGY
PROJECT NO. OR-754-750-1	DATE 8-27-76
DRAWN BY	CHECKED BY
APPROVED BY	DATE
FOR PER JUNE II (R-101)	
FWEC CONT. 15-1591	REQ. NO. 1591-121A

DESIGN OF THIS ITEM OR SYSTEM IS TENTATIVE SUBJECT TO DEVELOPMENTAL WORK IN PROGRESS OR ANTICIPATED. PRIOR TO PURCHASE, DESIGN SHOULD BE REVIEWED WITH FWEC TO INCORPORATE DEVELOPMENTAL RESULTS.

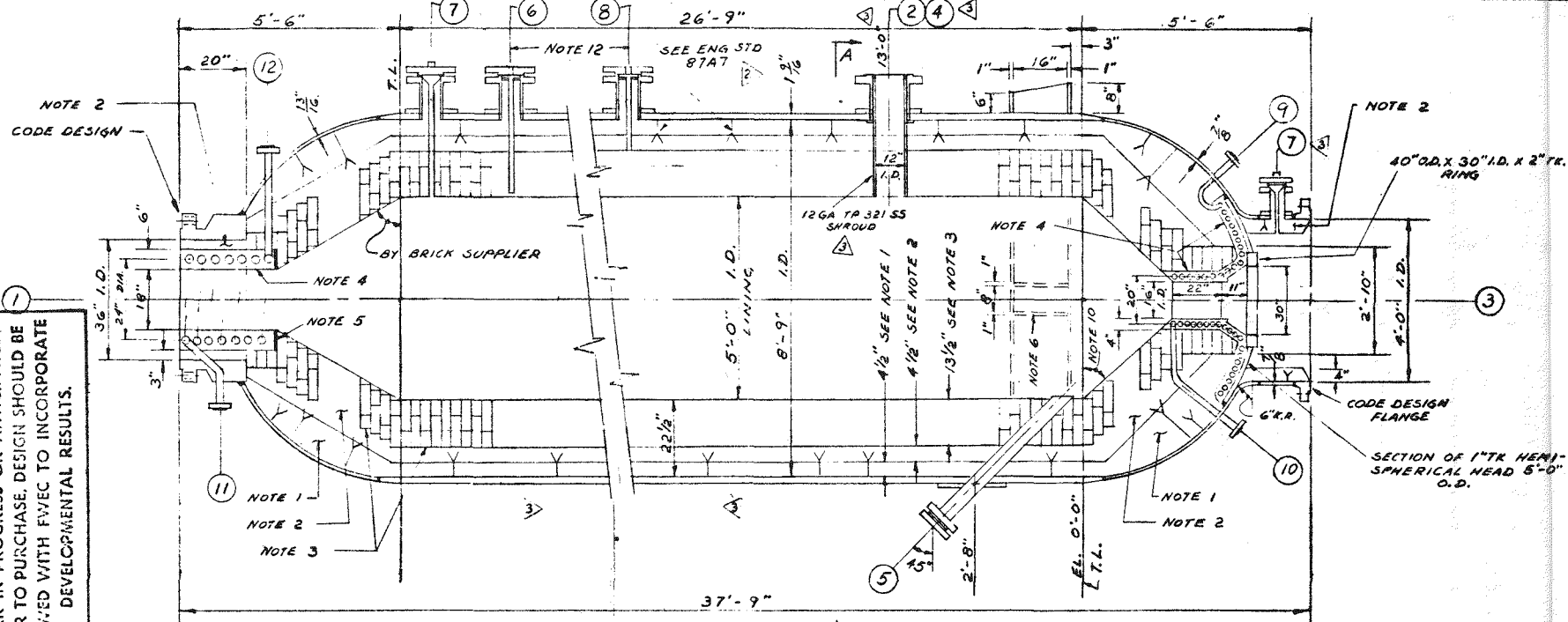


NOTES

- 1- H-W LIGHTWEIGHT CASTABLE 26 (BY OTHERS)
- 2- H-W LIGHTWEIGHT CASTABLE 30 (BY OTHERS)
- 3- H-W RUBY (BRICK) (BY OTHERS)
- 4- KORUNDAL PLASTIC, 188#/FT³ (BY OTHERS)
- 5- FIBERFRAX EXPANSION JOINT, BRICK SUPPLIER TO CALCULATE REQ'D THICKNESS (BY OTHERS)
- 6- 8 EQUALLY SPACED LUGS IN TWO CONTINUOUS RINGS
- 7- INJECTOR NOZZLES TO BE POSITIONED TANGENTIALLY TO A 15" DIAMETER FLAME CIRCLE.
- 8- COOLING COIL DETAILS (BY TECHNOLOGY) LATER
- 9- SIGHT PORT NOZZLES USED ONLY AFTER SHUTDOWN AND AFTER FLOODING OUT SLAG.
- 10- SIX CONNS. #2 EVENLY SPACED, ORIENTED AS SHOWN
- 11- CONNS. #4 LOCATED AT MID POINT BETWEEN CONNS. #2.

12- FOR CONNS. #6 & #8 SEE DETAIL FOR CONN. #5 ON DWG. OP-754-756

REFERENCE DRAWINGS, REQUISITIONS, STANDARDS
OP-754-758, 1590-10A1
1590-1100-B, 50A2, 52C4, 83A1
87A7



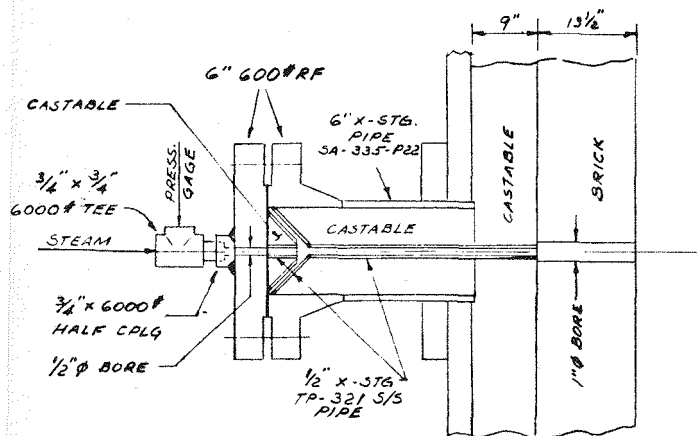
3	4-27-76	REV'D AS SHOWN, ADDED CONNS #4	DE	
2	4-7-76	ADDED CAST. & CONN. 2 & EXTEND. COILS	DE	
1	2-27-76	REV'D AS SHOWN	DE	
NO	DATE	REVISION	MADE	APPROVED
UNITED STATES ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION FOSSIL ENERGY COAL GASIFICATION COMBINED CYCLE PILOT PLANT SIOUX FALLS, SOUTH DAKOTA CONTRACT NO. ERDA-FE 14-32-0001-1521				
FOSTER WHEELER ENERGY CORP 110 SOUTH ORANGE AVENUE LIVINGSTON, NEW JERSEY			UNITED STATES ERDA FOSSIL ENERGY	
FW Dwg No. OP-754-757-3 DRAWN: DE CHECKED: DE APPROVED: DE			DATE: 5-21-75 DATE: _____ DATE: _____ REVIEWED: _____ APPROVED: _____ DRAWING NUMBER: _____	
DRAWING TITLE: GASIFIER STAGE I (R-102)			FWEC CONT. 15-1591 REQ'N N° 1591-1122-4	



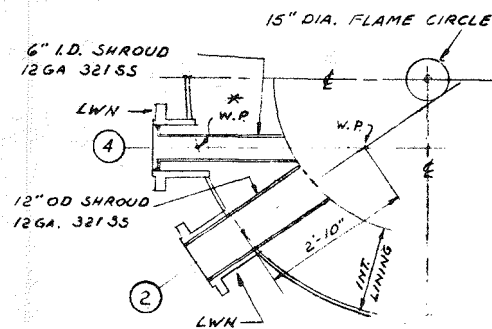
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NOTES

- 1- PROVIDE THERMOCOUPLES AS REQ'D AT VARIOUS INTERFACES, BETWEEN HIGH TEMP. BRICK.
- 2- THE 6.0 PSI IS TOTAL PRESSURE DROP ACROSS R-101 & R-102.
- 3- CONNS. # 4 & #5 TO BE SHIELDED FROM POSSIBLE SURGE DEPOSITS.
- 4- PURGE STEAM TO BE PROVIDED TO CONN. #7 TO KEEP NOZZLE COOL AND FREE FROM SLAG DEPOSITS.
- 5- NUMBER OF FLUID TEMPERATURE POINTS IS TENTATIVE. LOCATION OF FLUID TEMPERATURE POINTS IS ALSO TENTATIVE.
- 6- THE BOTTOM COIL (CONNS. # 9 & 10) TO BE MADE OF 1" DIA. TUBING, 0.137" AVE. THICKNESS AND SA-210-A1 MATL. COILS IN SPIRAL TO BE 2" C-C.



DETAIL OF CONN. N° 7



* SEE NOTE 11 OP-754-757

DETAIL OF CONNS 2 & 4

RELEASES

DWG. REV.	DATE	ISSUED FOR
	DATE OF ORDER	(A) PURCHASE SHELL AND HEAD MATERIAL, PREPARE BUT DO NOT SUBMIT SHOP DETAIL DRAWINGS.
		(B) ISSUE CHECKED FOSTER WHEELER DRAWING. PURCHASE ALL OTHER MATERIALS, FINALIZE AND SUBMIT CHECKED SHOP DETAIL DRAWING WITHIN ONE WEEK OF RELEASE DATE. PROCEED WITH COMPLETE FABRICATION.
		(C) VENDOR'S DRAWING RETURNED
		(D) FIELD CONSTRUCTION
		(E)

NOZZLE CHART

CORN. NO.	SIZE	USAS. RATING	SERVICE	NO. REQ'D
1	36" ID	DESIGN	GAS OUTLET	1
2	12" ID	600# RF	INJECTORS (LIMESTONE)	6
3	48" ID	SEE ELEV.	SLAG REMOVAL	1
4	12" ID	600# RF	LIGHT OFF PORTS	3
5	2"	600# RF	LIGHT PORTS W/SLING	2
6	4"		TI, TR (FLUID) NOTE 5	3
7	6"		PDI (SEE NOTE 4)	2
8	4"		TI NOTE 1	
9	1"		COOLING WATER IN	1
10	1"		" " OUT	1
11	1 1/2"		" " IN	1
12	1 1/2"		" " OUT	1

DESIGN OF THIS ITEM OR SYSTEM IS TENTATIVE SUBJECT TO DEVELOPMENTAL WORK IN PROGRESS OR ANTICIPATED. PRIOR TO PURCHASE, DESIGN SHOULD BE REVIEWED WITH FWEC TO INCORPORATE DEVELOPMENTAL RESULTS.

VESSEL DATA

1	ITEM NO:	R-102	NO. REQ'D:	ONE
2	SERVICE:	GASIFIER STAGE 1		
3		{ SHELL : 8'-9"		
4	DIAMETER/INSIDE LINING :	5'-0"		
5	TARGENT LENGTH:	26'-9"		
6	OPX. PRESSURE:	NOM. : 446	PSI G	
7	ABOVE LIQUID LEVEL, MAX. :		PSI	
8	DESIGN PRESSURE:	500	PSI G	
9	OPX. LIQUID HOLD-UP PRESS:		PSI	
10	OPX. PRESS. DROP THRU VESSEL:	6.0	PSI/NOTE 2	
11	MAX. RELIEVING PRESS. @ TOP NO.:		PSI	
12	MAX. OPER. TEMPERATURE:	2800° TO 3000°F		
13	DESIGN TEMPERATURE:	650°F		
14	SPECIFIC GRAVITY (PROCESS FLUID):			
15	CODE: ASME SECT. VIII DIV. 1	STAMPED: YES		
16	P.W.N.T.: FOR CODE: YES	FOR PROCESS: ~		
17	RADIOGRAPHED:	FULL		
18	JOINT EFFICIENCY:	100 %		
19	CORROSION ALLOWANCE: SHELLS:	HEADS:		
20	MATL., SHELL:	SA-387-22 CL.2		
21	MATL., HEADS:	" "		
22	MATL., SUPPORTS:	SA-285-C		
23	TYPE OF HEADS:	HEMISPHERICAL		
24	EXTERNAL BOLTING:	SA-193-B7 & SA-194-2H		
25	INTERNAL BOLTING:			
26	GASKETS:	SPIRAL WOUND 5/8 & ASBESTOS		
27	BOLT HOLES:	STRADDLE VESSEL CENTERLINE		
28	PAINT:	SHOP COAT SUPPORT RING		
29	INSULATION:	NONE		
30	SHIPMENT:	ONE PIECE		
31				
32	EMPTY WGT.:	77900	LBS	
33	WATER WGT.:		LBS	
34	TRAYS WGT.:		LBS	
35	INSULATION WGT. (INT.):	173800	LBS	
36	CURITE WGT.:		LBS	
37	OPER. LIQUID WGT.:		LBS	
38				
39	BULK AXIAL GAS FLOW VELOCITY THROUGH			
40	STAGE I =	6 FT/SEC.		
41	HYDROTEST: SHOP:	FIELD:	PSI	
42	GAGE LOCATION:			
43	MAX. ALLOW. PRESS. (HEB & COB):		PSI	

UNITED STATES
ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION
FOSSIL ENERGY

COAL GASIFICATION COMBINED CYCLE PILOT PLANT
SIOUX FALLS, SOUTH DAKOTA
CONTRACT NO. ERDA-FE 14-32-0001-1521

FOSTER WHEELER ENERGY CORP
110 SOUTH ORANGE AVENUE
LIVINGSTON, NEW JERSEY

UNITED STATES
ERDA

FOSSIL ENERGY

FW DWG NO. OP-754-758-2

DRAWN: DS
CHECKED: DATE: _____
APPROVED: DATE: _____

REVIEWED: _____
APPROVED: _____

DRAWING TITLE:
GASIFIER STAGE I (R-102)

DRAWING NUMBER

FWEC CONT. 15-1591

REQ'N N° 1591/1122-A

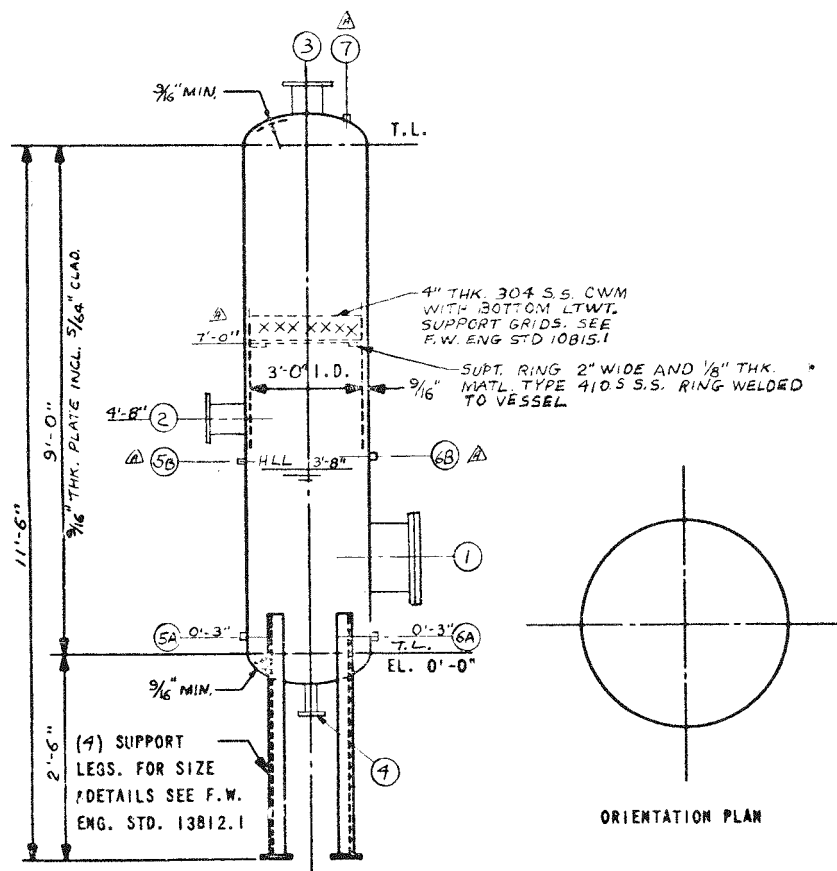
REFERENCE DRAWINGS, REQUISITIONS, STANDARDS

OP-754-757,



THIS DRAWING IS THE PROPERTY OF THE FOSTER WHEELER CORPORATION, 110 SOUTH ORANGE AVENUE, LIVINGSTON, NEW JERSEY, AND IS LENT WITHOUT CONSIDERATION OTHER THAN THE BORROWER'S AGREEMENT THAT IT SHALL NOT BE LENT OR DISPOSED OF DIRECTLY OR INDIRECTLY NOR USED FOR ANY PURPOSE OTHER THAN THAT FOR WHICH IT IS SPECIFICALLY FURNISHED. THE APPARATUS SHOWN IN THE DRAWING IS COVERED BY PATENTS.

- NOTES:
 1. STEAM TRACE AND INSULATE BOTTOM HEAD AND WALL UP TO NOZZLE COVN. 2.
 2. THIS VESSEL MAY BE STACKED WITH THE RECYCLE GAS COMPRESSOR DISCHARGE SEPARATOR, D-112.



RELEASES

CHG. REV.	DATE	ISSUED FOR
OP		(A) PURCHASE SHELL AND HEAD MATERIAL. PREPARE BUT DO NOT SUBMIT SHOP DETAIL DRAWINGS.
		(B) ISSUE CHECKED FOSTER WHEELER DRAWING. PURCHASE ALL OTHER MATERIALS. FINALIZE AND SUBMIT CHECKED SHOP DETAIL DRAWING WITHIN ONE WEEK OF RELEASE DATE. PROCEED WITH COMPLETE FABRICATION.
		(C) VENDOR'S DRAWING RETURNED
		(D) FIELD CONSTRUCTION
		(E)

NOZZLE CHART

CORR. NO.	SIZE	USAS. RATING	SERVICE	NO. REQD
1	18"	300 R.F.	MANWAY W/ DAVIT	1
2	6"		GAS-WATER INLET	1
3	8"		RECYCLE GAS OUTLET	1
4	1 1/2"		WATER OUTLET	1
5	1"	6000 C.P.L.G.	LT, LSH, LAH	2
6	3/4"		LG	2
7	1"		VENT	1

VESSEL DATA

1	ITEM NO. D-111	NO. REQD: ONE
2	SERVICE: RECYCLE GAS COMPRESSOR	
3	SUCTION SEPARATOR	
4	DIAMETER: 3'-0" I.D.	
5	TARGLET LENGTH: 9'-0"	
6	OPER. PRESSURE: NORM.: 389 PSIG	
7	MAVUE LIQUID LEVEL, MAX.: 389 PSIG	
8	DESIGN PRESSURE: 432 PSIG	
9	OPER. LIQUID HOLD-UP PRESS: 1.6 PSI	
10	OPER. PRESS. DROP THRU VESSEL: 0.4 PSI	
11	MAX. RELIEVING PRESS. @ TOP HD.: 430 PSIG	
12	MAX. OPER. TEMPERATURE: 120°F	
13	DESIGN TEMPERATURE: 170°F	
14	SPECIFIC GRAVITY (PROCESS FLUID): 1.0	
15	CODE: ASME SECT VIII DIV. I STAMPED: YES	
16	P.W.M.T.: FOR CODE: NO FOR PROCESS: NO	
17	RADIOGRAPHED: SPOT	
18	JOINT EFFICIENCY: 0.85	
19	CORROSION ALLOWANCE SHELLS: 3/64" CLAD HEADS: 3/64" CLAD	
20	MATL. SHELL: 516 GR 70 + 3/64" 410S S.S. CLAD	
21	MATL. HEADS: 516 GR 70 + 3/64" 410S S.S. CLAD	
22	MATL. SUPPORTS: SA-36	
23	TYPE OF HEADS: 2:1 ELLIPSOIDAL	
24	EXTERNAL BOLTING: SA-193-B7/SA-194-24	
25	INTERNAL BOLTING:	
26	GASKETS: 1/16" COMPRESSED ASBESTOS	
27	BOLT HOLES: STRADDLE VESSEL CENTERLINE	
28	PAINT: AS PER SPEC 1590-83A1	
29	INSULATION: YES (NOTE 1)	
30	SHIPMENT: ONE PIECE	
31		
32	EMPTY WGT.: 5160 LBS	
33	WATER WGT.: 4670 LBS	
34	TRAYS WGT.: LBS	
35	INSULATION WGT.: LBS	
36	CURITE WGT.: LBS	
37	OPER. LIQUID WGT.: 1950 LBS	
38		
39		
40		
41	HYDROTEST: SHOP: FIELD: PSI	
42	GAGE LOCATION:	
43	MAX. ALLOW. PRESS. (HEAT & COLD): PSI	

UNITED STATES
 ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION
 FOSSIL ENERGY

COAL GASIFICATION COMBINED CYCLE PILOT PLANT
 SIOUX FALLS, SOUTH DAKOTA
 CONTRACT NO ERDA-FE 14-32-0001-1521

FOSTER WHEELER ENERGY CORP
 100 SOUTH ORANGE AVENUE
 LIVINGSTON, NEW JERSEY

UNITED STATES
 ERDA

FW ENG NO. OP-764-569-A

FOSSIL ENERGY

DRAWN: M.S. DATE: 3/4/76
 CHECKED: DATE:
 APPROVED: DATE:

REVIEWED:
 APPROVED:

DRAWING TITLE: RECYCLE GAS COMPRESSOR SUCTION SEPARATOR D-111

DRAWING NUMBER

FW ENG CONT. 15-1591

REQ'N. NO. 1591-1131A

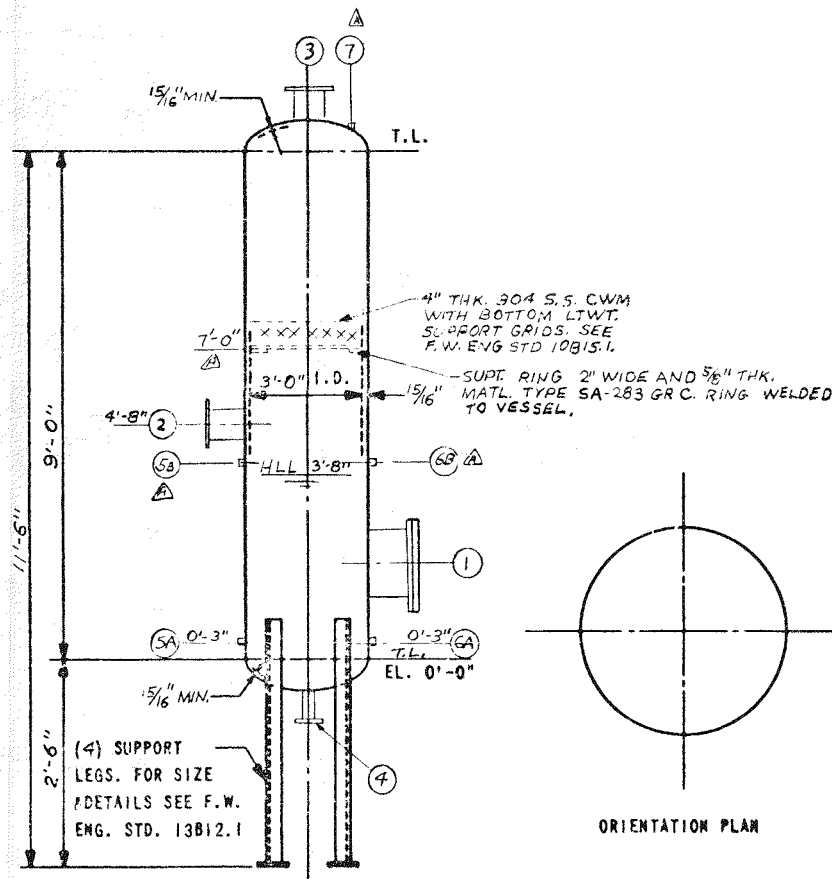
REFERENCE DRAWINGS, REQUISITIONS, STANDARDS

FW SPECS
 590-10A1 50A2 10815.1
 1590-105 52C4 13912.1
 1590-62A1

F.W. ENG STDs
 10815.1
 13912.1

THIS DRAWING IS THE PROPERTY OF THE FOSTER WHEELER CORPORATION, 110 SOUTH ORANGE AVENUE, LIVINGSTON, NEW JERSEY, AND IS LOANED WITHOUT CONSIDERATION OTHER THAN THE BORROWER'S AGREEMENT THAT IT SHALL NOT BE LOANED OR DISPOSED OF DIRECTLY OR INDIRECTLY FOR ANY PURPOSE OTHER THAN THAT FOR WHICH IT IS SPECIFICALLY FURNISHED. THE APPARATUS SHOWN IN THE DRAWING IS COVERED BY PATENTS.

- NOTES:
 1. STEAM TRACE AND INSULATE BOTTOM HEAD AND WALL UP TO NOZZLE CONN. NO. 2.
 2. THIS VESSEL MAY BE STACKED WITH RECYCLE GAS COMPRESSOR SUCTION SEPARATOR D-111.



RELEASES

OWG. REV.	DATE	ISSUED FOR
OP	DATE OF ORDER	(A) PURCHASE SHEL AND HEAD MATERIAL. PREPARE BUT DO NOT SUBMIT SHOP DETAIL DRAWINGS.
		(B) ISSUE CHECKED FOSTER WHEELER DRAWING. PURCHASE ALL OTHER MATERIALS. FINALIZE AND SUBMIT CHECKED SHOP DETAIL DRAWING WITHIN ONE WEEK OF RELEASE DATE. PROCEED WITH COMPLETE FABRICATION.
		(C) VENDOR'S DRAWING RETURNED
		(D) FIELD CONSTRUCTION
		(E)

NOZZLE CHART

CON. NO.	SIZE	USAS. RATING	SERVICE	NO. REQD.
1	18"	500HRF	MANWAY W/DAVIT	1
2	8"		GAS-WATER INLET	1
3	8"		GAS OUTLET	1
4	1 1/2"		WATER OUTLET	1
5	1"	6000# PLG	LT, LSH, LAH	2
6	3/4"		LG	2
7	1"		VENT	1

VESSEL DATA

1	ITEM NO.:	D-112	NO. REQD.:	ONE
2	SERVICE:	RECYCLE GAS COMPRESSOR		
3	DISCHARGE SEPARATOR			
4	DIAMETER:	3'-0" I.D.		
5	HEIGHT LENGTH:	9'-0"		
6	WATER PRESSURE:	NORM.:	475 PSIG	
7	WATER LIQUID LEVEL MAX.:		475 PSIG	
8	DESIGN PRESSURE:		527 PSIG	
9	WATER LIQUID HOLD-UP PRESS:		1.6 YB/G	
10	WATER PRESS. DUAL THRU VESSEL:		0.4 PSI	
11	MAX. RELIEVING PRESS. @ TOP HD.:		525 PSIG	
12	MAX. OPER. TEMPERATURE:		120°F	
13	DESIGN TEMPERATURE:		170°F	
14	SPECIFIC GRAVITY (PROCESS FLUID):		1.0	
15	CODE: ASME SECT VIII DIV. I, STAMPED: YES			
16	P.W.M.T.: FOR CODE: NO FOR PROCESS: NO			
17	RADIOGRAPHED:	SPOT		
18	JOINT EFFICIENCY:	0.85		
19	CORROSION ALLOWANCE: SHELLS: 1/4" HEADS: 1/4"			
20	MATL. SHELL: SA-516-GR 70			
21	MATL. HEADS: SA-516-GR 70			
22	MATL. SUPPORTS: SA-36			
23	TYPE OF HEADS: 2:1 ELLIPSOIDAL			
24	INTERNAL BOLTING: SA-193-B7 / SA-193-B7H			
25	INTERNAL BOLTING:			
26	WAGNETS: 1/4" COMPRESSED ASBESTOS			
27	BOLT HOLES: STRADDLE VESSEL CENTERLINE			
28	PAINT: YES AS PER SPEC 1590-83A1			
29	INSULATION: YES (SEE NOTE 1)			
30	SHIPMENT: ONE PIECE			
31				
32	EMPTY WGT.:	6940	LBS	
33	WATER WGT.:	4670	LBS	
34	TRAYS WGT.:		LBS	
35	INSULATION WGT.:		LBS	
36	WATER WGT.:		LBS	
37	OPER. LIQUID WGT.:	1950	LBS	
38				
39				
40				
41	HYDROTEST: SHOP: FIELD:		PSI	
42	GAGE LOCATION:			
43	MAX. ALLOW. PRESS. (NEW & COLU):		PSI	

UNITED STATES
 ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION
 FOSSIL ENERGY

COAL GASIFICATION COMBINED CYCLE PILOT PLANT
 SIOUX FALLS, SOUTH DAKOTA
 CONTRACT NO. EROA-FE 14-32-C001-1521

FOSTER WHEELER ENERGY CORP
 6715 SOUTH ORANGE AVENUE
 LIVINGSTON, NEW JERSEY

UNITED STATES
 ERDA
 FOSSIL ENERGY

F.W. NO. CP-764-570-A

DRAWN: M.S. DATE: 3/5/76

CHECKED: DATE: APPROVED: DATE:

DRAWING TITLE: RECYCLE GAS COMPRESSOR DISCHARGE SEPR D-112

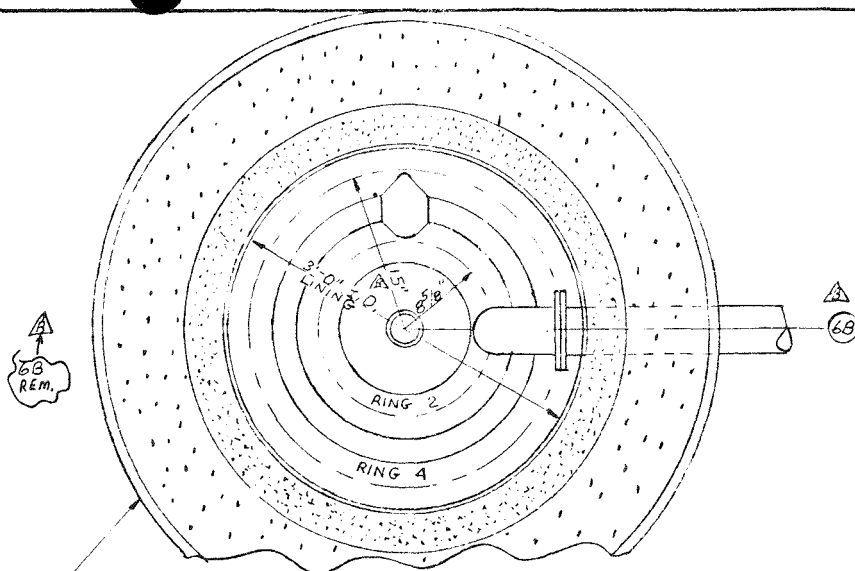
F.W. CONT. 15-1591

REQ'N NO. 1591-1131E

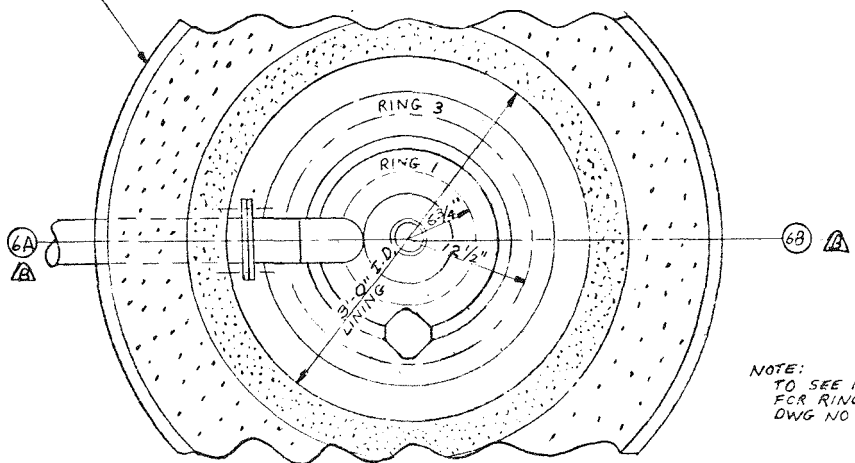
REFERENCE DRAWINGS, REQUISITIONS, STANDARDS

F.W. SPECS	F.W. ENG. STDS
1590-10A1 50A2 10B15.1	
1590-1100B 52C4 13B12.1	
1590-83A1	

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BTM. VIEW OF RINGS ASS. WITH CONN. 6B



BTM VIEW OF RINGS ASS. WITH CONN. 6A

NOTE:
TO SEE NOTES
FOR RINGS SEE
DWG NO OP-763-505A

RELEASES

DWG. REV.	DATE	ISSUED FOR
OP		(A) PURCHASE SHELL AND HEAD MATERIAL. PREPARE BUT DO NOT SUBMIT SHOP DETAIL DRAWINGS.
		(B) ISSUE CHECKED FOSTER WHEELER DRAWING. PURCHASE ALL OTHER MATERIALS. FINALIZE AND SUBMIT CHECKED SHOP DETAIL DRAWING WITHIN ONE WEEK OF RELEASE DATE. PROCEED WITH COMPLETE FABRICATION.
		(C) VENDOR'S DRAWING RETURNED
		(D) FIELD CONSTRUCTION
		(E)

NOZZLE CHART

CONN. NO.	SIZE	USAS. RATING	SERVICE	NO. REQ'D
1	36"	300" RF	MANWAY W/DAVIT	3
2	24" ID		LIFT GAS & CHAR OUT	1
3	3"		SECOND. LIFT GAS INLET	1
4	24" ID		CHAR INLET FROM S-102	2
5	30" ID		CHAR INLET FROM S-103	2
6	4"		FLUIDIZING GAS INLET	2
7	60"		SHELL FLANGES	2
8	20" ID		PRIMARY LIFT GAS INLET	1
9	1/2"	6000# CPLG	PDT, POR	1
10	1/2"		TI	2
11	1/2"		PT, PR	1
12	1/2"		PDT	1
13	BY RETROCARB		START UP CHAR ADDITION	1

NOTE:

ID OF PIPE GIVEN
FOR CLEARANCE
REASONS

VESSEL DATA

1	SPEC. NO.:	D-113	NO. REQ'D:	ONE
2	SERVICE:	CHAR SEAL POT		
3				
4	DIAMETER: TOP LINING	4'-6"	BTM LINING	3'-0"
5	TARGET LENGTH:	41'-2 1/8"		
6	OPER. PRESSURE:	NORM.:	440	PSIG
7	MAX. LIQUID LEVEL MAX.:			PSI
8	DESIGN PRESSURE:		500	PSIG
9	OPER. LIQUID HOLD-UP PRESS:			PSI
10	OPER. PRESS. DROP THRU VESSEL:		3.0	PSI
11	MAX. RELIEVING PRESS. @ TOP HD.:			PSI
12	MAX. OPER. TEMPERATURE (AT BTM)		2100	°F
13	DESIGN TEMPERATURE:	BY TECHNOLOGY		
14	SPECIFIC GRAVITY (PROCESS FLUID):	SEE NOTE 1		
15	CODE:	ASME SECT. VIII DIV. 1	STAMPED:	YES
16	W.M.T.:	FOR CODE: YES	FOR PROCESS:	
17	RADIOGRAPHED:			FULL
18	JOINT EFFICIENCY:			100%
19	CORROSION ALLOWANCE: SHELLS:		HEADS:	
20	MATL., SHELL:	SA-387 GR. 22 CL. 2		
21	MATL., HEADS:	SA-387 GR. 22 CL. 2		
22	MATL., SUPPORTS:	SA-285 GR. C		
23	TYPE OF HEADS:	2:1 ELLIP.		
24	EXTERNAL BOLTING:	SA-193-B7 & SA-194-2H		
25	INTERNAL BOLTING:	BY TECHNOLOGY		
26	WASKETS:	PER SPEC. 1590-50A2		
27	BOLT HOLES:	STRADDLE VESSEL CENTERLINE		
28	PAINT:	PER SPEC. 1590-83A1		
29	INSULATION:	NONE		
30	SHIPMENT:	ONE PIECE		
31				
32	EMPTY WGT.:	73100		LBS
33	WATER WGT. (ONLY)	81600		LBS
34	TRAYS WGT.:			LBS
35	INSULATION WGT.:			LBS
36	CASTABLE LINING	168000		LBS
37	OPER. LIQUID WGT.:			LBS
38	CHAR BED	3800		LBS
39				
40				
41	HYDROTEST: SHOP:		FIELD:	PSI
42	GAGE LOCATION:			
43	MAX. ALLOW. PRESS. (HOT & COLD):			PSI

UNITED STATES
ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION
FOSSIL ENERGY

COAL GASIFICATION COMBINED CYCLE PILOT PLANT
SIOUX FALLS, SOUTH DAKOTA
CONTRACT NO. ERDA-FE 14-32-0001-1521

FOSTER WHEELER ENERGY CORP
110 SOUTH ORANGE AVENUE
LIVINGSTON, NEW JERSEY

FW Dwg. NO. OP-754-772B

UNITED STATES
ERDA
FOSSIL ENERGY

DRAWN: B.A. YOUNG DATE: 11-20-75

CHECKED: DATE: APPROVED: DATE: APPROVED: DATE:

DRAWING TITLE: CHAR SEAL POT D-113

DRAWING NUMBER

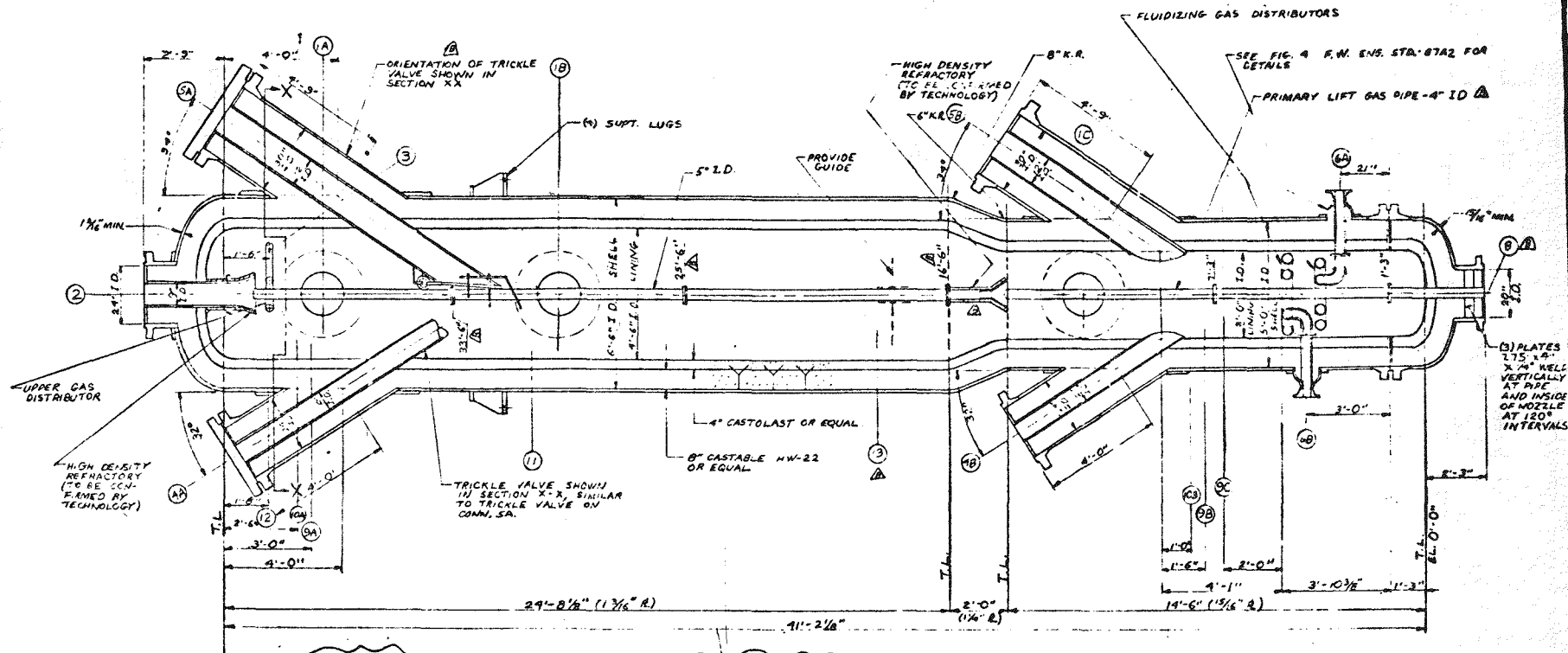
FWEC CONT. 15-1591

REQ'N NO. 1591-1131B

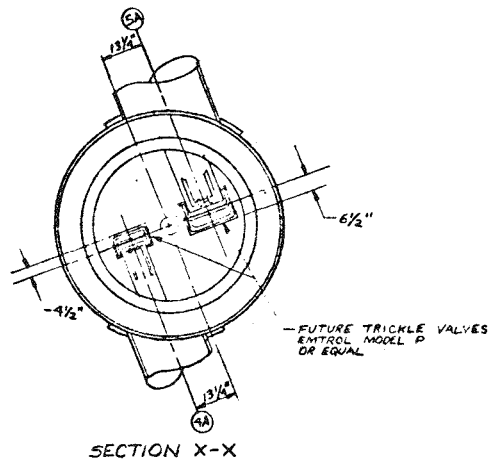
REFERENCE DRAWINGS, REQUISITIONS, STANDARDS
OP-763-505A



THIS DRAWING IS THE PROPERTY OF THE FOSTER WHEELER CORPORATION, 110 SOUTH ORANGE AVENUE, LIVINGSTON, NEW JERSEY, AND IS LENT WITHOUT CONSIDERATION OTHER THAN THE BORROWER'S AGREEMENT THAT IT SHALL NOT BE LENT OR DISPOSED OF DIRECTLY OR INDIRECTLY FOR ANY PURPOSE OTHER THAN THAT FOR WHICH IT IS SPECIFICALLY FURNISHED. THE APPLICABILITY SHOWN IN THE DRAWING IS COVERED BY PATENTS.



NOTE:
SELECTION OF MATERIALS FOR INTERNAL PIPE
AND RINGS TO BE DECIDED LATER



NOTES:

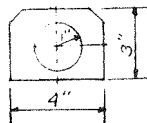
1. CHAR PARTICLE DENSITY CAN VARY FROM 20 TO 60 LBS/CU.FT.; CHAR BULK DENSITY CAN VARY FROM 6 TO 15 LBS/CU.FT.
2. THE CHAR WILL NORMALLY BE INTRODUCED VIA CYCLONE DIPLEGES (CONNS. 4B AND 5B). TWO 1/2" FLUIDIZED BED NOZZLE CONNS. 4A AND 5A ARE PROVIDED SO THAT THE CHAR MAY BE INTRODUCED ALTERNATELY ABOVE THE BED THROUGH THE TRICKLE VALVES PROVIDED. SEE SECTION X-X.
3. LOWER HODD TO BE TRUNCATED CONE. DETAILED DIMENSIONS TO BE DETERMINED LATER.
4. UPPER HODD TO BE TRUNCATED CONE. DETAILED DIMENSIONS TO BE DETERMINED LATER.
5. UPPER GAS DISTRIBUTOR TO BE PERFORATED RING. DETAILED DIMENSIONS TO BE DETERMINED LATER.

NOTES FOR INLET GAS DISTRIBUTORS - SEE ABOVE DWG. AND DWG. DP-779-772A

6. THERE ARE TO BE TWO FLUIDIZING GAS DISTRIBUTORS, EACH HAVING (2) 4" DIAMETER PIPE RINGS.
7. CONN. 6A SERVES RINGS 2 AND 4, CONN. 6B SERVES RINGS 1 AND 3.
8. RING 1 HAS 12 - 1/4" Ø HOLES EQUALLY SPACED FACING DOWNWARDS.
RING 2 HAS 33 - 1/4" Ø HOLES " " " "
RING 3 HAS 47 - 1/4" Ø HOLES " " " "
RING 4 HAS 61 - 1/4" Ø HOLES " " " "

DESIGN OF THIS ITEM OR SYSTEM IS
TENTATIVE SUBJECT TO DEVELOPMENTAL
WORK IN PROGRESS OR ANTICIPATED
PRIOR TO PURCHASE. DESIGN SHOULD BE
REVIEWED WITH FWC TO INCORPORATE
DEVELOPMENTAL RESULTS.

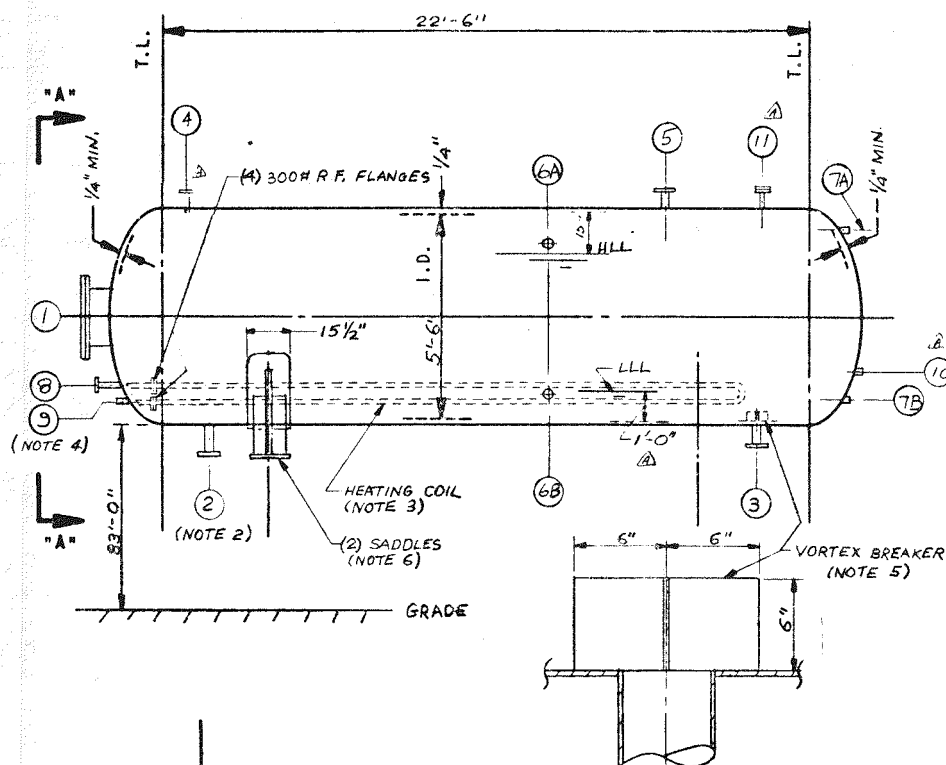
8/4/74	AS NOTED	MS
A. HODD HODD LOWER HODD LOWER HODD LOWER HODD		
SEALING EXTERIOR DISPERSE PLATE		
UNITED STATES ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION FOSSIL ENERGY		
COAL GASIFICATION COMBINED CYCLE PILOT PLANT SIOUX FALLS, SOUTH DAKOTA CONTRACT NO. DP-779-772A - 1001 - 1001		
FOSTER WHEELER ENERGY CORP. 110 SOUTH ORANGE AVENUE LIVINGSTON, NEW JERSEY		
UNITED STATES ERCA		
PROJECT NO. DP-763-505.3		
DESIGNED BY	DATE	FOSSIL ENERGY
CHECKED BY	DATE	
APPROVED BY	DATE	
CHAR FES: POT D-11		



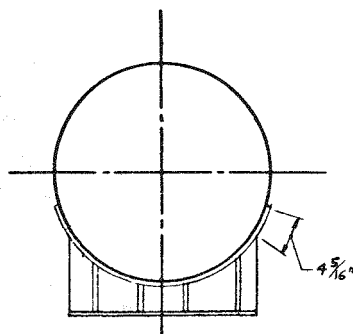
LIFTING LUGS



50 FORM 1251 50A



DETAIL AT CONN. 3



VIEW "A-A"

- NOTES:
1. DRAIN FOR SYSTEM IS AT PUMP SUCTION (P-104A/B) AT GRADE.
 2. WATER RETURN NOZZLE IS TO BE LOCATED AT BOTTOM OF DRUM.
 3. HEATING COIL CONSISTS OF 2" SCH. 160 PIPE, TOTAL LENGTH 46 FT.
 4. CONN. 9 IS A 2" TO 1 1/2" REDUCING COUPLING SOCKET WELDED TO STEAM COIL.
 5. VORTEX BREAKER CONSISTS OF TWO C.S. CROSS PLATES, EACH 12" X 6" X 1/4", WELDED TOGETHER.
 6. (2) SUPPORT SADDLES TO BE FURNISHED FOR DRUM, MARK NO. 8, F.W. STD. 13811.1, TO BE MODIFIED AS SHOWN.



ORIENTATION PLAN

RELEASES

DWG. REV.	DATE	ISSUED FOR
OP		(A) PURCHASE SHELL AND HEAD MATERIAL. PREPARE BUT DO NOT SUBMIT SHOP DETAIL DRAWINGS.
		(B) ISSUE CHECKED FOSTER WHEELER DRAWING. PURCHASE ALL OTHER MATERIALS. FINALIZE AND SUBMIT CHECKED SHOP DETAIL DRAWING WITHIN ONE WEEK OF RELEASE DATE. PROCEED WITH COMPLETE FABRICATION.
		(C) VENDOR'S DRAWING RETURNED
		(D) FIELD CONSTRUCTION
		(E)

NOZZLE CHART

CONN. NO.	SIZE	USAS. RATING	SERVICE	NO. REQ'D
1	20"	150H R.F.	MANWAY N/DAVIT	1
2	6"		WATER RETURN	1
3	6"		WATER OUTLET	1
4	2"		BFW MAKEUP INLET	1
5	6"		N ₂ PAD/PSV	1
6	3/4"	6000H CPLG	LG	2
7	1"		LT, LCL, LSH, LAH, LSL, LAL	2
8	2"	150H R.F.	65H STEAM INTO COIL	1
9	1 1/2"	6000H CPLG	CONDENSATE OUT OF COIL	1
10	1"	6000H CPLG	TT, TIC	1
11	2"	150" R.F.	VENT " / BLIND FLG.	1

VESSEL DATA

1	ITEM NO:	D-132	NO. REQ'D:	ONE
2	SERVICE:	GASIFIER COOLING WATER		
3	SURGE:	DRUM		
4	DIAMETER:	5'-6" I.D.		
5	TANGENT LENGTH:	22'-6"		
6	OPER. PRESSURE:	NORM.: 2" H ₂ O GAUGE		
7	ABOVE LIQUID LEVEL, MAX.:		PSI	
8	DESIGN PRESSURE:	27	PSIG	
9	OPER. LIQUID HOLD-UP PRESS:	1.8	PSI	
10	OPER. PRESS. DROP THRU VESSEL:	0	PSI	
11	MAX. RELIEVING PRESS. @ TOP V.D.:	25	PSIG	
12	MAX. OPER. TEMPERATURE:	166°F		
13	DESIGN TEMPERATURE:	450°F		
14	SPECIFIC GRAVITY (PROCESS FLUID):	1.0		
15	CODE:	ASME SECT VIII DIV I	STAMPED:	YES
16	P.W.M.T.: FOR CODE:	NO	FOR PROCESS:	NO
17	RADIOGRAPHED:	SPOT		
18	JOINT EFFICIENCY:	0.85		
19	CORROSION ALLOWANCE SHELLS:	1/16"	HEADS:	1/16"
20	MAT'L. SHELL:	SA-285 GR C		
21	MAT'L. HEADS:	SA-285 GR C		
22	M. T.L. SUPPORTS:	SA-285 GR C		
23	TYPE OF HEADS:	2:1 ELLIPSOIDAL		
24	EXTERNAL BOLTING:	SA-193-B7/SA-194-2H		
25	INTERNAL BOLTING:			
26	GASKETS:	1/16" COMPRESSED ASBESTOS		
27	BOLT HOLES:	STRADDLE VESSEL CENTERLINE		
28	PAINT:	AS PER SPEC 1591-83A1		
29	INSULATION:	NONE		
30	SHIPMENT:	ONE PIECE		
31				
32	EMPTY WGT.:	4080 LBS		
33	WATER WGT.:	38200 LBS		
34	TRAYS WGT.:	LBS		
35	INSULATION WGT.:	LBS		
36	UNIT WGT.:	LBS		
37	OPER. LIQUID WGT.:	32500 LBS		
38				
39	* REQUESTED BY PROCESS			
40				
41	HYDROTEST: SH(P):	FIELD:	PSI	
42	GAGE LOCATION:			
43	MAX. ALLOW. PRESS. (HEAT & COLD):		PSI	

UNITED STATES
ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION
FOSSIL ENERGY

COAL GASIFICATION COMBINED CYCLE PILOT PLANT
SIOUX FALLS, SOUTH DAKOTA
CONTRACT NO. ERDA-FE 14-32-0001-1321

FOSTER WHEELER ENERGY CORP
110 SOUTH ORANGE AVENUE
LIVINGSTON, NEW JERSEY

UNITED STATES
ERDA

FOSSIL ENERGY

F.W. DWG. NO. OP-764-556-A

DRAWN: M.S. DATE: 2/23/78
CHECKED: DATE: 2/23/78
APPROVED: DATE: 2/23/78

DRAWING TITLE: GASIFIER COOLING
WATER SURGE DRUM D-132

DRAWING NUMBER

F.W.C. CONT. 15-1591

REQ'N. NO. 1591-1131R

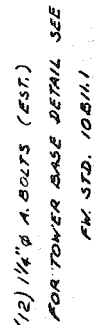
REFERENCE DRAWINGS, REQUISITIONS, STANDARDS

F.W. SPECS
590-10A1 50A2
590-100B 52C4
1590-83A1

F.W. ENG. STDS.
13811.1

THIS DRAWING IS THE PROPERTY OF THE FOSTER WHEELER CORPORATION, 110 SOUTH ORANGE AVENUE, LIVINGSTON, NEW JERSEY, AND IS LENT WITHOUT CONSIDERATION OTHER THAN THE BORROWER'S AGREEMENT THAT IT SHALL NOT BE LENT OR DISPOSED OF DIRECTLY OR INDIRECTLY NOR USED FOR ANY PURPOSE OTHER THAN THAT FOR WHICH IT IS SPECIFICALLY FURNISHED. THE APPARATUS SHOWN IN THE DRAWING IS COVERED BY PATENTS.





4- ESTIMATE 3 PAIRS OF LADDER CLIPS PER 46 B 21.3

OP-764-631 ; OP-764-632 ; 1590-10A1
1590-1100A; 10B11.1 & 3; 10B13.2; 10B14.5
10B12.1, 2 & 3; 50A2; 52C4; 83A1 OP-764 637

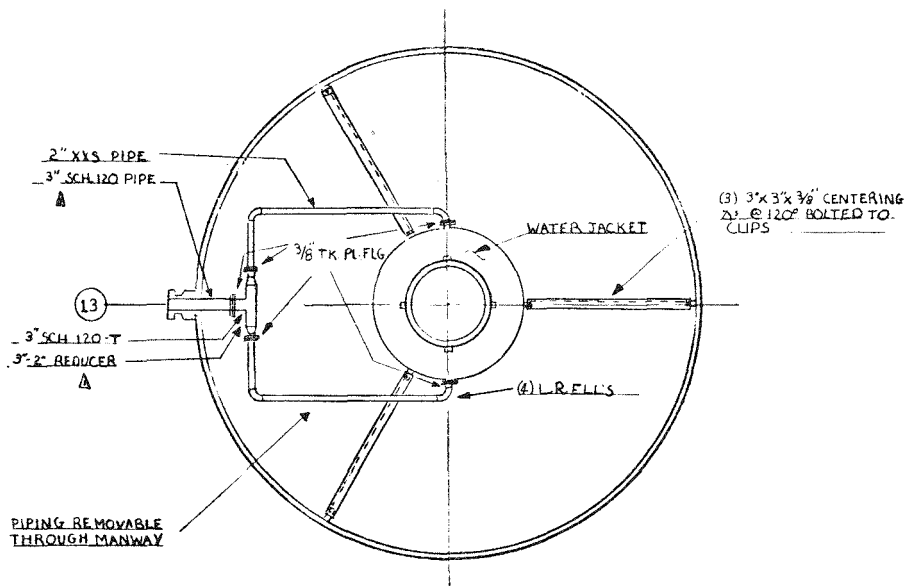
FWEC CONT. 15-1591

REQ'N # 1591-1131-R

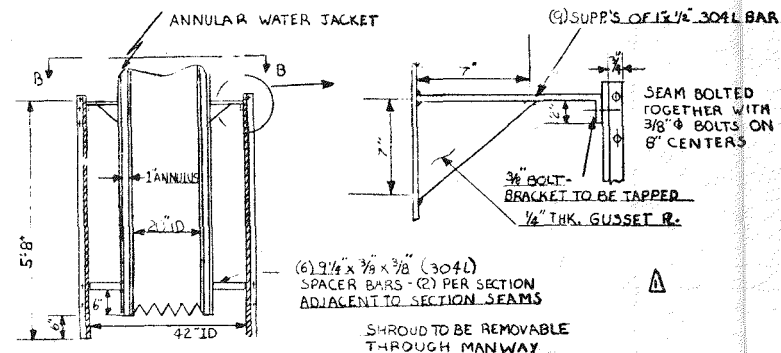
RELEASES					VESSEL DATA	
DWG. REV.	DATE	ISSUED FOR			1	ITEM NO. <i>D-133</i> NO. REQ'D: <i>ONE</i>
<i>OP</i>	DATE OF ORDER	A PURCHASE SHELL AND HEAD MATERIAL. PREPARE BUT DO NOT SUBMIT SHOP DETAIL DRAWINGS.			2	SERVICE: <i>START-UP QUENCH POT</i>
		B ISSUE CHECKED FOSTER WHEELER DRAWING. PURCHASE ALL OTHER MATERIALS. FINALIZE AND SUBMIT CHECKED SHOP DETAIL DRAWING WITHIN ONE WEEK OF RELEASE DATE. PROCEED WITH COMPLETE FABRICATION.			3	
		C VENDOR'S DRAWING RETURNED			4	DIAMETER: <i>12'-0" I.D.</i>
		D FIELD CONSTRUCTION			5	TANGENT LENGTH: <i>20'-0"</i>
		E			6	OPER. PRESSURE: NORM.: <i>167 PSIG</i>
					7	ABOVE LIQUID LEVEL, MAX.: <i>167 PSIG</i>
					8	DESIGN PRESSURE: <i>505 PSIG</i>
					9	OPER. LIQUID HOLD-UP PRESS: <i>2 PSI</i>
					10	OPER. PRESS. DROP THRU VESSEL: <i>3 PSI</i>
					11	MAX. RELIEVING PRESS. @ TOP NO.: <i>500 PSIG</i>
					12	MAX. OPER. TEMPERATURE: <i>343°F</i>
					13	DESIGN TEMPERATURE: <i>650°F</i>
					14	SPECIFIC GRAVITY (PROCESS FLUID): <i>0.9 @ 343°F</i>
NOZZLE CHART					15	CODE: <i>ASME SECT. VIII DIV. 1</i> STAMPED: <i>YES</i>
CORN. NO.	SIZE	USAS. RATING	SERVICE	NO. REQ'D	16	P.W.M.T.: FOR CODE: <i>YES</i> FOR PROCESS: <i>NO</i>
1	43"	300 # R.F.	STARTUP GAS + CHAR INLET	1	17	RADIOGRAPHED: <i>FULL</i>
2	12"		GAS + CHAR OUTLET	1	18	JOINT EFFICIENCY: <i>1.00</i>
3	4"		LIQUID + CHAR OUTLET	2	19	CORROSION ALLOWANCE: SHELLS: <i>CLAD</i> HEADS: <i>CLAD</i>
4	4"		MAKE UP WATER INLET	1	20	MATL. SHELL: <i>285-C / 5/64" 410 S CLAD</i>
5			DELETED	2	21	MATL. HEADS: <i>285-C / 5/64" 410 S CLAD</i>
6	1 1/2"		OIL DRAW OFF W/BLIND	1	22	MATL. SUPPORTS: <i>SA-283-GRC</i>
7	20"		MANWAY W/DRAVIT	1	23	TYPE OF HEADS: <i>HEMISPHERICAL</i>
8			DELETED	2	24	EXTERNAL BOLTING: <i>SA-193-B7 / SA-194-2H</i>
9			DELETED	1	25	INTERNAL BOLTING: <i>S.S.</i>
10	2"	300 # R.F.	VENT	1	26	GASKETS: <i>COMP. ASBESTOS 1/16" TK.</i>
11	1"	6000 CPG LG. LALL	LT. L.I.C., LAL, LAH	2	27	BOLT HOLES: <i>STRADDLE VESSEL CENTERLINE</i>
12	2"	300 # R.F.	STEAM OUT	1	28	PAINT: <i>YES PER 1590-83A1</i>
13	3"	300 # R.F.	ANNULUS WATER INLET	1	29	INSULATION: <i>NO</i>
					30	SHIPMENT: <i>ONE PIECE</i>
					31	
					32	EMPTY WGT.: (APPROX) <i>136 000 LBS</i>
					33	WATER WGT.: (ONLY) <i>247 000 LBS</i>
					34	TRAYS WGT.: <i>- LBS</i>
					35	INSULATION WGT.: <i>- LBS</i>
					36	CURITE WGT.: <i>- LBS</i>
					37	OPER. LIQUID WGT.: <i>857 000 LBS</i>
					38	
					39	
					40	
					41	HYDROTEST: SHOP: <i>FIELD</i> <i>PSI</i>
					42	GAGE LOCATION:
					43	MAX. ALLOW. PRESS. (HEW & COLS.): <i>PSI</i>
UNITED STATES ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION FOSSIL ENERGY						
COAL GASIFICATION COMBINED CYCLE PILOT PLANT SIOUX FALLS, SOUTH DAKOTA						
CONTRACT NO. ERDA-FE 14-32-0001-1521						
FOSTER WHEELER ENERGY CORP 110 SOUTH ORANGE AVENUE LIVINGSTON, NEW JERSEY					UNITED STATES ERDA FOSSIL ENERGY	
FW DWG NO. <i>OP-764-631-1</i>						
DRAWN <i>AK</i> DATE <i>3-28-76</i>					REVIEWED	
CHECKED					DATE	
APPROVED					APPROVED	
REFERENCE DRAWINGS, REQUISITIONS, STANDARDS <i>OP-754-630, OP-754-632, 1590-10A1, 1590-1100A, 10B111, 23, 10B132, 10B14.5, 10B121, 243, 50A2, 52C4, 83A1, OP-764-631</i>					DRAWING NUMBER	
STARTUP QUENCH POT D-133						
FWEC CONT. 15-1591					REQ'N NO. <i>159-1131-R</i>	



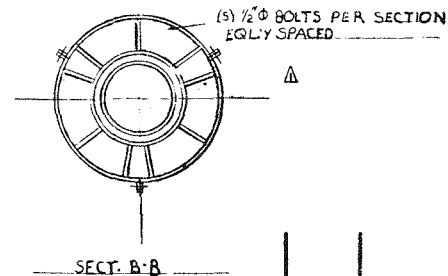
THIS DRAWING IS THE PROPERTY OF THE FOSTER WHEELER CORPORATION, 110 SOUTH ORANGE AVENUE, LIVINGSTON, NEW JERSEY, AND IS LENT WITHOUT CONSIDERATION OTHER THAN THE BORROWER'S AGREEMENT THAT IT SHALL NOT BE LENT OR DISPOSED OF DIRECTLY OR INDIRECTLY NOR USED FOR ANY PURPOSE OTHER THAN THAT FOR WHICH IT IS SPECIFICALLY FURNISHED. THE APPARATUS SHOWN IN THE DRAWING IS COVERED BY PATENTS.



SECTION A-A



SHROUD DETAIL



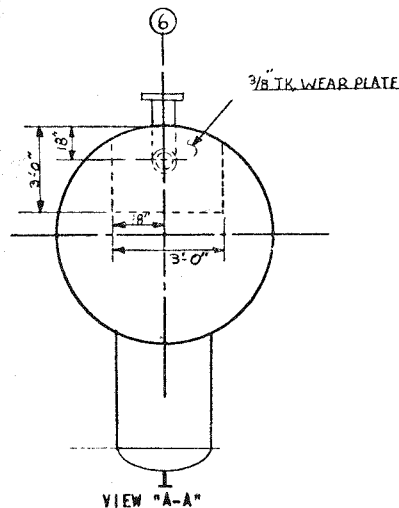
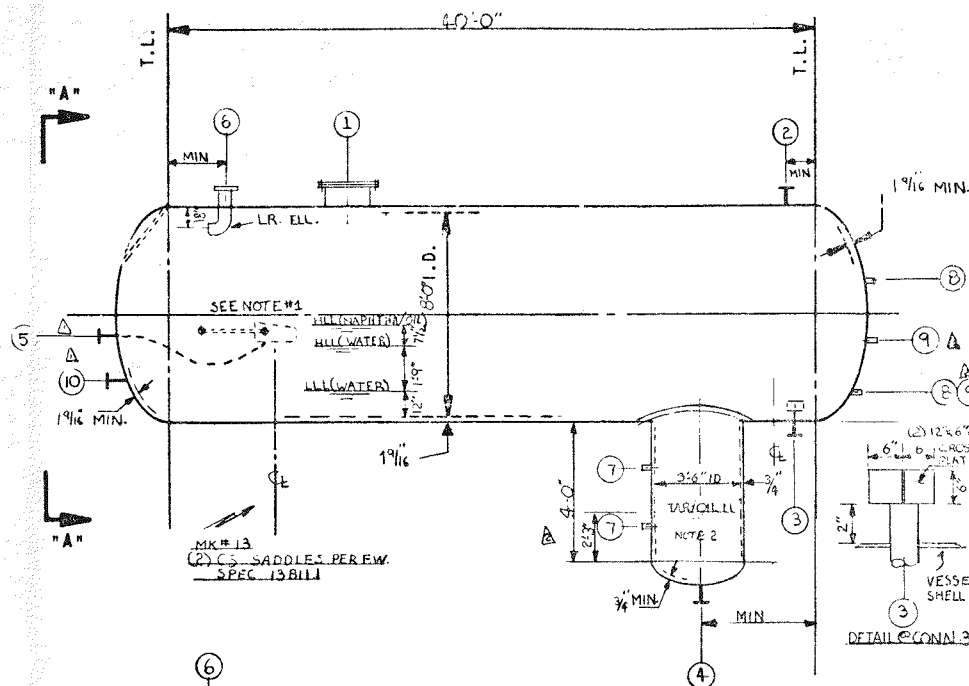
SECT. B-B

2			
1	4/23/76	AS NOTED	RLK
NO.	DATE	REVISION	BY
UNITED STATES ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION FOSSIL ENERGY			
COAL GASIFICATION COMBINED CYCLE PILOT PLANT SIOUX FALLS, SOUTH DAKOTA CONTRACT NO EROA-FE 14 - 32 - 0001 - 1521			
FOSTER WHEELER ENERGY CORP 110 SOUTH ORANGE AVENUE LIVINGSTON, NEW JERSEY		UNITED STATES EROA FOSSIL ENERGY	
FW DWE NO. OP-764-637-1		DRAWN: RLK DATE: 3/20/76 CHECKED: DATE: APPROVED: DATE:	
DRAWING TITLE STARTUP QUENCH POT D-133		REVIEWED: APPROVED:	
FWD CONT. 15-1591		REQ'N NO.	

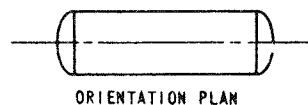
REFERENCE DRAWINGS, REQUISITIONS, STANDARDS
 OP-764-630
 OP-764-631



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- NOTES**
1. VESSEL FAB TO SUPPLY & INSTALL FLOATING SKIMMER THAT WILL REST ON NAPHTHA-WATER INTERFACE. FLOATING SKIMMER IS CONNECTED TO THE NAPHTHA/OIL OUTLET VIA A FLEXIBLE HOSE. NAPHTHA LAYER SHOWN IS THAT CORRESPONDING TO NAPHTHA COLLECTED OVER A 24 HOUR START-UP PERIOD.
 2. INTERFACE LIQUID LEVEL SHOWN BETWEEN WATER AND TAR/OIL MIXTURE CORRESPONDS TO 2 HOURS OF ACCUMULATION OF TAR/OIL MIXTURE.
 3. SG. OF WATER @ 222°F = .96. SG. OF NAPHTHA/OIL @ 222°F = .94. SG. OF TAR/OIL @ 222°F = .85.



ORIENTATION PLAN

RELEASES

DWG. REV.	DATE	ISSUED FOR
OP	DATE OF ORDER	(A) PURCHASE SHELL AND HEAD MATERIAL. PREPARE BUT DO NOT SUBMIT SHOP DETAIL DRAWINGS.
		(B) ISSUE CHECKED FOSTER WHEELER DRAWING. PURCHASE ALL OTHER MATERIALS. FINALIZE AND SUBMIT CHECKED SHOP DETAIL DRAWING WITHIN ONE WEEK OF RELEASE DATE. PROCEED WITH COMPLETE FABRICATION.
		(C) VENDOR'S DRAWING RETURNED
		(D) FIELD CONSTRUCTION
		(E)

NOZZLE CHART

CON. NO.	SIZE	USAS. RATING	SERVICE	NO. REQD.
1	20"	300# RF	MANWAY W/DAVIT	1
2	10"		GAS OUTLET	1
3	6"		WATER OUTLET	1
4	1 1/2"		TAR/OIL OUTLET	1
5	1 1/2"		NAPHTHA/OIL OUTLET	1
6	12"		GAS-LIQUID INLET	1
7	3/4"	6000# CMLG	LG. FOR BOOT	2
8	3/4"	6000# CMLG	LG. LT	2
9	3/4"	6000# CMLG	LG	2
10	1 1/2"	300# RF	STEAM OUT	1

VESSEL DATA

1	ITEM NO. D-124	NO. REQ'D: ONE
2	SERVICE: START-UP K.O. DRUM	
3		
4	DIAMETER: 8'-0"	
5	TANGENT LENGTH: 40'-0"	
6	OPER. PRESSURE: NORM.: 137	PSIG
7	ABOVE LIQUID LEVEL: MAX.	PSI
8	DESIGN PRESSURE: 503	PSIG
9	OPER. LIQUID HOLD-UP PRESS: 2.5	PSI
10	OPER. PRESS. DROP THRU VESSEL: -	PSI
11	MAX. RELIEVING PRESS. @ TOP HD.: 500	PSIG
12	MAX. OPER. TEMPERATURE: 222°F	
13	DESIGN TEMPERATURE: 650°F	
14	SPECIFIC GRAVITY (PROCESS FLUID): NOTE 4	
15	CODE: ASME SEC. VIII DIV. 1	STAMPED: YES
16	P.W.M.T.: FOR CODE: YES	FOR PROCESS: NO
17	RADIOGRAPHED: FULL	
18	JOINT EFFICIENCY: 100%	
19	CORROSION ALLOWANCE SHELLS: 1/8	HEADS: 1/8
20	MATL. SHELL: SA-516-70	
21	MATL. HEADS: SA-516-70	
22	SUPPORTS: SA-283-C	
23	TYPE OF HEADS: 2:1 ELLIP	
24	EXTERNAL BOLTING: SA-193-B7/SA-194-2H	
25	INTERNAL BOLTING:	
26	GASKETS: COMP ASB.	
27	BOLT HOLES: STRADDLE VESSEL CENTERLINE	
28	PAINT: PER. SPEC 1590-83A1	
29	INSULATION: YES (BY OTHERS)	
30	SHIPMENT: ONE PIECE	
31		
32	EMPTY WGT.: 49000	LBS
33	WATER WGT.: (ONLY) 138876	LBS
34	TRAYS WGT.: -	LBS
35	INSULATION WGT.: -	LBS
36	QUITE WGT.: -	LBS
37	OPER. LIQUID WGT.: -	LBS
38		
39		
40		
41	HYDROTEST: SHOP: FIELD:	PSI
42	GAGE LOCATION:	
43	MAX. ALLOW. PRESS. (HEAT & COLD):	PSI

UNITED STATES
ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION
FOSSIL ENERGY

COAL GASIFICATION COMBINED CYCLE PILOT PLANT
SIOUX FALLS, SOUTH DAKOTA
CONTRACT NO. ERDA-FE 14-32-(0001-131)

FOSTER WHEELER ENERGY CORP
110 SOUTH ORANGE AVENUE
LIVINGSTON, NEW JERSEY

UNITED STATES
ERDA

FW DWG NO. OP-754-769-2

FOSSIL ENERGY

DRAWN: RUK
CHECKED: RUK
APPROVED: RUK

DATE: 6/1/76
DATE: 6/1/76
DATE: 6/1/76

DRAWING TITLE:
START-UP K.O. DRUM D-124

DRAWING NUMBER

FWEC CONT. 15-1592

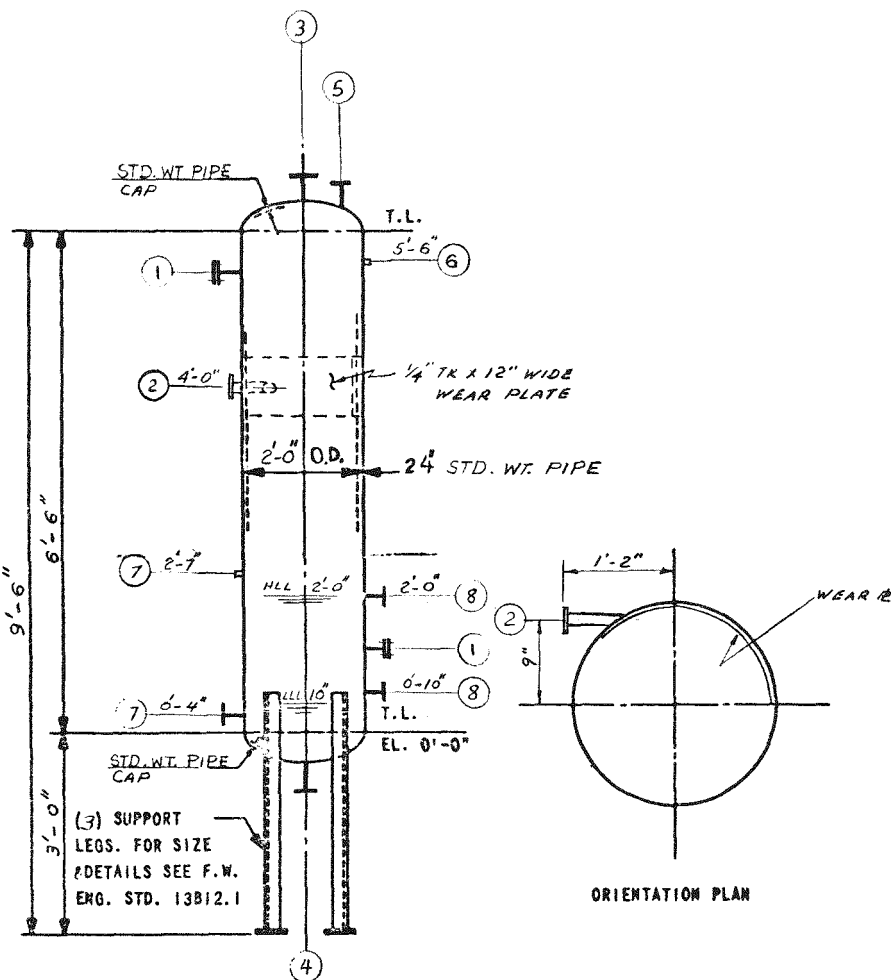
REQ'N. NO.

REFERENCE DRAWINGS, REQUISITIONS, STANDARDS

1590-ICM1 52-C4
1590-11CC1 10B132
1590-SCAL 1510-83A1

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RELEASES

ENG. REV.	DATE	ISSUED FOR
		(A) PURCHASE SHELL AND HEAD MATERIAL. PREPARE BUT DO NOT SUBMIT SHOP DETAIL DRAWINGS.
		(B) ISSUE CHECKED FOSTER WHEELER DRAWING. PURCHASE ALL OTHER MATERIALS. FINALIZE AND SUBMIT CHECKED SHOP DETAIL DRAWING WITHIN ONE WEEK OF RELEASE DATE. PROCEED WITH COMPLETE FABRICATION.
		(C) VENDOR'S DRAWING RETURNED
		(D) FIELD CONSTRUCTION
		(E)

NOZZLE CHART

CON. NO.	SIZE	USAS. RATING	SERVICE	NO. RECD.
1	6"	150# RF	HAND HOLE W/BLIND	2
2	1 1/2"		CONTINUOUS B.B. INLET	1
3	3"		STEAM OUTLET	1
4	1 1/2"		LIQUID OUTLET	1
5	1"		VENT	1
6	3/4"	6000# CPLG.	PI	1
7	3/4"	6000# CPLG.	LG	2
8	2"	300# RF	LT	2

VESSEL DATA

1	ITEM NO. D-136	NO. REQ'D: ONE
2	SERVICE: BLOWDOWN FLASH DRUM	
3		
4	DIAMETER: 2'-0"	O.D.
5	TANK LENGTH: 6'-6"	
6	OPER. PRESSURE: NORM.: 70 PSI G	
7	(ABOVE LIQUID LEVEL) MAX.: 110 PSI G	
8	DESIGN PRESSURE: 136 PSI G	
9	OPER. LIQUID HOLD-UP PRESS: 1 PSI	
10	OPER. PRESS. DROP THE VESSEL: 0 PSI	
11	MAX. BELIEVING PRESS. @ TOP NO.: 135 PSI G	
12	MAX. OPER. TEMPERATURE: 344 °F	
13	DESIGN TEMPERATURE: 400 °F	
14	SPECIFIC GRAVITY (PROCESS FLUID): .91	
15	CODE: ASME SEC VIII, DIV. 1	STAMPED: YES
16	P.W.M.T.: FOR CODE: NO	FOR PROCESS: NO
17	RADIOGRAPHED: SPOT	
18	JOINT EFFICIENCY: 100% & 85%	
19	CORROSION ALLOWANCE: SHELLS: 1/8" HEADS: 1/8"	
20	MATL. SHELL: SA-106-G1, B	
21	MATL. HEADS: SA-234-WPB	
22	MATL. SUPPORTS: SA-36	
23	TYPE OF HEADS: PIPE CAPS	
24	EXTERNAL BOLTING: SA-193-B7 & SA-194-2H	
25	INTERNAL BOLTING:	
26	GASKETS: COMP. ASBESTOS	
27	BOLT HOLES: STRADDLE VESSEL CENTERLINE	
28	PAINT: PER 83A1 FW. STD.	
29	INSULATION: H.C. * (BY OTHERS)	
30	SHIPMENT:	
31		
32	EMPTY WGT.: 900	LBS
33	WATER WGT.: 1000	LBS
34	TRAYS WGT.:	LBS
35	INSULATION WGT.:	LBS
36	COBIDE WGT.:	LBS
37	OPER. LIQUID WGT.:	LBS
38		
39	* INSUL SUPPORT BY VESS. FAB. (PER 10B14.2)	
40		
41	HYDROTEST: SHOP: FIELD: PSI	
42	GAGE LOCATION:	
43	MAX. ALLOW. PRESS. (HEAT & COLD): PSI	

UNITED STATES
ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION
FOSSIL ENERGY

COAL GASIFICATION COMBINED CYCLE PILOT PLANT
SIOUX FALLS, SOUTH DAKOTA
CONTRACT NO. ERDA-FE 14-32-0001-1521

FOSTER WHEELER ENERGY CORP.
60 SOUTH ORANGE AVENUE
LIVINGSTON, NEW JERSEY

UNITED STATES
ERDA

FWEC NO. 0P-154-765-1

FOSSIL ENERGY

DRAWN: A.K. DATE: 10/13/75

CHECKED: DATE:

APPROVED: DATE:

REVIEWED

APPROVED

DRAWING NUMBER

BLOWDOWN FLASH DRUM D-136

FWEC CONT. 15-1590

REFERENCE DRAWINGS, REQUISITIONS, STANDARDS

1590-10A1	83A1	13B12.1
1590-1100B	52C4	10B14.2
1590-50A2		

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MATERIAL REQUISITION



FOSTER WHEELER CORPORATION

PAGE 1 OF 1

FORM 135-20

FOR	ERDA-FE-14-32-0001-1521 F.W.REF. 15-1590	REQUISITION NUMBER	DATE
SITE	NSP LAWRENCE STATION, SIOUX FALLS, SD		5/1/76
MATERIAL	Coal Storage Hopper	SUPERSEDED BY CHANGE NO.:	
	TK-111 EX	C1	C4
		C2	C5
		C3	C6

This requisition describes existing equipment at Northern States Power Company, Lawrence Generating Station located near Sioux Falls, South Dakota. This equipment will be utilized for the Combined Cycle Pilot Plant if it is to be located at this site, and therefore should not be duplicated.

NSP Designation: Coal Bunker (Unit No. 3)

Size: 28'-0" x 18'-0" x 41'-0" overall height

Capacity: 400 tons coal

Description: Rectangular vertical hopper with 2 rectangular cone-shaped discharge chutes.

BY:	P.O.NO.	SUPPLIER:
-----	---------	-----------

MATERIAL REQUISITION



FOSTER WHEELER CORPORATION

PAGE 1 OF 1

FORM 135-20

FOR	ERDA-FE-14-32-0001-1521 F.W. REF. 15-1590	REQUISITION NUMBER	DATE
SITE	NSP LAWRENCE STATION, SIOUX FALLS, SD		5/1/76
MATERIAL	Coal Unloading Hopper TK-113 EX	SUPERSEDED BY CHANGE NO.:	
		C1	C4
		C2	C5
		C3	C6

This requisition describes existing equipment at Northern States Power Company, Lawrence Generating Station located near Sioux Falls, South Dakota. This equipment will be utilized for the Combined Cycle Pilot Plant if it is to be located at this site, and therefore should not be duplicated.

NSP Designation: Track Hopper

Size: 16'-0" wide x 42'-0" long x 12'-6" overall height

Capacity: 110 tons coal

Description: Rectangular hopper located over apron feeder
with 4 rectangular cone-shaped discharge openings.

BY:	P.O. NO.	SUPPLIER:
-----	----------	-----------

MATERIAL REQUISITION

SHELL & TUBE
EXCHANGERS

110 SOUTH ORANGE AVENUE, LIVINGSTON, N. J.

PAGE 1 OF 1

CONTRACT NO. 15-1591		REQ'N. NO. 1591-1211-C		DATE 2-18-76	
CUSTOMERS NAME UNITED STATES E.R.D.A. - FOSSIL ENERGY		LOCATION SIOUX FALLS, SOUTH DAKOTA			
SUPERSEDED BY					
CHANGE NO.	C-1	C-2	C-3	C-4	C-5
DATE	4-5-76	5-13-76			
SERVICE OF UNIT RECYCLE GAS SUCTION COOLER				ITEM NO. E-105	
SIZE 19-240	TYPE BEM		CONNECTED IN -		
SQ. FT. SURF. / IN. T. (EFF.)	1200	SHELLS/UNIT	ONE	SQ. FT. SURF. / SHELL (EFF.)	1200
PERFORMANCE OF ONE UNIT					
		SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED		COOLING WATER		RECYCLE GAS (4)	
△ TOTAL FLUID ENTERING	221,320	LB/HR		67,500	LB/HR
VAPOR		LB/HR			LB/HR
LIQUID	221,320	LB/HR			LB/HR
STEAM		LB/HR		308	LB/HR
△ NON-CONDENSABLES		LB/HR		67,192	LB/HR
FLUID (VAPORIZED) (CONDENSED)		LB/HR			LB/HR
STEAM CONDENSED		LB/HR		96	LB/HR
GRAVITY					
VISCOSITY CPS				0.032 @ 316°F ; 0.01 @ 120°F	
MOLECULAR WEIGHT	18			25.10	
SPECIFIC HEAT	1.0	BTU/LB-°F		0.314 (GAS) BTU/LB-°F	
THERMAL CONDUCTIVITY @ Tavg		BTU/HR-FT-°F		0.01 BTU/HR-FT-°F	
LATENT HEAT		BTU/LB		1025 BTU/LB	
TEMPERATURE IN	85	°F		375	°F
TEMPERATURE OUT	110	°F		120	°F
OPERATING PRESSURE, INLET	55 @ GRADE	(PSIG)		418	(PSIG)
NO. PASSES PER SHELL	ONE			ONE	
VELOCITY		FT/SEC		24.0	FT/SEC
PRESSURE DROP ALLOW. CALC'D.	15.0	PSI		5.0	PSI
FOULING RESISTANCE MIN.	0.002			0.001	
HEAT EXCHANGED - BTU/HR.	5,533,000			MTD CORRECTED-OF	113.6
TRANSFER RATE - SERVICE	40.5			CLEAN	
CONSTRUCTION OF ONE SHELL					
△ DESIGN PRESSURE	100	PSIG		460	PSIG
TEST PRESSURE	PER CODE	PSIG		PER CODE	PSIG
DESIGN TEMPERATURE	160	°F		425	°F
△ TUBES SS 430	NO. 312	O.D. 3/4"	BWG 16	MIN. LENGTH 20'	PITCH 15/16" △
SHELL C.S.	I.D. 19.25"	SHELL COVER		(INTEG) (REMOV)	
CHANNEL OR BONNET 410 "S" CLAD C.S. (5)	CHANNEL COVER				
TUBESHEET - STATIONARY 410 "S" CLAD C.S.	TUBESHEET - FLOATING				
BAFFLES - CROSS C.S. TYPE SEGMENTAL	FLOATING HEAD COVER				
BAFFLES - LONG TYPE	IMPINGMENT PROTECTION C.S.				
TUBE SUPPORTS					
TUBE TO TUBESHEET JOINT					
GASKETS					
CONNECTIONS - SHELL SIDE	IN 6"	OUT 6"	RATING 150 LBS RF		
CONNECTIONS - TUBE SIDE	IN 8"	OUT 8"	RATING 300 LBS RF		
CORROSION ALLOWANCE - SHELL SIDE 1/8	IN.	TUBE SIDE	IN.		
CODE REQUIREMENTS ASME VIII		TEMA CLASS R			
REMARKS: (1) NOZZLE & SUPPORT LOCATION TO BE AS NOTED ON F.W. STD. 21B11.1					
(2) FOR GENERAL NOTES REFER TO REQ'N. 1590 - 1200A WHICH IS AN INTEGRAL PART OF THIS REQ					
(3) PROVIDE EXPANSION JOINT ON SHELL (4) RECYCLE GAS COMPOSITION (VOL %): 0.64 H ₂ O, 13.89 H ₂ , 19.67 CO, 7.85 CO ₂ , 4.05 CH ₄ , 53.38 N ₂ , 0.26 NH ₃ (NML) CO ₂ , MAY CONTAIN UP TO 0.54 H ₂ S; THIS GAS HAS A DESIGN FLOW OF 300 LBS/HR OF < 50 MICRON SOLIDS WITH A _{MAX} = 60 LBS/FT ² . (5) BONNET CLADDINGS TO BE 5/64" THICK MIN.					

MATERIAL REQUISITION

SHELL & TUBE
EXCHANGERS

110 SOUTH ORANGE AVENUE, LITTLE ROCK, AR 72201

PAGE 1 OF 1

CONTRACT NO. 15 - 1591		REQ'N. NO. 1591-1211-D		DATE 2-18-76	
CUSTOMER'S NAME UNITED STATES ERDA - FOSSIL ENERGY		LOCATION SIOUX FALLS, SOUTH DAKOTA			
SUPERSEDED BY					
CHANGE NO.	C-1	C-2	C-3	C-4	C-5
DATE	4-5-76				
SERVICE UNIT GASIFIER COOLING WATER COOLER				ITEM NO. E-106	
SIZE 28-240	TYPE BEM		CONNECTED IN		
SQ. FT. SURF./UNIT 2680	SHELLS/UNIT ONE		SQ. FT. SURF./SHELL (EFF) 2680		
PERFORMANCE OF ONE UNIT					
FLUID CIRCULATE		SHELL SIDE		TUBE SIDE	
TOTAL FLOW ENTERING		GASIFIER COOLING WATER (BFW)		COOLING WATER	
VAPOR		232,500 LB/HR		520,000 LB/HR	
LIQUID		232,500 LB/HR		520,000 LB/HR	
STEAM					
NON-CONDENSABLES					
FLUID VAPORIZED (CONDENSED)					
STEAM CONDENSED					
GRAVITY		0.99		1.0	
VISCOSITY @ TAVG. - CPS		0.55		0.7	
MOLEULAR WEIGHT		18.016		18.016	
SPECIFIC HEAT		1.0 BTU/LB-°F		1.0 BTU/LB-°F	
THERMAL CONDUCTIVITY @ TAVG.		0.363 BTU/HR-FT-°F		0.363 BTU/HR-FT-°F	
LATENT HEAT		BTU/LB		BTU/LB	
TEMPERATURE IN		166 °F		85 °F	
TEMPERATURE OUT		110 °F		110 °F	
OPERATING PRESSURE INLET		116 (PSIG)		55 @ GRADE (PSIG)	
NO. PASSES PER SHELL		ONE		2	
VELOCITY		FT/SEC		3.8 FT/SEC	
PRESSURE DROP - ALLOW		10 PSI		15 PSI	
FOULING RESISTANCE, MIN.		0.001		0.002	
HEAT EXCHANGER RTU/HR.		13,000,000		MID CORRECTED OF 31.0	
TRANSFER RATE - SERVICE		156.5		CLEAN	
CONSTRUCTION OF ONE SHELL					
DESIGN PRESSURE		135 PSIG		100 PSIG	
TEST PRESSURE		PER CODE PSIG		PER CODE PSIG	
DESIGN TEMPERATURE		220 °F		160 °F	
TUBES C.S.	NO. 693	O.D. 3/4"	BWG 14	LENGTH 20'	PITCH 15/16" Δ
SHELL C.S.		I.D. 28"	SHELL COVER	(INTEG)	(REMOV)
CHANNEL OR BONNET	C.S.		CHANNEL COVER		
TUBESHEET - STATIONARY	C.S.		TUBESHEET - FLOATING		
BAFFLES - CROSS	C.S. TYPE SEGMENTAL		FLOATING HEAD COVER		
BAFFLES - LONG	TYPE		IMPINGMENT PROTECTION	C.S.	
TUBE SUPPORTS					
TUBE TO TUBESHEET JOINT					
GASKETS					
CONNECTIONS - SHELL SIDE	IN 6"	OUT 6"	RATING 150 LBS RF		
CONNECTIONS - TUBE SIDE	IN 8"	OUT 8"	RATING 150 LBS RF		
CORROSION ALLOWANCE - SHELL SIDE	1/8 IN.	TUBE SIDE	1/8 IN.		
CODE REQUIREMENTS ASME VIII			TEMA CLASS R		
REMARKS: (1) NOZZLE & SUPPORT LOCATION TO BE AS NOTED ON I.W. STD. 21B11.1					
(2) FOR GENERAL NOTES REFER TO REQ'N. 1590-1200 A WHICH IS AN INTEGRAL PART OF THIS REQ'N					
(3) PROVIDE EXPANSION JOINT ON SHELL					

MATERIAL REQUISITION

SHELL & TUBE
EXCHANGERS

110 SOUTH ORANGE AVENUE, L. L. KINGSTON, N. J.

PAGE 1 OF 1

CONTRACT NO. 15-1591		REQ'N. NO. 1591-1211-F		DATE 2-18-76	
CUSTOMER'S NAME UNITED STATES E.R.D.A.-FOSSIL ENERGY		LOCATION SIoux FALLS, SOUTH DAKOTA			
SUPERSEDED BY					
CHANGE NO.	C-1	C-2	C-3	C-4	C-5
DATE	4-5-76	5-13-76			
SERVICE OF UNIT RECYCLE GAS COMPRESSOR AFTERCOOLER				ITEM NO. E-112	
SIZE	13-240	TYPE	BEM	CONNECTED IN -	
SQ. FT. SURF./UNIT	555	SHELLS/UNIT	ONE	SQ. FT. SURF./SHELL	555
PERFORMANCE OF ONE UNIT					
FLUID CIRCULATED		SHELL SIDE		TUBE SIDE	
TOTAL FLUID ENTERING		COOLING WATER		RECYCLE GAS (4)	
VAPOR		69,820 LB/HR		67,318 LB/HR	
LIQUID		69,820 LB/HR		LB/HR	
STEAM		LB/HR		211 LB/HR	
NON-CONDENSABLES		LB/HR		67,107 LB/HR	
FLUID (VAPORIZED)(CONDENSED)		LB/HR		LB/HR	
STEAM CONDENSED		LB/HR		126 LB/HR	
GRAVITY					
VISCOSITY CPS @ Tavg.				0.023 @ 160°F	
MOLECULAR WEIGHT		18		23.9	
SPECIFIC HEAT		1.0 BTU/LB-°F		0.3 BTU/LB-°F	
THERMAL CONDUCTIVITY @ Tavg.		BTU/HR-FT-°F		0.01 @ 160°F BTU/HR-FT-°F	
LATENT HEAT		BTU/LB		1031 BTU/LB	
TEMPERATURE IN		85 °F		200 °F	
TEMPERATURE OUT		110 °F		120 °F	
OPERATING PRESSURE, INLET		55 @ GRADE (PSIG)		482 (PSIG)	
NO. PASSES PER SHELL		ONE		ONE	
VELOCITY		FT/SEC		41.8 FT/SEC	
PRESSURE DROP - ALLOW. CALC'D.		15.0 PSI		5.0 PSI	
FOULING RESISTANCE, MIN.		0.002		0.001	
HEAT EXCHANGED - BTU/HR.		1,746,000		MTD CORRECTED-°F 58.2	
TRANSFER RATE - SERVICE		54.0		CLEAN	
CONSTRUCTION OF ONE SHELL					
DESIGN PRESSURE		100 PSIG		530 PSIG	
TEST PRESSURE		PER CODE PSIG		PER CODE PSIG	
DESIGN TEMPERATURE		160 °F		250 °F	
TUBES	SS 430	NO.	143	O.D.	3/4" BWG 16 (MIN) LENGTH 20' PITCH 15/16" Δ
SHELL	C.S.	I.D. 13.25"		SHELL COVER (INTEG)(REMOV)	
CHANNEL OR BONNET	410 "S" CLAD C.S. (5)	CHANNEL COVER			
TUBESHEET - STATIONARY	410 "S" CLAD C.S.	TUBESHEET - FLOATING			
BAFFLES - CROSS	C.S. TYPE SEGMENTAL	FLOATING HEAD COVER			
BAFFLES - LONG	TYPE	IMPINGEMENT PROTECTION C.S.			
TUBE SUPPORTS					
TUBE TO TUBESHEET JOINT					
GASKETS					
CONNECTIONS - SHELL SIDE		IN	3"	OUT	3" RATING 150 LBS RF
CONNECTIONS - TUBE SIDE		IN	8"	OUT	8" RATING 300 LBS RF
CORROSION ALLOWANCE - SHELL SIDE		1/8	IN.	TUBE SIDE	- IN.
CODE REQUIREMENTS ASME VIII				TEMA CLASS R	
REMARKS: (1) NOZZLE & SUPPORT LOCATION TO BE AS NOTED ON I.W. STD. 21B11.1					
(2) FOR GENERAL NOTES REFER TO REQ'N. 1590-1200 A WHICH IS AN INTEGRAL PART OF THIS REQ					
(3) PROVIDE EXPANSION JOINT ON SHELL. (4) RECYCLE GAS COMPOSITION (VOL%): 0.64 H ₂ O, 13.89 H ₂ , 19.67 CO, 7.85 CO ₂ , 4.05 CH ₄ , 53.38 N ₂ , (NIL) CO _S , 0.26 NH ₃ , MAY CONTAIN UP TO 0.54 H ₂ S; THIS GAS HAS A DESIGN FLOW OF 300 LBS/HR OF < 50 MICRON SOLIDS W/ P _{MAX} = 60 LBS/FT ² . (5) BONNET CLADDINGS TO BE 3/64" THK. MIN.					

MATERIAL REQUISITION

SHELL & TUBE
EXCHANGERS

110 SOUTH ORANGE AVENUE, LIVINGSTON, N.J.

PAGE 1 OF 2

CONTRACT NO.	15-1591	REQ'N. NO.	1591-1211-6	DATE	2-18-76
CUSTOMER'S NAME	UNITED STATES E.R.D.A.-FOSSIL ENERGY		LOCATION SIOUX FALLS, SOUTH DAKOTA		
SUPERSEDED BY					
CHANGE NO.	C-1	C-2	C-3	C-4	C-5
DATE	4-5-76	5-13-76			
SERVICE NAME	RECYCLE GAS - L.P. STEAM EXCHANGER			ITEM NO. E-113	
SIZE	27/13-240	TYPE	BKM	CONNECTED IN -	
SQ. FT. SURF./UNIT	480	SHELLS/UNIT	ONE	SQ. FT. SURF./SHELL (EFF)	480

PERFORMANCE OF ONE UNIT

	SHELL SIDE		TUBE SIDE
FLUID CIRCULATED	BOILER FEED WATER		RECYCLE GAS (6)
TOTAL FLUID ENTERING	9,409	LB/HR	69,500
VAPOR		LB/HR	
LIQ. TO	9,409	LB/HR	
STEAM		LB/HR	317
NOT CONDENSABLES		LB/HR	69,183
FLUID VAPOR (EFF)	9,315	LB/HR	
BLOWDOWN	94	LB/HR	
GRAVITY			
VISCOSITY CPS			0.032 @ 800 °F; 0.025 @ 375 °F
MOLECULAR WEIGHT	18		29.1
SPECIFIC HEAT		BTU/LB-°F	0.314
THERMAL CONDUCTIVITY @ TANG.		BTU/HR-FT-°F	0.03
LATENT HEAT	898 @ 316 °F	BTU/LB	
TEMPERATURE IN	225	°F	800
TEMPERATURE OUT	316	°F	375
OPERATING PRESSURE INLET	70 (PSIG)		424 (PSIG)
NO. PASSES PER SHELL	KETTLE		ONE
VELOCITY		FT/SEC	94
PRESSURE DROP ALLOW. CALC'D.	PSI	PSI	10.0
FOULING RESISTANCE MIN.	0.002		0.001
HEAT EXCHANGED - BTU/HR.	9,325,000	MTD CORRECTED-OF	207.5
TRANSFER RATE - SERVICE	93.6	CLEAN	

CONSTRUCTION OF ONE SHELL

DESIGN PRESSURE	95	PSIG	465	PSIG
TEST PRESSURE	PER CODE	PSIG	PER CODE	PSIG
DESIGN TEMPERATURE	365	°F	900	°F
TUBES SS 430	NO. 125	O.D. 3/4"	BWG 16	LENGTH 20'
SHELL C.S.	I.D. 27"	SHELL COVER	(INTG)(REMOV)	
CHANNEL OR BONNET C.S.		CHANNEL COVER		
TUBESHEET - STATIONARY C.S.		TUBESHEET - FLOATING		
BAFFLES - CROSS TYPE		FLOATING HEAD COVER		
BAFFLES - LONG TYPE		IMPINGMENT PROTECTION	C.S.	
TUBE SUPPORTS C.S.				
TUBE TO TUBESHEET JOINT				
GASKETS				
CONNECTIONS - SHELL SIDE	IN 1 1/2"	OUT 6"	RATING 150 LBS RF	
CONNECTIONS - TUBE SIDE	IN 8"	OUT 8"	RATING 300 LBS RF	
CORROSION ALLOWANCE - SHELL SIDE	1/8 IN.	TUBE SIDE	1/8 IN.	
CODE REQUIREMENTS ASME VIII		TEMA CLASS R		

MARKS: (1) NOZZLE & SUPPORT LOCATION TO BE AS NOTED ON F.W. STD. 21B11.1
 (2) FOR GENERAL NOTES REFER TO REQ'N. 1590-1200A WHICH IS AN INTEGRAL PART OF THIS REQ'N
 (3) PROVIDE ONE 1 1/2" DISTRIBUTION PIPE AT SHELL INLET, AND ONE 6" DRY PIPE AT SHELL OUTLET. (4) UNIT
 SHALL BE POSTWELD HEAT TREATED, WELDED JOINTS SHALL BE FULLY RADIOGRAPHED AS PER UW 2(c) OF
 ASME VIII DIV. I (5) PROVIDE EXPANSION JOINT ON SHELL. (6) GAS COMP. (VOL %): 0.64 H₂O, 13.89 H₂, 19.67 CO,
 .85 CO₂, 4.05 CH₄, 53.38 N₂ (Wt) COS. 0.26 NH₃; GAS HAS DESIGN FLOW OF 300 LBS/HR OF <50 MICRON SOLIDS.

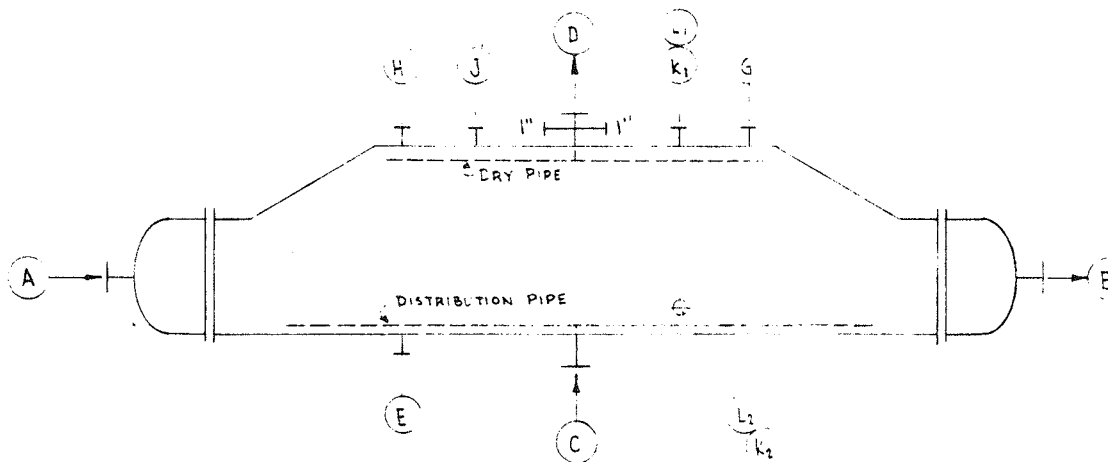
MATERIAL REQUISITION

FOSTER WHEELER CORPORATION

110 SOUTH ORANGE AVENUE, LIVINGSTON, N. J.

PAGE 2 OF 2

CONTRACT NO. 15-1591		REQ'N. NO. 1591-1211-G		DATE 2-18-76	
CUSTOMERS NAME UNITED STATES E.R.D.A. - FOSSIL ENERGY ITEM NO. E-113					
CHANGE NO.	C-1	C-2	C-3	C-4	C-5
DATE	4-5-76	5-13-76			



NO.	SIZE	SERVICE	REMARK
A	8"	RECYCLE GAS INLET	
B	8"	RECYCLE GAS OUTLET	
C	1½"	BOILER FEED WATER INLET	PROVIDE DISTRIBUTION PIPE
D	6"	STEAM OUTLET	PROVIDE DRY PIPE
E	1½"	INTERMITTENT BLOWDOWN	
G	1½"	VENT	
H	LATER	PSV	1 REQUIRED
J	..	PI	
K1, K2	..	LT, LSL, LAL, LSH, LAH	2 REQUIRED
L1, L2	..	LG	2 REQUIRED

REMARKS:

MATERIAL REQUISITION

FOSTER WHEELER CORPORATION

DOUBLE PIPE
EXCHANGERS

110 SOUTH ORANGE AVENUE, LIVINGSTON, N. J.

PAGE 1 OF 1

CONTRACT NO. 15-1591		REQ'N. NO. 1591-1221-A		DATE 2-18-76	
CUSTOMERS NAME UNITED STATES E.R.D.A. - FOSSIL ENERGY LOCATION SIOUX FALLS, SOUTH DAKOTA					
SUPERSEDED BY					
CHANGE NO.	C-1	C-2	C-3	C-4	C-5
DATE	4-5-76				
SERVICE OF UNIT SLIP STREAM AIR COOLER			ITEM NO. E-115		
SIZE		TYPE - BARE TUBE ☐		FINNED TUBE ☐	
SQ. FT. SURF./UNIT (BARE) (EXT'D)		SECTIONS/UNIT		SQ. FT. SURF./SECTION (BARE) (EXT'D)	
SECTION ARRANGEMENT -		SHELL SIDE PAR. BY		SER. TUBE SIDE PAR. BY	
PERFORMANCE OF ONE UNIT					
FLUID CIRCULATED		SHELL SIDE		TUBE SIDE	
TOTAL FLUID ENTERING		AIR WITH MOISTURE		COOLING WATER	
VAPOR		3,005 LB/HR		12,480 LB/HR	
LIQUID		LB/HR		LB/HR	
STEAM		27 LB/HR		12,480 LB/HR	
NON-CONDENSABLES		2,978 LB/HR		LB/HR	
FLUID (VAPORIZED)(CONDENSED)		LB/HR		LB/HR	
STEAM CONDENSED		23 LB/HR		LB/HR	
GRAVITY					
VISCOSITY Cps		DRY AIR 0.02 @ 110°F ; 0.028 @ 500°F			
MOLECULAR WEIGHT		DRY AIR 29			
SPECIFIC HEAT		DRY AIR 0.244 BTU/LB-°F		BTU/LB-°F	
THERMAL CONDUCTIVITY		BTU/HR-FT-°F		BTU/HR-FT-°F	
LATENT HEAT		MOISTURE 1124 BTU/LB		BTU/LB	
TEMPERATURE IN		500 (3) °F		85 °F	
TEMPERATURE OUT		100 (3) °F		110 °F	
OPERATING PRESSURE, INLET		577 (PSIG)		50 (PSIG)	
NO. PASSES PER SHELL					
VELOCITY		FT/SEC		FT/SEC	
PRESSURE DROP - ALLOW. CALC'D.		1.0 PSI PSI		10.0 PSI PSI	
FOULING RESISTANCE, MIN.		0.002		0.002	
HEAT EXCHANGED - BTU/HR.		312,000		MTD CORRECTED-°F	
TRANSFER RATE - SERVICE		CLEAN			
CONSTRUCTION OF ONE SECTION					
DESIGN PRESSURE		635 PSIG		100 PSIG	
TEST PRESSURE		PER CODE PSIG		PER CODE PSIG	
DESIGN TEMPERATURE		550 °F		160 °F	
DIA	TKNS	NOM. LENGTH	O.D. SCH.	O.D. SCH.	
MATERIAL		C.S.		C.S.	
CORROSION ALLOWANCE		1/8 IN.		(0.04" ON TUBES) IN.	
SECTION: NOZZLE SIZE, IN OUT		2" 2"		1 1/2" 1 1/2"	
NOZZLE RATING					
MANIFOLDS: BY VENDOR		YES ☐ NO ☐		YES ☐ NO ☐	
SIZE, IN OUT					
NOZZLE RATING					
NO. OF TUBES/SECT.		NO. OF FINS/TUBE		FIN MATERIAL	
CODE REQUIREMENTS ASME VIII		WEIGHT OF UNIT, EMPTY		FULL OF WATER	
REMARKS: (1) PROVIDE COMPANION FLANGES FOR ALL NOZZLES IF NOT ASA STANDARD					
(2) FOR GENERAL NOTES REFER TO REQ'N. 1590 - 1200 A WHICH IS AN INTEGRAL PART OF THIS REQ'N.					
(3) NORMAL INLET TEMP. IS 440°F AND OUTLET TEMP. IS 110°F.					

MATERIAL REQUISITION

SHELL & TUBE
EXCHANGERS

110 SOUTH ORANGE AVENUE, LIVINGSTON, N. J.

PAGE 1 OF 2

CONTRACT NO. 15-1591		REQ'N. NO 1591-1211-K		DATE 2-18-76	
CUSTOMER'S NAME UNITED STATES E.R.D.A. - FOSSIL ENERGY		LOCATION SIOUX FALLS, SOUTH DAKOTA			
SUPERSEDED BY					
CHANGE NO.	C-1	C-2	C-3	C-4	C-5
DATE	4-5-76	5-13-76			
SERVICE OF UNIT START-UP GAS CONDENSER			ITEM NO. E-116		
SIZE 35-240	TYPE BEM		CONNECTED IN -		
SQ. FT. SURF./UNIT 3892	SHELLS/UNIT ONE		SQ. FT. SURF./SHELL (EET) 3892		
CASE 1 PERFORMANCE OF ONE UNIT					
FLUID CIRCULATED		SHELL SIDE		TUBE SIDE	
TOTAL FLUID ENTERING		COOLING WATER		START-UP EFFLUENT GAS (4)	
VAPOR		3,312,000 LB/HR		142,850 LB/HR	
LIQUID		3,312,000 LB/HR		LB/HR	
STEAM		LB/HR		80,640 LB/HR	
NON-CONDENSABLES		LB/HR		62,210 LB/HR	
FLUID (VAPORIZED)(CONDENSED)		LB/HR		LB/HR	
STEAM CONDENSED		LB/HR		77,325 LB/HR	
GRAVITY LBS/Cu Ft	62 @ TANG.		0.42 @ INLET		
VISCOSITY CPS	0.2 @ TANG.		0.017 @ INLET		
MOLECULAR WEIGHT	18		22.0 @ INLET		
SPECIFIC HEAT	1.0 BTU/LB-°F		0.35 BTU/LB-°F		
THERMAL CONDUCTIVITY	0.393 @ TANG. BTU/HR-FT-°F		0.017 @ INLET BTU/HR-FT-°F		
LATENT HEAT	BTU/LB		978 BTU/LB		
TEMPERATURE IN	85 °F		343 °F		
TEMPERATURE OUT	110 °F		200 °F		
OPERATING PRESSURE, INLET	55 @ GRADE (PSIG)		147 (PSIG)		
NO. PASSES PER SHELL	ONE		ONE		
VELOCITY	FT/SEC		40 FT/SEC		
PRESSURE DROP - ALLOW. CALC'D.	15.0 PSI		10.0 PSI		
FOULING RESISTANCE, MIN.	0.002		0.001		
HEAT EXCHANGED - BTU/HR.	82,800,000		MTD CORRECTED-°F 167.11		
TRANSFER RATE SERVICE	127.3		CLEAN		
CONSTRUCTION OF ONE SHELL					
DESIGN PRESSURE	100 PSIG		485 PSIG		
TEST PRESSURE	PER CODE PSIG		PER CODE PSIG		
DESIGN TEMPERATURE	160 °F		450 °F		
TUBES SS 430	NO. 1022	O.D. 3/4"	BWG 16	LENGTH 20'	PITCH 15/16" Δ
SHELL C.S.	I.D. 35"	SHELL COVER (INTG)(REMOV)			
CHANNEL OR BONNET 410 "S" CLAD C.S. (5)	CHANNEL COVER				
TUBESHEET - STATIONARY 410 "S" CLAD C.S.	TUBESHEET - FLOATING				
BAFFLES - CROSS C.S. TYPE SEGMENTAL	FLOATING HEAD COVER				
BAFFLES - LONG TYPE	IMPINGMENT PROTECTION C.S.				
TUBE SUPPORTS					
TUBE TO TUBESHEET JOINT					
GASKETS					
CONNECTIONS - SHELL SIDE	IN 16"	OUT 16"	RATING 150 LBS RF		
CONNECTIONS - TUBE SIDE	IN 12"	OUT 12"	RATING 300 LBS RF		
CORROSION ALLOWANCE - SHELL SIDE 1/8	IN.	TUBE SIDE	IN.		
CODE REQUIREMENTS ASME VIII TEMA CLASS R					
REMARKS: (1) NOZZLE & SUPPORT LOCATION TO BE AS NOTED ON F.W. STD. 21B11.1					
(2) FOR GENERAL NOTES REFER TO REQ'N. 1590-1200A WHICH IS AN INTEGRAL PART OF THIS REQ'N					
(3) PROVIDE EXPANSION JOINT ON SHELL (4) INLET GAS COMP. (WT.%): 56.44 H ₂ O, 0.38 H ₂ , 1.89 CO, 13.24 CO ₂ , 28.05 N ₂ ; GAS MAY CONTAIN UP TO 40 LBS/HR OF < 5 MICRON CHAR. (5) BONNET CLADDINGS TO BE 5/64" THK. MIN.					

MATERIAL REQUISITION

SHELL & TUBE
EXCHANGERS

110 SOUTH ORANGE AVENUE, LIVINGSTON, N. J.

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CONTRACT NO. 15-1591		REQ'N. NO. 1591-1211-K		DATE 2-18-76	
CUSTOMER'S NAME UNITED STATES E.R.D.A. - FOSSIL ENERGY		LOCATION SIOUX FALLS, SOUTH DAKOTA			
SUPERSEDED BY					
CHANGE NO.	C-1	C-2	C-3	C-4	C-5
DATE	4-5-76				
SERVICE OF UNIT	START-UP GAS CONDENSER			ITEM NO. E-116	
SIZE 35-240	TYPE BEM		CONNECTED IN -		
SQ. FT. SURF. / UNIT	3892	SHELLS/UNIT	ONE	SQ. FT. SURF. / SHELL	3892
CASE II PERFORMANCE OF ONE UNIT					
FLUID CIRCULATED		SHELL SIDE		TUBE SIDE	
TOTAL FLUID ENTERING		COOLING WATER		START-UP EFFLUENT GAS (4)	
		2,609,130 LB/HR		153,250 LB/HR	
WATER		LB/HR		LB/HR	
LIQUID		2,609,130 LB/HR		LB/HR	
STEAM		LB/HR		69,500 LB/HR	
NON CONDENSABLES		LB/HR		83,150 LB/HR	
FLUID (VAPOR & LIQ) (CONDENSED)		LB/HR		LB/HR	
STEAM CONDENSE		LB/HR		62,000 LB/HR	
GRAVITY	LBS/CUFT			0.39 @ INLET	
VISCOSITY	CPS			0.017 @ INLET	
MOLECULAR WEIGHT				21.3 @ INLET	
SPECIFIC HEAT		BTU/LB-°F		0.355 BTU/LB-°F	
THERMAL CONDUCTIVITY		BTU/HR-FT-°F		0.017 @ INLET BTU/HR-FT-°F	
LATENT HEAT		BTU/LB		965.2 BTU/LB	
TEMPERATURE IN	85 °F			321 °F	
TEMPERATURE OUT	110 °F			222 °F	
OPERATING PRESSURE INLET	55 @ GRADE (PSIG)	(PSIG)		151 (PSIG)	
NO. PASSES PER SHELL	ONE			ONE	
VELOCITY		FT/SEC		42 FT/SEC	
PRESSURE DROP ALLOW. / CALC'D.	15.0 PSI	PSI		10.0 PSI	
FOULING RESISTANCE, MIN.	0.002			0.001	
HEAT EXCHANGE CAP. BTU/HR.	65,228,300	MTD CORRECTED °F		171.34	
TRANSFER RATE - SERVICE	97.8	CLEAN			
CONSTRUCTION OF ONE SHELL (As PER PAGE 1 OF 2)					
DESIGN PRESSURE	PSIG		PSIG		
TEST PRESSURE	PSIG		PSIG		
DESIGN TEMPERATURE	°F		°F		
TUBES	NO.	O.D.	BWG	LENGTH	PITCH
SHELL	I.D.	SHELL COVER		(INTEG)(REMOV)	
CHANNEL OR BONNET			CHANNEL COVER		
TUBESHEET - STATIONARY			TUBESHEET - FLOATING		
BAFFLES - CROSS	TYPE			FLOATING HEAD COVER	
BAFFLES - LONG	TYPE			IMPINGMENT PROTECTION	
TUBE SUPPORTS					
TUBE TO TUBESHEET JOINT					
GASKETS					
CONNECTIONS - SHELL SIDE	IN	OUT	RATING		
CONNECTIONS - TUBE SIDE	IN	OUT	RATING		
CORROSION ALLOWANCE - SHELL SIDE	IN	TUBE SIDE	IN.		
CODE REQUIREMENTS	TEMA CLASS				
REMARKS: (1) NOZZLE & SUPPORT LOCATION TO BE AS NOTED ON F.W. STD. 21B11.1					
(2) FOR GENERAL NOTES REFER TO REQ'N. WHICH IS AN INTEGRAL PART OF THIS REQ'N					

MATERIAL REQUISITION

SHELL & TUBE
EXCHANGERS

110 SOUTH ORANGE AVENUE, LIVINGSTON, N. J.

PAGE 1 OF 1

CONTRACT NO. 15-1591		REQ. N. NO. 1591-1211-AA		DATE 3-8-76	
CUSTOMER'S NAME UNITED STATES ERDA - FE		LOCATION SIOUX FALLS, S. DAKOTA			
SUPERSEDED BY					
CHANGE NO.	C-1	C-2	C-3	C-4	C-5
DATE	4-5-76				
SERVICE UNIT	STEAM SUPERHEATER			ITEM NO. E-118	
SIZE	31-192	TYPE BEM		CONNECTED IN SERIES	
SQ. FT. SURF. / UNIT	4600	SHELLS / UNIT	Two	SQ. FT. SURF. / SHELL (EFF.)	2300
PERFORMANCE OF ONE UNIT					
FLUID CIRCULATOR		SHELL SIDE		TUBE SIDE	
TOTAL FLUID ENTERING		STEAM		GASIFIER PRODUCT GAS (9)	
		79,864		197,783 (7)	
VAPOR		LB/HR		LB/HR	
LIQUID		LB/HR		LB/HR	
STEAM		79,864		13,633	
NON-CONDENSABLES		LB/HR		184,150	
FLUID (VAPOR) (CONDENSED)		LB/HR		LB/HR	
STEAM CONDENSED		LB/HR		LB/HR	
GRAVITY				0.035 @ 1000°F; 0.031 @ 690°F	
VISCOSITY, CPS				24.77 (WET GAS)	
MOLECULAR WEIGHT				(0.42 SOLID) 0.34 GAS	
SPEIFIC HEAT		BTU/LB-°F		BTU/LB-°F	
THERMAL CONDUCTIVITY		BTU/HR-FT-°F		BTU/HR-FT-°F	
LATENT HEAT		BTU/LB		BTU/LB	
TEMPERATURE IN		537 °F		996 (8) °F	
TEMPERATURE OUT		900 °F		692 (8) °F	
OPERATING PRESSURE, WET		920 (PSIG)		418 (PSIG)	
NO. OF SHELLS		ONE		ONE	
VELOCITY		FT/SEC		FT/SEC	
PRESSURE DROP, WET		15 PSI		10 PSI	
FOULING FACTOR, MIN.		0.0005		0.01	
HEAT EXCHANGED, BTU/HR		20,549,000		MTD CORRECTED-OF	
TRANSMISSION SERVICE		36.2		CLEAN	
CONSTRUCTION OF ONE SHELL					
DESIGN PRESSURE	1020	PSIG	462	PSIG	
TEST PRESSURE	PER CODE	PSIG	PER CODE	PSIG	
DESIGN TEMPERATURE	950	°F	1250 (INLET); 850 (OUTLET) (3)	°F	
TUBES INCOLOY 800	NO. 766	O.D. 3/4"	BWG 12	MIN. LENGTH 16'	PITCH 1" Δ
SHELL C.S.		I.D. 31"	SHELL COVER		(INTEG)(REMOV)
CHANNEL OR BONNET C.S. REFRACTORY LINED (3)(4)			CHANNEL COVER		
TUBESHEET - STATIONARY C.S. REFRACTORY LINED (4)(6)			TUBESHEET - FLOATING		
BAFFLES - CROSS C.S. TYPE SEGMENTAL			FLOATING HEAD COVER		
BAFFLES - LONG TYPE			IMPINGMENT PROTECTION C.S.		
TUBE SUPPORTS					
TUBE TO TUBESHEET JOINT STRENGTH WELDED					
GASKETS					
CONNECTIONS - SHELL SIDE	IN 8"	OUT 8"	RATING 2500 LBS RF		
CONNECTIONS - TUBE SIDE	IN 17" ID REFRACTORY	OUT 16" I.D.	RATING 300 LBS RF (4)		
CORROSION ALLOWANCE - SHELL SIDE	1/8 IN.	TUBE SIDE	1/8 IN.	ON C.S.	
CODE REQUIREMENTS ASME VIII			TEMA CLASS R		
REMARKS: (1) NOZZLE & SUPPORT LOCATION TO BE AS NOTED ON P.W. STD. 21B11.1					
(2) FOR GENERAL NOTES REFER TO REQ'N. 1590-1200A WHICH IS AN INTEGRAL PART OF THIS REQ'N					
(3) DESIGN TEMPERATURE FOR ALL CHANNELS TO BE 650°F. (4) TUBESIDE NOZZLES, CHANNELS, AND TUBESHEETS TO BE REFRACTORY LINED 4" VSL 50 AND 3" LOW ABRASE (A.P. GREEN) OR EQUAL. (5) UNIT SHALL BE POSTWELD HEAT TREATED. WELDED JOINTS SHALL BE FULLY RADIOGRAPHED AS PER UW2(c) OF ASME VIII DIV. I. (6) USE THIN TUBESHEET DESIGN AND PROVIDE EXPANSION JOINT ON SHELL. (7) GAS MAY CONTAIN UP TO 1180 LBS/HR OF <100% SOLIDS. (8) ALTERNATE CONDITION: INLET 1180°F OUTLET 780°F.					

 (9) GAS COMPOSITION: 9.5 H₂O, 12.4 H₂, 17.5 CO, 8.5 CO₂, 3.6 CH₄, 47.5 N₂, 0.5 H₂S, 0.5 C₂H₆ + NH₃

MATERIAL REQUISITION

SHELL & TUBE
EXCHANGERS

110 SOUTH ORANGE AVENUE, KINGSTON, N. Y.

PAGE 1 OF 1

CONTRACT NO. 15-1591		REQ'N. NO. 1591-1211-AB		DATE 3-8-76	
CUSTOMER'S NAME UNITED STATES ERDA - FE		LOCATION SIOUX FALLS, S. DAKOTA			
SUPERSEDED BY					
CHANGE NO.	C-1	C-2	C-3	C-4	C-5
DATE	4-5-76	5-13-76			
SERVICE OF UNIT BOILER FEEDWATER PREHEATER				ITEM NO. E-119	
SIZ 32-240	TYPE BEM		CONNECTED IN SERIES		
SQ. FT. OF UNIT 6390	SHELLS/UNIT Two		SQ. FT. SURF./SHELL (EFF) 3195		
PERFORMANCE OF ONE UNIT					
SHELL SIDE BOILER FEEDWATER		TUBE SIDE GASIFIER PRODUCT GAS (7)			
TOTAL FLOW INTER-M		80,671	LB/HR	197,783 (3)	LB/HR
VAPOR			LB/HR		LB/HR
LIQUID		80,671	LB/HR		LB/HR
HEAT			LB/HR	13,633	LB/HR
NON CONDENSABLES			LB/HR	184,150	LB/HR
FLUID (VAPOR OR LIQ) (CONDENSED)			LB/HR		LB/HR
STEAM CONDENSED			LB/HR		LB/HR
GRAVITY					
VISCOSITY, CPS				0.031 @ 690°F; 0.026 @ 300°F	
NO. OF TUBES		18		24.71 (WET GAS)	
SPECIFIC HEAT		1.093	BTU/LB-°F	0.336	BTU/LB-°F
THERMAL CONDUCTIVITY			BTU/HR-FT-°F		BTU/HR-FT-°F
LATENT HEAT			BTU/LB		BTU/LB
TEMPERATURE		240	°F	692 (6)	°F
TEMPERATURE		537	°F	300	°F
OPERATING PRESSURE INLET		1174	(PSIG)	406	(PSIG)
NO. TUBES PER SHELL		ONE		ONE	
VELOCITY			FT/SEC	56.8	FT/SEC
PRESSURE DROP SHELL CALC'D		10	PSI	10	PSI
FOULING RESISTANCE, MEN		0.001		0.01	
HEAT TRANSFER COEFFICIENT		26,193,000	MTD CORRECTED-°F	100.1	
TRANSF. RATE SERVICE		41	CLEAN		
CONSTRUCTION OF ONE SHELL					
DESIGN PRESSURE		1370	PSIG	462	PSIG
TEST PRESSURE		PER CODE	PSIG	PER CODE	PSIG
DESIGN TEMPERATURE		590	°F	850	°F
TUBES INCOLOY 800		NO. 849	O.D. 3/4"	BWG 10	LENGTH 20' PITCH 1" Δ
SHELL C.S.		I.D. 32"	SHELL COVER (INTEG)(REMOV)		
CHANNEL OR BONNET SS 410 S CLAD C.S. (8)		CHANNEL COVER			
TUBESHEET - STATIONARY SS 410 S CLAD C.S. (5)(8)		TUBESHEET - FLOATING			
BAFFLES CROSS C.S. TYPE SEGMENTAL		FLOATING HEAD COVER			
BAFFLES - LONG TYPE		IMPINGMENT PROTECTION C.S.			
TUBE SUPPORTS					
TUBE TO TUBESHEET JOINT STRENGTH WELDED					
GASKETS					
CONNECTIONS - SHELL SIDE		IN 4"	OUT 4"	RATING 900 LBS RF	
CONNECTIONS - TUBE SIDE		IN 1/8"	OUT 12"	RATING 600 LBS RF	
CORROSION ALLOWANCE - SHELL SIDE		1/8	IN.	TUBE SIDE	1/8 IN.
CODE REQUIREMENTS ASME VIII		TEMA CLASS R			
REMARKS: (1) NOZZLE & SUPPORT LOCATION TO BE AS NOTED ON F.W. STD. 21B11.1					
(2) FOR GENERAL NOTES REFER TO REQ'N. 1590-1200 A WHICH IS AN INTEGRAL PART OF THIS REQ'N					
(3) GAS MAY CONTAIN UP TO 1180 LBS/HR OF < 100μ SOLIDS (Cp = 0.42) (4) UNIT SHALL BE POSTWELD HEAT TREATED, WELDED					
JOINTS SHALL BE FULLY RADIOGRAPHED AS PER UW 2(c) OF ASME VIII DIV. I (5) USE THIN TUBESHEET DESIGN AND					
PROVIDE EXPANSION JOINT ON SHELL. (6) ALTERNATE INLET TEMP. 780°F. (7) GAS COMP. (VOL %): 9.5 H ₂ O, 12.4 H ₂ , 17.5 CO, 8.5					
CO ₂ , 3.6 CH ₄ , 47.5 N ₂ , 0.5 H ₂ S, 0.5 C ₆ S + NH ₃ . (8) DR 309 L/308 L WELD OVERLAY.					

FOSTER WHEELER CORPORATION

CENTRIFUGAL PUMPS PAGE 1 OF 1

FOR ERDA-FE-14-32-0001-1521 F.W. CONTRACT 15-1591

SITE NSP LAWRENCE STATION, SIOUX FALLS, SOUTH DAKOTA

SERVICE GASIFIER COOLING WATER PUMP

NO. REQ'D 2 ITEM NOS. P-104 A/B

NO. OF MOTORS REQ'D 2 : ITEM NOS.

SUPPLIED BY PUMP MFR MOUNTED BY PUMP MFR

NO. OF TURBINES REQ'D : ITEM NOS.

SUPPLIED BY MOUNTED BY

PUMP MFR.

SIZE & MODEL

NO. STAGES

OPERATING CONDITIONS, EACH PUMP:

LIQUID BOILER FEED WATER

U.S.GPM @ PT: MIN NORM 475

RTD. 523

DISCH. PSIG

RTD. 115

P.T. °F. (MAX 166) 166

SUCT. PSIG (MAX 32.8)

RTD. 31

SP. GR. AT PT 0.98

DIFF. PSI

RTD. 84

VAP. PSIA @ PT 5.5

TOTAL DIFF. HEAD, FT.

RTD. 198

VIS. @ PT 0.4 CPS

NPSHA, FT.

RTD. 95

CORR./EROS. FROM

HYD HP 26

CONSTRUCTION SIMILAR TO PENDING ANSI STANDARD

NOZZLES	SIZE	ANSI RATING	FACING	LOCATION
SUCTION		300	RF	SIDE
DISCHARGE		300	RF	SIDE

CASE-MOUNT ☐ CENTERLINE ☐ FOOT ☐ BRACKET ☒ IN-LINE ☐-SPLIT: ☐ AXIAL ☒ RADIAL-VOLUTE: ☐ SINGLE ☒ DOUBLE ☐ DIFFUSER ☐

-DESIGN: PSIG @ °F. HYDRO TEST PSIG

-AUX. CONNECTS: ☒ VENTS ☒ DRAINS ☐ GAGES ☐

IMPELLER: DIA.: RATED , MAX. , MIN. TYPE

MOUNTING ☐ BETWEEN BEARINGS ☐ OVERHUNG ☐WEAR RINGS: ☐ INLET ONLY ☐ BOTH SIDES ☐ CASE ONLY ☐ CASE & IMPELL.

BEARINGS: TYPE: RADIAL - BALL IN DRIVER, THRUST = BALL IN DRIVER

LUBE: ☐ RING ☐ FLOOD ☐ FLINGER ☐ MIST ☐ PRESSURE

COUPLING: MFR: MODEL: RIGID SPACER

DRIVER 1/2 MTD BY: ☒ PUMP MFR. ☐ DRIVER MFR. ☐ PURCH.

GUARD TYPE:

PACKING: MFR & TYPE SIZE NO. RINGS

MECH. SEAL: MFR & MODEL MFR'S CODE API CODE USPXL*

CRANE OR EQUAL

* SEAL GASKET MTL: ETHYLENE PROPYLENE

AUXILIARY PIPING:

C.W. PIPE PLAN , WITH ☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPETOTAL C.W. REQ'D GPM. INCLUDE: ☐ FLOW INDIC. ☐ VALVE "C"

PACKING INJECTION: FLUID= @ °F. REQ'D= GPM @ PSIG

SEAL FLUSH PLAN 11 , WITH ☒ C.S. ☐ S.S. ☒ TUBING ☐ PIPE

EXT. FLUSH FLUID= @ °F. REQ'D= GPM @ PSIG

AUX. SEAL PLAN , WITH ☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPE

QUENCH FLUID=

MOTOR DRIVERS:

HP , S.F. , RPM , FRAME , 460 V 3 PH 60 HZ

MFR. BEARINGS LUBE

TYPE INSUL. CLASS B

AMPS, FULL LOAD

ENCL. XP RISE °C 80

AMPS, LOCKED ROTOR

VERT. UNITS: ☐ VSS ☐ VHS THRUST CAP., LBS. UP DN.

TURBINE DRIVERS:

☐ IF BY PUMP VENDOR SEE PAGE ATTACHED☐ IF BY OTHERS: MFR.

MODEL

BHP

APPLICABLE DOCUMENTS: 1520-1300A, 1590-38A1, 1520-52A2, 1520-50A4, 1520-92A1

1520-31A2

REQUISITION NO. DATE

1591-1311-A 1-23-76

SUPERSEDED BY CHANGE NO.

C1 2-6-76 C3 C5

C2 4-20-76 C4 C6

PERFORMANCE

PROPOSAL CURVE NO.

RPM NPSHR (WATER), FT.

MIN. CONTINUOUS U.S.GPM

ROTATION, VIEWING FROM COUPLING

WITH RATED IMPELLER:

EFFICIENCY AT RATED POINT, %

IF EFF. IS VISCOUS, WATER EFF. =

BHP: RATED NORM MAX

IF HP IS VISC., RATED WATER BHP =

MAX. TOTAL HEAD, FT.

MAX. POSSIBLE DISCH. PRESS.: PSIG

WITH RATED SUCT. PRESS. =

WITH MAX. SUCT. PRESS. =

SHOP TESTS:

PERFORMANCE

REQUIRED WITNESSED

YES NO

NPSHR

DISMANTLE & INSPECT

HYDROTEST CASE

YES NO

HYDROTEST BOWLS

MATERIALS:

☒ PUMP API CLASS S-1☐

BASE PLATE

VERTICAL PUMPS

THRUST, LBS. UP, DOWN

OTHER DETAILS PER PAGE NO.

APPROX. WEIGHTS

(LBS NET EACH)

PUMP ONLY

MOTOR

BASE

TURBINE

SITE DATA

AMBIENT +23 °F MAX TO -25 °F MIN.

INSTALLED ☒ OUTDOORS ☐ INDOORS☒ CL II - GRF - DIV 2. ☐ NON-HAZARDOUS

COOLING WATER: TYPE

°F & PSIG IN, °F MAX & PSIG OUT

FOSTER WHEELER CORPORATION

CENTRIFUGAL PUMPS

PAGE / OF /

FOR <u>ERDA-FE-14-32-0001-1521</u>	F.W. CONTRACT <u>15-1591</u>	REQUISITION NO. <u>1591-1311-W</u>	DATE <u>2-27-75</u>
SITE <u>NSP LAWRENCE STATION, SIOUX FALLS, SOUTH DAKOTA</u>	SUPERSEDED BY CHANGE NO.		
SERVICE <u>START-UP RE-CIRCULATING WATER PUMP</u>	C1 <u>4-20-76</u>	C3	C5
NO. REQ'D <u>2</u>	ITEM NOS. <u>P-115A/B</u>	C2	C6

NO. OF MOTORS REQ'D. 2 : ITEM NOS. _____ SUPPLIED BY PUMP MFR MOUNTED BY PUMP MFR

NO. OF TURBINES REQ'D _____ : ITEM NOS. _____ SUPPLIED BY _____ MOUNTED BY _____

PUMP MFR. _____ SIZE & MODEL _____

NO. STAGES _____

OPERATING CONDITIONS, EACH PUMP:

LIQUID <u>WATER</u>	U.S.GPM @ PT: MIN _____ NORM <u>200</u> RTL <u>220</u>	PROPOSAL CURVE NO. _____
P.T. °F. (MAX <u>222</u>) <u>222</u>	DISCH. PSIG _____	RTD <u>591</u> RPM _____ NPSHR (WATER), FT. _____
SP.GR. AT PT <u>0.96</u>	SUCT. PSIG (MAX. <u>488</u>)	RTD <u>452</u> MIN. CONTINUOUS U.S.GPM _____
VAP. PSIA @ PT <u>17.2</u>	DIFF. PSI <u>139</u>	ROTATION, VIEWING FROM COUPLING _____
VIS. @ PT <u>0.3 cP</u>	TOTAL DIFF. HEAD, FT. <u>335</u>	
CORR./EROS. FROM <u>H₂S, CO₂, NH₃, CO₂</u>	NPSHA, FT. <u>25</u>	
	HYD HP <u>17.9</u>	

CONSTRUCTION

NOZZLES	SIZE	ANSI RATING	FACING	LOCATION
SUCTION		<u>300</u>	<u>1"</u>	<u>1"</u>
DISCHARGE		<u>300</u>	<u>1"</u>	<u>1"</u>

CASE-MOUNT ☐ CENTERLINE ☐ FOOT ☐ BRACKET ☒ IN-LINE ☐-SPLIT: ☐ AXIAL ☒ RADIAL-VOLUTE: ☒ SINGLE ☐ DOUBLE ☐ DIFFUSER ☐

-DESIGN: _____ PSIG @ _____ °F. HYDRO TEST _____ PSIG

-AUX. CONNECTS: ☒ VENTS ☒ DRAINS ☐ GAGES ☐

IMPELLER: DIA.: RATED _____, MAX. _____, MIN. _____ TYPE _____

MOUNTING ☐ BETWEEN BEARINGS ☐ OVERHUNG ☐WEAR RINGS: ☐ INLET ONLY ☐ BOTH SIDES ☐ CASE ONLY ☐ CASE & IMPELL.BEARINGS: TYPE: RADIAL ☒ BALL BEARING, THRUST = 2000 LBS.LUBE: ☐ RING ☐ FLOOD ☐ FLINGER ☐ MIST ☐ PRESSURECOUPLING: MFR: _____ MODEL: 1-11-125KDRIVER 1/2 MTD BY: ☒ PUMP MFR. ☐ DRIVER MFR. ☐ PURCH.

GUARD TYPE: _____

PACKING: MFR & TYPE _____ SIZE _____ NO. RINGS _____

MECH. SEAL: MFR & MODEL _____ MFR'S CODE _____ API CODE BSTXL* SEAL GASKET MTL: ETHYLENE PROPYLENE

AUXILIARY PIPING:

C.W. PIPE PLAN _____, WITH ☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPETOTAL C.W. REQ'D. _____ GPM. INCLUDE: ☐ FLOW INDIC. ☐ VALVE "C"

PACKING INJECTION: FLUID= _____ @ _____ °F. REQ'D= _____ GPM @ _____ PSIG

SEAL FLUSH PLAN 21, WITH ☐ C.S. ☒ S.S. ☒ TUBING ☐ PIPE

EXT. FLUSH FLUID= _____ @ _____ °F. REQ'D= _____ GPM @ _____ PSIG

AUX. SEAL PLAN _____, WITH ☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPE

QUENCH FLUID= _____

MOTOR DRIVERS:

HP _____, S.F. _____, RPM _____, FRAME _____, 460 V/ 3 PH/ 60 HZ

MFR. _____ BEARINGS _____ LUBE _____

TYPE _____ INSUL. CLASS B AMPS, FULL LOAD _____ENCL. XP RISE °C 30 AMPS, LOCKED ROTOR _____VERT. UNITS: ☐ VSS ☐ VHS THRUST CAP., LBS. _____ UP _____ DN. _____

TURBINE DRIVERS:

☐ IF BY PUMP VENDOR SEE PAGE _____ ATTACHED☐ IF BY OTHERS: MFR. _____ MODEL _____ BHP _____LICABLE DOCUMENTS: 1590-1300A, 1590-38A1, 1590-50A2, 1590-50A4, 1590-92A11590-31A1

PERFORMANCE

WITH RATED IMPELLER:

EFFICIENCY AT RATED POINT, % _____

IF EFF. IS VISCOUS, WATER EFF. = _____

BHP: RATED _____ NORM _____ MAX _____

IF HP IS VISC., RATED WATER BHP = _____

MAX. TOTAL HEAD, FT. _____

MAX. POSSIBLE DISCH. PRESS.: _____ PSIG

WITH RATED SUCT. PRESS. = _____

WITH MAX. SUCT. PRESS. = _____

SHOP TESTS:

PERFORMANCE REQUIRED WITNESSEDNPSHR EC NO

DISMANTLE & INSPECT

HYDROTEST CASE EC NO

HYDROTEST BOWLS

MATERIALS:

☐ PUMP API CLASS C-6☐

BASE PLATE

VERTICAL PUMPS

THRUST, LBS. _____ UP, _____ DOWN

OTHER DETAILS PER PAGE NO. _____

APPROX. WEIGHTS

(LBS NET EACH)

PUMP ONLY _____ MOTOR _____

BASE _____ TURBINE _____

SITE DATA

AMBIENT 93 °F MAX TO 25 °F MIN.INSTALLED ☒ OUTDOORS ☐ INDOORS☒ CL II - GR F-DIV 2 ☐ NON-HAZARDOUS

COOLING WATER: TYPE _____

°F & PSIG IN, °F MAX & PSIG OUT

FOSTER WHEELER ENERGY CORP.

110 SOUTH ORANGE AVENUE, LIVINGSTON, N.J.

CENTRIFUGAL COMPRESSORS

PAGE 1 OF 9

MATERIAL REQUISITION

FOR ERDA-FE-14-32-0001-1521 FW REF. 15-1571
 SITE NSP-LAWRENCE STATION, SIOUX FALLS, S.DAK. TA
 SERVICE RECYCLE GAS COMPRESSOR ITEM NO. C-102
 MFR.

REQUISITION NO. 1541-1321-A
 DATE 4-5-76

SIZE AND TYPE NO. REQD. ONE
 DRIVER: ☐ MOTOR, ☒ STEAM TURBINE, ☐
 GENERAL NOTES REQUISITION 1590-1300-A IS AN
 INTEGRAL PART OF THIS REQUISITION.

SUPERSEDED BY
 CHG. DATE CHG. DATE
 C1 4-12-76 C4
 C2 C5
 C3 C6

SPECIFICATIONS: CENTRIFUGAL COMPRESSORS AND ATTENDANT
 EQUIPMENT COVERED IN THIS REQUISITION SHALL BE FURNISHED IN
 ACCORDANCE WITH THE FOLLOWING SPECIFICATIONS:

1590-32A1 CENT. COMPRESSORS 1590-39A2 LUBE & SEAL OIL
 1590-38A1 IND. MOTORS 1590-50A2 & GASKETS
 1590-38A2 GEN. PURP. TURBINES 1590-92A1 PREP. FOR SHIPMENT
 1590-38A3 SPEC. PURP. TURBINES

INSTALLATION: UNIT WILL BE INSTALLED IN AN

☒ OUTDOORS-UNPROTECTED LOCATION,
☐ ENCL. BLDG., ☐

AT ☒ GRADE, ☐ MEZZANINE LEVEL.

BAROMETER 14.0 Psia. ALTITUDE 1315 FT.

AMB. TEMP. +93 OF MAX., -25 OF MIN.

CONDITIONS OF SERVICE FOR EACH MACHINE

	DESIGN	TURNDOWN	TALE UP
GAS HANDLED (SEE ANALYSIS BELOW)	RECYCLE GAS	RECYCLE GAS	NITROGEN
RELATIVE HUMIDITY, %	SEE COMPOSITION BELOW		
MOLECULAR WEIGHT	(1) 23.90	24.72	28.0
Cp/Cv @ OF	(1) 1.38	1.38	1.40
COMPRESSIBILITY FACTOR @ INLET Z1	(1) 1.0	1.0	1.0
COMPRESSIBILITY FACTOR @ DISCH Z2			
SCFM @ 14.7 Psia & 60 OF: ☐ DRY, ☐ WET.			
FM @ INLET CONDITIONS	778.4	606	600
WEIGHT FLOW, Lb/MM. HR	70,496	21,362	25,635
INLET PRESSURE, Psia	393	132	158
INLET TEMPERATURE, OF	120	120	120
DISCH. PRESSURE, Psia	496	165	200
DISCH. TEMPERATURE, OF			
POLYTROPIC HEAD Ft.-Lb/Lb.			
COMPRESSOR BHP			
COMPRESSOR RPM			
BHP REQUIRED AT DRIVER SHAFT			
DRIVER RATED HP			
EST. SURGE CAPACITY @ RATED RPM, ICFM			
DISCH. TEMP. AT SURGE CAPACITY			
PERFORMANCE CURVE NO.			

GAS ANALYSIS

COMPOSITION	MOL. WT.	MOL. %	MOL. %	MOL. %	MOL. %
H ₂ O		0.44	0.47	0	
H ₂		13.91	15.04	0	
CO		12.70	20.58	0	
CO ₂		7.87	7.29	0	
CH ₄		4.06	4.24	0	
N ₂		53.48	52.35	100.0	
COS+H ₂ S ①		.27	.02	0	
NH ₃		.27	.01	0	
TOTAL		100.00	100.00	100.0	

GAS CONTAINS H₂S, CO₂, NH₃, CHAR DUST ②

COMMENTS REGARDING GAS HANDLED: ① VENDOR T ② CHAR DUST (0.15%
 OF < 5 MICRON SIZE HAVING A MAXIMUM PARTICLE DENSITY OF 60 LB/FT.
 ③ H₂S CONTENT MAY BE AS HIGH AS 0.54% BY VOLUME

FOSTER WHEELER ENERGY CORP.

110 SOUTH ORANGE AVENUE, LIVINGSTON, N.J.

CENTRIFUGAL COMPRESSORS

PAGE 2 OF 9

MATERIAL REQUISITION

FOR ERDA FE-14-32-0001-1521 FW REF. 15-1591

SITE NSP-LAWRENCE STATION, SIOUX FALLS, SOUTH DAKOTA

SERVICE RECYCLE GAS COMPRESSOR ITEM NO. C-102

MATERIAL

SIZE AND TYPE NO. REQD.

DRIVER: ☐ MOTOR, ☐ STEAM TURBINE, ☐ IS AN

GENERAL NOTES REQUISITION

INTEGRAL PART OF THIS REQUISITION.

REQUISITION NO.

DATE

1591-1321-A 4-5-76

SUPERSEDED BY

CHG.

DATE

CHG.

DATE

C1

4-12-76

C4

C2

C5

C3

C6

CONSTRUCTION DETAILS

MANUFACTURERS DATA: MODEL . CASING SPLIT: ☐ HORIZ., ☒ VERT. NO. STAGES 1IMPELLERS: TYPE: ☐ ENCLOSED - BACKWARD LEANING, ☐ DIA. IN.CONSTRUCTION: ☐ CAST, ☐ RIVETED, ☐ WELDED, ☐ MILLED, ☐ TIP SPEED FPS

SPEED DATA: MAX. CONT. RPM. FIRST CRITICAL RPM. SECOND CRITICAL RPM.

COMPRESSOR ROTATION: VIEWED FROM DRIVER END OF UNIT: ☐ CW, ☐ CCW.

MATERIALS OF CONSTRUCTION:

CASING: ☒ CAST STEEL, ☐ FORGED STEEL, ☐ CAST IRON, ☐

DIAPHRAGMS: INTERSTAGE LABYRINTHS:

IMPELLERS: SHAFT: SLEEVES:

OTHER:

TEMPERATURE AND PRESSURE LIMITATIONS:

MAX. WORKING TEMP: SUCTION END OF. DISCH. END. OF.

MIN. WORKING TEMP: SUCTION END. OF. DISCH. END. OF.

MAX. WORKING PRESS: SUCTION END Psig. DISCH. END Psig.

HYDRO. TEST PRESS: SUCTION END Psig. DISCH. END Psig.

FLANGE RATINGS:

CONNECTION	SIZE (IN.)	ASA RATING	FACING	UP	DN	RT	LF	OTHER
MAIN SUCTION				☐	☐	☐	☐	AXIAL
MAIN DISCHARGE				☒	☐	☐	☐	
				☐	☐	☐	☐	
				☐	☐	☐	☐	

ALL FLANGE ORIENTATIONS ARE VIEWED FROM THE DRIVER END OF THE UNIT. ALLOWABLE FLANGE LOADINGS SHALL BE INDICATED ON THE VENDORS CERTIFIED DRAWINGS.

SHAFT SEAL: ☐ LABYRINTH, ☐ RESTRICTIVE RING, ☒ LIQUID FILM, ☐ MECHANICAL (CONTACT).SEALING MEDIUM: ☒ OIL, ☐ AIR, ☐ INERT GAS, ☐BEARINGS: BEARING HOUSING CONSTRUCTION: ☐ INTERNAL, ☒ EXTERNAL.JOURNAL BEARING TYPE: ☒ BABBITTED SLEEVE, ☐LUBE: ☒ FORCE FEED, ☐ RING OIL, ☐THRUST BEARING TYPE: ☐ SINGLE KINGSBURY, ☒ DOUBLE KINGSBURY, ☐ BALL,☐ ROLLER ☐LUBE: ☒ FORCE FEED ☐ RING OIL, ☐

CASING DRAINS: QUANTITY 5. SIZE 3/4". VENDOR SHALL FURNISH

☒ VALVED, ☐ PLUGGED, ☐ BLIND FLANGE, ☐ CONNECTIONS.BASEPLATE: SUPPLIED BY ☒ COMPRESSOR VENDOR, ☐TYPE: ☐ CONTINUOUS STRUCTURAL STEEL COMMON TO COMPRESSOR AND DRIVE UNIT.PROVIDED WITH DRIP PAN ☒ YES, ☐ NO.COUPLINGS: SUPPLIED BY ☒ COMPRESSOR VENDOR, ☐

LOCATION:	COMP. TURBINE			
MFG:	FAST (ON STEEL)			
TYPE:	SEMI			
LUBE:	OIL			

COUPLING GUARDS: SUPPLIED BY ☒ COMPRESSOR VENDOR, ☐TYPE: ☐ SHEET METAL, ☒ NON-SPARKING, ☐

COMMENTS REGARDING CONSTRUCTION DETAILS:

FOSTER WHEELER CORPORATION

110 SOUTH ORANGE AVENUE, LIVINGSTON, N.J.

CENTRIFUGAL COMPRESSORS

PAGE 3 OF 9

FOR ERDA-FE-14-32-0001-1521 PW REF. 15-1591

SITE NSP-LAWRENCE STATION, SIOUX FALLS, SOUTH DAKOTA

SERVICE RECYCLE GAS COMPRESSOR ITEM NO. C-102

REQUISITION NO.

DATE

1591-1321-1 4-5-76

SUPERSEDED BY

MATERIAL

SIZE AND TYPE

NO. REQD.

CHG.

DATE

CHG.

DATE

DRIVER: ☐ MOTOR, ☐ STEAM TURBINE, ☐

C1

4-12-76

C4

GENERAL NOTES REQUISITION

IS AN

C2

C5

INTEGRAL PART OF THIS REQUISITION.

C3

C6

LUBE AND SEAL OIL SYSTEMS: A FORCE FEED LUBE OIL SYSTEM COMMON TO THE ☒ COMPRESSOR,

☐ GEAR, ☒ DRIVER, WITH ☒ A COMBINED, ☐ A SEPARATE, NO SEAL OIL SYSTEM, SHALL BE

FURNISHED BY THE COMP. MFR. IN ACCORDANCE WITH API 617 FIG. A-32

LUBE & SEAL OIL SYSTEM

SYSTEM OPERATING PRESS. Psig.

SYSTEM MAX. ALLOW OPER. PRESS. Psig.

RESERVOIR: LOCATED ☐ IN BASE, ☒ ON CONSOLE.

CAPACITY GAL. RET. TIME MIN.

TO BE FURNISHED WITH ☒ ELECTRIC, ☐ STEAM

HEATER, ☐ INSULATION SUPPORTS AND

MAIN LUBE OIL PUMP: LOCATED ON ☐ BASE,

☒ CONSOLE AND DRIVEN BY ☐ SHAFT,

☒ INDUCTION MOTOR, ☐ STEAM TURBINE.

MFR. DELAVAL MODEL

TYPE 415 CASE MATL. STEEL

GPM RPM BHP

AUX. LUBE OIL PUMP: LOCATED ON ☐ BASE,

☒ CONSOLE AND DRIVEN BY ☐ SHAFT,

☐ INDUCTION MOTOR, ☒ STEAM TURBINE.

MFR. DELAVAL MODEL

TYPE 1MO CASE MATL. STEEL

GPM RPM BHP

RELIEF VALVES: ☐ INTEGRAL, ☒ SEPARATE.

COOLERS: ☒ TWIN, ☐ SINGLE, LOCATED ON

BASE, ☒ CONSOLE,

MFR. TYPE

CODE: ☒ TEMA C,

SHELL: OD IN. DES. PRESS. Psig.

TUBES: OD IN. BWG

MATL: SHELL TUBES

FILTERS: ☒ TWIN, ☐ SINGLE, LOCATED ON

BASE, ☒ CONSOLE,

MFR. MODEL

CASE MATL. STEEL MICRON

ELEMENT: ☒ CLEANABLE, ☐ REPLACEABLE.

TRANSFER VALVES: MFR. KAISER

QUAN. ONE TYPE MATL.

SOUR OIL TRAPS: REQD. ☒ YES, ☐ NO. LOCATED ON ☐ BASE, ☐ CONSOLE, ☒ BY PURCHASER. NOTE ④

PIPING BY ☒ COMP. VENDOR, ☐ PURCHASER. SEAL OIL LOSS GAL./DAY/SEAL MAX.

OVHD. SEAL OIL TANK: REQD. ☒ YES, ☐ NO. LOCATED FT. ABOVE COMP. CENTER LINE.

MTD. BY ☐ COMP. VENDOR, ☒ PURCHASER.

CLARIFIER: REQD. YES, ☒ NO. LOCATED ON ☐ BASE, ☐ CONSOLE, ☐ BY PURCHASER.

PIPING BY ☐ COMP. VENDOR, ☐ PURCHASER. BYPASS GPM. MFR.

PIPING: ☒ CARBON STEEL PICKLED AND CLEANED, ☐ STAINLESS STEEL, ☐

STAINLESS STEEL DRAIN LINES,

OTHER:

④ TRAP LOCATED ON SKID PIPED BY COMPRESSOR VENDOR

SEAL OIL SYSTEM

SYSTEM OPERATING PRESS. Psig.

SYSTEM MAX. ALLOW OPER. PRESS. Psig.

RESERVOIR: LOCATED ☐ IN BASE, ☐ ON CONSOLE.

CAPACITY GAL. RET. TIME MIN.

TO BE FURNISHED WITH ☐ ELECTRIC, ☐ STEAM

HEATER, ☐ INSULATION SUPPORTS AND

MAIN SEAL OIL PUMP: LOCATED ON ☐ BASE,

CONSOLE AND DRIVEN BY ☐ SHAFT,

☐ INDUCTION MOTOR, ☐ STEAM TURBINE.

MFR. MODEL

TYPE CASE MATL.

GPM RPM BHP

AUX. SEAL OIL PUMP: LOCATED ON ☐ BASE,

☐ CONSOLE AND DRIVEN BY ☐ SHAFT,

☐ INDUCTION MOTOR, ☐ STEAM TURBINE.

MFR. MODEL

TYPE CASE MATL.

GPM RPM BHP

RELIEF VALVES: ☐ INTEGRAL, ☐ SEPARATE.

COOLERS: ☐ TWIN, ☐ SINGLE, LOCATED ON

BASE, ☐ CONSOLE,

MFR. TYPE

CODE: ☐ TEMA C,

SHELL: OD IN. DES. PRESS. Psig.

TUBES: OD IN. BWG

MATL: SHELL TUBES

FILTERS: ☐ TWIN, ☐ SINGLE, LOCATED ON

☐ TWIN, ☐ CONSOLE,

MFR. MODEL

CASE MATL. MICRON

ELEMENT: ☐ CLEANABLE, ☐ REPLACEABLE.

TRANSFER VALVES: MFR.

QUAN. TYPE MATL.

FOSTER WHEELER CORPORATION

110 SOUTH ORANGE AVENUE, LIVINGSTON, N.J.

CENTRIFUGAL COMPRESSORS

MATERIAL REQUISITION

PAGE 4 OF 9

FOR ERDA-FE-14-32-0001-1521 FW REF. 15-1591
SITE NSP-LAWRENCE STATION, SIOUX FALLS, SOUTH DAKOTA
SERVICE RECYCLE GAS COMPRESSOR ITEM NO. C-102

MATERIAL

SIZE AND TYPE _____ NO. REQD. _____

DRIVER: ☐ MOTOR, ☐ STEAM TURBINE, ☐ _____

GENERAL NOTES REQUISITION _____ IS AN

INTEGRAL PART OF THIS REQUISITION.

REQUISITION NO.

DATE

1591-1321-A

4-5-76

SUPERSEDED BY

CHG.	DATE	CHG.	DATE
C1	4-12-76	C4	
C2		C5	
C3		C6	

INSTRUMENTATION

LOCAL COMPRESSOR PANEL:

FURNISHED BY ☒ COMP. VENDOR, ☐ PURCHASER, ☐ NOT REQD.

PURCHASERS ELECTRICAL AND INSTRUMENT CONNECTIONS SHALL BE ☒ BROUGHT OUT TO TERMINAL BOXES
BY THE COMP. VENDOR, ☐ MADE BY THE PURCHASER.

GAGES AND INDICATORS:

PRESSURE GAGES:	MFR. _____	SIZE AND TYPE _____
TEMPERATURE GAGES:	MFR. _____	SIZE AND TYPE _____
LEVEL INDICATORS:	MFR. _____	SIZE AND TYPE _____
SIGHT FLOW INDICATORS:	MFR. _____	SIZE AND TYPE _____
TACHOMETER:	MFR. _____	SIZE AND TYPE _____
	MFR. _____	SIZE AND TYPE _____

INSTRUMENTATION: COMPRESSOR VENDOR SHALL FURNISH THE FOLLOWING:

	LOCAL	PANEL		LOCAL	PANEL
PRESSURE GAGES:					
☒ OIL PUMP DISCHARGE	☒	☐	☐ MAIN STEAM INLET	☐	☐
☒ LUBE OIL EACH LEVEL	☒	☐	☐ FIRST STAGE STEAM	☐	☐
☒ SEAL OIL EACH LEVEL	☒	☐	☐ STEAM EXHAUST	☐	☐
☒ SEAL OIL DIFF.	☒	☐	☐ _____	☐	☐
☒ BEFORE/AFTER FILTERS	☒	☐	☐ _____	☐	☐
☒ CONTROL OIL	☒	☐	☐ _____	☐	☐

TEMPERATURE GAGES:

☒ OIL OUTLET EACH BRG.	☒	☐	☐ _____	☐	☐
☒ OIL OUTLET EACH SEAL	☒	☐	☐ _____	☐	☐
☒ BEFORE/AFTER COOLERS	☒	☐	☐ _____	☐	☐

SWITCHES:

	ALARM	TRIP		ALARM	TRIP
☒ LOW LUBE OIL PRESS.	☒ *	☒ *	☐ COMP. HIGH DISCH. TEMP.	☒ *	☒ *
☒ LOW SEAL OIL PRESS.	☒ *	☒ *	☐ _____	☐	☐
☒ LOW OIL RES. LEVEL	☒ *	☐	☐ _____	☐	☐
☒ LOW CONTROL OIL PRESS.	☒ *	☐	☐ _____	☐	☐
☒ AUX. PUMP START	☒ *	☐	☐ _____	☐	☐

OTHER:

☒ REMOTE SHUTDOWN: ☒ ELECTRICAL, ☐ HYDRAULIC, ☐ PNEUMATIC.
☒ SIGHT FLOW EACH BEARING AND SEAL OIL RETURN LINE.
☒ OIL RESERVOIR LEVEL.
☐ _____, ☐ _____

ALARM CONTACTS SHALL ☒ OPEN, ☐ CLOSE TO SOUND ALARM. SHUTDOWN CONTACTS SHALL
☒ OPEN, ☐ CLOSE TO SHUTDOWN.

WHERE INDICATED BY (*), ALARM LIGHTS SHALL BE FURNISHED BY THE COMPRESSOR VENDOR AND MOUNTED ON THE LOCAL
PANEL WITH ALL NECESSARY RELAY DEVICES.

PURCHASERS ELECTRICAL AND INSTRUMENT CONNECTIONS WITHIN THE CONFINES OF THE BASEPLATE AND CONSOLE SHALL
BE ☒ BROUGHT OUT TO TERMINAL BOXES, ☐ MADE DIRECTLY BY THE PURCHASER.

COMMENTS REGARDING INSTRUMENTATION: VENDOR TO IDENTIFY INSTRUMENTATION
AS TO MODEL + MAKE. ALL INSTRUMENTS WILL BE SUBJECT TO
PURCHASERS APPROVAL.

FOSTER WHEELER CORPORATION
110 SOUTH ORANGE AVENUE, LIVINGSTON, N.J.

CENTRIFUGAL COMPRESSORS

MATERIAL REQUISITION

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FOR ERDA FE 14-32-0001-1521 FW REF. 15-1591
SITE NCP-LAWRENCE STATION, SIOUX FALLS, SOUTH DAKOTA
SERVICE RECYCLE GAS COMPRESSOR ITEM NO. C-102

MATERIAL

SIZE AND TYPE _____ NO. REQD. _____
DRIVER: ☐ MOTOR, ☐ STEAM TURBINE, ☐ _____
GENERAL NOTES REQUISITION _____ IS AN
INTEGRAL PART OF THIS REQUISITION.

REQUISITION NO.		DATE	
1591-1321-A		4-5-76	
SUPERSEDED BY			
CHG.	DATE	CHG.	DATE
C1	4-12-76	C4	
C2		C5	
C3		C6	

CONTROL

NORMAL OPERATING: DISCHARGE THROTTLE VALVES

SURGE CONTROL: BY 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96. 97. 98. 99. 100.

INSPECTION AND TESTING

COMPRESSOR:

- ☒ SHOP INSPECTION.
- ☒ HYDROSTATIC TEST.
- ☒ IMPELLER OVERSPEED _____ % OF _____ RPM.
- ☒ DYNAMIC BALANCE OF ROTOR
- ☒ MECHANICAL RUN.
- ☐ _____
- ☐ _____
- ☐ _____

WITNESSED:

- | | | | |
|-------------------------------------|-----|--------------------------|----|
| ☒ | YES | ☐ | NO |
| ☒ | YES | ☐ | NO |
| ☒ | YES | ☐ | NO |
| ☒ | YES | ☐ | NO |
| ☒ | YES | ☐ | NO |
| ☐ | YES | ☐ | NO |
| ☐ | YES | ☐ | NO |
| ☐ | YES | ☐ | NO |

DRIVER:

- ☒ SHOP INSPECTION
- ☒ TURBINE 15% SEC PAGE 9
- ☐ _____
- ☐ _____

- | | | | |
|-------------------------------------|-----|--------------------------|----|
| ☒ | YES | ☐ | NO |
| ☒ | YES | ☐ | NO |
| ☐ | YES | ☐ | NO |
| ☐ | YES | ☐ | NO |

CONSOLE:

- ☒ SHOP INSPECTION.
- ☐ _____
- ☐ _____

- | | | | |
|-------------------------------------|-----|--------------------------|----|
| ☒ | YES | ☐ | NO |
| ☐ | YES | ☐ | NO |
| ☐ | YES | ☐ | NO |

OIL COOLERS:

- ☒ HYDROSTATIC TEST (150% DESIGN)
_____ Psig OIL SIDE. _____ Psig WATER SIDE.

- | | | | |
|--------------------------|-----|-------------------------------------|----|
| ☐ | YES | ☒ | NO |
|--------------------------|-----|-------------------------------------|----|

INTERCOOLERS:

- ☐ HYDROSTATIC TEST
_____ Psig AIR SIDE. _____ Psig WATER SIDE.

- | | | | |
|--------------------------|-----|--------------------------|----|
| ☐ | YES | ☐ | NO |
|--------------------------|-----|--------------------------|----|

COMMENTS REGARDING TESTING:

<u>SCOLD LEVELS</u>	<u>MAINTENANCE</u>	<u>3 SA</u>	<u>EXPECTED</u>	<u>GUARANTEE</u>
<u>SCOLD LEVELS</u>	<u>COMPLETION</u>			
<u>EQ. PAINT OPERATING AT COMPRESSOR</u>	<u>TURBINE</u>			
<u>PAINT CONDITIONS ARE</u>				
<u>(MEASURED IN ACC. WITH A 1/2" S.S.I.)</u>	<u>TOTAL TRAIL</u>			

FOSTER WHEELER CORPORATION

110 SOUTH ORANGE AVENUE, LIVINGSTON, N.J.

CENTRIFUGAL COMPRESSORS

MATERIAL REQUISITION

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FOR ERDA-FE-14-32-0001-1521 FW REF. 15-1591

SITE MSP-LAWRENCE STATION, SIOUX FALLS, SOUTH DAKOTA

SERVICE RECYCLE GAS COMPRESSOR ITEM NO. C-102

MATERIAL

SIZE AND TYPE

NO. REQD.

DRIVER: ☐ MOTOR, ☐ STEAM TURBINE,

GENERAL NOTES REQUISITION

INTEGRAL PART OF THIS REQUISITION.

REQUISITION NO.

DATE

1591-1321-A

4-5-76

SUPERSEDED BY

CHG.

DATE

CHG.

DATE

C1

4-12-76

C4

C2

C5

C3

C6

UTILITY DATA

ELECTRICAL:

CLASSIFICATION:

☒ CLASS II - GROUP F, ☐ DIV. 1, ☒ DIV. 2, ☐MOTORS 1/2 HP AND BELOW: 115 VOLTS, 1 PHASE, 60 CYCLES.MOTORS 3/4 HP THROUGH 150 HP: 460 VOLTS, 3 PHASE, 60 CYCLES.MOTORS 200 HP AND ABOVE: 4000 VOLTS, 3 PHASE, 60 CYCLES.ALARM SWITCHES: ☒ AC, ☐ DC 115 VOLTS, 1 PHASE, 60 CYCLES. SPDTSHUTDOWN SWITCHES: ☒ AC, ☐ DC 115 VOLTS, 1 PHASE, 60 CYCLES. SPDTSWITCH ENCLOSURE: ☒ EXPLOSION PROOF, ☐ WEATHER PROOF, ☐

STEAM:

MAIN COMP. DRIVE

AUX. DRIVES

	MAX.	NOR.	MIN.	MAX.	NOR.	MIN.
INLET Psig		700			60	
INLET TT OF		750			SAT	
EXH. Psig		150			15	
In. HG. ABS.						

(80 PSIG DESIGN)

(*) DENOTES CONDITIONS AT WHICH STEAM RATE IS TO BE GUARANTEED.

COOLING WATER:

☐ FRESH, ☐ SALT, ☒ COOLING TOWER (100 PSIG. DESIGN)AVAILABLE AT 55 Psig AND 85 OF. FOULING FACTOR 1.002.ALLOW TEMP. RISE 25 OF. ALLOW PRESSURE DROP 20 Psi.INSTRUMENT AIR: AVAILABLE TO CONTROL DEVICES AT 50 Psig. (125 PSIG DESIGN)

DRIVER AND UTILITY SUMMARY

MOTORS:

- ☐ COMPRESSOR DRIVE
☒ LUBE PUMP DRIVE
☒ SEAL PUMP DRIVE
☐

QUAN.	MFR.	TYPE	ENCL.	HP	SF	RPM
1		IND	XP			
1		IND	XP			

STEAM TURBINES:

- ☒ COMPRESSOR DRIVE
☒ LUBE PUMP DRIVE
☒ SEAL PUMP DRIVE
☐

QUAN.	MFR.	TYPE	STAGES	HP	RPM	WR
1						
1						
1						

DRIVERS MARKED ☒ SHALL BE FURNISHED BY THE COMP. VENDOR. SEE PAGES 789 OF THIS REQ'N. FOR COMPLETE DETAILS OF THE MAIN COMPRESSOR DRIVE UNIT.

COOLING WATER CONSUMPTION:

LUBE OIL COOLERS _____ GPM _____ OF. RISE.
LUBE & SEAL OIL COOLERS _____ GPM _____ OF. RISE.
INTER COOLERS _____ GPM _____ OF. RISE.
_____ GPM _____ OF. RISE.

STEAM CONSUMPTION:

COMPRESSOR DRIVE _____ Lb/Hr.
EACH LUBE PUMP DRIVE _____ Lb/Hr.
EACH SEAL PUMP DRIVE _____ Lb/Hr.
_____ Lb/Hr.

COMMENTS REGARDING UTILITIES:

FOSTER WHEELER CORPORATION

SPECIAL-PURPOSE STEAM TURBINES

PAGE 7 OF 9

FOR <u>ERDA-FE-14-32-0001-1521</u> F.W. CONTRACT <u>15-1591</u>		REQUISITION NUMBER <u>1591-1321A</u>	DATE <u>4-5-76</u>
SITE <u>NSP-LAWRENCE STATION, SIOUX FALLS, SOUTH DAKOTA</u>		SUPERSEDED BY CHANGE NO.	
ITEM NO. <u>C-102</u>	SERVICE <u>RECYCLE GAS COMPRESSOR</u>	C1 <u>4-12-76</u>	C4
DRIVEN EQUIP. <u>CENTRIFUGAL COMPRESSOR</u>		C2	C5
MFR. _____	MODEL _____	C3	C6
NO. REQ'D <u>1</u>			

OPERATING CONDITIONS

	BHP	RPM
RATED	_____	_____
NORMAL	_____	_____
_____	_____	_____
_____	_____	_____
MAX. CONTINUOUS SPEED:	_____ RPM	
TRIP SPEED:	_____ RPM	
CRITICAL SPEED:	_____ RPM FIRST	_____ RPM SECOND

STEAM:	MAXIMUM	NORMAL	MINIMUM
THROTTLE PSIG	_____	<u>700</u>	_____
THROTTLE °F.	_____	<u>750</u>	_____
EXHAUST PSIG	_____	<u>150</u>	_____
_____	_____	_____	_____

OTHER DATA:

STEAM RATES, BASIS OUTPUT SHAFT OF ☒ TURBINE ☐ GEAR			
(* = GUAR. POINT)	OUTPUT	STEAM	LBS/BHP-HR
RATED	_____	NORMAL	_____
RATED	_____	WORST	_____
NORMAL	_____	NORMAL	_____

PERFORMANCE CURVE NO.

MAXIMUM POSSIBLE STEAM FLOWS:	LBS/HR
AT THROTTLE (WITH MAX. INLET PRESS.)	_____
TO EXHAUST (EXT. & INDUCT. TURB. ONLY)	_____
FROM EXTRACT. (WITH MAX. THROTTLE PRESS.)	_____

ROTATION (VIEWED FROM H.P. INLET END): ☐ CW ☐ CCW

THRUST FROM DRIVEN EQUIP.: ☐ NORMAL ☐ _____

DUTY: ☒ CONTINUOUS ☐ _____

START-UP: ☒ MANUAL ☐ EMERGENCY AUTOMATIC

LOCATION: ☐ INDOOR ☐ OUTDOOR ☒ SEMI-ENCL. BLDG.

☒ AT GRADE ☐ ON MEZZANINE

AREA: ☒ CL. II - GR. F - DIV. 2 ☐ NON-HAZARDOUS

AMBIENT: 73 °F. MAX. TO -25 °F. MIN.

1315 FT. ALTITUDE 14.0 PSIA BAROMETER

PROTECTION: ☒ WINTERIZED ☐ TROPICALIZED ☐ STANDARD

GEARS: BY _____ SEE _____ FOR DATA

EVALUATION: FOR PERIOD OF _____ HOURS
H.P. STEAM AT \$ _____ /M LBS.

COOL-OFF TIME: _____

1 APPLICABLE DOCUMENTS:

2	<u>1590-39A3</u>	SPECIAL-PURPOSE TURBINES
3	<u>1590-39A2</u>	GEN'L.-PURP. TURBS. (FOR AUX. SVC.)
4	<u>1590-39A1</u>	INDUCTION MOTORS
5	<u>1590-39A2</u>	OIL SYSTEMS
6		GEARS
7	<u>1590-1300-A</u>	GENERAL NOTES REQUISITION
8	<u>1590-5042+4</u>	GASKETS
9	<u>1590-92A1</u>	PREPARATION FOR SHIPMENT

11 CONSTRUCTION FEATURES:

12	TYPE: ☐ VERT. SHAFT ☒ HORIZ. SHAFT	_____ STAGES.
13	CASING SPLIT: ☒ AXIAL ☐ RADIAL	
14	CASING MOUNT: ☐ FOOT ☒ CENTERLINE	
15	FLOW TYPE: FIRST STAGE = _____	
16	OTHER STAGES = _____	
17		
18	ROTOR: ☐ BUILT-UP ☐ SOLID	
19	SPEED GOVERNOR: NEMA CLASS <u>D</u> MFR. = <u>WOODWARD</u>	
20	TYPE = <u>PG</u>	
21	OTHER GOV.: FOR _____ MFR. = _____	
22	TYPE = _____	
23	SPEED CHANGER: ☒ MANUAL ☐ AUTOMATIC	
24	RANGE FROM <u>80</u> % TO <u>105</u> % OF RATED RPM.	
25	ACTION SIGNAL = _____	
26	NO. AUTO. VALVES: _____ MAIN INLET, LIFTED BY _____	
27	_____ LIFTED BY _____	
28		

29 HAND NOZZLE VALVES: TWO

30	TRIP VALVE: ☐ TRIP ONLY ☒ TRIP & THROTTLE
31	REMOTE TRIP REQ'D ACTUATED BY _____
32	

33 BEARINGS:

	THRUST	RADIAL
34	TYPE <u>BALL</u>	<u>SLEEVE</u>
35	MANUFACTURER _____	
36	CALC. LOAD. LBS. _____	
37	CAPACITY, LBS. _____	
38	LUBE METHOD <u>FROM OIL PANS IN LUBE SYSTEM</u>	
39	COOLING JACKETS _____	
40		

41 SHAFT SEALS, INTERSTAGE:

41	SHAFT SEALS, INTERSTAGE: ☐ LABYRINTH ☐ _____
42	SHAFT SEALS, OUTER: ☐ LABYRINTH ☒ CARBON RING
43	

45 DESIGN MAX:

	H.P. INLET	PSIG & _____ °F.
45	H.P. CASING	PSIG & _____ °F.
46	I.P. CASING	PSIG
47	L.P. CASING	PSIG
48	COOL. JKTS.	PSIG
49		

50 MAX. ALLOWABLE SPEED _____ RPM

51 MAX. ALLOWABLE TRIP SPEED _____ RPM

52 POTENTIAL MAX. POWER @ RATED RPM _____ BHP

REQUISITION NUMBER	DATE
1591-1321-A	4-5-76
SUPERSEDED BY CHANGE NO.	
C1 4-12-76 C3	C5
C2	C4 C6

FOR ERDA-FE-14-32-0001-1521

F.W. CONTRACT 15 1591

SITE NSP-LAWRENCE STATION, SIOUX FALLS, SOUTH DAKOTA

ITEM NO. C-102

ACCESSORIES:

- ☐ SEE PAGE ___ FOR SP. CHANGER, TRIP VALVE, REMOTE TRIP
- ☐ TRIP VALVE LIMIT SWITCHES: VALVE ☐ OPEN ☐ SHUT.
- ☐ TRIP VALVE DEVICE FOR TESTING WHILE OPERATING
- ☐ GOV. VALVE POSITION INDICATOR: _____
- ☒ INSULATION: MAT'L. = _____
- ☒ JACKET: MAT'L. = _____
- ☒ EXHAUST SENTINEL VALVE, _____ PSIG SET
- ☒ EXHAUST FULL FLOW PSV, _____ PSIG SET
- ☐ EXTRACT FULL FLOW PSV, _____ PSIG SET
- ☐ NON-RETURN VALVE ☐ EXTRACTION ☐ EXHAUST
- AUX. FORCE CLOSING BY _____

- ☒ TACHOMETER TYPE: _____
- INDICATOR, NO. & TYPE _____
- ☐ SHAFT TURNING GEAR: _____
- ☒ STEAM STRAINER: ☐ SEPARATE ☐ IN
- ☐ LOCAL PANEL: MOUNTED ON ☐ TURB. ☐ TURB. BASE
- ☐ SEPARATE FREESTANDING.

- ☒ BASE: ☒ BY DRIVEN EQUIP. MFR.:
- ☐ SOLEPLATES. ☐ FABR. STEEL, ☐ WITH DECK

- ☐ GOV. LIMIT DEVICE FOR ☐ LOAD ☐ EXTRACT. FLOW
- ☐ INITIAL STEAM PRESSURE
- ☐ HIGH EXHAUST TEMP. SWITCH ☐ ALARM ☐ TRIP
- ☐ HIGH EXHAUST TEMP. WATER INJECTION SYSTEM COMPLETE
- ☐ VACUUM BREAKER
- ☐ WATER WASH OFFICE MIXER
- ☐ SPACE HEATERS FOR INSUL. & JACKET
- ☐ SHAFT SEAL SYSTEM: ☐ MANUAL ☐ AUTO. CONTROL
- VACUUM DEVICE ☐ STM. EJECT. ☐ WATER EDUCTOR
- ☐ FAN ☐ LIQUID RING COMPRESSOR
- CONDENSER ☐ DIRECT CONTACT ☐ SHELL & TUBE
- SURF _____ SQ. FT., ☐ TEMA-C ☐ TEMA-R,
- WITH _____ SHELL, _____ WATER BOXES
- & _____ TUBES _____ BWG X _____ O.D. X _____ L

UTILITIES REQ'D.: _____ GPM WATER

_____ LBS/HR _____ PSIG STEAM

_____ KW OF _____ V- _____ PH- _____ HZ

- ☐ VIBRATION DETECT. EQUIP.: _____
- ☐ AXIAL POSITION EQUIP.: _____

OIL SYSTEM:

- TURBINE MFR'S. OIL REQUIREMENTS: _____ GPM _____ PSIG.
- LUBRICATION _____
- CONTROL, STEADY STATE _____
- CONTROL, TRANSIENT _____
- VISCOSITY: _____ SSU @ 100°F & _____ SSU @ 210°F
- _____ SSU MAX. ALLOWABLE FOR START-UP.
- MAX. ALLOWABLE FILTRATION: _____ MICRONS
- LUBRICATING OIL _____
- CONTROL OIL (NOT OVER 25) _____

TURBINE MFR. TO SUPPLY SYSTEM COMPONENTS AS FOLLOWS:

- ☐ NONE (ALL COMPONENTS BY OTHERS)
- ☒ AS AGREED WITH MFR. OF DRIVEN EQUIPMENT
- ☐ TOTAL SYSTEM PER PAGE _____
- ☐ AT TURB. ☐ & GEAR ONLY (SINGLE I/P/OUT CONNECTS).
- ☐ WITH ☐ WITHOUT LOCAL INSTRUMENTS
- ☐ PARTIAL SYSTEM PER PAGE _____

PIPING MATERIALS AT TURBINE (& GEAR):

L.O. PRESSURE LINES STEEL

CONTROL PRESS LINES STEEL

DRAIN LINES STEEL

COUPLINGS:

- TURB. -
- FURNISHED BY COMP. V. 100%
- MANUFACTURER _____
- MODEL NO. _____
- TYPE _____
- LUBE METHOD _____
- BORE TYPE, DRIVING HALF _____
- BORE TYPE, DRIVEN HALF _____
- MOUNT DRIVING HALF _____
- MOUNT DRIVEN HALF _____
- TYPE OF GUARD _____

OTHER REQUIREMENTS:

- ☐ TORSIONAL CRITICAL SPEED ANALYSIS BY _____
- ☐ LATERAL CRITICAL SPEED ANALYSIS BY _____
- ☐ SUPPLY ABOVE CALCULATIONS TO _____
- ☐ SUPPLY CAMPBELL DIAGRAMS TO _____
- ☒ REVIEW & COMMENT ON PURCHASER'S PIPING DRAWINGS
- ☒ REVIEW & COMMENT ON PURCHASER'S FOUND DRAWINGS
- ☐ _____
- ☐ SUPPLY SHAFT MOTOR ASSEMBLY
- ☐ _____

FOSTER WHEELER CORPORATION

SPECIAL-PURPOSE STEAM TURBINES

PAGE 9 OF 9

FOR <u>ERDA-FE-14-32-0001-1521</u>	F.W. CONTRACT <u>15-1521</u>	REQUISITION NUMBER <u>1521-1321-A</u>	DATE <u>4-5-76</u>
SITE <u>NISP-LAWRENCE STATION, SIOUX FALLS, SOUTH DAKOTA</u>		SUPERSEDED BY CHANGE NO.	
ITEM NO. <u>C-102</u>		C1 <u>4-2-76</u>	C3 <u> </u>
		C2 <u> </u>	C4 <u> </u>
		C5 <u> </u>	C6 <u> </u>

MATERIALS:

H.P. INLET	GOV. VALVE DISC
VALVE CHEST	GOV. VALVE SEAT
H.P. CASING	GOV. VALVE STEM
I.P. CASING	EXTR. VALVE DISC
L.P. CASING	EXTR. VALVE SEAT
H.P. DIAPHR.	EXTR. VALVE STEM
H.P. NOZZLES	TRIP VALVE BODY
I.P. DIAPHR.	TRIP VALVE DISC
I.P. NOZZLES	TRIP VALVE SEAT
L.P. DIAPHR.	TRIP VALVE STEM
L.P. NOZZLES	NON-RETURN BODY
SHAFT	NON-RETURN DISC
WHEELS	NON-RETURN SEAT
H.P. BLADING	NON-RETURN STEM
L.P. BLADING	STM. STRAIN. BODY
H.P. SHROUDS	STM. STR. BASKET
L.P. SHROUDS	

STATIONARY OUTER SEAL ELEMENTS

ROTATING OUTER SEAL ELEMENTS

STATIONARY INTERSTAGE SEAL ELEMENTS

ROTATING INTERSTAGE SEAL ELEMENTS

SHAFT & OUTER SEALS BY ☐ SPRAY ☐ PLATE

SHAFT & INTSTG. SEALS BY ☐ SPRAY ☐ PLATE

OIL SYSTEM (S): SEE PAGE 3

CONNECTIONS: SIZE ANSI RATED FACING ORIENTED

MAIN H.P. INLET				
EXHAUST				

WEIGHTS & DIMENSIONS:

	LBS. NET	LBS. SHIPPING
TOTAL TURBINE ASS'Y		
H.P. TURBINE ASS'Y		
L.P. TURBINE ASS'Y		
MAX. ERECTION		FOR
MAX. MAINTENANCE		FOR

APPROX. OVERALL DIMENS. = L. X W. X H.

SHOP TESTS:

	REQUIRED	WITNESSED
1 MECHANICAL RUN	YES	YES
2 PERFORMANCE	YES	YES
3 CHECK CONTROLS	YES	YES
4 DISMANTLE-REASS'Y	NO	
5 FIT SPARE ROTOR		
6 MECH. RUN SP. ROTOR		
7 DYNAMIC BALANCING	YES	
8 EMERGENCY TRIP		RPM YES
9 HYDRO H.P. INLET		PSIG NO
10 HYDRO VALVE CHEST		PSIG NO
11 HYDRO H.P. CASING		PSIG NO
12 HYDRO I.P. CASING		PSIG NO
13 HYDRO L.P. CASING		PSIG NO
14 HYDRO COOL JACKETS		PSIG NO
15 HYDRO TRIP VALVE		PSIG NO
16 HYDRO NON-RET. VALVE		PSIG NO
17 STEAM STRAINER		PSIG NO

USE JOB VIBRATION DETECTORS:

USE JOB AXIAL DETECTORS:

TEST CERTIFICATES: YES

UTILITIES: (FOR AUXILIARIES)

COOLING WATER: TYPE = COOLING TOWER

SUPPLY AT 55 PSIG & 85 OF.

DISCHARGE 35 PSIG & 110 OF. MAX.

MECH. DESIGN 100 PSIG & OF.

WATER SIDE F.F. = (BTU/HR/SQ.FT./IN.)-1

PLANT AIR PSIG TO PSIG

INSTRUMENT AIR 60 PSIG TO 125 PSIG

ELECTRIC INSTRUMENTS:

115 VOLTS: ☒ AC ☐ DC

CONTACTS TO OPEN TO ALARM

CONTACTS TO OPEN TO TRIP

CONTACTS TO OPEN TO START AUX. EQUIP.

ELECTRIC POWER:

 V- PH- HZ FOR

 V- PH- HZ FOR

STEAM: AT EQUIP.

MECH. DESIGN

MATERIAL REQUISITION



FOSTER WHEELER

PAGE 1 OF 7

FORM 135-20A

FOR <u>ERDA-FE</u>	F.W. REF. <u>15-1591</u>	REQUISITION NUMBER	DATE
SITE <u>SIOUX FALLS, SOUTH DAKOTA</u>		<u>1591-1351E</u>	<u>Feb. 23, 1976</u>
MATERIAL <u>COAL DISTRIBUTION CONVEYOR, ITEM CR-107</u>		SUPERSEDED BY CHANGE NO.:	
	C1		C4
Contract No. <u>ERDA-FE-14-32-0001-1521</u>	C2		C5
Location - <u>NSP, Lawrence Station, Sioux Falls, S. D.</u>	C3		C6

I. GENERAL

- A. Furnish a Coal Distribution Conveyor System suitable for feeding coal from NSP existing coal storage hopper outlets to a pulverizer rotary air lock valve. Equipment shall include an enclosed, air tight, variable speed volumetric feeder conveyor complete with inlet downspouts, nuclear coal monitors, coal valves and feeder outlet hopper with discharge downspout as described in this requisition.
- B. All equipment shall be designed for continuous operation. The feed end of the conveyor system will be located inside NSP existing building and the discharge end will be located in the new coal pulverizing and drying building.
- C. Structural steel supports will be furnished by others.
- D. Erection of equipment will be by others.

II. APPLICABLE SPECIFICATIONS

- A. The following Foster Wheeler Energy Corporation specifications are an integral part of this requisition.
 1. General Notes for Mechanical Equipment, 1590-1300A, Rev. C-1.
 2. Induction Motors, 1590-38A1.
- B. Equipment shall be furnished in accordance with the applicable provisions of the latest revisions of the following codes, specifications, etc.:

1. National Electrical Code	NFPA70
2. Pulverized Fuel Systems	NFPA60
3. Inerting for Fire & Explosion Prevention	NFPA69
4. Coal Preparation Plants	NFPA653
5. Purged Enclosures for Electrical Equipment	NFPA496
6. Explosion Venting Guide	NFPA68
7. Static Electricity	NFPA77
8. Air Pollution Control Regulations for the State of South Dakota.	

BY: <u> </u>	P.O. NO.	SUPPLIER:
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II. APPLICABLE SPECIFICATIONS (Cont'd)

C. Noise Specification

1. Noise level shall conform to the requirements of OSHA or any local, city, county or state code with more stringent requirements. Seller shall furnish data for the whole unit indicating its conformity to this requirement.
2. The following minimum requirements shall also apply:
 - a. Permissible noise level 90 DB(A)
 - b. Estimated duration of worker exposure 2 hours per day
 - c. Reference sound pressure level .0002 microbar
 - d. Worker exposure location is at 3 feet horizontal distance and at 5 feet height above floor level from any noise source located within the unit. Minor protuberances such as conduit boxes or bearing housings shall be neglected in determining these distances

III. PROCESS SPECIFICATION

A. Capacity

1. Design Capacity: 28.2 short tons/hr. (includes 20% H₂O)
2. Minimum Turndown Ratio: 4 to 1, by remote electronic signal, while feeder is in operation.

B. Coals to be fed

1. Design Case: Illinois No. 6 coal
2. Alternate Feeds:
 - a. Colstrip Coal
 - b. Big Horn Coal
 - c. Rosebud Coal
 - d. North Dakota Lignite
 - e. Pittsburgh Seam No. 8

C. Supply Temperature: 50°F

D. Feed Size Distribution:

1. Design Case: 3/4" Maximum
2. Alternate Case: 2" to 2½", occurring during crusher shutdown, at which time crusher is bypassed. If necessary, a reduced capacity will be acceptable when handling 2" to 2½" coal. Vendor to advise reduced capacity.

III. PROCESS SPECIFICATION (Cont'd)

E. Bulk Density

- | | |
|-------------|--------------------------|
| 1. Maximum: | 50 lbs./ft. ³ |
| 2. Normal: | 45 lbs./ft. ³ |
| 3. Minimum: | 35 lbs./ft. ³ |

F. Angle of Repose: 37°

IV. DESIGN CONDITIONS

- A. Length of feeder conveyor: 100 ft. horizontal distance from centerline of feeder outlet hopper to centerline of farthest inlet downspout.
- B. Conveyor Incline: Horizontal
- C. Conveyor Speed: Vendor to specify
- D. Belt Width: Vendor to specify

V. EQUIPMENT SPECIFICATIONS

A. Inlet Downspouts

1. Two (2) downspouts shall be provided, one (1) at each existing bunker outlet, to connect a new bunker outlet coal valve with the coal valve at feeder inlet.
2. Inlet downspouts shall be 24 3/4" outside diameter constructed of carbon steel. Downspouts shall be of sufficient length to provide a suitable coal head seal above the feeder conveyor. Headroom available below the existing bunker hopper outlet flange is 19'-10 1/4".
3. Ends of downspouts shall be provided with 3/4" thick carbon steel flanges with suitable gaskets as specified by vendor.
4. A removable section shall be provided near the upper end of each inlet downspout to connect the downspout to a 12" diameter emergency chute in order to divert the coal to waiting trucks in case of spontaneous combustion of coal stored in the bunkers. The removable section shall be constructed of 11 ga. carbon steel and shall be provided with 1/4" thick carbon steel flanges. A filler piece shall be provided for normal operation and shall be constructed of the same material and thickness as the downspout. The 12" diameter emergency chute will be inclined 50° from the horizontal and will be provided by others.

V. EQUIPMENT SPECIFICATIONS (Cont'd)

B. Nuclear Coal Monitors

1. Two (2) nuclear coal monitors shall be provided, to be mounted on the upper section of each downspout above the feeder, in order to detect the lack of coal in case of bridging at the bunker outlet.
2. Each monitor shall consist of a gamma radiation source, Geiger-Mueller detector tube, and calibration blocks, assembled on a common frame to maintain the required relationship to each other, and shall operate entirely outside of the downspout. Each monitor shall be mounted on a column capable of swingout for calibration. The control box shall be mounted at the bottom of the column and shall be readily accessible from the operating floor. The control box shall contain all the logic circuitry for the monitors, terminal blocks for field connections, indicating lights, and test handle.
3. It shall be possible to test the monitors without disturbing any operations. Alarm response time shall be 1 second or less, and alarm off response 2 seconds or less. A "Ready" light to indicate all systems are "Go" and an alarm light shall be provided on the control box for the monitor.

C. Coal Valves

1. Four (4) coal valves shall be provided, to be mounted at each end of the inlet downspouts, one valve connecting to the bunker outlet and the other valve to the feeder inlet. Existing bunker outlet flange is 18" square, inside dimensions. Valve shall be entirely dust and water tight, and fabricated to withstand 60" internal water pressure. Valve body shall be provided with ample access covers for maintenance and service.
2. Valve inlet and outlet openings shall be a full 24" inside. The gate shall be formed U-shaped, with punches and coined ladder rack on either side. The gate plate surface shall be fully protected from corrosion and abrasion by a 1/8" thick, type 410 stainless steel liner. The gate shall be operated by stainless steel pinions, of a self-cleaning design, and both the pinions and gate teeth shall be located entirely above the bottom of the valve inlet skirt. The gate supporting rollers and pinion shaft shall be carried by heavy duty ball bearings, housed in stainless steel shells, and lubricated from the outside of the valve body.
3. The valve shall be equipped with 18" diameter pocket sheave, with chain guard and handchain, for operation from operating floor.

V. EQUIPMENT SPECIFICATIONS (Cont'd)

D. Volumetric Feeder

1. One (1) volumetric feeder conveyor shall be provided with two (2) 24" I.D. inlet openings located 14'-0 $\frac{1}{2}$ " horizontally from each other.
2. Volumetric Feeder shall discharge 2 cubic feet of coal per turn of the head shaft. Head shaft speed and corresponding coal feed rate shall be determined by an accurately controllable, variable speed drive through an electronic speed controller.
3. Feeder body shall be designed to withstand a static internal pressure of 50 PSIG in accordance with the explosion requirement of the National Fire Prevention Association's Code 60. It shall be complete with bull's-eyes and lights for inspection of interior and for assurance of accurate tracking of the belt.
4. The rubber feed belt shall be 3 ply, molded construction, endless type, and curved on each side, to keep sifting dust and dripping water from the feeder to an absolute minimum. Stainless steel side skirts shall be provided above the belt, extending the full length of the belt to confine the coal stream. All portions of the feeder in contact with normal coal flow shall be 410 stainless steel or rubber.
5. The feeder shall be driven through a helical and worm type gear reducer by a variable speed motor. Motor-drive shall have sufficient power to start the feeder conveyor fully loaded. Variable feed rate shall be accomplished by the use of a variable speed motor controlled by a suitable solid state speed control unit. This control shall include a tachometer feedback network. It shall provide a close speed control of the feeder drive with a rapid and accurate response to an external 4 to 20 milliamp control signal.
6. The feeder shall be provided with a conduit entry box having terminals for making the necessary electrical connection to external power supply and control wires. Feeder internal conduit and wiring, from motors and illuminating lights to their terminal blocks shall be furnished by the vendor.
7. The feeder shall have a tachometer indicator, for remote mounting, to indicate rate of coal feed in R.P.M. of the head shaft.
8. All bearings shall be equipped for pressure lubrication. Where shafts pass through pressure shell, suitable seals against internal pressure shall be provided.
9. A nitrogen purge connection shall be provided on the feeder shell for customers 1 $\frac{1}{2}$ " flanged pipe connection.

V. EQUIPMENT SPECIFICATIONS (Cont'd)

D. Volumetric Feeder (Cont'd)

10. Two (2) paddle type coal stoppage alarm switches shall be furnished as an integral part of the feeder. One paddle type coal flow switch shall be installed at the discharge of the feeder to stop the feeder in the event of flooding in the hopper. The second alarm shall be placed over the feed belt to stop the feeder in case of coal stoppage.
11. A separate electrical enclosure shall be provided in which shall be mounted the Solid State Variable Speed Control Unit.
12. A rubber scraper type belt cleaner shall be provided at the discharge end of the feeder conveyor.
13. The feeder conveyor shall be equipped with a drag type cleanout conveyor to remove dust accumulations from the bottom of the feeder body through the outlet. The cleanout conveyor shall consist of a suitable malleable iron chain with stainless steel pins. Cleanout conveyor shall run on a 3/16" thick stainless steel pan. A separate motor and gear reducer shall be employed to drive the cleanout conveyor. Cleanout conveyor is to operate only for a few minutes each hour. Motor starter and control circuit, including timers and alarm will be supplied by Purchaser.

E. Feeder Outlet Hopper

1. A feeder outlet hopper shall be provided at the discharge end of the feeder. Hopper shall be constructed of carbon steel and reinforced for 50 P.S.I. explosion pressure requirements. An offset, commensurate with feeder capacity, shall be provided between centerline of hopper inlet and discharge, to minimize wear. Hopper overall height shall be 4'-0".

F. Discharge Downspout

1. A vertical discharge downspout shall be provided to connect the feeder outlet hopper to customer's pulverizer rotary air lock valve.
2. Discharge downspout shall be 14" outside diameter constructed of carbon steel.
3. Discharge downspout shall be of approximately 20'-0" overall length and shall consist of three (3) flanged sections to facilitate installation and removal.
4. Ends of downspout sections shall be provided with 3/4" thick carbon steel flanges with suitable gaskets as specified by vendor.

VI. ELECTRICAL

- A. Power - Motors 3/4 HP through 150 HP - 460V, 3Ø, 60 Hz.
- B. Power Controls & Lighting - 115V, 1Ø, 60 Hz.
- C. Area Classification
 - 1. Inside Feeder: Class II, Group F, Division 1
 - 2. Outside Feeder: Class II, Group F, Division 2
- D. Motor Enclosure: TEFC
- E. Control Enclosure: Nema 9F

VII. GUARANTEE

- A. Performance Guarantee - Based on information supplied, the subject equipment shall be unconditionally guaranteed to perform within the limits of its service conditions.

Vendor shall guarantee all equipment and material furnished by him and the system designed by him will meet the following requirements:

- 1. Rated capacity of the system as specified in Section IIIA-1, including delivery of coal from existing coal storage hopper to pulverizer rotary air lock valve.
- 2. Alternate capacity when handling larger feed size per Section IIID-2.
- 3. Turndown capacity as determined by Section IIIA-2.

Acceptance of the system will be based on satisfactory performance of a running test of the system. Tests shall be run in the presence of a representative of Foster Wheeler Energy Corp.

In the event that the system does not perform in accordance with the above requirements, vendor shall take the necessary steps, at his expense, to make the system meet guaranteed performance.

MATERIAL REQUISITION



FOSTER WHEELER ENERGY CORPORATION

PAGE 1 OF 1

FORM 135-20

FOR OFFICE COAL RESEARCH	F.W. REF. 15-1590	REQUISITION NUMBER	DATE
SITE SIOUX FALLS, SOUTH DAKOTA		1590-1493-A	03/19/75
MATERIAL FREIGHT ELEVATOR - 6000# CAPACITY		SUPERSEDED BY CHANGE NO.:	
ITEM CR-108	C1		C4
CONTRACT NO. ERDA-FE 14-32-0001-154	C2		C5
LOCATION NSP-LAWRENCE STATION, SIOUX FALLS, S.D.	C3		C6

I. SCOPE:

Design, fabricate, test, deliver to site, one (1) 6000 lb. electric freight elevator complete with platform frame, car frame, center vertical opening doors, controller, motor, drive, hoisting machine, dual elevator control operation, automatic micro self leveling, switches, landing and door buttons, emergency override button, lights, controls, starters, fuses, required structural steel and bracing, phone, alarm bell, in accordance with the attached specifications and other documents which form an integral part of this requisition.

The limits of supply involved are indicated on sketch 11/26/73, page 4.

The switches and controls are vendors scope of supply.

II. GENERAL:

A. The equipment shall be furnished in accordance with applicable provisions of the latest revisions of the following codes, specifications, for the freight elevator.

1. National, state and local requirements.

- a. State and local requirements.
- b. American National Standards Association
- c. National Electrical Code
- d. National Fire Protection Ass'n -- appropriate requirements for flammable liquid, gases and solids.

2. Foster Wheeler standards and/or specifications (attached).

<u>STANDARD NO.</u>	<u>SUBJECT</u>
1590-38A1	Induction Motors
1590-40A1	Wind and Earthquake Loading
1590-46A1	Structural Steel Standard
1590-46C1	Structural Steel Fabrication Standard
1590-70A1	Electrical Standard
1590-83A1	Painting Standard
1590-92A1	Preparation of Material for Shipment

BY: ML	P.O. NO.	SUPPLIER:
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II. GENERAL: (Cont'd)

B. The following general notes are integral parts of this requisition:

<u>Standard No.</u>	<u>Subject</u>
1590-1300B	General Notes Requisition for Mechanical Equipment.

C. Site Conditions: (Sioux Falls, South Dakota)

1. Altitude (above sea level)	1,315 ft
2. Design temperature - winter	-25°F + wind chill factor
- summer	93°F
3. Extreme ambient temperature - winter	-25°F
- summer	93°F
4. Location	Indoors
5. Design Snow Loading	30 PSF
6. Earthquake Zone	I
7. Wind Loading	(See spec 1590 40A1)
8. Maximum rainfall in 24 hours	3.92 inches
9. Prevailing Wind	Northwest
10. Wind Velocity	100 MPH

D. Electrical Data:

a. Power - Motors 200 HP and above	4000 V 3 ϕ , 60 HZ
3/4 HP thru 150 HP	460 V, 3 ϕ , 60 HZ
1/2 HP and below	115 V 1 ϕ , 60 HZ
Controls and Lighting	115 V, 1 ϕ 60 HZ

E. Electrical Classification: Class I, Group D, Division II (Hazardous).

III. DESIGN REQUIREMENTS:

- A. 1. Equipment shall be designed for 24 hours a day continuous service, seven days a week.
2. All switches to be located inside in dustproof and weatherproof enclosures.
3. Safety, dust, noise level frequency shall be in accordance with OSHA latest code requirements, local, state, municipal codes and laws that apply.
4. All carbon steel surfaces shall be shop finish coated.

IV. SYSTEM DETAILS:

1. One (1) Electric Freight Elevator

Capacity:	6000 lbs. (3 ton)
Platform Size:	8'-4" W. x 12'-0" D.
Door Opening:	8'-0" x 8'-0"
Floor Stops:	11
Rise:	155 Feet
Speed:	400 FPM
Service:	24 hours/day - 7 days a week.

V. SYSTEM CONTROLS:

Electrical and control systems shall be installed by others. Vendor shall provide all field mounted electrical devices including limit switches, panel, coded receptacle sets, etc. Vendor shall also forward complete schematic control diagram.

VI. SAFETY:

Provide removable guards at all couplings, sprockets and chains and after points of danger to personnel. All equipment and accessories, including guards shall comply with the safety standards and applicable codes.

VII. VENDOR RESPONSIBILITY

In addition to responsibilities listed above, the vendor shall be responsible for the performance of the system in this specification.

VIII. BID QUOTATION REQUIREMENTS:

- A. Equipment arrangement drawings showing equipment layout, overall dimensions, unit dimensions, support details and unit weights.
- B. Electrical schematic drawings.
- C. Statement of any exception taken to this specification.
- D. Complete description list of all items provided by vendor, and a separate list of all items necessary for the installation and operation of the system that must be supplied by others.
- E. Vendor shall advise the number of mandays included in his proposal, or the recommended number of mandays and applicable per diem rate, for the services of a competent erection supervisor to inspect the installation, supervise control check-out, start-up, and instruct Owner's operating personnel.
- F. Spare parts lists, safety instruction sheets, and other data as required, shall be provided on forms supplied by the Purchaser.

BUILDING
ENCLOSURE
BY CUSTOMER

17'-2" (6000 # CAP ELEV.)

TOP FLOOR EL. 255'

EL. 240'

EL. 225'

EL. 210'

EL. 195'

EL. 180'

EL. 165'

EL. 150'

EL. 135'

EL. 120'

CENTER OPENING DOORS (11)

GRADE EL. 100'

PIT 5'-4"

F
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ELEVATOR PLAN

MATERIAL REQUISITION



FOSTER WHEELER CORPORATION

PAGE

FORM 135-2

FOR	ERDA-FE-14-32-0001-1521 F.W. REF. 15-1590	REQUISITION NUMBER	DATE
SITE	NSP LAWRENCE STATION, SIOUX FALLS, SD	1591-1351 Q	5/1/76
MATERIAL	Coal Apron Feeder	SUPERSEDED BY CHANGE NO.:	
	CR-119EX	C1	C4
		C2	C5
		C3	C6

This requisition describes existing equipment at Northern States Power Company, Lawrence Generating Station located near Sioux Falls, South Dakota. This equipment will be utilized for the Combined Cycle Pilot Plant if it is to be located at this site, and therefore should not be duplicated.

NSP Designation: Conveyor, Lower Apron, Coal Pit

Conveyor Mfg.: Link Belt Co., 300 West Pershing Rd., Chicago, Ill.
 Order No.: 722346
 Data: Drawing #C 6158 Capacity 100 tons/hr.
 Speed 20 ft/min. Belt width 36"

Motor Mfg.: Louis Allis Co., Milwaukee, Wisc.
 Ser. No.: 1 298276
 Data: Type JEA Form R
 Frame 254 Code H
 Class N H.P. 5
 R.P.M. 1750 Volts 220/440
 Amps 13/6.5 Phase 3
 Cycle 60
 Temp. Rise 55°C Full Load
 Underwriters Insp. SB-129 156

Reduction Gear:
 Mfg.: Link Belt Co., 300 W. Pershing Rd., Chicago, Ill.
 Order No.: H7-12 663
 Data: Size T-65-RH Ratio 116
 Input R.P.M. 1750 Output R.P.M. 15
 Input H.P. 5.67 Service Factor 1

Starter: Mfg.: Allen Bradley, Milwaukee, Wisc.
 Data: Bulletin 709 Size 2
 Form 2 NEMA 9
 S.F. Ord. No. 903 Item #5

Control Mfg.: Allen Bradley, Milwaukee, Wisc.
 Data: Momentary contact Style Push Button
 Bulletin 800 Type 2HA7A
 S.F. Ord. No. 903 Item #14

Safety Switch:
 Mfg.: Square D Company, Detroit
 Data: Amps 60 Volts 575
 Pole 3 Single Throw
 Non Fusible NEMA 9
 S.F. Ord. No. 955 Item #7

BY:

P.O. NO.

SUPPLIER:

MATERIAL REQUISITION



FOSTER WHEELER CORPORATION

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FORM 135-20

FOR	ERDA-FE-14-32-0001-1521	F.W. REF. 15-1590	REQUISITION NUMBER	DATE
SITE	NSP LAWRENCE STATION, SIOUX FALLS, SD			5/1/76
MATERIAL	Transfer Conveyor		SUPERSEDED BY CHANGE NO.:	
	CR-120EX		C1	C4
			C2	C5
			C3	C6

This requisition describes existing equipment at Northern States Power Company, Lawrence Generating Station located near Sioux Falls, South Dakota. This equipment will be utilized for the Combined Cycle Pilot Plant if it is to be located at this site, and therefore should not be duplicated.

NSP Designation: Conveyor, Cross Apron Coal Pit

Conveyor: Mfg.: Link Belt Co., 300 West Pershing Rd., Chicago, Ill.
 Ser. #
 Data Belt width 24", capacity 100 tons/hr., speed 300 ft./min.

Motor: Mfg.: Louis Allis Co., Milwaukee, Wisc.
 Ser. # 1 298 275
 Data Type JEX Phase 3
 Frame 225 Cycle 60
 Class S Volts 220/440
 Form R Amps 8.4/4.2
 Code J Design W
 H.P. 3 Temp. Rise 55°C Full Load
 R.P.M. 1750 Underwriters Insp. SB-129- 167

Reduction Gear:
 Mfg.: Link Belt Co., 300 West Pershing Rd., Chicago, Ill.
 Order No.: H-12 663B
 Data.: Size S-40-LH/ Ratio 9.67-1/
 A.G.M.A. H.P. 4.19/R.P.M. Input 1750 Output 180.9

Sioux Falls Ord. No. 867

Starter: Mfg.: Allen Bradley, Milwaukee, Wisc.
 Data.: Bulletin 709 NEMA 9
 Size 2 S.F. Ord. No. 905 Item 5
 Form 2

Control: Mfg.: Allen Bradley, Milwaukee, Wisc.
 Data.: Two Momentary Contacts
 Style Push Button
 Bulletin 800
 Type 2HA7A
 S.F. Ord. No. 903 Item 14

Safety Switch:
 Mfg.: Square D Company, Detroit Pole 3
 Data.: Amps 60 Single Throw
 Volts 575 Non Fusible
 Pole 3 NEMA 9
 S.F. Order No. 955 Item 7

BY:	P.O. NO.	SUPPLIER:
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MATERIAL REQUISITION



FOSTER WHEELER CORPORATION

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FORM 135-20

FOR	ERDA-FE-14-32-0001-1521 F.W. REF. 15-1590	REQUISITION NUMBER	DATE
SITE	NSP LAWRENCE STATION, SIOUX FALLS, SD		5/1/76
MATERIAL	Coal Elevator CR-121EX	SUPERSEDED BY CHANGE NO.:	
		C1	C4
		C2	C5
		C3	C6

This requisition describes existing equipment at Northern States Power Company, Lawrence Generating Station located near Sioux Falls, South Dakota. This equipment will be utilized for the Combined Cycle Pilot Plant if it is to be located at this site, and therefore should not be duplicated.

NSP Designation: Coal Elevator and Chute

Elevator: Mfg. Link Belt Co., 300 West Pershing Rd., Chicago
 Order No. 7.22346
 Data: Dwg. No. C6159 Speed 72 ft./min.
 Capacity 100 tons/hr.

Motor: Mfg. Louis Allis Co., Milwaukee, Wisc.
 Serial No. 1 298 278
 Data. Type JEA Frame 364
 Class 2E2 Form R
 Code E H.P. 20
 R.P.M. 1 760 Phase 3
 Cycle 60 Volts 220/440
 Amps 52.6/26.3 Design L
 Temp Rise 55°C Full Load
 Underwriters Insp. LA-893 454

Reduction Gearing:
 Mfg.: Link Belt Co., 300 W. Pershing Rd., Chicago
 Order No.: H-12 663
 Data.: Size D-80-RH Input RPM 1750
 Ratio 48.37-1 Output RPM 36
 Input H.P. 21.6 Service Factor 1

Sioux Falls Order No. 867
 Starter: Mfg.: Allen Bradley, Milwaukee, Wisc.
 Data.: Bulletin 709 Size 2
 Form 2 NEMA 9
 S.F. Ord. No. 903 Item #5

Control: Mfg.: Allen Bradley, Milwaukee, Wisc.
 Data.: Two Momentary Contacts
 Style Push Buttons Bulletin 800
 Type 2HA7A
 S.F. Ord. No. 903 Item 14

Safety Switch:
 Mfg.: Square D Mfg. Co., Detroit S.F. Ord. No.
 Data.: Amps 60 Volts 575 955
 Pole 3 Single throw
 Non fusible NEMA 9 Item 7

BY:	P.O.NO.	SUPPLIER:
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MATERIAL REQUISITION



FOSTER WHEELER CORPORATION

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FOR	ERDA-FE-14-32-0001-1521	F.W. REF. 15-1590	REQUISITION NUMBER	DATE
SITE	NSP LAWRENCE STATION, SIOUX FALLS, SD			5/1/76
MATERIAL	Upper Coal conveyor		SUPERSEDED BY CHANGE NO.:	
	CR-122 EX		C1	C4
			C2	C5
			C3	C6

This requisition describes existing equipment at Northern States Power Company, Lawrence Generating Station located near Sioux Falls, South Dakota. This equipment will be utilized for the Combined Cycle Pilot Plant if it is to be located at this site, and therefore should not be duplicated.

NSP Designation: Conveyor, Upper Apron, Bunkers

Conveyor: Mfg.: Link Belt Co., 300 W. Pershing Rd.
Chicago, Ill.

Order No.: 722 346 P

Data.: Dwg. No. C6160 Capacity 100 tons/hr.
Speed 300 ft./min. Belt width 24"

Motor: Mfg.: Louis Allis Co., Milwaukee, Wisc.

Ser. No.: 1 298 277

Data.: Type	JEA	Frame	284
Class	D	Form	R
Code	G	H.P.	7.5
R.P.M.	1760	Phase	3
Cycle	60	Volts	220/440
Amps	21.4/10.7	Temp. Rise	55°C full
Underwriters Insp.	LA 893 452		load

Reduction Gearing: Mfg.: Link Belt Co., 300 W. Pershing Rd.,
Chicago, Ill.

Order No.: H 12 663

Data: Size S-50-LH Ratio 9.91-1
AGMA H.P. Rat. 8.28 Input R.P.M. 1750
Output R.P.M. 176.5 Service Factor 1

Starter: Mfg.: Allen Bradley, Milwaukee, Wisc.

Data.: Bulletin 709 Size 2
Form 2 NEMA 9
S.F. Ord. No. 903 Item #5

Control: Mfg.: Allen Bradley, Milwaukee, Wisc.

Data.: Momentary contact Bulletin 800
Style Push Button Type 2HA7A
S.F. Ord. No. 903 Item #14

Safety Switch: Mfg.: The Square D Mfg. Co. Detroit

Data.: Amps 60 Volts 575
Pole 3 Single Throw
Non Fusible NEMA 9
S.F. Ord. No. 955 Item #7

BY:

P.O.NO.

SUPPLIER:

MATERIAL REQUISITION



FOSTER WHEELER CORPORATION

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FOR	ERDA-FE-14-32-0001-1521 F.W.REF. 15-1590	REQUISITION NUMBER	DATE
SITE	NSP LAWRENCE STATION, SIOUX FALLS, SD		5/1/76
MATERIAL	Coal Storage Hopper Feed Conveyor	SUPERSEDED BY CHANGE NO.:	
	CR-123 EX	C1	C4
		C2	C5
		C3	C6

This requisition describes existing equipment at Northern States Power Company, Lawrence Generating Station located near Sioux Falls, South Dakota. This equipment will be utilized for the Combined Cycle Pilot Plant if it is to be located at this site, and therefore should not be duplicated.

Size: 24" wide belt x approx. 75' long

Capacity: 100 tons/hr.

Description: Covered conveyor connecting upper coal conveyor (CR-122 EX) and coal storage hopper (TK-111EX)

BY:	P.O.NO.	SUPPLIER:
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MATERIAL REQUISITION



FOSTER WHEELER CORPORATION

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FOR	ERDA-FE-14-32-0001-1521	F.W.REF. 15-1590	REQUISITION NUMBER	DATE
SITE	NSP LAWRENCE STATION, SIOUX FALLS, SD		5/1/76	
MATERIAL	Front End Loader		SUPERSEDED BY CHANGE NO.:	
	CR-125 EX		C1	C4
			C2	C5
			C3	C6

This requisition describes existing equipment at Northern States Power Company, Lawrence Generating Station located near Sioux Falls, South Dakota. This equipment will be utilized for the Combined Cycle Pilot Plant if it is to be located at this site, and therefore should not be duplicated.

Model:

Manufacturer:

Serial No.:

Capacity: 5 cubic yards

BY:	P.O.NO.	SUPPLIER:
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MATERIAL REQUISITION



FOSTER WHEELER CORPORATION

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FOR	U.S. ERDA	F.W. REF.	15-1591	REQUISITION NUMBER	DATE
SITE	SIOUX FALLS, SOUTH DAKOTA			1591-13490	4/26/76
MATERIAL	ATMOSPHERIC COAL DUST FILTER F-107			SUPERSEDED BY CHANGE NO.:	
		C1		C4	
		C2		C5	
		C3		C6	

GENERAL

1. The Vendor shall design, fabricate and furnish a bag filter system for removal of coal dust, complete with filters, pulsing central elements and panels, and auxiliaries. The unit shall be equipped with all components and accessories as required for complete, fully instrumented systems. Also included in the scope, a hopper for collection of the coal dust as well as a rotary gas lock feeder for removal of said coal dust.

2. Utilities will be available as follows:

a. Electric Power

Controls	115 volts	single phase	60 hertz
Motors (3/4 HP to 200 HP)	460 volts	three phase	60 hertz
Motors (below 1/2 HP)	115 volts	single phase	60 hertz

b. Instrument Air: 100 psig

3. The following standards shall be considered an integral part of this requisition:

1590-1900A	General Notes for Miscellaneous Equipment
1590-1600A	General Notes for Instruments
1590-60A1	Instrumentation Standard
1590-64A1	Control Panel - Shop Fabricated
1590-38A1	Induction Motors
1590-70A1	Electrical Standard
1590-96A2	Noise Control Specification

PROCESS DATA

1. Gas Handled Low Btu Gas

2. Mol. Wt. 24.9

3. Gas composition, volume %

H ₂ O	= 0.01
H ₂	= 14.31
N ₂	= 54.74
CO ₂	= 0.01
CO	= 6.64
CH ₄	= 4.10
CO ₂	= 20.19
Total	= 100.00

BY:

P.O.NO.

SUPPLIER:

B. <u>PROCESS DATA</u> (cont'd)	Case I	Case II
	Filling <u>Storage Injector</u>	Depressurizing <u>Storage Injector*</u>
4. Max. Instant. Gas Flow, lb/hr	80	15,000
5. Max. Instant. Gas Flow, ACFH	1620	304,000
6. Hourly Avg. Coal Dust Flow, lb/hr	60	8.3
7. Hourly Avg. Gas Flow, lb/hr	28	33
8. Hourly Avg. Gas Flow, ACFH	572	668
9. Avg. Solids Feeding, Gr/ACF	734	87.5
10. Duration of Flow, min/20 min.	6.7	0.1

*The storage injector is actually a lock hopper of a solids feeding system for coal. The bag filter, to be provided by Vendor, is to remove coal dust from the lock hopper gases vented to the atmosphere.

11. Solids bulk Density (minimum)	35 lb/CF
12. Percent Surface Moisture of Solids	Nil
13. Particle Size Range:	From 2 microns up to 300 microns
14. Design Surge Volume of Hopper (As contained between high and low solids levels. Hopper must always contain a solids level so as to minimize gas entrainment thru gas lock)	8.0 ft ³ (approx. equiv. of solids collected every 4 hrs)
15. Maximum Operating Temperature	200°F
16. Operating Pressure	Atmospheric
17. Filter Efficiency	99.0% minimum, for 2 micron particles

C. MECHANICAL DESIGN

1. Design Temperature 250°F
2. Design Pressure

*Vendor to advise if lower design pressure can be achieved thru use of explosion doors.
3. Cleaning of Bags - A mechanical shaking device is to be employed (gas blowback is not desired)
4. Rotary Gas Lock - This valve must be as tight as possible to minimize the amount of low BTU gas leakage and/or nitrogen leakage in the reverse direction from bin below at 3" H₂O gage (bin by others). Gas lock to be sized to remove 8.0 ft.³ of coal dust in 5.0 min.
5. Nozzle Connections:
 - a. Gas & Solids Inlet 20" (to be confirmed later)
 - b. Gas Outlet 20" (to be confirmed later)
 - c. Solids Outlet 10" (Vendor to confirm)
 - d. Inerting Gas 1½"

MATERIAL REQUISITION



FOSTER WHEELER

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FORM 135-20A

FOR <u>ERDA - Fossil Energy</u>	F.W.REF. <u>15-1591</u>	REQUISITION NUMBER	DATE
SITE <u>Sioux Falls, South Dakota</u>		<u>1591-1626-A</u>	<u>8-5-75</u>
MATERIAL <u>HOT GAS VALVES</u>		SUPERSEDED BY CHANGE NO.:	
<u>MOV-102; MOV-103</u>		C1 <u>9-29-75</u>	C4
		C2 <u>10-22-75</u>	C5
		C3	C6

1. SCOPE

Two "On-Off" Hot Gas Valves" for use in a high temperature-high pressure coal gasification process. Each valve to be suitable for operation at the design conditions with a minimum leakage rate from either direction.

2. DESIGN CONDITIONS

(2) Fluid: Gasifier effluent gas with particulate matter.

(2) Maximum Temperature - 2100°F
 Normal Pressure - 440 psig
 Maximum ΔP for valve actuation - 500 psi (In either direction)
 Differential pressure for valve sizing - Minimum

A. Valve

	<u>MOV-102</u>	<u>MOV-103</u>
(2) Size	20" I.D.; 42" O.D. nominal	20" I.D.; 42" O.D. nominal
Flow Rates	<u>Gas</u>	<u>Gas</u>
	<u>Solids</u>	<u>Solids</u>
(2) Normal	191,413 #/hr.	97,524 #/hr.
	34,149 #/hr.	13,332 #/hr.
(2) Minimum	63,804 #/hr.	48,599 #/hr.*
	11,383 #/hr.	2,667 #/hr.*
(2) Design	-----	40,000 #/hr.
	97,524 #/hr.	13,660 #/hr.
Normal Press.	440 psig	440 psig
(2) Minimum Press.*	45 psig	45 psig
Design Press.	500 psig	500 psig
Normal Temp.	1800°F	1800°F
Design Temp.	2150°F	2150°F
Design ΔP (In either direction)	500 psi	500 psi

Gas Velocity

- a. Light Off* ----- 89 ft./sec. (short periods)
 Start-Up
- b. Normal Start-Up ----- 75 ft./sec.
- c. Normal Operation - 53 ft./sec

(2)* Conditions During Light Off

BY: <u>JS</u>	P.O. NO.	SUPPLIER:
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B. Gas Composition

<u>Component</u>	<u>Volume Percent</u>
H ₂ O	9.8
H ₂	13.2
CO	18.0
CO ₂	8.5
CH ₄	3.7
N ₂	45.8
H ₂ S	0.5
COS & NH ₃	0.5

Molecular Weight: 24.53

Gas Density at 1800°F and 440 psig: 0.4595 lbs/ft³

Gas Viscosity at 1800°F: 0.044 cps

Compressibility Factor: 1

C. Particulate Composition:

Type----- CHAR from coal gasification

<u>Species</u>	<u>Weight percent</u>
Carbon	82.8
Ash	17.2

Density: 20-60 lbs/ft³

Particle Size Distribution:

<u>Micron Size</u>	<u>Weight Percent</u>
<.5	0
.5 to 1.79	.06
1.79 to 3.78	.15
3.78 to 9.77	1.04
9.77 to 13.28	.75
13.28 to 32.02	5.00
32.02 to 64.32	11.00
64.32 to 100	12.00
100 to 109.5	3.00
109.5 to 186	19.50
186 to 212	5.50
212 to 276	11.00
276 to 358	6.00
358 to 416	3.00
416 to 582	6.00
582 to 2000	16.00

Note: This size distribution remains the same for all solids flow rates.

2. REFERENCES

ANSI Standards
B16.25 Buttwelding Ends

API Standards
598 Valve Inspection and Test
600 Steel Gate Valves, Flanged or Buttwelding Ends

ASTM Standards
E164 Ultrasonic Contact Inspection of Weldments

ASME Boiler and Pressure Vessel Codes:
Section VIII, Unfired Pressure Vessels, 1974, Div. 1

Foster Wheeler Standards
1590-92A1 Preparation of Material for Shipment
1590-1620A Control Valve - General Requirements
1590-1600A General Notes for Instruments

3. MATERIALS

3.1 Body material shall be of fabricated carbon or alloy steel

Valve disc design shall be one of the following and designed to minimize scoring of the seating surfaces.

Slab Gate (goggle)
Flexible Wedge Design
Spherical (Ball)

3.2 Refractory Lining

(1) Valve shall be installed in refractory lined piping; the refractory lining shall consist of 3" Resco 17A facing backed by 8" Resco #3. Where valve is refractory lined manufacturer shall indicate type of refractory and method of application.

3.3 Gate valve trim as a minimum shall be API 600 trim no. 5. Disc guides shall be hard faced with Stellite #6 and running surfaces shall be smoothed by grinding or machining.

3.4 Bonnet to body flanges shall have an oval ring type joint.

3.5 Valves shall be designed so that internals, disc or ball can be removed from body without removing body from line.

3. MATERIALS (Continued)

- 3.6 Ball valve shall have a blow-out proof stem design.
- 3.7 Manufacturer shall indicate in detail materials of construction for Foster Wheeler approval prior to start of fabrication.
- 3.8 Upon receipt of purchase order manufacturer shall submit for Foster Wheeler's review a list of all welding procedures (giving the identification number and date of latest revision) which he intends to follow for welding of all pressure parts.
- 3.9 A manufacturer with whom an order has been placed shall not suborder assembled valves from other sources without Foster Wheeler approval.

4. REACTOR VALVE (Process Line) MOV-102

- 4.1 Valve and operator shall be designed for installation in a horizontal line with valve stem in either a vertical or horizontal position.
- 4.2 Valves shall be installed outdoors; ambient design temperature of (-) 25°F to +93°F.
- 4.3 Mechanical Design
 - a. Size 20" inside flow diameter
 - b. Valve shall be designed for the following fluid conditions:
Pressure - 500 psig
Temperature - 2,150°F
 - c. Maximum differential pressure in either direction across valve in closed position: 500 psi @ 2,150°F.
- 4.4 If valve is to be liquid cooled manufacturer shall specify coolant and quantity circulated.

- (1) 4.5 Nominal temperature of valve body and bonnet shall be 250°F based
- (1) on 70°F ambient temperature.

5. REACTOR VALVE (START UP LINE) MOV-103

- 5.1 Valve and operator shall be designed for installation in a horizontal line with valve stem in either a vertical or horizontal position.
- 5.2 Valve shall be installed outdoors; ambient design temperature (-) 25°F to +93°F.

5. REACTOR VALVE (START UP LINE) MOV-103 (Continued)

5.3 Mechanical Design

- a. Size 20" inside flow diameter
- b. Valve shall be designed for the following fluid conditions
Pressure - 500 psig
Temperature - 2,150°F
- c. Maximum differential pressure in either direction across valve in closed position: 500 psi at 2150°F fluid temperature.

5.4 If valve is to be liquid cooled manufacturer shall specify coolant and quantity circulated.

- (2) 5.5 Nominal temperature of valve body and bonnet shall be 250°F based on 70°F ambient temperature.

6. ADDITIONAL REQUIREMENTS FOR VALVES

- 6.1 With valves in closed position leakage past seats shall be held to a minimum. Refer to Section 7 for test leakage rates.
- 6.2 Valve shall have end connections prepared per ANSI B16.25 for butt welding.
- 6.3 Connections for purging CHAR from valve shall be added as required.
- 6.4 Minimum size connection shall be 3/4".

7. INSPECTION AND TESTING

- 7.1 Valves shall be inspected per API 598; paragraphs 2.1, 2.2(a) and (c) supplementary examination shall consist of 100% radiographic examination of all pressure containing butt welds per Section VIII, Unfired Pressure Vessels, Div. 1, para. UW51 and ultrasonic testing of other pressure containing welds per ASTM E164, para 2.2.4.
- 7.2 Valves shall be tested per API 598. High pressure closure test shall be performed on both MOV-102 and MOV-103. The high pressure closure test shall be performed at the design pressure of 500 psi differential pressure. Test leakage in either direction shall not exceed 3.8 S.C.F.M. per inch of inside diameter using air as a test medium at a temperature below 100°F.

Low pressure seat test shall be performed on gate or ball valves per para. 4.3.a.1 with allowable leakage per para. 3.7.

7. INSPECTION AND TESTING (Continued)

- 7.3 API valve seat pressure tightness tests shall be performed after all welding, machining and refractory installation is complete. Seating surfaces shall be clean and free from oil.
- 7.4 Required closure torque during test, without lubrication: For motor operated valves, tests shall be conducted with stem closure torque not exceeding design closure torque.
- 7.5 Valves shall be fully stroked a minimum of 12 times (6 openings and 6 closings) at the valve manufacturer's plant before shipping.
- 7.6 Notification of Inspection and Test shall be per API 598 Section 2.

8. PREPARATION FOR SHIPMENT

- 8.1 Preparation of material for shipment shall be in accordance with Job Spec. 1590-92A1.
- 8.2 Valves shall be shipped in the closed position.
- 8.3 Manufacturer shall advise approximate weight of each valve.

9. VALVE OPERATOR

Manufacturer shall provide an automatic operator for each valve capable of opening or closing the valve in not more than 60 seconds. The operator shall be suitable for continuous duty at the ambient temperature range specified previously. Each operator shall be equipped with a manual override to permit full opening and full closing of the valve in case of automatic operator or motive power failure. Manufacturer shall fully describe the operator as to make, model number, size, construction details, method of operation and all information necessary to fully describe its operation.

10. VALVE INTERLOCKS

Each valve shall be provided with interlocks to prevent either valve from closing unless the other valve is full open when in automatic operation. Unpowered switches shall be provided to indicate on purchaser's annunciator when either valve is pulsed to open when the other valve is not fully open. Unpowered S.P.D.T. switches shall be provided for each valve to be operated at the full closed and the full open position.

A S.P.D.T. unpowered switch shall be provided at each operator for indication of the engagement and disengagement of the manual operator. Switches shall be rated for 10 amps at 110 volts, 60 Hz.

All electrical components shall be located in housings suitable for Class I Group D Division I location.

MATERIAL REQUISITION



FOSTER WHEELER CORPORATION

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FORM 135-20

FOR	ERDA-FE-14-32-0001-1521 F.W. REF. 15-1590	REQUISITION NUMBER	DATE
SITE	NSP LAWRENCE STATION, SIOUX FALLS, SD		5/1/76
MATERIAL	Coal Crusher	SUPERSEDED BY CHANGE NO.:	
	SR-103 EX	C1	C4
		C2	C5
		C3	C6

This requisition describes existing equipment at Northern States Power Company, Lawrence Generating Station located near Sioux Falls, South Dakota. This equipment will be utilized for the Combined Cycle Pilot Plant if it is to be located at this site, and therefore should not be duplicated.

NSP Designation: Crusher, Coal

Starter: Mfg. Allen Bradley Milwaukee, Wisc.
 Data. Bulletin 709 Size 3
 Form 2 NEMA 9
 S.F. Ord. No. 903 Item 4

Control: Mfg. Allen Bradley Milwaukee, Wisc.
 Data. Momentary Contact Style Push button
 Bulletin 800 Type 2HA7A
 S.F. Ord. No. 903 Item 14

Safety Switch: Mfg. The Square D Mfg. Co., Detroit
 Data. Amps 200 Volts 575
 Pole 3 Single throw
 Non Fusible NEMA 9
 S.F. Ord. No. 955 Item 8

Crusher Mfg. American Pulverizer Co., Chicago, Ill.
 Data. Crusher size 5 1/2" to 3/4"
 Capacity 100 ton/hr with 15%
 moisture and frozen coal

Motor: Mfg. Gen. Electric Co., Schenectady, New York
 Serial No. SE6731419
 Data. Totally enclosed fan cooled induction motor
 Code H Model 5K6325FH1J
 Frame 6325 Type K
 Volts 440 Amps 65
 Phase 3 Cycles 60
 R.P.M. 705 H.P. 50
 Degree Rise 55 Centigrade

Crusher: Mfg. American Pulverizer Co., St. Louis, Mo.
 Serial No. 2652
 Data. Type S
 Machine #30

BY:	P.O. NO.	SUPPLIER:
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MATERIAL REQUISITION



FOSTER WHEELER CORPORATION

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FORM 135-20

FOR <u>U.S. ERDA, F.E.</u>	F.W.REF. <u>15-1591</u>	REQUISITION NUMBER	DATE
SITE <u>SIOUX FALLS, SOUTH DAKOTA</u>		<u>1591-1349E</u>	<u>11/27/76</u>
MATERIAL <u>FLARE DUST DRY SCRUBBER, S-118</u>	SUPERSEDED BY CHANGE NO.:		
	C1		C4
	C2		C5
	C3		C6

A. GENERAL

- The vendor shall design, fabricate and furnish a cyclone (Peerless Dry Scrubber, or equal) for the removal of coal and char dusts from flue gases. Also included in the vendor's scope will be a hopper for collection of the dusts.

- Utilities will be available as follows:

a. Electric Power

Controls	115 volts	single phase	60 hertz
Motors (3/4 HP to 200 HP)	460 volts	three phase	60 hertz

Motors (below 1/2 HP)	115 volts	single phase	60 hertz
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b. Instrument Air: 100 psig

- The following standards shall be considered an integral part of this requisition:

1590-1900A	General Notes for Miscellaneous Equipment
1590-1600A	General Notes for Instruments
1590-60A1	Instrumentation Standard
1590-64A1	Control Panel - Shop Fabricated
1590-38A1	Induction Motors
1590-70A1	Electrical Standard
1590-96A2	Noise Control Specification

B. PROCESS DATA

- Gas Handled Low Btu Gas
- Mol. wt. 24.9
- Gas Composition:

<u>Component</u>	<u>Mol Percent</u>
H ₂ O	0.01
H ₂	14.31
CO	20.19
CO ₂	6.64
CH ₄	4.10
N ₂	54.74
COS	0.01
Total	100.00

BY:	P.O.NO.	SUPPLIER:
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B. PROCESS DATA

4. Average Flow Rate of Gas	1686 lb/hr *
5. Maximum instantaneous gas flow	42,336 lb/hr *
6. Maximum instantaneous gas flow	631,000 ACFH *
7. Average flow rate of coal dust, only	8.3 lb/hr *
8. Average solids loading	2.3 GR/ACF
9. Design Solids loading	4.5 GR/ACF
10. Mixed bulk density of coal & coal dust	15 lbs/CF

* Gas and solids flow occur 2.7 to 5.6 minutes, every 20 minutes

11. Percent surface moisture of solids	nil
12. Particle size range: from 1 micron up to 10 microns	
13. Design surge volume of hopper (as contained between high and low solids levels. Hopper must always contain solids level so as to minimize gas entrainment)	40 ft ³ (approx. equivalent of solids collected in one day)
14. Normal operating temperature	200°F
15. Maximum operating temperature	750°F
16. Operating pressure	0 - 5 psig
17. Scrubber efficiency:	

<u>Particle size</u>	<u>% Removal eff.</u>
6 microns	99
4 - 6 microns	90
2 - 4 microns	85

C. MECHANICAL DESIGN

1. Design temperature	800°F
2. Design pressure	75 psig
3. Nozzle connections:	
a. Gas & solids inlet	18" (to be confirmed later)
b. Gas outlet	18"
c. Solids outlet	10" (Vendor to confirm, solids discharge by gravity flow at rate of 8 ft ³ /min) at into receiver at
d. PSV	later

FORM 136-23

CORE CERTIFICATION
FOSTER WHEELER ENERGY CORPORATION
INSTRUMENT PROCESS DATA

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PREPARED BY RSB

FLOWSHEET NO. 10

ENG. FLOW SHEET NO. OP-751-566

(1) ITEM NUMBER OR SERVICE	(2) NOM. LINE SIZE	(3) FLUID TYPE & STATE	(4) NORMAL lb/h	FLOW %		SP. GR. AT.		(9) MOL. WT.	(10) VISC. CPS. @ TEMP.	(11) LIQ. VAPOR PRESS. PSIA	(12) LIQ. CRITICAL PRESS. lb/in ² a	(13) VAPOR COMP. FACTOR	(14) VAPOR Cp/Cv	(15) NORM. OP. TEMP. °F	PRESSURES AT NORM. FLOW		PRESSURES AT MAX. FLOW		PRESSURES AT MIN. FLOW		(18) DOWNSTREAM FLASHING	(19) TIGHT SHUTOFF	(20) AIR FAILURE	(21) REMARKS AND/OR ALARM AND SHUTDOWN SETTINGS	(22) REVISION	
				(5)	(6)	(7)	(8)								(16a)	(17a)	(16b)	(17b)	(16c)	(17c)						
				MAX.	MIN.	60°F	COND.								UPSTREAM lb/in ² a	DOWN- STREAM lb/in ² a	UPSTREAM lb/in ² a	DOWN- STREAM lb/in ² a	UPSTREAM lb/in ² a	DOWN- STREAM lb/in ² a						
TE(FLUID) IN R-102	IN	9,10,GAS,												3000										ALL THERMOWELLS IN VERY HIGH	0	
TE-1484	VESSEL	CHAR																						TEMPERATURE SERVICE TO BE PURGED		
TI(FLUID) IN R-102														3000												0
TI-1483																										0
TR(FLUID) FOR R-102														3000												0
TR-1484																										0
TAH(FLUID) FOR R-102														3000												0
TAH-1484																										0
TAL(FLUID) FOR R-102														3000												0
TAL-1484																										0
TAHH(FLUID) FOR R-102														3000												0
TAHH-1484																										0
TE(FLUID) IN R-102														3000										ALL THERMOWELLS IN VERY HIGH	0	
TE-1486																								TEMPERATURE SERVICE TO BE PURGED		
TI(FLUID) IN R-102														3000												0
TI-1485																										0
TR(FLUID) FOR R-102														3000												0
TR-1486																										0
TAH(FLUID) FOR R-102														3000												0
TAH-1486																										0
TAL(FLUID) FOR R-102														3000												0
TAL-1486																										0
TAHH(FLUID) FOR R-102														3000												0
TAHH-1486																										0
TE(FLUID) AT BOTTOM OF R-101														3000										ALL THERMOWELLS IN VERY HIGH	0	
TE-1479																								TEMPERATURE SERVICE TO BE PURGED		
TI(FLUID) AT BOTTOM OF R-101														3000												0
TI-1479																										0
TR(FLUID) AT BOTTOM OF R-101														3000												0
TR-1479																										0
TE(FLUID) IN MIDDLE OF R-101														2100										ALL THERMOWELLS IN VERY HIGH	0	
TE-1481																								TEMPERATURE SERVICE TO BE PURGED		
TI(FLUID) IN MIDDLE OF R-101	IN	9,10,GAS,												2100												0
TI-1480	VESSEL	CHAR																								

FORM NO (110)-25B

A SHELL TEMPERATURE MONITORING SYSTEM FOR R-101 & R-102 IS TO BE FURNISHED.
A REFRACTORY TEMPERATURE MONITORING SYSTEM FOR R-101 & R-102 IS TO BE FURNISHED.

COAL GASIFICATION
FOSTER WHEELER ENERGY CORPORATION
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**FOSTER WHEELER ENERGY CORPORATION
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(1) ITEM NUMBER OR SERVICE	(2) NOM. LINE SIZE	(3) FLUID TYPE & STATE	(4) NORMAL lb/h	FLOW %		SP. GR. AT.		(9) MOL. WT.	(10) VISC. CPS. @ TEMP.	(11) LIQ. VAPOR PRESS. PSIA	(12) LIQ. CRITICAL PRESS. lb/in ² a	(13) VAPOR COMP. FACTOR	(14) VAPOR Cp/Cv	(15) NORM. OP. TEMP. °F	PRESSURES AT NORM. FLOW		PRESSURES AT MAX. FLOW		PRESSURES AT MIN. FLOW		(18) DOWNSTREAM FLASHING	(19) TIGHT SHUTOFF	(20) AIR FAILURE	(21) REMARKS AND OR ALARM AND SHUTDOWN SETTINGS	(22) REVISION
				(5)	(6)	(7)	(8)								(16a)	(17a)	(16b)	(17b)	(16c)	(17c)					
				MAX.	MIN.	60°F	COND.								UPSTREAM lb/in ² a	DOWN- STREAM lb/in ² a	UPSTREAM lb/in ² a	DOWN- STREAM lb/in ² a	UPSTREAM lb/in ² a	DOWN- STREAM lb/in ² a					
PDT ACROSS R-101 POT-1480	ON VESSEL	9,10,GAS, CHAR												2100	454										0
PDR ACROSS R-101 PDR-1480														2100	454										0
PDAH ACROSS R-101 PDAH-1480														2100	454										0
PDT ACROSS R-101 & R-102 PDT-1478														3000	460										0
PDR ACROSS R-101 & R-102 PDR-1478														3000	460										0
PDAH ACROSS R-101 & R-102 PDAH-1478														3000	460										0
PT, PR ACROSS R-101 OUTLET	ON VESSEL													3000	460										0
PT-1479																									
PDT ACROSS MOV-102 PDT-1476	20" I.D.													2100	454										0
PDAL-1476														2100	454										0
PDIC-1476														2100	454										0
PDT ACROSS MOV-103 PDT-1477														2100	454										0
PT,PI ACROSS OUTLET LINE FROM R-101 TO D-133 PT-1477														2100	454										0
PDIC ACROSS OUTLET LINE FROM R-101 TO D-133 PDIC-1477 (MOV-103)														2100	454										0
PDAL ACROSS OUTLET LINE FROM R-101 TO D-133 MOV-103 PDAL-1477	20" I.D.	9,10,GAS, CHAR												2100	454										0

COAL GASIFICATION
FOSTER WHEELER ENERGY CORPORATION
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FLWSHEET NO. 10

ENG. FLOW SHEET NO. OP-751-566

(1) ITEM NUMBER OR SERVICE	(2) NOM. LINE SIZE	(3) FLUID TYPE & STATE	(4) NORMAL lb/h	FLOW %		SP. GR. AT.		(9) MOL. WT.	(10) VISC. CPS. @ TEMP.	(11) LIQ. VAPOR PRESS. PSIA	(12) LIQ. CRITICAL PRESS. lb/in ² _a	(13) VAPOR COMP. FACTOR	(14) VAPOR Cd/Cv	(15) NORM. OP. TEMP. OF	PRESSURES AT NORM. FLOW		PRESSURES AT MAX. FLOW		PRESSURES AT MIN. FLOW		(18) DOWNSTREAM FLASHING	(19) TIGHT SHUTOFF	(20) AIR FAILURE	(21) REMARKS AND/OR ALARM AND SHUTDOWN SETTINGS	(22) REVISION
				(5) MAX.	(6) MIN.	(7) 60°F	(8) COND.								(16a) UPSTREAM lb/in ² _a	(17a) DOWN- STREAM lb/in ² _a	(16b) UPSTREAM lb/in ² _a	(17b) DOWN- STREAM lb/in ² _a	(16c) UPSTREAM lb/in ² _a	(17c) DOWN- STREAM lb/in ² _a					
FO ON STEAM TO PURGE CHAR WITHDRAWAL NOZZLE FO-1476	1"	8,STEAM						18.0						900	915										0
MOV-102	20" I.D.	9 GAS	197,783	110	25			24.77	.035			1.0		2100	454		454		114			NO	—	INTERLOCKED WITH MOV-103 ON-OFF VALVE (NO THROTTLING)	0
		10 GAS,CHAR	LBS/HR GAS 33,629 LBS/HR CHAR																						
MOV-103	20" I.D.	9 GAS	97,524	110	25			22.0	.035			1.0		2100	454		454		114			NO	—	INTERLOCKED WITH MOV-102 ON-OFF VALVE (NO THROTTLING)	0
		10 GAS,CHAR	LBS/HR GAS 13,332 LBS/HR CHAR 600 LBS/HR OIL 180 LBS/HR NAPATAR 400 LBS/HR TAR																						
FCV ON NITROGEN TO LINE FROM GASIFIER TO STARTUP SYSTEM	1½"	14,N ₂		110	33			28.016	.02			1.0		100	615		615					NO	0		0

CHAR SEPARATION AND COOLING
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(1) ITEM NUMBER OR SERVICE	(2) NOM. LINE SIZE	(3) FLUID TYPE & STATE	(4) NORMAL lb/h	FLOW %		SP. GR. AT.		(9) MOL. WT.	(10) VISC. CPS. ° TEMP.	(11) LIQ. VAPOR PRESS. PSIA	(12) LIQ. CRITICAL PRESS. lb/in ² _a	(13) VAPOR COMP. FACTOR	(14) VAPOR Cp/Cv	(15) NORM. OP. TEMP. °F	PRESSURES AT NORM. FLOW		PRESSURES AT MAX. FLOW		PRESSURES AT MIN. FLOW		(18) DOWNSTREAM FLASHING	(19) TIGHT SHUTOFF	(20) AIR FAILURE	(21) REMARKS AND/OR ALARM AND SHUTDOWN SETTINGS	(22) REVISION	
				(5) MAX.	(6) MIN.	(7) 60°F	(8) COND.								(16a) UPSTREAM lb/in ² _a	(17a) DOWN- STREAM lb/in ² _a	(16b) UPSTREAM lb/in ² _a	(17b) DOWN- STREAM lb/in ² _a	(16c) UPSTREAM lb/in ² _a	(17c) DOWN- STREAM lb/in ² _a						
PI ON INLET TO S-102 PI-1501	20" I.D. REFTRY	9, GAS & CHAR												2100	452											0
PT, PR ON D-113 PR, PT-1504	ON VESSEL	9, GAS												1700	454											0
PDT, PDI CONNECTING LINE TO S-102 AND DIPLEG OUT OF S-103 AND LINE OUT OF S-103 PDT-1507	20" I.D. 8" I.D.	9, GAS & CHAR												2100	454											0
PDT, PDR ON D-113 AND ON OUTLET OF S-102 PDT-1503	20" I.D. REFTRY													2100	454											0
PDT, PDR IN LOWER SECTION OF D-113 PDT-1506	ON VESSEL													2100	454											0
PDT, PDR ON D-113 WITH ONE TAP IN BOTTOM SECTION AND ONE TAP IN UPPER SECTION PDT-1505														2100	454											0
PDRR FROM PT TAKING SIGNALS FROM BOTH PDTs ON D-113 PDR-1506														2100	454											0
PDAH FROM PY ON D-113 PDFSH-1506														2100	454											0
PDAH FROM PY ON D-113 PFSHH-1506	ON VESSEL	9, GAS & CHAR												2100	454											0
PDT FROM RECYCLE GAS LINE FOR DIPLEG PURGING PDT-1507	3/4"	9, GAS												120	487											0
PDIC ON DIPLEG PURGE LINE PDIC-1507	3/4"	9, GAS												120	487											0
PT ON FLUIDIZING GAS TO D-113 PT-1510	6"	9, GAS												120	487											0
PT ON PRIMARY LIFT GAS TO D-113 PT-1509	4"	9, GAS												120	487											0

CHAR SEPARATION AND COOLING
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GAS COOLING
FOSTER WHEELER ENERGY CORPORATION
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FLOWSHEET NO. 14

ENG. FLOW SHEET NO. OP-761-49

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(1) ITEM NUMBER OR SERVICE	(2) NOM. LINE SIZE	(3) FLUID TYPE & STATE	(4) NORMAL lb/h	FLOW %		SP. GR. AT.		(9) MOL. WT.	(10) VISC. CPS. @ TEMP.	(11) LIQ. VAPOR PRESS. PSIA	(12) LIQ. CRITICAL PRESS. lb/in2a	(13) VAPOR COMP. FACTOR	(14) VAPOR Cb/Cv	(15) NORM. OP. TEMP. OF	PRESSURES AT NORM. FLOW		PRESSURES AT MAX. FLOW		PRESSURES AT MIN. FLOW		(18) DOWNSTREAM FLASHING	(19) TIGHT SHUTOFF	(20) AIR FAILURE	(21) REMARKS AND/OR ALARM AND SHUTDOWN SETTINGS	(22) REVISION
				(5) MAX.	(6) MIN.	(7) 60°F	(8) COND.								(16a) UPSTREAM lb/in2a	(17a) DOWN- STREAM lb/in2a	(16b) UPSTREAM lb/in2a	(17b) DOWN- STREAM lb/in2a	(16c) UPSTREAM lb/in2a	(17c) DOWN- STREAM lb/in2a					
TAH ON E-117 TUBESIDE OUTLET BEFORE BYPASS	16"	9,10,GAS & CHAR												580											0
TAH-1362																									
TR ON E-117 TUBESIDE OUTLET BEFORE BYPASS														580											0
TR-1362																									
TI ON E-117 TUBESIDE OUTLET BEFORE BYPASS														580											0
TI-1361																									
TAHH ON E-117 TUBESIDE OUTLET BEFORE BYPASS	16"													580											0
TAHH-1362																									
TAH ON E-117 TUBESIDE OUTLET AFTER BYPASS	17" I.D.													996											0
TAH-1359																									
TI ON E-117 TUBESIDE OUTLET AFTER BYPASS														996											0
TI-1360																									
TR ON E-117 TUBESIDE OUTLET AFTER BYPASS														996											0
TR-1359																									
TAHH ON E-117 TUBESIDE OUTLET AFTER BYPASS	17" I.D.													996											0
TAHH-1359																									
TI ON E-118 TUBESIDE OUTLET	16"													692											0
TI-1366																									
TI ON E-119 TUBESIDE OUTLET	12"	9,10,GAS & CHAR												300											0
TI-1368																									

GAS COOLING

ENG. FLOW SHEET NO. OP-761-44

PREPARED BY RSB

FORM NO (110)-25B

GAS COOLING
FOSTER WHEELER ENERGY CORPORATION
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FLWSHEET 14

ENG. FLOW SHEET NO. OP-761-44

(1) ITEM NUMBER OR SERVICE	(2) NOM. LINE SIZE	(3) FLUID TYPE & STATE	(4) NORMAL lb/h	FLOW %		SP. GR. AT.		(9) MOL. WT.	(10) VISC. CPS. @ TEMP.	(11) LIQ. VAPOR PRESS. PSIA	(12) LIQ. CRITICAL PRESS. lb/in ² _a	(13) VAPOR COMP. FACTOR	(14) VAPOR Cp/Cv	(15) NORM. OP. TEMP. °F	PRESSURES AT NORM. FLOW		PRESSURES AT MAX. FLOW		PRESSURES AT MIN. FLOW		(18) DOWNSTREAM FLASHING	(19) TIGHT SHUTOFF	(20) AIR FAILURE	(21) REMARKS AND/OR ALARM AND SHUTDOWN SETTINGS	(22) REVISION
				(5) MAX.	(6) MIN.	(7) 60°F	(8) COND.								(16a) UPSTREAM lb/in ² _a	(17a) DOWN- STREAM lb/in ² _a	(16b) UPSTREAM lb/in ² _a	(17b) DOWN- STREAM lb/in ² _a	(16c) UPSTREAM lb/in ² _a	(17c) DOWN- STREAM lb/in ² _a					
PI ON D-135 PI-1359	ON VESSEL	8,STEAM 1,BFW												537	1014										0
PDT ACROSS TUBESHEET INLET OF E-117 & TUBESHEET OUTLET OF E-119	20" I.D. 12"	9,10,GAS & CHAR												2100	445										0
PDI ACROSS TUBESHEET INLET OF E-117 & TUBESHEET OUTLET OF E-119 PDI-1363	20" I.D. 12"													2100	445										0
PDAH ACROSS TUBESHEET INLET OF E-117 & TUBESHEET OUTLET OF E-119 PDAH-1363	20" I.D. 12"	9,10,GAS & CHAR												2100	445										0
PI ON D-136 PI-1362	ON VESSEL	8,STEAM 1,BLOWDOWN												315	124										0
			</																						

GAS COOLING
FOSTER WHEELER ENERGY CORPORATION
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(1) ITEM NUMBER OR SERVICE	(2) NOM. LINE SIZE	(3) FLUID TYPE & STATE	(4) NORMAL lb/h	FLOW %		SP. GR. AT.		(9) MOL. WT.	(10) VISC. CFS. ° TEMP.	(11) LIQ. VAPOR PRESS. PSIA	(12) LIQ. CRITICAL PRESS. lb/in ² a	(13) VAPOR COMP. FACTOR	(14) VAPOR Cp/Cv	(15) NORM. OP. TEMP. °F	PRESSURES AT NORM. FLOW		PRESSURES AT MAX. FLOW		PRESSURES AT MIN. FLOW		(18) DOWNSTREAM FLASHING	(19) TIGHT SHUTOFF	(20) AIR FAILURE	(21) REMARKS AND/OR ALARM AND SHUTDOWN SETTINGS	(22) REVISION
				(5) MAX.	(6) MIN.	(7) 60°F	(8) COND.								(16a) UPSTREAM lb/in ² a	(17a) DOWN STREAM lb/in ² a	(16b) UPSTREAM lb/in ² a	(17b) DOWN STREAM lb/in ² a	(16c) UPSTREAM lb/in ² a	(17c) DOWN STREAM lb/in ² a					
FT ON STEAM FROM D-135 TO E-118 FT-1361	8"	8,STEAM	79,864	110	33			18	.030			.80	1.33	537	934										0
FY ON STEAM FROM D-135 TO E-118 FY-1361			79,864	110	33			18	.030			.80	1.33	537	934										0
FR ON STEAM FROM D-135 TO E-118 FR-1361	8"		79,864	110	33			18	.030			.80	1.33	537	934										0
FT ON STEAM PURGE TO PSV SET @ 462 PSIG FT-1357	1"		500					18	.031			.95	1.33	900	915										0
FI ON STEAM PURGE TO PSV SET @ 462 PSIG FI-1357			500					18	.031			.95	1.33	900	915										0
FAL ON STEAM PURGE TO PSV SET @ 462 PSIG FAL-1357			500					18	.031			.95	1.33	900	915										0
FT ON STEAM PURGE TO PSV SET @ 470 PSIG FT-1356			500					18	.031			.95	1.33	900	915										0
FI ON STEAM PURGE TO PSV SET @ 470 PSIG FI-1356			500					18	.031			.95	1.33	900	915										0
FAL ON STEAM PURGE TO PSV SET @ 470 PSIG FAL-1356	1"	8,STEAM	500					18	.031			.95	1.33	900	915										0
FT ON BFW FROM DUMMY TUBESHEET OF E-117 TO E-119 FT-1360	4"	1,BFW	80,671	110	33	1.0	.95	.2	25					240	1188										0
FY ON BFW FROM DUMMY TUBESHEET OF E-117 TO E-119 FY-1360			80,671	110	33	1.0	.95	.2	25					240	1188										0
FR ON BFW FROM DUMMY TUBESHEET OF E-117 TO E-119 F-1360	4"	1,BFW	80,671	110	33	1.0	.95	.2	25					240	1188										0

GAS COOLING
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OP-761-44
 FLOWSHEET NO. 14

FOSTER WHEELER CORPORATION
 RELIEF VALVES
 PROCESS DATA
 GAS COOLING

PLANT ERDA COAL GASIFICATION
 LOCATION SIOUX FALLS, S.D.

BY RSB

DATE APR. 29, 1976

SHEET NO. 1 OF 1
 JOB NO. 15-1591

ITEM NO. (Flow Plan Symbol)		PSV- 1360	PSV- 1361	PSV-	PSV-
Service		ON TUBESHEET OUTLET OF E-117	ON TUBESHEET OUTLET OF E-117		
Number of Valves Required		ONE	ONE		
In Regular Use		ONE	STANDBY		
As Spares					
Interlocks Required					
Fluid and State		GASIFIER EF- FLUENT&CHAR	GASIFIER EF- FLUENT&CHAR		
Corrosive Compounds		H ₂ S, COS, NH ₃	H ₂ S, COS, NH ₃		
Flow (Total) at Relieving Conditions	gal/min	(NOTE 1)	(NOTE 1)		
	lb/h	148,340	148,340		
Sp. gr. at Relieving Conditions					
Molecular Weight		24.77	24.77		
Compressibility Factor		1.0	1.0		
Normal Operating Temperature, ¹ °F		580	580		
Relieving Temperature, ² °F		580	580		
Relieving (Set) Pressure, lb/in ²		462	470		
Superimposed Back Pressure, ³ lb/in ²		10	10		
Built-up Back Pressure, ⁴ lb/in ²		LATER	LATER		
Allowable Accumulation, %		10	10		
Minimum Orifice Area Required, in ²					
Governing Conditions ⁵		BLOCKED IN	BLOCKED IN		
Relief Valve Type					
Relief Valve Size					
Balanced Type ⁶		YES	YES		
Total Orifice Area (effective) Provided					

NOTES: (1) ABOUT 25% OF GAS THROUGH E-117 IS BYPASSED

Form 110-16

RECYCLE GAS SYSTEM
FOSTER WHEELER ENERGY CORPORATION
INSTRUMENT PROCESS DATA

FLOWSHEET NO. 15

ENG. FLOW SHEET NO. OP-751-570

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PREPARED BY RSB

(1) ITEM NUMBER OR SERVICE	(2) NOM. LINE SIZE	(3) FLUID TYPE & STATE	(4) NORMAL lb/h	FLOW %		SP. GR. AT.		(9) MOL. WT.	(10) VISC. CPS. @ TEMP.	(11) LIQ. VAPOR PRESS. PSIA	(12) LIQ. CRITICAL PRESS. lb/in ² a	(13) VAPOR COMP. FACTOR	(14) VAPOR CR/CV	(15) NORM. OP. TEMP. °F	PRESSURES AT NORM. FLOW		PRESSURES AT MAX. FLOW		PRESSURES AT MIN. FLOW		(18) DOWNSTREAM FLASHING	(19) TIGHT SHUTOFF	(20) AIR FAILURE	(21) REMARKS AND/OR ALARM AND SHUTDOWN SETTINGS	(22) REVISION
				(5) MAX.	(6) MIN.	(7) 60°F	(8) COND.								(16a) UPSTREAM lb/in ² a	(17a) DOWN- STREAM lb/in ² a	(16b) UPSTREAM lb/in ² a	(17b) DOWN- STREAM lb/in ² a	(16c) UPSTREAM lb/in ² a	(17c) DOWN- STREAM lb/in ² a					
TI ON LINE FROM S-110 TO E-113	8"	9,GAS												800											0
TI-1551														800											0
TI ON LINE FROM S-110 TO E-113														800											0
TI-1552														800											0
TR ON LINE FROM S-110 TO E-113														800											0
TR-1551														800											0
TAL ON LINE FROM S-110 TO E-113														800											0
TAL-1551														800										SET @ 850°F	0
TAH ON LINE FROM S-110 E-113														800										SET @ 900°F	0
TAH-1551														800											0
TAHH ON LINE FROM S-110 TO E-113														800											0
TAHH-1551														800											0
TIC ON LINE FROM S-110 TO E-113														800											0
TIC-1551														800											0
TI ON LINE FROM E-113 TO E-105	8"	9,GAS												800											0
TI-1552														110											0
TW ON CW OUTLET OF E-105 TW-1553	6"	1,WATER												120											0
TI ON LINE FROM E-105 TO S-109	8"	9,GAS												120											0
TI-1554														120											0
TI ON LINE FROM D-111 TO C-102 (NEAR D-111)																									0
TI-1559																									0
TI ON LINE FROM D-111 TO C-102 (NEAR C-102)	8"	9,GAS												120											0
TI-1558																									0

RECYCLE GAS SYSTEM
FOSTER WHEELER ENERGY CORPORATION
INSTRUMENT PROCESS DATA

FLWSHEET NO. 15

ENG. FLOW SHEET NO. OP-751-570

JOB NO. 15-1591

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PREPARED BY RSB

[illegible]

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ENG. FLOW SHEET NO. OP-751-570

PREPARED BY RSB

FORM NO (110)-25B

RECYCLE GAS SYSTEM
FOSTER WHEELER ENERGY CORPORATION
INSTRUMENT PROCESS DATA

FLWSHEET NO. 15

ENG. FLOW SHEET NO. OP-751-570

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PREPARED BY RSB

[illegible]

P-751-750
 FLOW SHEET NO. 15

FOSTER WHEELER CORPORATION
 RELIEF VALVES
 PROCESS DATA

RECYCLE GAS SYSTEM

PLANT U.S. - ERDA SHEET NO. 1 OF 1
 LOCATION SIOUX FALLS, S.D. BY RKR/RSB DATE APR. 29, 1976 JOB NO. 15-1591

ITEM NO. (Flow Plan Symbol)		PSV- 1555	PSV- 1556	PSV- 1557	PSV- 1563
Service		ON E-113	THERMAL RE- LIEF ON TUBE- SIDE C.W.OUT- LET OF E-105	THERMAL RE- LIEF ON TUBE- SIDE C.W.OUT- LET OF E-112	ON STEAM OUTLET ON C-102 TUR- BINE DRIVER
Number of Valves Required		ONE	ONE	ONE	ONE
In Regular Use		ONE	ONE	ONE	ONE
As Spares					
Interlocks Required					
Fluid and State		STEAM	COOLING WATER	COOLING WATER	STEAM
Corrosive Compounds					
Flow (Total) at Relieving Conditions	gal/min				
	lb/h	9400	SEE RELIEF VALVE TYPE	SEE RELIEF VALVE TYPE	24,090
Sp. gr. at Relieving Conditions					
Molecular Weight		18.0	18.0	18.0	18.0
Compressibility Factor					
Normal Operating Temperature, ¹ °F		316	110	110	370
Relieving Temperature, ² °F					
Relieving (Set) Pressure, lb/in ²		95	100	100	175
Superimposed Back Pressure, ³ lb/in ²		ATMOSPHERIC	ATMOSPHERIC	ATMOSPHERIC	ATMOSPHERIC
Built-up Back Pressure, ⁴ lb/in ²					
Allowable Accumulation, %		10			10
Minimum Orifice Area Required, in ²					
Governing Conditions ⁵		BLOCKED	HYDRAULIC EXPANSION	HYDRAULIC EXPANSION	BLOCKED
Relief Valve Type			THERMAL LIQ- UID RELIEF	THERMAL LIQ- UID RELIEF	
Relief Valve Size					
Balanced Type ⁶		NO	NO	NO	NO
Total Orifice Area (effective) Provided					

STARTUP SYSTEM
FOSTER WHEELER ENERGY CORPORATION
INSTRUMENT PROCESS DATA

FLOWSHEET NO. 50

ENG. FLOW SHEET NO. OP-751-602

JOB NO. 15-1591

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DATE APRIL 14, 1976

PREPARED BY RSB

(1) ITEM NUMBER OR SERVICE	(2) NOM. LINE SIZE	(3) FLUID TYPE & STATE	(4) NORMAL lb/h (NOTE 1)	FLOW %		SP. GR. AT.		(9) MOL. WT.	(10) VISC. CPS. @ TEMP.	(11) LIQ. VAPOR PRESS. PSIA	(12) LIQ. CRITICAL PRESS. lb/in ² a	(13) VAPOR COMP. FACTOR	(14) VAPOR Cp/Cv	(15) NORM. OP. TEMP. °F (NOTE 1)	PRESSURES AT NORM. FLOW		PRESSURES AT MAX. FLOW		PRESSURES AT MIN. FLOW		(18) DOWNSTREAM FLASHING	(19) TIGHT SHUTOFF	(20) AIR FAILURE	(21) REMARKS AND/OR ALARM AND SHUTDOWN SETTINGS	(22) REVISION
				(5)	(6)	(7)	(8)								(16a)	(17a)	(16b)	(17b)	(16c)	(17c)					
				MAX.	MIN.	60°F	COND.								UPSTREAM lb/in ² a	DOWN- STREAM lb/in ² a	UPSTREAM lb/in ² a	DOWN- STREAM lb/in ² a	UPSTREAM lb/in ² a	DOWN- STREAM lb/in ² a					
TI ON GAS OUTLET OF D-133 TI-1427	12"	9, GAS & CHAR												343											0
TR ON GAS OUTLET OF D-133 TR-1428	12"													343											0
TAH ON GAS OUTLET OF D-133 TAH-1428	12"													343											0
TAHH ON GAS OUTLET OF D-133 TAHH-1428	12"	9, GAS & CHAR												343											0
TI ON GAS INLET TO E-116 TI-1431	12"	9, GAS												343											0
TI ON GAS OUTLET OF E-116 TI-1433	12"	9, GAS												222											0
TW ON CW OUTLET OF E-116 TW-1432	16"	1, CW												110											0
TI ON LIQUID OUTLET OF D-113	3"	1, WATER & CHAR												343											0
PDAL ON SUCTION OF P-115A/B PDAL-1434	6"	1, WATER												222	500 MAX									PRESSURE RANGE OF 150 PSIA TO 500 PSIA	0
PT ON GAS OUTLET OF D-134 PT-1433	10"	9, GAS												222										PRESSURE RANGE OF 150 PSIA TO 500 PSIA	0
PR ON GAS OUTLET OF D-134 PR-1433	10"	9, GAS												222										PRESSURE RANGE OF 150 PSIA TO 500 PSIA	0
PIC ON GAS OUTLET OF D-134 PIC-1433	10"	9, GAS												222	500 MAX									PRESSURE RANGE OF 150 PSIA TO 500 PSIA	0
PI ON DISCHARGE OF P-115A PI-1429	4"	1, WATER												222	605 MAX									PRESSURE RANGE OF 200 PSIA TO 500 PSIA	0
PI ON DISCHARGE OF P-115B PI-1430	4"	1, WATER												222	605 MAX									PRESSURE RANGE OF 200 PSIA TO 500 PSIA	0

FORM NO (110)-25B

(1) THERE IS NO TRUE "NORMAL CASE" FOR THE STARTUP SYSTEM, THEREFORE MAXIMUM CONDITIONS AND/OR RANGES OF OPERATION WILL BE GIVEN. THE STARTUP SYSTEM WILL SOMETIMES OPERATE WHEN THE GASIFIER IS IN NORMAL OPERATION IN ORDER TO BLOWDOWN CHAR OR COAL. DURING STARTUP ITSELF, THERE ARE DIVERSE MODES OF OPERATION SUCH AS CHAR LIGHTOFF, CHAR CASE AND COAL CASE.

STARTUP SYSTEM
FOSTER WHEELER ENERGY CORPORATION
INSTRUMENT PROCESS DATA

FLWSHEET NO. 50

ENG. FLOW SHEET NO. OP-751-602

JOB NO. 15-1591

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REVISION 0

DATE APRIL 14, 1976

PREPARED BY RSB

(NOTE 1)

(1) ITEM NUMBER OR SERVICE	(2) NOM. LINE SIZE	(3) FLUID TYPE & STATE	(4) NORMAL lb/h (NOTE 1)	FLOW %		SP. GR. AT.		(9) MOL. WT.	(10) VISC. CPS. @ TEMP.	(11) LIQ. VAPOR PRESS. PSIA	(12) LIQ. CRITICAL PRESS. lb/in ² _a	(13) VAPOR COMP. FACTOR	(14) VAPOR Cp/Cv	(15) (NOTE 1) NORM. OP TEMP. °F	PRESSURES AT NORM. FLOW		PRESSURES AT MAX. FLOW		PRESSURES AT MIN. FLOW		(18) DOWNSTREAM FLASHING	(19) TIGHT SHUTOFF	(20) AIR FAILURE	(21) REMARKS AND/OR ALARM AND SHUTDOWN SETTINGS	(22) REVISION	
				(5) MAX.	(6) MIN.	(7) 60°F	(8) COND.								(16a) UPSTREAM lb/in ² _a	(17a) DOWN- STREAM lb/in ² _a	(16b) UPSTREAM lb/in ² _a	(17b) DOWN- STREAM lb/in ² _a	(16c) UPSTREAM lb/in ² _a	(17c) DOWN- STREAM lb/in ² _a						
LT ON D-133	ON	1, WATER &				1.0	.770	(NOTE						343	500											0
LT-1426	VESSEL	CHAR					.9	2)							MAX											
LG ON D-133						1.0								343												0
LG-1427																										
LAH ON D-133						1.0								343										HLL AT 5'-4" FROM BOTTOM T.L.	0	
LAH-1426																										
LAL ON D-133						1.0								343										LLL AT 2'-0" FROM BOTTOM T.L.	0	
LAL-1426																										
LALL ON D-133						1.0								343												0
LALL-1426																										
LIC ON D-133						1.0	.770	(NOTE						343												0
LIC-1426							.9	2)																		
LG ON TOP OF D-134		1, WATER & 4,				—	.94							222												0
LG-1431		NAPHTHA, OIL																								
LG ON D-134		1, WATER & 4,				—	.94							222												0
LG-1430		NAPHTHA, OIL																								
LIC, LT ON D-134		1, WATER				1.0	.96							222												0
LT-1429																										
LAH ON D-134		1, WATER				1.0	.96							222												0
LAH-1429																										
LAL ON D-134		1, WATER				1.0	.96							222										HLL AT 3'-4½" FROM BOTTOM T.L.	0	
LAL-1429																										
LG ON BOOT OF D-134		4, TAR/OIL				—	1.05							222										LLL AT 1'-0" FROM BOTTOM T.L.	0	
LG-1432																										
LG ON PIPING ITEM FOR HOLDING THE OIL FROM	ON VESSEL	4, TAR/OIL				—	1.05							222												0
D-134																										
LG-1433																										
DE ON LIQUID OUTLET OF D-133	3"	1, WATER & CHAR				1.0	.770							343												0
DE-1426							.9																			
DT ON LIQUID OUTLET OF D-133	3"					1.0								343												0
DT-1426																										
DR ON LIQUID OUTLET OF D-133	3"					1.0								343												0
DR-1426																										
DAH ON LIQUID OUTLET OF D-133	3"	1, WATER & CHAR				1.0	.770							343	500											0
DAH-1426							.9								MAX											

FORM NO (110)-25B

NOTE: (2) SPECIFIC GRAVITY OF 16 WT % SLURRY DEPENDS ON CHAR PARTICLE DENSITY WHICH COULD BE ANYWHERE FROM 20 LBS/CF to 60 LBS/CF.

STARTUP SYSTEM
FOSTER WHEELER ENERGY CORPORATION
INSTRUMENT PROCESS DATA

FLOWSHEET NO. 50

ENG. FLOW SHEET NO. OP-751-602

JOB NO. 15-1591
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REVISION 0
DATE APRIL 14, 1976
PREPARED BY RSB

(NOTE 1)

(1) ITEM NUMBER OR SERVICE	(2) NOM. LINE SIZE	(3) FLUID TYPE & STATE	(4) NORMAL lb/h (NOTE 1)	FLOW %		SP. GR. AT.		(9) MOL. WT.	(10) VISC. CPS. @ TEMP.	(11) LIQ. VAPOR PRESS. PSIA	(12) LIQ. CRITICAL PRESS. lb/in ² _a	(13) VAPOR COMP. FACTOR	(14) VAPOR Cp/Cv	(15) NORM. OP. TEMP. OF 1)	PRESSURES AT NORM. FLOW		PRESSURES AT MAX. FLOW		PRESSURES AT MIN. FLOW		(18) DOWNSTREAM FLASHING	(19) TIGHT SHUTOFF	(20) AIR FAILURE	(21) REMARKS AND/OR ALARM AND SHUTDOWN SETTINGS	(22) REVISION
				(5) MAX.	(6) MIN.	(7) 60°F	(8) COND.								(16a) UPSTREAM lb/in ² _a	(17a) DOWN- STREAM lb/in ² _a	(16b) UPSTREAM lb/in ² _a	(17b) DOWN- STREAM lb/in ² _a	(16c) UPSTREAM lb/in ² _a	(17c) DOWN- STREAM lb/in ² _a					
FO ON BFW MAKEUP TO D-133	3"	1,BFW	0			1.0	0.96		.25	14.7				225	500									DESIGN FLOW OF 30,000 LBS/HR	0
FO-1427																									
FT ON WATER FROM SLUDGE	3"	1,WATER	28,955	110	100	1.0	0.98		.40	4.1				153	500										0
REMOVAL TO D-133																									
FT-1426																									
FIL ON WATER FROM SLUDGE	3"		28,955	110	100	1.0	0.98		.40	4.1				153	500										0
REMOVAL TO D-133																									
FIL-1426																									
FAL ON WATER FROM SLUDGE	3"		28,955	110	100	1.0	0.98		.40	4.1				153	500										0
REMOVAL TO D-133																									
FAL-1426																									
FALL ON WATER FROM SLUDGE	3"	1,WATER	28,955	110	100	1.0	0.98		.40	4.1				153	500										0
REMOVAL TO D-133																									
FALL-1426																									
FE ON LIQUID OUTLET	3"	1,WATER & CHAR	69,993 H ₂ O 5,333 CHAR	110	25	1.0	.7 (NOTE TO.9 2)		.1	123				343	500 MAX										0
FROM D-133																									
FE-1428																									
FT ON LIQUID OUTLET OF	3"			110	25	1.0			.1	123				343											0
D-133																									
FT-1428																									
FAL ON LIQUID OUTLET OF	3"			110	25	1.0			.1	123				343											0
D-133																									
FAL-1428																									
FALL ON LIQUID OUTLET OF	3"			110	25	1.0			.1	123				343											0
D-133																									
FALL-1428																									
FIC ON LIQUID OUTLET OF	3"			110	25	1.0			.1	123				343											0
D-133																									
FIC-1428																									
FR ON LIQUID OUTLET OF	3"	1,WATER & CHAR	69,993 H ₂ O 5,333 CHAR	110	25	1.0	.7 (NOTE TO.9 2)		.1	123				222	500 MAX										0
D-133																									
FR-1428																									
FT,FI ON DISCHARGE OF	1½"	1,WATER	0			1.0	0.96		.25	14.7				222	605 MAX									DESIGN FLOW OF 17,500 LBS/HR	0
P-115 A/B TO SLUDGE																									
REMOVAL (EXCESS)																									
FT,FI ON DISCHARGE OF	4"	1,WATER	96,761	110	25	1.0	0.96		.25	14.7				222	605 MAX										0
P-115 A/B TO D-133																									
FT-1434																									
FT,FI ON DISCHARGE OF	4"	1,WATER	96,761	110	25	1.0	0.96		.25	14.7				222	605 MAX										0
P-115 A/B TO S-117																									

STARTUP SYSTEM
FOSTER WHEELER ENERGY CORPORATION
INSTRUMENT PROCESS DATA

FLWSHEET NO. 50

ENG. FLOW SHEET NO. OP-751-602

JOB NO. 15-1591

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DATE APRIL 14, 1976

PREPARED BY RSB

(NOTE 1)

(1) ITEM NUMBER OR SERVICE	(2) NOM. LINE SIZE	(3) FLUID TYPE & STATE	(4) NORMAL lb/h (NOTE 1)	FLOW %		SP. GR. AT.		(9) MOL. WT.	(10) VISC. CPS. @ TEMP.	(11) LIQ. VAPOR PRESS. PSIA	(12) LIQ. CRITICAL PRESS. lb/in ² a	(13) VAPOR COMP. FACTOR	(14) VAPOR CR. CV	(15) NORM. OP. TEMP. OF (NOTE 1)	PRESSURES AT NORM. FLOW		PRESSURES AT MAX. FLOW		PRESSURES AT MIN. FLOW		(18) DOWNSTREAM FLASHING	(19) TIGHT SHUTOFF	(20) AIR FAILURE	(21) REMARKS AND/OR ALARM AND SHUTDOWN SETTINGS	(22) REVISION
				(5) MAX.	(6) MIN.	(7) 60°F	(8) COND.								(16a) UPSTREAM lb/in ² a	(17a) DOWN- STREAM lb/in ² a	(16b) UPSTREAM lb/in ² a	(17b) DOWN- STREAM lb/in ² a	(16c) UPSTREAM lb/in ² a	(17c) DOWN- STREAM lb/in ² a					
FT-1431																									
FAL ON DISCHARGE OF P-115 A/B TO S-117 FAL-1431	4"	1, WATER	96,761	110	25	1.0	0.96		.25	14.7				222	605 MAX										0
FCV ON WATER TO ANNULUS IN D-133 FCV-1426	3"	1, WATER	28,955	110	100	1.0	0.98		.40	4.1	3208			153	500		500		56			NO	0		0
FCV ON BFW MAKEUP TO D-133	3"	1, BFW	0			1.0	0.96		.25	14.7	3208			225	500		500		56			NO	0	DESIGN FLOWRATE OF 30,000 LBS/HR	0
FCV ON LIQUID OUTLET OF D-133 FCV-1428A	3"	1, WATER & CHAR	69,993H ₂ O 5,333 CHAR	110	25	1.0	.7 TO .9	(NOTE 2)	.1	123	3208			343	500		500		56			NO	0	MINIMUM FLOW STOP	0
FCV ON LIQUID OUTLET OF D-133 (SPARE FOR ABOVE VALVE) FCV-1428-B	3"	1, WATER & CHAR	69,993H ₂ O 5,333 CHAR	110	25	1.0	.7 TO .9	(NOTE 2)	.1	123	3208			343	500		500		56			NO	0	MINIMUM FLOW STOP	0
LCV ON DISCHARGE OF P-116 LCV-1426A	4"	1, WATER	96,761	110	25	1.0	0.96		.25	14.7	3208			222	605		605		90			NO	0	(NOTE 3)	0
LCV ON LINE FROM P-115A/B TO D-133 LCV-1426B	4"	1, WATER	0			1.0	0.96		.25	14.7	3208			222	605		605		90			NO	0	DESIGN FLOW OF 96,761 LBS/HR (NOTE 3)	0
LCV ON WATER FROM SLUDGE REMOVAL TO D-134 LCV-1429A	3"	1, WATER	34,761	110	25	1.0	0.98		.40	4.1	3208			153	500		500		56			NO	0	(NOTE 4)	0
LCV ON DISCHARGE OF P-116 A/B TO SLUDGE REMOVAL (EXCESS WATER) LCV-1429B	1½"	1, WATER	0			1.0	0.96		.25	14.7	3208			222	500		500		500			NO	0	(NOTE 4) DESIGN FLOW OF 17,500 LBS/HR	0
FCV ON OUTLET OF P-115A FCV-1432	4"	1, WATER	(30,000 MAX)	110	25	1.0	0.96		.25	14.7	3208			222	605		605		90			NO	0	YARWAY ARC	0
FCV ON OUTLET OF P-115B FCV-1433	4"	1, WATER	(30,000 MAX)	110	25	1.0	0.96		.25	14.7	3208			222	605		605		90			NO	0	YARWAY ARC	0
PDCV ON GAS OUTLET OF D-134 PDCV-1476	3"	9,10, GAS	(10,000 MAX)					25.7				1.0		222	500							NO	0		0
PCV ON GAS OUTLET OF D-134 TO INCINERATOR PCV-1433A	10"	9,10, GAS	91,247	110	25			25.7				1.0		222	151		151		151			NO	0		0
PCV ON LINE FROM S-117 TO INCINERATOR PCV-1433B	12"	9,10, GAS	73,210	110	25			21.2				1.0		269	46		46		46			NO	0		0

FORM NO (110)-25B

NOTES: (3) THESE TWO VALVES ARE ON SPLIT-RANGE CONTROL. VALVE ON LINE FROM P-116 DISCHARGE OPERATES ON SIGNAL OF 4 TO 12 MV, WHILE VALVE ON P-115 A/B DISCHARGE OPERATES ON SIGNAL OF 12 TO 20 MV. SIGNAL FROM LT ON D-133.
(4) THESE TWO VALVES ARE ON SPLIT RANGE LEVEL CONTROL FROM LT SIGNAL ON D-134.

OP-751-602
 FLOWSHEET NO. 50

FOSTER WHEELER CORPORATION
 RELIEF VALVES
 PROCESS DATA

STARTUP SYSTEM

PLANT U.S. - ERDA
 LOCATION SIoux FALLS, S.D.

BY RKR/RSB

DATE APR. 29, 1976 SHEET NO. 1 OF 1
 JOB NO. 15-1591

ITEM NO. (Flow Plan Symbol)		PSV- 1431	PSV- 1432	PSV-	PSV-
Service		ON GAS INLET TO E-116	THERMAL RE- LIEF ON TUBE- SIDE C.W.OUT- LET OF E-116		
Number of Valves Required		ONE	ONE		
In Regular Use		ONE	ONE		
As Spares					
Interlocks Required					
Fluid and State		QUENCHED GAS- IFIER EFFLUENT	COOLING WATER		
Corrosive Compounds		H ₂ S, COS, NH ₃ , CHAR			
Flow (Total) at Relieving Conditions	gal/min				
	lb/h	153,250	SEE RELIEF VALVE TYPE		
Sp. gr. at Relieving Conditions					
Molecular Weight		22.0	18.0		
Compressibility Factor		1.0			
Normal Operating Temperature, ¹ °F		343	110		
Relieving Temperature, ² °F		343			
Relieving (Set) Pressure, lb/in ²		485	100		
Superimposed Back Pressure, ³ lb/in ²		10	ATMOSPHERIC		
Built-up Back Pressure, ⁴ lb/in ²		LATER			
Allowable Accumulation, %		10			
Minimum Orifice Area Required, in ²					
Governing Conditions ⁵		BLOCKED IN	HYDRAULIC EXPANSION		
Relief Valve Type			THERMAL LIQUID RELIEF		
Relief Valve Size					
Balanced Type ⁶		YES	NO		
Total Orifice Area (effective) Provided					

GASIFIER COOLING WATER SYSTEM
FOSTER WHEELER ENERGY CORPORATION
INSTRUMENT PROCESS DATA

JOB NO. 15-1591
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DATE APRIL 14, 1976
PREPARED BY KKK & RSB

FLOWSHEET NO. 51

ENG. FLOW SHEET NO. OP-751-603

(1) ITEM NUMBER OR SERVICE	(2) NOM. LINE SIZE	(3) FLUID TYPE & STATE	(4) NORMAL lb/h	FLOW %		SP. GR. AT.		(9) MOL. WT.	(10) VISC. CPS. @ TEMP.	(11) LIQ. VAPOR PRESS. PSIA	(12) LIQ. CRITICAL PRESS. lb/in ² a	(13) VAPOR COMP. FACTOR	(14) VAPOR Cp/Cv	(15) NORM. OP. TEMP. °F	PRESSURES AT NORM. FLOW		PRESSURES AT MAX. FLOW		PRESSURES AT MIN. FLOW		(18) DOWNSTREAM FLASHING	(19) TIGHT SHUTOFF	(20) AIR FAILURE	(21) REMARKS AND/OR ALARM AND SHUTDOWN SETTINGS	(22) REVISION
				(5)	(6)	(7)	(8)								(16a)	(17a)	(16b)	(17b)	(16c)	(17c)					
				MAX.	MIN.	60°F	COND.								lb/in ² a	DOWN- STREAM lb/in ² a	lb/in ² a	DOWN- STREAM lb/in ² a	lb/in ² a	DOWN- STREAM lb/in ² a					
TI ON E-106 INLET TI-1302	6"	1, WATER												166		UPSTREAM lb/in ² a	DOWN- STREAM lb/in ² a	UPSTREAM lb/in ² a	DOWN- STREAM lb/in ² a					0	
TI ON E-106 OUTLET TI-1304	6"													110										0	
TI ON R-101 BOTTOM THROAT COIL OUTLET TI-1306	2"													205										0	
TI ON R-102 TOP THROAT COIL OUTLET TI-1307	2"													205										0	
TI ON R-102 SLAG MONKEY COIL OUTLET TI-1308	1½"													190										0	
TI ON R-103 SLAG SWIPER COIL OUTLET TI-1309	2"													120										0	
TI ON COAL INJECTOR #1 OUTLET TI-1315	1½"													130										0	
TI ON COAL INJECTOR #2 OUTLET TI-1314	1½"													130										0	
TI ON COAL INJECTOR #3 OUTLET TI-1313	1½"													130										0	
TI ON COAL INJECTOR #4 OUTLET TI-1312	1½"													130										0	
TI ON COAL INJECTOR #5 OUTLET FI-1311	1½"													130										0	
TI ON COAL INJECTOR #6 OUTLET FI-1310	1½"													130										0	
TI ON CHAR INJECTOR #1 OUTLET TI-1321	1½"													130										0	
TI ON CHAR INJECTOR #2 OUTLET TI-1320	1½"	1, WATER												130										0	

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FLWSHEET NO. 51

ENG. FLOW SHEET NO. OP-751-603

(1) ITEM NUMBER OR SERVICE	(2) NOM. LINE SIZE	(3) FLUID TYPE & STATE	(4) NORMAL lb/h	FLOW %		SP, GR, AT.		(9) MOL. WT.	(10) VISC. CFS. @ TEMP.	(11) LIQ. VAPOR PRESS. PSIA	(12) LIQ. CRITICAL PRESS. lb/in ² a	(13) VAPOR COMP. FACTOR	(14) VAPOR Cp/Cv	(15) NORM. OP. TEMP. °F	PRESSURES AT NORM. FLOW		PRESSURES AT MAX. FLOW		PRESSURES AT MIN. FLOW		(18) DOWNSTREAM FLASHING	(19) TIGHT SHUTOFF	(20) AIR FAILURE	(21) REMARKS AND/OR ALARM AND SHUTDOWN SETTINGS	(22) REVISION
				(5) MAX.	(6) MIN.	(7) 60°F	(8) COND.								(16a) UPSTREAM lb/in ² a	(17a) DOWN- STREAM lb/in ² a	(16b) UPSTREAM lb/in ² a	(17b) DOWN- STREAM lb/in ² a	(16c) UPSTREAM lb/in ² a	(17c) DOWN- STREAM lb/in ² a					
TI ON CHAR INJECTOR #3 OUTLET	1½"	1. WATER												130											0
TI-1319																									
TI ON CHAR INJECTOR #4 OUTLET	1½"													130											0
TI-1318																									
TI ON CHAR INJECTOR #5 OUTLET	1½"													130											0
TI-1317																									
TI ON CHAR INJECTOR #6 OUTLET	1½"													130											0
TI-1316																									
TAH ON R-103 SLAG SWIPER COIL OUTLET	1½"													120										ALARM @ 145°F	0
TAH-1325																									
TAH ON R-102 SLAG MONKEY COIL OUTLET	1½"													190										ALARM @ 215°F	0
TAH-1324																									
TAH ON R-102 TOP THROAT COIL OUTLET	2"													205										ALARM @ 230°F	0
TAH-1323																									
TAH ON R-102 BOTTOM THROAT COIL OUTLET	2"													205										ALARM @ 230°F	0
TAH-1322																									
TAH ON COAL INJECTOR #1 OUTLET	1½"													130										ALARM @ 155°F	0
TAH-1331																									
TAH ON COAL INJECTOR #2 OUTLET	1½"													130										ALARM @ 155°F	0
TAH-1330																									
TAH ON COAL INJECTOR #3 OUTLET	1½"													130										ALARM @ 155°F	0
TAH-1329																									
TAH ON COAL INJECTOR #4 OUTLET	1½"													130										ALARM @ 155°F	0
TAH-1328																									
TAH ON COAL INJECTOR #5 OUTLET	1½"	1. WATER												130										ALARM @ 155°F	0
TAH-1327																									

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(1) ITEM NUMBER OR SERVICE	(2) NOM. LINE SIZE	(3) FLUID TYPE & STATE	(4) NORMAL lb/h	FLOW %		SP. GR. AT.		(9) MOL. WT.	(10) VISC. CPS. @ TEMP.	(11) LIQ. VAPOR PRESS. PSIA	(12) LIQ. CRITICAL PRESS. lb/in ² a	(13) VAPOR COMP. FACTOR	(14) VAPOR Cp/Cv	(15) NORM. OP. TEMP. °F	PRESSURES AT NORM. FLOW		PRESSURES AT MAX. FLOW		PRESSURES AT MIN. FLOW		(18) DOWNSTREAM FLASHING	(19) TIGHT SHUTOFF	(20) AIR FAILURE	(21) REMARKS AND/OR ALARM AND SHUTDOWN SETTINGS	(22) REVISION	
				(5) MAX.	(6) MIN.	(7) 60°F	(8) COND.								(16a) UPSTREAM lb/in ² a	(17a) DOWN- STREAM lb/in ² a	(16b) UPSTREAM lb/in ² a	(17b) DOWN- STREAM lb/in ² a	(16c) UPSTREAM lb/in ² a	(17c) DOWN- STREAM lb/in ² a						
TAH ON COIL INJECTOR #6 OUTLET TAH-1326	1½"	1, WATER												130										ALARM @ 155°F	0	
TAH ON CHAR INJECTOR #1 OUTLET TAH-1337	1½"													130											ALARM @ 155°F	0
TAH ON CHAR INJECTOR #2 OUTLET TAH-1336	1½"													130											ALARM @ 155°F	0
TAH ON CHAR INJECTOR #3 OUTLET TAH-1335	1½"													130											ALARM @ 155°F	0
TAH ON CHAR INJECTOR #4 OUTLET TAH-1334	1½"													130											ALARM @ 155°F	0
TAH ON CHAR INJECTOR #5 OUTLET TAH-1333	1½"													130											ALARM @ 155°F	0
TAH ON CHAR INJECTOR #6 OUTLET TAH-1332	1½"													130											ALARM # 155°F	0
FT ON WATER HEADER TO COAL INJECTORS FT-1301	4"		74,250	110	100	1.0	0.99		.62	1.3				110	77.9		77.9									0
FIC ON WATER HEADER TO THE COAL INJECTORS FIC-1301	4"		74,250	110	100	1.0	0.99		.62	1.3	3208			110	77.9		77.9									0
FAL ON WATER HEADER TO THE COAL INJECTORS FAL-1301	4"		74,250	110	100	1.0	0.99		.62	1.3				110	77.9		77.9							SET AT 80% OF NORMAL FLOW	0	
FALL ON WATER HEADER TO THE COAL INJECTORS FALL-1301	4"		74,250	110	100	1.0	0.99		.62	1.3				110	77.9		77.9							SET AT 60% OF NORMAL FLOW	0	
FT ON EACH COAL INJECTOR INLET FT-1307 THRU FT-1312	1½"	1, WATER	12,375	110	100	1.0	0.99		.62	1.3				110	77.9		77.9								PROVIDE SIX (6) FT'S	0

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FLWSHEET NO. 51

ENG. FLOW SHEET NO. OP-751-603

(1) ITEM NUMBER OR SERVICE	(2) NOM. LINE SIZE	(3) FLUID TYPE & STATE	(4) NORMAL lb/h	FLOW %		SP, GR, AT.		(9) MOL. WT.	(10) VISC. CPS. @ TEMP.	(11) LIQ. VAPOR PRESS. PSIA	(12) LIQ. CRITICAL PRESS. lb/in ² a	(13) VAPOR COMP. FACTOR	(14) VAPOR Cd/Cv	(15) NORM. OP. TEMP. °F	PRESSURES AT NORM. FLOW		PRESSURES AT MAX. FLOW		PRESSURES AT MIN. FLOW		(18) DOWNSTREAM FLASHING	(19) TIGHT SHUTOFF	(20) AIR FAILURE	(21) REMARKS AND/OR ALARM AND SHUTDOWN SETTINGS	(22) REVISION
				(5) MAX.	(6) MIN.	(7) 60°F	(8) COND.								(16a) UPSTREAM lb/in ² a	(17a) DOWN- STREAM lb/in ² a	(16b) UPSTREAM lb/in ² a	(17b) DOWN- STREAM lb/in ² a	(16c) UPSTREAM lb/in ² a	(17c) DOWN- STREAM lb/in ² a					
FI FOR EACH COAL INJECTOR INLET FI-1307 TO FI-1312	1½"	1, WATER	12,375	110	100	1.0	0.99		.62	1.3				110	77.9		77.9							PROVIDE SIX (6) FIs	0
FAL FOR EACH COAL INJECTOR FAL-1307 TO FAL-1312	1½"		12,375	110	100	1.0	0.99		.62	1.3				110	77.9		77.9							PROVIDE SIX (6) FALS EACH SET AT 80% OF NORMAL FLOW	0
FT ON WATER HEADER TO THE CHAR INJECTORS FT-1304	4"		74,250	110	100	1.0	0.99		.62	1.3				110	93.1		93.1								0
FIC ON WATER HEADER FOR CHAR INJECTORS FIC-1304	4"		74,250	110	100	1.0	0.99		.62	1.3				110	93.1		93.1								0
FAL ON WATER HEADER TO CHAR INJECTORS FAL-1304	4"		74,250	110	100	1.0	0.99		.62	1.3				110	93.1		93.1							SET AT 80% OF NORMAL FLOW	0
FALL ON WATER HEADER TO THE CHAR INJECTORS FALL-1304	4"		74,250	110	100	1.0	0.99		.62	1.3				110	93.1		93.1							SET AT 60% OF NORMAL FLOW	0
FT ON EACH CHAR INJECTOR INLET FT-1313 THRU FT-1318	1½"		74,250	110	100	1.0	0.99		.62	1.3				110	93.1		93.1							PROVIDE SIX (6) FTs	0
FI FOR EACH CHAR INJECTOR INLET FI-1313 THRU FI-1318	1½"		74,250	110	100	1.0	0.99		.62	1.3				110	93.1		93.1							PROVIDE SIX (6) FIs	0
FAL FOR EACH CHAR INJECTOR INLET FAL-1313 THRU FAL-1318	1½"		74,250	110	100	1.0	0.99		.62	1.3				110	93.1		93.1							PROVIDE SIX (6) FALS EACH SET AT 80% OF NORMAL FLOW	0
FT ON WATER LINE TO R-101 BOTTOM THROAT FT-1302	2"		24,750	110	100	1.0	0.99		.62	1.3				110	85.7		85.7								0
FIC ON WATER LINE TO R-101 BOTTOM THROAT FIC-1302	2"		24,750	110	100	1.0	0.99		.62	1.3				110	85.7		85.7								0
FAL FOR R-101 BOTTOM THROAT FAL-1302	2"	1, WATER	24,750	110	100	1.0	0.99		.62	1.3				110	85.7		85.7							SET AT 80% OF NORMAL FLOW	0

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FLWSHEET NO. 51

ENG. FLOW SHEET NO. OP-751-603

(1) ITEM NUMBER OR SERVICE	(2) NOM. LINE SIZE	(3) FLUID TYPE & STATE	(4) NORMAL lb/hr	FLOW %		SP. GR. AT.		(9) MOL. WT.	(10) VISC. CPS. @ TEMP.	(11) LIQ. VAPOR PRESS. PSIA	(12) LIQ. CRITICAL PRESS. lb/in ² a	(13) VAPOR COMP. FACTOR	(14) VAPOR CP/Cv	(15) NORM. OP. TEMP. °F	PRESSURES AT NORM. FLOW		PRESSURES AT MAX. FLOW		PRESSURES AT MIN. FLOW		(18) DOWNSTREAM FLASHING	(19) TIGHT SHUTOFF	(20) AIR FAILURE	(21) REMARKS AND/OR ALARM AND SHUTDOWN SETTINGS	(22) REVISION	
				(5)	(6)	(7)	(8)								(16a)	(17a)	(16b)	(17b)	(16c)	(17c)						
				MAX.	MIN.	60°F	COND.								UPSTREAM lb/in ² a	DOWN- STREAM lb/in ² a	UPSTREAM lb/in ² a	DOWN- STREAM lb/in ² a	UPSTREAM lb/in ² a	DOWN- STREAM lb/in ² a						
FALL FOR R-101 BOTTOM THROAT FALL-1302	2"	1, WATER	24,750	110	100	1.0	0.99		.62	1.3				110	85.7		85.7							SET AT 60% OF NORMAL FLOW	0	
FT FOR WATER TO TOP THROAT FT-1303	2"		24,750	110	100	1.0	0.99		.62	1.3				110	87.8											0
FIC FOR WATER TO TOP THROAT FIC-1303	2"		24,750	110	100	1.0	0.99		.62	1.3				110	87.8											0
FAL FOR R-101 BOTTOM THROAT & FALL, FAL-1302	2"		24,750	110	100	1.0	0.99		.62	1.3				110	87.8		87.8								SET AT 80% OF NORMAL FLOW	0
FALL FOR R-102 TOP THROAT & FAL - FAL-1303	2"		24,750	110	100	1.0	0.99		.62	1.3				110	87.8		87.8								SET AT 60% OF NORMAL FLOW	0
FT ON WATER TO SLAG MONKEY FT-1305	1½"		7,425	110	100	1.0	0.99		.62	1.3				110	97.4		97.4									0
FIC ON WATER TO SLAG MONKEY FIC-1305	1½"		7,425	110	100	1.0	0.99		.62	1.3				110	97.4		97.4									0
FAL FOR SLAG MONKEY FAL-1305	1½"		7,425	110	100	1.0	0.99		.62	1.3				110	97.4		97.4								SET AT 80% OF NORMAL FLOW	0
FALL FOR SLAG MONKEY FALL-1305	1½"		7,425	110	100	1.0	0.99		.62	1.3				110	97.4		97.4								SET AT 60% OF NORMAL FLOW	0
FT ON WATER TO SLAG SWIPER FT-1306	1½"		15,000	110	100	1.0	0.99		.62	1.3				110	103.8		103.8									0
FIC ON WATER TO SLAG SWIPER FIC-1306	1½"		15,000	110	100	1.0	0.99		.62	1.3				110	103.8		103.8									0
FAL FOR STATIONARY SLAG SWIPER FAL-1306	1½"	1, WATER	15,000	110	100	1.0	0.99		.62	1.3				110	103.8		103.8								SET AT 80% OF NORMAL FLOW	0

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FOSTER WHEELER CORPORATION
 RELIEF VALVES
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GASIFIER COOLING WATER SYSTEM

PLANT ERDA COAL GASIFICATION

SHEET NO. 1 OF 1

LOCATION SIOUX FALLS, S.D. BY RSB DATE APR. 29, 1976 JOB NO. 15-1591

ITEM NO. (Flow Plan Symbol)		PSV- 1302	PSV- 1306	PSV-	PSV-
Service		ON OUTLET OF D-132	THERMAL RE- LIEF ON TUBE- SIDE C.W.OUT- LET OF E-106		
Number of Valves Required		ONE	ONE		
In Regular Use		ONE	ONE		
As Spares					
Interlocks Required					
Fluid and State		N, STEAM, GASIF- COOLING IER EFFLUENT WATER			
Corrosive Compounds		H ₂ S, COS, NH ₃	NONE		
Flow (Total) at Relieving Conditions	gal/min	---	---		
	lb/h	40,000	SEE RELIEF VALVE TYPE		
Sp. gr. at Relieving Conditions					
Molecular Weight		22	18.0		
Compressibility Factor		1.0			
Normal Operating Temperature, ¹ °F		166	110		
Relieving Temperature, ² °F		280			
Relieving (Set) Pressure, lb/in ²		25	100		
Superimposed Back Pressure, ³ lb/in ²		10	ATMOSPHERIC		
Built-up Back Pressure, ⁴ lb/in ²		LATER			
Allowable Accumulation, %		10			
Minimum Orifice Area Required, in ²					
Governing Conditions ⁵		COOLING TUBE RUPTURE	HYDRAULIC EXPANSION		
Relief Valve Type			THERMAL LIQ. RELIEF		
Relief Valve Size					
Balanced Type ⁶		YES	NO		
Total Orifice Area (effective) Provided					

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GASIFIER INJECTOR/BURNER PIPING
FOSTER WHEELER ENERGY CORPORATION
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(1) ITEM NUMBER OR SERVICE	(2) NOM. LINE SIZE	(3) FLUID TYPE & STATE	(4) NORMAL lb/h	FLOW %		SP. GR. AT.		(9) MOL. WT.	(10) VISC. CPS. @ TEMP.	(11) LIQ. VAPOR PRESS. PSIA	(12) LIQ. CRITICAL PRESS. lb/in ² a	(13) VAPOR COMP. FACTOR	(14) VAPOR CP/CV	(15) NORM. OP. TEMP. °F	PRESSURES AT NORM. FLOW		PRESSURES AT MAX. FLOW		PRESSURES AT MIN. FLOW		(18) DOWNSTREAM FLASHING	(19) TIGHT SHUTOFF	(20) AIR FAILURE	(21) REMARKS AND/OR ALARM AND SHUTDOWN SETTINGS	(22) REVISION
				(5) MAX.	(6) MIN.	(7) 60°F	(8) COND.								(16a) UPSTREAM lb/in ² a	(17a) DOWN- STREAM lb/in ² a	(16b) UPSTREAM lb/in ² a	(17b) DOWN- STREAM lb/in ² a	(16c) UPSTREAM lb/in ² a	(17c) DOWN- STREAM lb/in ² a					
FIC ON PREHEATED AIR HEADER TO CHAR BURNERS FIC-1601	8"	14,AIR	125,458	110	25			29	.034			1.0	1.40	800	565										0
FAL ON PREHEATED AIR HEADER TO CHAR BURNERS FAL-1601	8"		125,458	110	25			29	.034			1.0	1.40	800	565										0
FAH ON PREHEATED AIR HEADER TO CHAR BURNERS FAH-1601	8"		125,458	110	25			29	.034			1.0	1.40	800	565										0
FT ON PREHEATED AIR HEADER TO CHAR BURNERS FT-1601	8"		125,458	110	25			29	.034			1.0	1.40	800	565										0
FR ON PREHEATED AIR HEADER TO CHAR BURNERS FR-1601	8"		125,458	110	25			29	.034			1.0	1.40	800	565										0
FY ON PREHEATED AIR HEADER TO CHAR BURNERS FY-1601	8"		125,458	110	25			29	.034			1.0	1.40	800	565								SQUARE ROOT		0
FFY ON PREHEATED AIR HEADER TO CHAR BURNERS FFY-1601	8"		125,458	110	25			29	.034			1.0	1.40	800	565										0
FFAHH ON PREHEATED AIR HEADER TO CHAR BURNERS FFAHH-1601	8"		125,458	110	25			29	.034			1.0	1.40	800	565										0
FFAH ON PREHEATED AIR HEADER TO CHAR BURNERS FFAH-1601	8"	14,AIR	125,458	110	25			29	.034			1.0	1.40	800	565										0
FO ON NITROGEN TO AIR HEADER FO-1602	1"	14,N ₂	(500 MAX)					28	.02			1.0	1.40	100	615										0
FT ON 900 PSIG 900°F STEAM HEADER TO COAL INJECTORS FT-1625	3"	8,STEAM	1,513	110	25			18	.031			.94	1.33	900	915										0
FIC ON 900 PSIG 900°F STEAM HEADER TO COAL INJECTORS FIC-1625	3"	8,STEAM	1,513	110	25			18	.031			.94	1.33	900	915										0

GASIFIER INJECTOR/BURNER PIPING
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(1) ITEM NUMBER OR SERVICE	(2) NOM. LINE SIZE	(3) FLUID TYPE & STATE	(4) NORMAL lb/h	FLOW %		SP. GR. AT.		(9) MOL. WT.	(10) VISC. CPS. @ TEMP.	(11) LIQ. VAPOR PRESS. PSIA	(12) LIQ. CRITICAL PRESS. lb/in ² a	(13) VAPOR COMP. FACTOR	(14) VAPOR CR/CV	(15) NORM. OP. TEMP. °F	PRESSURES AT NORM. FLOW		PRESSURES AT MAX. FLOW		PRESSURES AT MIN. FLOW		(18) DOWNSTREAM FLASHING	(19) TIGHT SHUTOFF	(20) AIR FAILURE	(21) REMARKS AND/OR ALARM AND SHUTDOWN SETTINGS	(22) REVISION
				(5) MAX.	(6) MIN.	(7) 60°F	(8) COND.								(16a) UPSTREAM lb/in ² a	(17a) DOWN- STREAM lb/in ² a	(16b) UPSTREAM lb/in ² a	(17b) DOWN- STREAM lb/in ² a	(16c) UPSTREAM lb/in ² a	(17c) DOWN- STREAM lb/in ² a					
FO ACROSS BYPASS AROUND 900 PSIG, 900°F STEAM HEADER TO COAL INJECTORS FO-1612	1"	8,STEAM	(500 MAX)					18	.031			.94	1.33	900	915										0
FT ON 250 PSIG, 400°F STEAM HEADER TO COAL INJECTORS FT-1613	6"		(19,500MAX)					18	.019			.92	1.33	400	265										0
FIC ON 250 PSIG, 400°F STEAM HEADERS TO COAL INJECTORS FIC-1613	6"		(19,500MAX)					18	.019			.92	1.33	400	265										0
FT ON 900 PSIG, 900°F STEAM 4" HEADER TO CHAR INJECTORS FT-1614A	4"		18,487	110	25			18	.031			.94	1.33	900	915										0
FT ON 900 PSIG, 900°F STEAM 4" HEADER TO CHAR INJECTORS FT-1614B	4"		18,487	110	25			18	.031			.94	1.33	900	915										0
FR ON 900 PSIG, 900°F STEAM HEADER TO CHAR INJECTORS FR-1614	4"		18,487	110	25			18	.031			.94	1.33	900	915										0
FIC ON 900 PSIG, 900°F STEAM HEADER TO CHAR INJECTORS FIC-1614	4"		18,487	110	25			18	.031			.94	1.33	900	915										0
FO ON BYPASS ACROSS 900 PSIG, 900°F STEAM HEADER TO CHAR INJECTORS FO-1615	1"	8,STEAM	(500 MAX)					18	.031			.94	1.33	900	915										0
FT ON STARTUP AIR TO BR-102A, BR-102C, BR-102E FT-1610, 1640, 1650	1½"	14,AIR	(2100 MAX)					29	.019			1.0	1.40	120	113									PROVIDE THREE FTs - ONE FOR EACH LISTED CHAR BURNER	0
FR ON STARTUP AIR TO BR-102A, BR-102C, BR-102E FR-1610, 1640, 1650	1½"	14,AIR	(2100 MAX)					29	.019			1.0	1.40	120	113									PROVIDE THREE FRs - ONE FOR EACH LISTED CHAR BURNER	0
FY ON STARTUP AIR TO BR-102A, BR-102C, BR-102E FY-1610, 1640, 1650	1½"	14,AIR	(2100 MAX)					29	.019			1.0	1.40	120	113									PROVIDE THREE FFYs - ONE FOR EACH LISTED CHAR BURNER	0

GASIFIER INJECTOR/BURNER PIPING
FOSTER WHEELER ENERGY CORPORATION
INSTRUMENT PROCESS DATA

FLOWSHEET NO. 52

ENG. FLOW SHEET NO. OP-751-604

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PREPARED BY RSB

(1) ITEM NUMBER OR SERVICE	(2) NOM. LINE SIZE	(3) FLUID TYPE & STATE	(4) NORMAL lb/h	FLOW %		SP. GR. AT.		(9) MOL. WT.	(10) VISC. CPS. @ TEMP.	(11) LIQ. VAPOR PRESS. PSIA	(12) LIQ. CRITICAL PRESS. lb/in ² a	(13) VAPOR COMP. FACTOR	(14) VAPOR CP/CH @60°F	(15) NORM. OP. TEMP. °F	PRESSURES AT NORM. FLOW		PRESSURES AT MAX. FLOW		PRESSURES AT MIN. FLOW		(18) DOWNSTREAM FLASHING	(19) TIGHT SHUTOFF	(20) AIR FAILURE	(21) REMARKS AND/OR ALARM AND SHUTDOWN SETTINGS	(22) REVISION
				(5) MAX.	(6) MIN.	(7) 60°F	(8) COND.								(16a) UPSTREAM lb/in ² a	(17a) DOWN- STREAM lb/in ² a	(16b) UPSTREAM lb/in ² a	(17b) DOWN- STREAM lb/in ² a	(16c) UPSTREAM lb/in ² a	(17c) DOWN- STREAM lb/in ² a					
FO ON 900 PSIG, 900°F STEAM TO BR-102A, BR-102B, BR-102C, BR-102D, BR-102E, BR-102F	2"	8, STEAM	3,080	110	25			18	.031			.94	1.33	900	915									PROVIDE SIX ROs FOR EACH OF SIX CHAR BURNERS	0
FO-1608, 1605, 1638, 1635, 1648, 1645																									
FT ON PREHEATED AIR TO OUTER ANNULUS ON BR-102A, BR-102B, BR-102C, BR-102D, BR-102E, BR-102F	2"	14, AIR	10,455	110	25			29	.034			1.0	1.4	800	565									PROVIDE SIX FTs FOR EACH OF SIX CHAR BURNERS	0
FT-1606, 1603, 1636, 1633, 1646, 1643																									
FR ON PREHEATED AIR TO OUTER ANNULUS ON BR-102A, BR-102B, BR-102C, BR-102D, BR-102E, BR-102F	2"	14, AIR	10,455	110	25			29	.034			1.0	1.4	800	565									PROVIDE SIX FRs FOR EACH OF SIX CHAR BURNERS	0
DIT TO FIT NUMBERS																									
FT ON PREHEATED AIR INTO STEAM LINE TO BR-102A, BR-102B, BR-102C, BR-102D, BR-102E, BR-102F	2"	14, AIR	10,455	110	25			29	.034			1.0	1.4	800	565									PROVIDE SIX FTs FOR EACH OF SIX CHAR BURNERS	0
FT-1607, 1604, 1637, 1634, 1647, 1649																									
FR ON PREHEATED AIR INTO STEAM LINE TO BR-102A, BR-102B, BR-102C, BR-102D, BR-102E, BR-102F	2"	14, AIR	10,455	110	25			29	.034			1.0	1.4	800	565									PROVIDE SIX FRs FOR EACH OF SIX CHAR BURNERS	0
DIT TO FT #1s																									
FT ON STARTUP PROPANE TO BR-102A, BR-102C, BR-102E	1"	14, PROPANE	(1230 MAX)					44	.01			0.90	1.13	AMB	89									PROVIDE THREE FTs FOR EACH OF THREE CHAR BURNERS LISTED	0
FT-1609, 1639, 1649																									
FR ON STARTUP PROPANE TO BR-102A, BR-102C, BR-102E	1"	14, PROPANE	(1230 MAX)					44	.01			0.90	1.13	AMB	89									PROVIDE THREE FRs FOR EACH OF THREE CHAR BURNERS LISTED	0
FR-1609, 1639, 1649																									
FIC ON STARTUP PROPANE TO BR-102A, BR-102C, BR-102E	1"	14, PROPANE	(1230 MAX)					44	.01			0.90	1.13	AMB	89									PROVIDE THREE FICs FOR EACH OF THREE CHAR BURNERS LISTED	0
FIC-1609, 1639, 1649																									

GASIFIER INJECTOR/BURNER PIPING
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FLWSHEET NO. 52
ENG. FLOW SHEET NO. OP-751-604

(1) ITEM NUMBER OR SERVICE	(2) NOM. LINE SIZE	(3) FLUID TYPE & STATE	(4) NORMAL lb/h	FLOW %		SP. GR. AT.		(9) MOL. WT.	(10) VISC. CPS. @ TEMP.	(11) LIQ. VAPOR PRESS. PSIA	(12) LIQ. CRITICAL PRESS. lb/in ² a	(13) VAPOR COMP. FACTOR	(14) VAPOR Cp/Cv	(15) NORM. OP. TEMP. °F	PRESSURES AT NORM. FLOW		PRESSURES AT MAX. FLOW		PRESSURES AT MIN. FLOW		(18) DOWNSTREAM FLASHING	(19) TIGHT SHUTOFF	(20) AIR FAILURE	(21) REMARKS AND/OR ALARM AND SHUTDOWN SETTINGS	(22) REVISION
				(5) MAX.	(6) MIN.	(7) 60°F	(8) COND.								(16a) UPSTREAM lb/in ² a	(17a) DOWN- STREAM lb/in ² a	(16b) UPSTREAM lb/in ² a	(17b) DOWN- STREAM lb/in ² a	(16c) UPSTREAM lb/in ² a	(17c) DOWN- STREAM lb/in ² a					
FCV ON PREHEATED AIR TO TO CHAR BURNERS	8"	14,AIR	125,458	110	25			29	.034			1.0		800	565		565		141			YES	C	PROVIDE WITH DOUBLE BLOCKS AND TRIPLE BLEEDS	0
FCV-1601																									
FCV ON 900 PSIG, 900°F STEAM TO COAL INJECTORS	3"	8,STEAM	1,513	110	25			18	.031			.94		900	915		915		915			NO	0		0
FCV-1625																									
FCV ON 250 PSIG, 400°F STEAM TO COAL INJECTORS	6"	8,STEAM	(19,500MAX)					18	.019			.92		900	265		265		265			NO	0	MINIMUM FLOW STOP	0
FCV-1613																									
FCV ON 900 PSIG, 900°F STEAM TO CHAR INJECTORS	4"	8,STEAM	18,487	110	25			18	.031			.94		900	915		915		915			NO	0		0
FCV-1614																									
ON-OFF DIAPHRAGM VALVE ON STARTUP PROPANE	1½"	14,PROPANE	(1230 MAX)					44	.01			.90		AMB	89		89		89				C		0
XY-1603																									
ON-OFF DIAPHRAGM VALVE FOR STARTUP AIR FROM D-506	3"	14,AIR	(2100 MAX)					29	.019			1.0		120	113		113		113				C		0
XY-1602																									
ON-OFF DIAPHRAGM VALVE FOR NITROGEN TO PREHEATED AIR HEADER TO CHAR BURNERS	1"	14,N ₂	(500 MAX)					28	.02			1.0		100	615		615		615				0		0
XY-1601																									
ON-OFF DIAPHRAGM VALVE ON PREHEATED AIR HEADER TO CHAR BURNERS	8"	14,AIR	125,458	110	25			29	.034			1.0		800	565		565		141				C		0
XY-1604																									
HICV FOR PREHEATED AIR TO OUTER ANNULUS TO BR-102A, BR-102B,BR-102C,BR-102D, BR-102E,BR-102F	2"	14,AIR	10,455	110	25			29	.034			1.0		800	565		565		141					PROVIDE SIX HICs - ONE FOR EACH CHAR BURNER	0
HCV-1603,1601,1633,1632, 1643,1641																									
HICV FOR PREHEATED AIR TO 900 PSIG STEAM LINE ON BR-102A,BR-102B,BR-102C, BR-102D,BR-102E,BR-102F	2"	14,AIR	10,455	110	25			29	.034			1.0		800	565		565		141					PROVIDE SIX HICs - ONE FOR EACH CHAR BURNER	0
HCV-1604,1602,1634,1632, 1644,1642																									

GASIFIER INJECTOR/BURNER PIPING
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PREPARED BY RSB

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MATERIAL REQUISITION



FOSTER WHEELER

PAGE 1 OF 13

FOR <u>ERDA-FE</u>	F.W. REF. <u>15-1591</u>	REQUISITION NUMBER	DATE
SITE <u>NSP Lawrence Station, Sioux Falls, S.D.</u>		<u>1591-1593-A</u>	<u>4/22/76</u>
MATERIAL <u>Coal & Char Gasifier Injectors</u>		SUPERSEDED BY CHANGE NO.:	
<u>BR-101 A-F and</u>		C1 <u>5-14-76</u>	C4
<u>BR-102 A-F</u>		C2	C5
		C3	C6

INDEX

- I SCOPE
- II GENERAL
- III BASIS OF DESIGN - COAL INJECTORS
- IV BASIS OF DESIGN - CHAR BURNERS
- V DRAWINGS
- VI STANDARDS AND SPECIFICATIONS

BY:	P.O. NO.	SUPPLIER:
-----	----------	-----------

I. SCOPE

This requisition calls for the design and fabrication of 6 coal injectors and 6 char gasifier injectors for operation in a two-stage pressurized coal gasifier. The injectors for pulverized coal injection into Stage II of the gasifier, and injectors for char/limestone injection into Stage I of the gasifier are to be both designed and provided by FWEC Research Department and/or vendor.

ITEMS

BR 101A thru F	Coal Injectors
BR 102A thru F	Char Burners

II. GENERAL

C-1

A. The design of all equipment of vendor's supply will comply with all regulations applicable to the proposed location i.e. Sioux Falls, S.D. All materials to be of United States origin. Equipment shall be furnished in accordance with the standards noted in Part VI of this specification.

B. The following is required by ERDA-FE:

No subcontract shall be on a cost-plus-a-percentage-basis.

"This contract or purchase order pertains to the performance of ERDA-FE contract no. 14-32-0001-1521 between the United States and Foster Wheeler Energy Corporation and the sub contractor agrees that the Contracting Officer, ERDA-Fossil Energy or his authorized representative may inspect the plant and audit the books and records of the subcontractor with respect to work done or supplies, material and equipment furnished under this contract or purchase order".

Such requirements shall not apply to competitively advertised procurements, or standard "off the shelf" purchases of equipment or the subcontract or purchase order which is \$10,000 or less.

III. BASIS OF DESIGN - COAL INJECTORS

A. Number of coal injectors: Six (6)

B. Materials injected - all flowrates reflect total flow to all six injectors.

1. Pulverized Coal

a. Type

1. Base Case: Illinois No. 6

2. Alternate Coals

a. Colstrip

b. Big Horn

c. Rosebud

d. North Dakota Lignite

e. Pittsburgh Seam No. 8

III. BASIS OF DESIGN - COAL INJECTORS Cont'd

B. Materials injected Cont'd

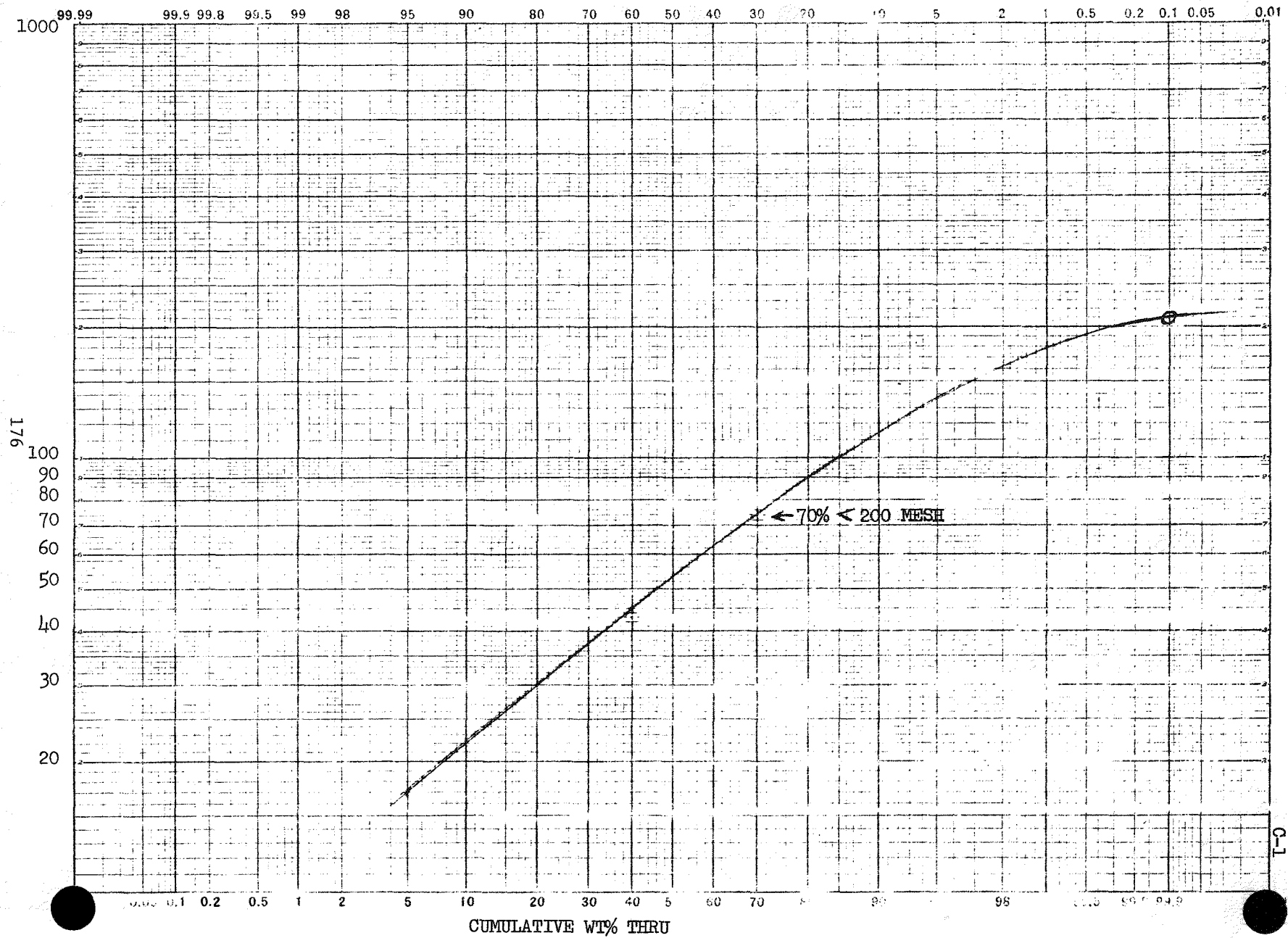
1. Pulverized Coal Cont'd

- b. Coal Analysis - See Table I
 - c. Flowrate: 40,000 lbs/hr of coal containing 4.2% by wt. total moisture
 - d. Temperature: 200°F
 - e. Coal particle size distribution - see Figure 1 on Page 4
 - f. Particle density: 90 to 100 lbs/ft³
 - g. Pressure: 535 psig upstream of Petrocarb's "mix-tee" at 100% plant capacity (also see Sections II.E.2 and II.B.2)
2. Transport gas (as used by Petrocarb for coal and char feeding).
- a. Gas type: clean process gas
 - b. Typical Composition:

<u>Species</u>	<u>Volume %</u>
H ₂ O	.01
H ₂	14.31
CO	20.19
CO ₂	6.64
CH ₄	4.10
N ₂	54.74
COS	.01
NH ₃	0
H ₂ S	0
	100.00

- c. Flowrate: 9399 lb/hr
 - d. Temperatures: 350°F throughout entire operating range.
 - e. Compressibility factor: 1.0
3. Process Steam (During normal gasifier operation)
- a. Type: High pressure superheated steam.
 - b. Flowrate: 1513 lbs/hr
 - c. Temperature: 900°F
 - d. Pressure: 900 psig } upstream of control valve
4. Quench Steam During "Char Lightoff", Startup Case C-1
- a. Type Steam: 250 psig saturated (405°F)
 - b. Flowrate: 17,225 lbs/hr
5. Quench Steam During "Char" Startup Case C-1
- a. Type Steam: 250 psig saturated
 - b. Flowrate: 34445 lbs/hr

FIGURE 1: COAL PARTICLE SIZE DISTRIBUTION



III. BASIS OF DESIGN - COAL INJECTORS Cont'd

C. Pressure considerations

1. Normal operating pressure of Stage II Gasifier: 440 psig
2. Design pressure drop of injector at full capacity: 50 psi
3. Atmospheric pressure: 14.0 psia

D. Temperature considerations

1. Normal operating temperature of Stage II Gasifier: 1800°F.
2. Maximum operating temperature of Stage II Gasifier: 2100°F.

E. Turndown

1. Capacity: Coal, transport gas and steam will range from 100% to 25% of flowrates given herein.
2. Pressure at injector inlet flange:

<u>Plant Throughout</u>	<u>PSIG, at Injector Flange</u>
100%	490
50%	238
33 1/3%	154
25%	112

F. Injector Orientation

Six injectors to be located radially, 60° apart, positioned upwards and directed towards the longitudinal axis of Stage II of the gasifier. Angle of upward position to the horizontal to be 40° and later confirmed by FWEC Research Department, based on results of "Cold Flow" model studies.

C-1

G. Startup Considerations (Design) - During "Coal" Startup Case

1. Coal: 16, 797 lbs/hr @ 200°F
2. Process Steam: 0 lbs/hr
3. Coal transport gas: 3760 lbs/hr of nitrogen @ 350°F.

IV. BASIS OF DESIGN - CHAR BURNERS

- A. Number of Char Burners Six (6)
- B. Materials injected - All flowrates reflect total flow to all six injectors

1. Char

a. Typical Analysis

<u>Species</u>	<u>Wt.%</u>
Carbon	82.8
Ash	<u>17.2</u>
	100.0

b. Flow rates

1. Normal: 32,849 lbs/hr
2. Design: 40,000 lbs/hr

c. Temperature: 800°F normal, 850°F maximum.

d. Particle density: 20 to 60 lbs/ft³

e. Pressure: 540 psig upstream of Petrocarb's mix-tee, at 100% plant capacity (see Sections II.B.2 and III.E.2)

f. Particle size distribution

<u>Micron Size</u>	<u>Normal, lbs/hr</u>	<u>Design, lbs/hr</u>
< .5	0	0
.5 to 1.79	19	23
1.79 to 3.78	50	61
3.78 to 9.77	341	416
9.77 to 13.28	246	300
13.28 to 32.02	1643	2001
32.02 to 64.32	3613	4399
64.32 to 100	3942	4800
100 to 109.49	986	1201
109.49 to 186	6405	7800
186 to 212	1806	2198
212 to 276	3614	4400
276 to 358	1971	2400
358 to 416	986	1201
416 to 582	1971	2400
582 to 2000	<u>5256</u>	<u>6400</u>
	32,849	40,000

2. Transport gas (used by Petrocarb for coal and char feeding)

- a. Gas type: clean process gas
b. Typical composition - see Section II, B.2
c. Flowrate: 7580 lb/hr
d. Temperature: 350°F throughout entire operating range.
e. Compressibility factor: 1.0

IV. BASIS OF DESIGN - CHAR BURNERS Cont'd

B. Materials injected Cont'd

3. Process Steam
 - a. Type: High pressure, superheated steam
 - b. Flowrate: 18,487 lb/hr
 - c. Temperature: 900°F
 - d. Pressure 900 psig } upstream of control valve
4. Process Air (not including slipstream air)
 - a. Flowrates:
 1. Normal: 123,738 lbs/hr
 2. Design: 130,320 lbs/hr
 - b. Temperature: 800°F
 - c. Pressure: 541 psig (upstream of control valve at 100% plant capacity).
5. Slipstream Air (used by Petrocarb for limestone feeding)
 - a. Flowrates:
 1. Normal: 1720 lbs/hr
 2. Design: 2680 lbs/hr
 - b. Temperature: 110°F
 - c. Pressure: 570 psig (upstream of Petrocarb control valve at 100% plant capacity).
6. Limestone (for fluxing slag)
 - a. Flowrates:
 1. Normal: 900 lbs/hr
 2. Design: 1400 lbs/hr
 - b. Temperature: Ambient
 - c. Pressure: 540 psig upstream of Petrocarb's "mix-tee" at 100% plant capacity. Also see Section III.E.2.
 - d. Particle Size Disbribution
 - 100% passes through 14 tyler mesh
 - 70% passes through 200 tyler mesh
 - 30% passes through 325 tyler mesh
 - e. Approve density: 103 lbs/ft³

C-1

C. Pressure Considerations

1. Normal operating pressure of Stage I of gasifier: 446 psig.
2. Design pressure drop of injector at full capacity: 50 psi.
3. Atmospheric pressure: 14.0 psia.

D. Temperature Considerations

1. Normal Stage I Gasifier operating temperature: 2800°F.
2. Maximum Stage I Gasifier operating temperature: 3000°F.

IV. BASIS OF DESIGN - CHAR BURNERS Cont'd

E. Range of operation (not including char lightoff. See III G.2).

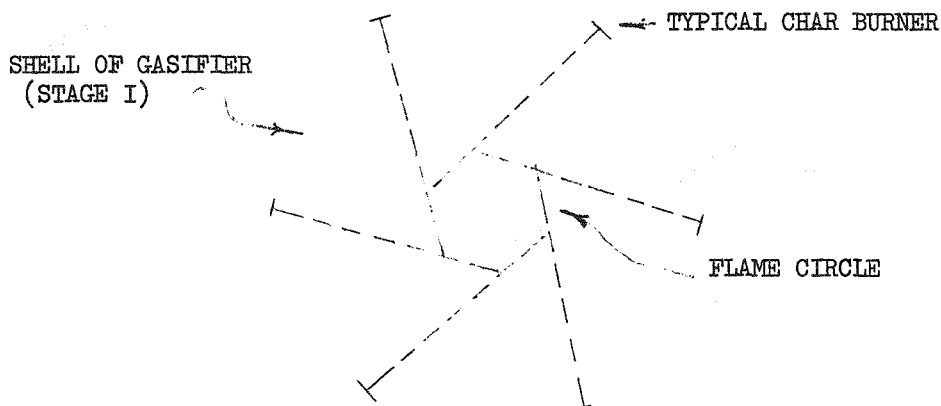
1. Capacity: Char, transport gas and steam can range from 117% to 30% of the normal flowrates given herein.
2. Pressure at injector inlet flange:

<u>Plant Throughput</u>	<u>PSIG, at Injector Flange</u>
117%	496
100%	496
50%	241
33 1/3%	156
30%	139

F. Burner Orientation

Six injectors are to be positioned tangentially to a 15" diameter flame circle and semitangentially to the gasifier shell as shown below:

C-1



Burners are 60° apart and in a horizontal plane.

IV. BASIS OF DESIGN - CHAR BURNERS Cont'd

G. Start-up Conditions

1. Initial heatup of gasifier.

a. Beginning of heatup

- * 1. Propane use: 970 lbs/hr @ 77°F.
- 2. Steam to burner: 5830 lbs/hr (900°F, 900 psig).
- 3. Air: 1620 lbs/hr @ 800°F
- 4. Stage I temperature: 2500°F
- 5. Char: 0 lbs/hr

C-1

b. Near end of heatup.

- * 1. Propane use: 1230 lbs/hr @ 77°F
- 2. Steam to burner: 7390 lbs/hr (900°F, 900 psig)
- 3. Air: 2132 lbs/hr @ 800°F
- 4. Stage I temperature: 2710°F
- 5. Char: 0 lbs/hr

*Char burner to have 10:1 turndown ability when firing propane

2. Char Lightoff Case

- a. Char flowrate: 6,666 lbs/hr @ ambient temperature
- b. Air: 24,657 lbs/hr @ 800°F
- c. Char transport gas: 1,200 lbs/hr of nitrogen @ 350°F
- d. Process steam: 2285 lbs/hr (900°F, 900 psig)
- e. Propane: Required as necessary to ignite char (say propane maintained at max. flow of 1230 lbs/hr).

3. Char Case (design maximum for Start-up)

C-1

- a. Char flowrate: 13,332 lbs/hr @ ambient temperature
- b. Air: 49,314 lbs/hr @ 800°F.
- c. Char transport gas: 2,400 lbs/hr of nitrogen @ 350°F.
- d. Process steam: 4,569 lbs/hr (900°F, 900 psig)
- e. No propane normally required.

4. Coal Case (Design Maximum for Start-up)

- a. Char flowrate: 13,332 lbs/hr @ ambient temperature.
- b. Air: 61,479 lbs/hr @ 350°F.
- c. Char transport gas: 2,400 lbs/hr @ 350°F.
- d. Process steam: 15,800 lbs/hr (900°F, 900 psig).
- e. No propane normally required.

V. DRAWINGS

- A. Drawings of the Coal Injector, OP 763-38 and the Char Injector OP 763-37 are contained on pages 12 and 13.

These sketches are offered as a guide in the design of these two items of equipment. The vendor is required to review these designs, offer his own or improve on the sketches to facilitate fabrication, operation and Maintenance.

VI. STANDARDS AND JOB SPECIFICATIONS

A. The following documents shall be considered as an integral part of this requisition: C-1

- | | |
|---------------|--------------------------|
| 1. 1590-50A2 | Gaskets and Surface |
| 2. 1590-82A1 | External Insulation |
| 3. 1590-83A1 | Painting |
| 4. 1590-92A1 | Preparation for Shipment |
| 5. 1590-1200B | General Notes |

COAL PROPERTIES

	Illinois No. 6		Colstrip Montana		Big Horn		Rosebud		North Dakota Lignite*		Pitt. Seam No. 8	
	<u>Pulverized</u>	<u>Dry</u>	<u>Received</u>	<u>Dry</u>	<u>Received</u>	<u>Dry</u>	<u>Received</u>	<u>Dry</u>	<u>Received</u>	<u>Dry</u>	<u>Received</u>	<u>Dry</u>
Proximate Analysis, Percent by Weight:												
Moisture	4.2	0	28.0	0	22.96	0	22.43	0	34.73	0	3.53	0
Volatiles	34.2	35.70	27.8	39.0	32.26	41.88	30.98	39.94	25.59	39.21	37.88	39.63
Fixed Carbon	52.0	54.28	35.2	49.5	40.57	52.66	39.97	51.53	31.68	48.54	50.21	52.59
Ash	9.6	10.02	9.0	11.5	4.21	5.46	6.62	8.53	8.00	12.25	7.36	7.71
Ultimate Analysis, Percent by Weight (Moisture and Ash Free):												
Hydrogen	5.9		5.08		4.92		4.93		4.88		5.25	
Carbon	77.4		76.84		75.13		77.57		73.45		79.39	
Nitrogen	1.4		0.79		1.14		0.79		1.25		1.71	
Oxygen	11.0		16.16		18.18		16.06		19.84		2.88	
Sulfur	4.3		1.13		0.59		0.60		0.56		3.07	
Chlorine	(0.04)		-----		0.04		0.05		0.02		-----	
Gross Heating Value, Btu/lb	12,330†		11,160		11,928 (dry)		12,086 (dry)		11,180 (dry)		14,017 (dry)	
Net Heating Value, Btu/lb	11,803†											
Hardgrove Grindability	50		50		40		55		37-81§		64	

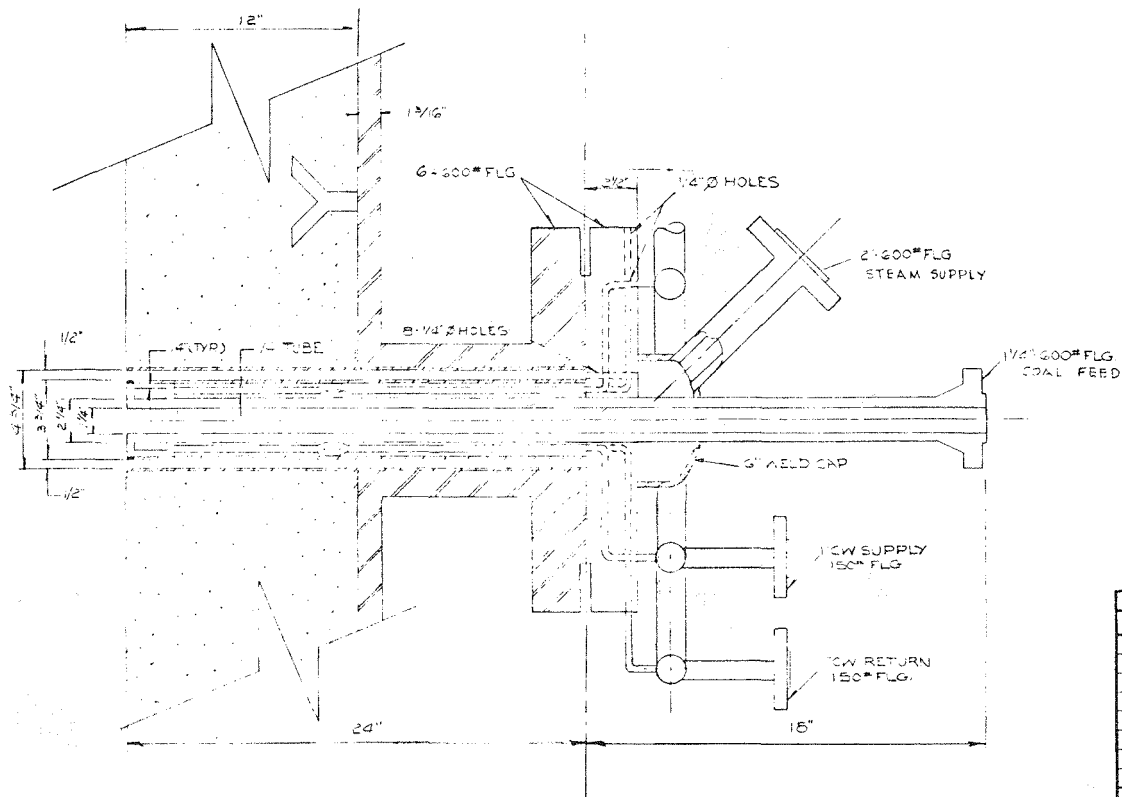
SLAG PROPERTIES

	<u>Assume Jackson</u>	<u>Northern State Power's Coal</u>	<u>Unknown County and Bed</u>	<u>Assume Richmond DO</u>	<u>Baukol-Noonen</u>	<u>Consolidated Loveridge Slack</u>
Analysis, Percent by Weight:						
Silicon Dioxide	49.3	32.0	22.1	21.9	26.0	39.62
Aluminum Trioxide	22.3	21.0	15.5	13.8	13.1	22.01
Iron Trioxide	19.5	0.5	6.4	5.9	6.6	20.72
Titanium Dioxide	1.2	0.5	1.2	0.7	0.3	0.84
Phosphorous Pentoxide	0.06	6.0	0.11	0.46	0.1	0.74
Calcium Oxide	1.7	17.0	18.9	31.4	21.9	7.60
Magnesium Oxide	0.8	4.0	6.6	10.4	5.5	1.38
Sodium Oxide	0.4	0.3	1.0	0.3	11.3	2.11
Potassium Oxide	2.2	0.3	0.4	0.3	0.4	-----
Sulphur Trioxide	1.0	16.5	26.2	12.6	12.8	0.46
Unaccounted for	1.54	1.9	1.59	2.24	2.0	4.52
Ash Temperatures, °F:		<u>Reducing</u> <u>Oxidizing</u>				
Initial Deformation	2130	2150 2220	2260	2450	2202	2020
Softening (Tcv)	2180	2200 2280	2380	2490	2250	2080
Fluid	2470	2250 2320	2470	2540	2324	2280
Silicon, Ratio T	69.1	54.2	40.9	31.47	43.33	
Average Molecular Weight	71.18	64.74	65.53	58.00	50.19	
Viscosity at 2600°F, Poises	150	19	3	1	3	
Specific Gravity			1.47	1.47	1.58	

*Average of 100 coals

†For coal containing moisture and ash

§Depends on moisture content



DESIGN OF THIS ITEM OR SYSTEM IS TENTATIVE SUBJECT TO DEVELOPMENTAL WORK IN PROGRESS OR ANTICIPATED PRIOR TO PURCHASE DESIGN SHOULD BE REVIEWED WITH FWEC TO INCORPORATE DEVELOPMENTAL RESULTS.

SIX (6) REQUIRED

LETTER	DATE	DESCRIPTION
REVISIONS		
①		FIELD CONSTRUCTION
②		FABRICATION
③		PREPARATION OF SHOP DETAILS
④		CUSTOMER COMMENTS
⑤		PURCHASE OF ALL MATERIALS
⑥		PURCHASE OF MAJOR MATERIALS
⑦		PRELIMINARY ARRANGEMENT
DWG. REV.	DATE	ISSUED FOR

COAL INJECTORS BR-101A-F
COAL GASIFICATION
COMBINED CYCLE PLANT
SRDA

UNITED STATES OF AMERICA

SIOUX FALLS, SOUTH DAKOTA

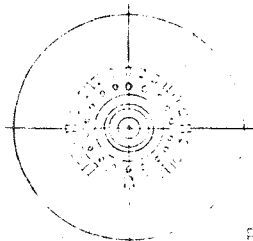
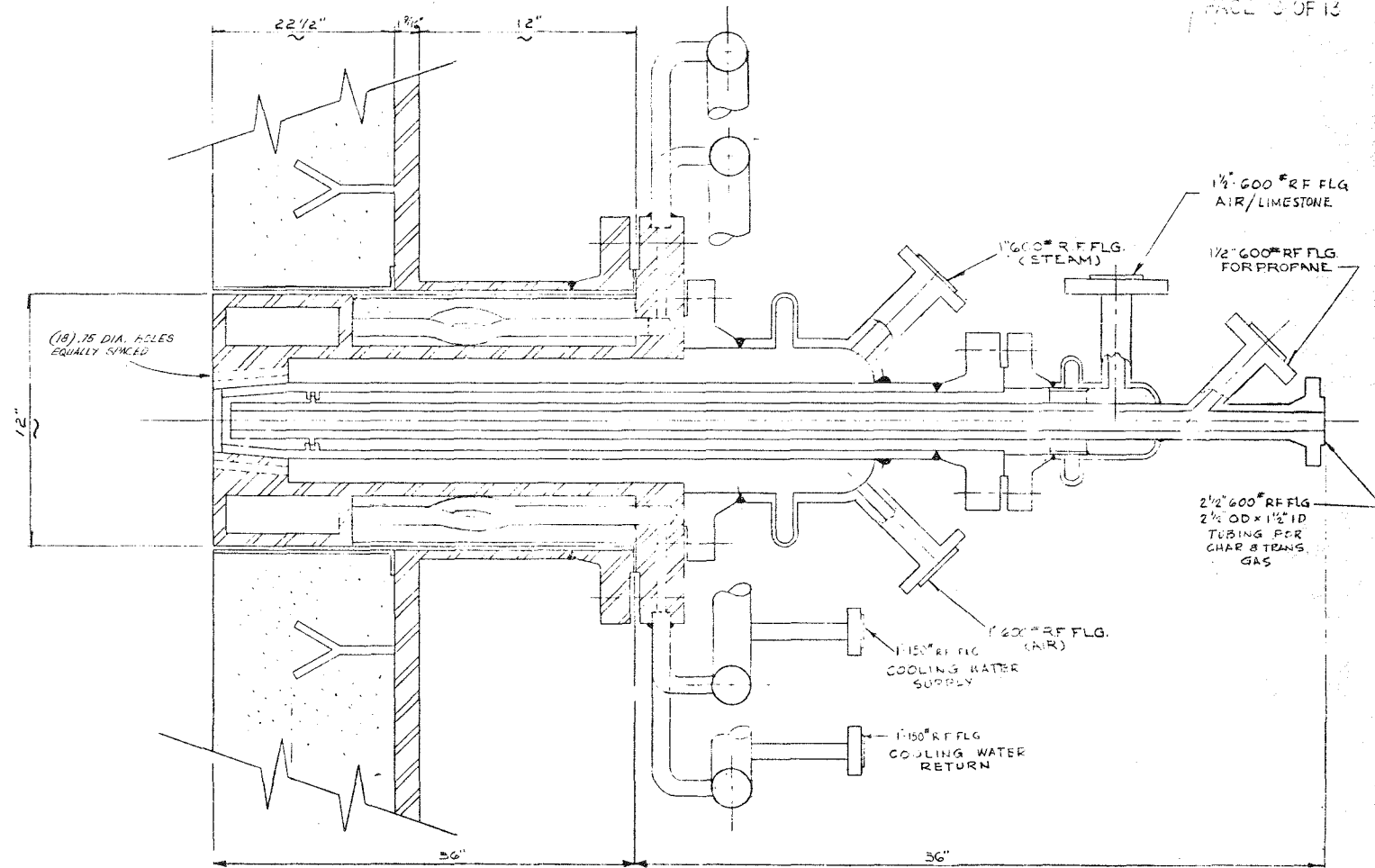
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ORDER NO.
15-1591

DWG. No.

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SIX (6) REQ'D

BR102 A THRU F

CHAR & STARTUP BURNERS
COAL GASIFICATION COMBINED CYCLE
PILOT PLANT
SIOUX FALLS SOUTH DAKOTA

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APPROVED BY			OP-763-37

MATERIAL REQUISITION



FOSTER WHEELER ENERGY CORPORATION

PAGE 1 OF 4

FORM 135-

FOR <u>ERDA-FE</u>	F.W. REF. <u>15-1591</u>	REQUISITION NUMBER	DATE
SITE <u>NSP - LAWRENCE STATION SIOUX FALLS, S.D.</u>		<u>1591-1913-A</u>	<u>6/17/75</u>
MATERIAL <u>SLIPSTREAM AIR DRYER PACKAGE</u>	Item <u>A-101</u>	SUPERSEDED BY CHANGE NO.:	
<u>ERDA-FE CONT. NO. 14-32-0001-1521</u>		C1 <u>4/15/76</u>	C4
		C2	C5
		C3	C6

INDEX

- I. SCOPE
- II GENERAL
- III PROCESS BASIS OF DESIGN
- IV MECHANICAL SPECIFICATIONS
- V CYCLE OF OPERATION
- VI SITE CONDITIONS
- VII UTILITIES AVAILABLE
- VIII REFERENCES

BY: <u>[Signature]</u>	P.O. NO.	SUPPLIER:
------------------------	----------	-----------

I. SCOPE

This requisition covers the design, fabrication and supply of a package unit for the drying of air (used for conveying of Limestone). To include all regeneration facilities and instrumentation.

ITEM A-101

II. GENERAL

A. The design of all equipment of vendors supply will comply with all regulations applicable to the proposed location i.e. Sioux Falls, S.D. All materials to be of United States origin. Equipment shall be furnished in accordance with the applicable provisions of the latest revisions of the following codes and the Foster Wheeler Corp. standards (see Section VIII references).

B. The following is required by ERDA-FE:

No subcontract shall be on a cost-plus-a-percentage-basis.

"This contract or purchase order pertains to the performance of ERDA-FE contract no. 14-32-0001-1521 between the United States and Foster Wheeler Energy Corporation and the sub contract agrees that the Contracting Officer, ERDA-Fossil Energy or his authorized representative may inspect the plant and audit the books and records of the subcontractor with respect to work done or supplies, material and equipment furnished under this contract or purchase order."

Such requirements shall not apply to competitively advertised procurements, or standard "off the shelf" purchases of equipment or the subcontract or purchase order order which is \$10,000 or less.

C. The system shall be furnished completely fabricated, erected, piped, wired and tubed as an integrally mounted system on a skid. The system shall include all necessary valves and piping to isolate and bypass the individual components independtly of any of the other components. The

II. GENERAL (Cont'd)

- C. Vendor shall supply a completely operable system requiring only purchaser's inlet and outlet piping connections, and one three phase feeder cable 460V, 60 HZ, of a size suitable for Vendor's blower, Electric heater's, and control circuit load. The package shall include (but not be limited to) the initial dessicant charge, all pressure gauges, thermometers, relief valves, flow indicators and all the necessary appurtenances for a complete system.

III. PROCESS BASIS OF DESIGN

A. Air Feed to Bryer

1. Temperature - 110°F
2. Pressure - 576 PSIG
3. Design flowrates - 2984 lbs/hr Air
- 5 lbs/hr Water
4. Water content

Design: Air saturated with water vapor at 110°F & 576 PSIG

B. Outlet Air Requirements

1. Dew Point of minus 30°F measured at 570 PSIG
2. Capacities of Dried Air
 - a. normal : 590 SCFM
 - b. design : 650 SCFM
 - c. Allowable pressure drop: 5.0 PSI maximum through entire package

IV. MECHANICAL SPECIFICATIONS

- A. Design Temperature : 160°F
Design Pressure : 635 PSIG

- B. General Notes 1590-1100B shall be considered part of the req.
General Notes 1590-1300B shall be considered part of this req.

- C. All instruments and controls furnished as part of this requisition shall be identified as to make and model number and be subject to purchaser's approval.

V. CYCLE OF OPERATION

Vendor to provide an eight hour semi-automatic cycle.

VI. SITE CONDITIONS

- | | | |
|--------------------------------|---|------------------------|
| 1. Altitude (above sea level) | - | 1315 ft. |
| 2. Atmospheric Pressure | - | 14.0 PSIA |
| 3. Design Temperature - Winter | - | (-) 25°F |
| - Summer | - | (+) 93°F |
| 4. Location | - | Indoors in Comp. Bldg. |
| 5. Type of Operation | - | Continuous |
| 6. Earthquake & Wind Loading | - | (See Spec. 1590-40A1) |

VII. UTILITIES

1. Power Motors

200 HP & above	-	4000 V, 3 ϕ 60 HZ
3/4 HP thru 150 HP	-	460 V, 3 ϕ 60 HZ
1/2 HP & Below	-	115V, 1 ϕ 60 HZ

(Vendor to advise connected loads at each voltage level)
2. Vendor to supply panel for 460 V connect only.
Vendor shall supply all other voltages as required.
3. Regeneration heat by Electrical Power.

VIII. REFERENCES

(Shall be considered part of this requisition)

1590-10A1	Welded Unfired Pressure Vessels
1590-38A3	Induction Motors
1590-40A1	Wind, Snow & Earthquakes Loading
1590-50A2	Gaskets & Surface Finish for Bolted Flange Joints
1590-50A4	Dim. Of Non-Std. Gaskets & Surface Finish for Proper Compression
1590-92A1	Preparation of Shipment
1590-96A2	Equipment Noise Control
1590-1100B	General Notes - Vessels
1590-1300B	General Notes - Mechanical

MATERIAL REQUISITION



FOSTER WHEELER

PAGE 1 OF 12

FORM 135-20A

FOR <u>ERDA - FE</u>	F.W.REF. <u>15-1591</u>	REQUISITION NUMBER	DATE
SITE <u>Sioux Falls, South Dakota</u>		<u>1591-1343 D</u>	<u>10/27/75</u>
MATERIAL <u>Char Recovery Cyclones (A-102)</u>		SUPERSEDED BY CHANGE NO.:	
Item Nos. <u>S-102, S-103 and S-110</u>	C1	<u>2-9-76</u>	C4
Contract No. <u>ERDA-FE-14-32-0001-1521</u>	C2		C5
Location - <u>NSP, Lawrence Station, Sioux Falls, S.D.</u>	C3		C6

I. GENERAL

This requisition covers the design of a cyclone system for recovery of Char in the operation of a pressurized coal gasification pilot plant. Vendor shall quote a complete system including all equipment to perform a prescribed amount of Char Recovery from gas streams as described herein. The corresponding equipment required is listed below and is depicted in Figures 1 and 2 on Section V of this requisition.

All equipment shall be designed for continuous operation. The system will be installed outdoors at the site location of Northern State Power Company, Lawrence Generating Station, Sioux Falls, South Dakota.

Erection of all equipment will be by others.

II. SCOPE OF SUPPLY

- A. The Char Recovery Cyclone system shall consist of the following equipment:

<u>Item Number</u>	<u>Description</u>
S-102	First Stage Char Removal Cyclone
S-103	Second Stage Char Removal Cyclone
S-110	Recycle Gas Cyclone

- B. Vendor shall supply Trickle Valves for S-102 and S-103.
- C. Vendor shall specify dipleg diameter and any required dipleg aeration. If aeration is required, then vendor shall specify quantity and interval of such aeration. (See Section V, Fig. 2).
- D. Vendor shall guarantee the delivery of solids discharges from cyclones to receiving vessels. Vendor is given the option of supplying diplegs should this be necessary to insure guarantee of solids delivery. (See Section V, Fig. 2).
- E. Some cyclones may have to be "High Efficiency" cyclones of the tube-type, or equivalent, in order to achieve efficiencies required herein.

BY: SL

P.O.NO.

SUPPLIER:

III. APPLICABLE SPECIFICATIONS

- A. The following Foster Wheeler Energy Corporation specifications are an integral part of this requisition.
 - 1. General Notes for Mechanical Equipment, 1590-1300A, Rev. C-1.
- B. Equipment shall be furnished in accordance with the applicable provisions of the latest revisions of the following codes, specifications, etc:
 - 1. Pressure Vessels - ASME UPV Code, Section VIII., Stamp required.
- C. Welding
 - 1. Vendor shall submit all welding procedures to Foster Wheeler Energy Corporation for review and approval before any welding begins.
- D. Noise Specification
 - 1. Noise level, shall conform to the requirements of OSHA or any local, city, county or state code with more stringent requirements. Seller shall furnish data for the whole unit indicating its conformity to this requirement.
 - 2. The following minimum requirements shall also apply:
 - a. Permissible noise level 90 DB(A)
 - b. Estimated duration of worker exposure 2 hours per day
 - c. Reference sound pressure level .0002 microbar
 - d. Worker exposure location is at 3 feet horizontal distance and at 5 feet height above floor level from any noise source located within the unit.

IV. DEFINITION OF STREAMS IN FIGURE 1 - Table 1

<u>Stream Numbers</u>	<u>Definitions</u>
1	Gasifier Effluent Gas and Char. Stream properties are given on Sections VI - A and B.
3	Recycled Char and Gas. Stream properties are given on Sections VI - A and B. All Char particles in this stream will be less than 186 microns for the case where the particle density is 20 lbs/ft ³ . All Char particles in this stream will be less than 100 microns for the case where the particle density is 60 lbs/ft ³ . Vendor to supply flowrate and size distrib.
4	Bottoms from S-110. Vendor to supply flowrate and size distribution of Char.
7	Overhead from S-103. Vendor to supply flowrate and size distribution of Char.

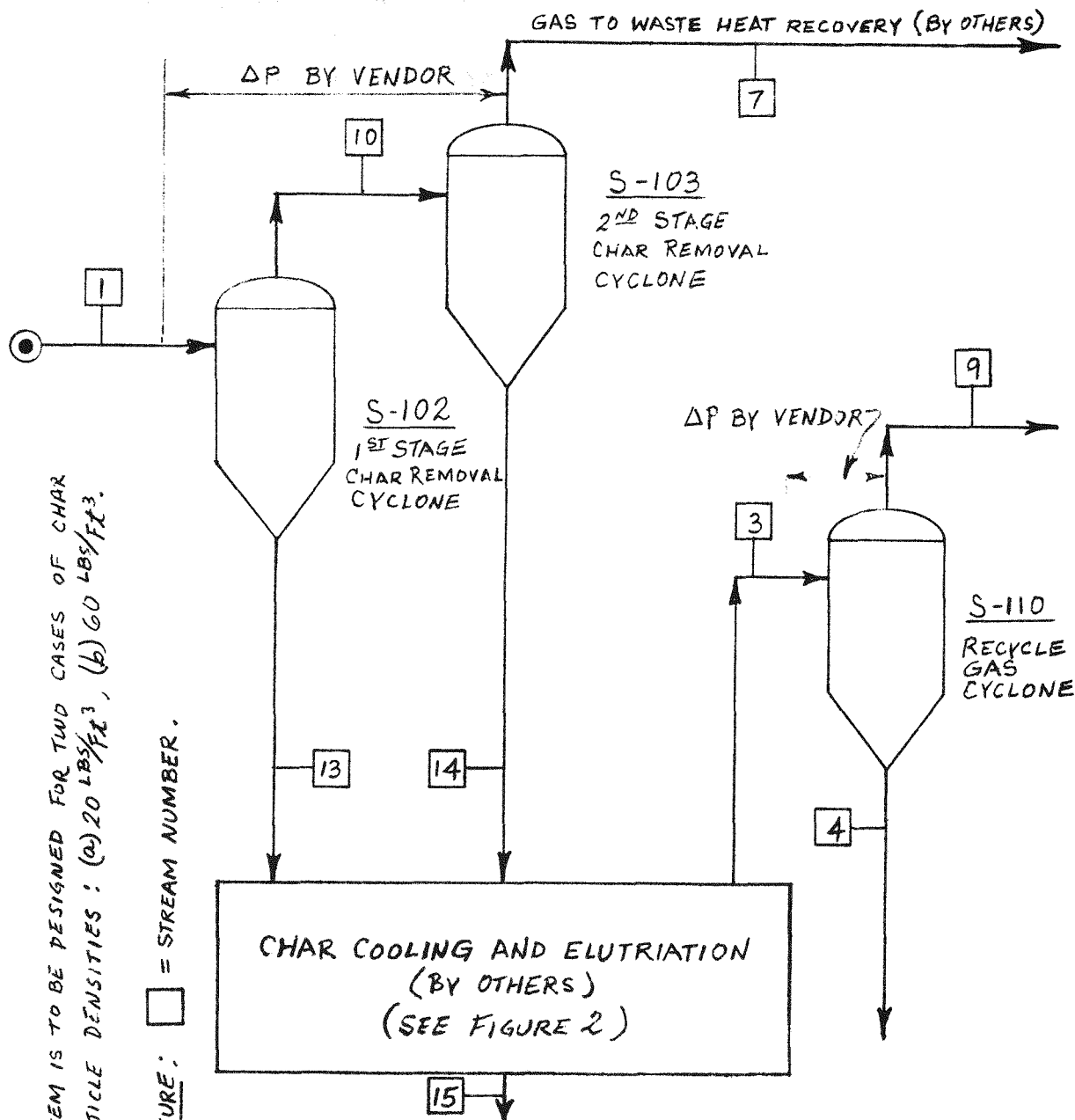
IV. DEFINITION OF STREAM IN FIGURE 1 - Table 1 (Cont'd)

<u>Stream Numbers</u>	<u>Definitions</u>
9	Overhead from S-110. Vendor to supply flowrate and size distribution of Char.
10	Overhead from S-102. Vendor to supply flowrate and size distribution of Char.
13	Bottoms from S-102. Vendor to supply flowrate and size distribution of Char.
14	Bottoms from S-103. Vendor to supply flowrate and size distribution of Char.
15	Combined Char heavies from bottoms of S-102 & 103. Vendor to supply flowrate and size distribution of Char.

Note that the Char recovery cyclone system must be capable of handling two separate cases involving a minimum and maximum Char particle density (for density details see Section VI-B-5). Thus the vendor is to supply the flowrate and size distribution for the above streams as corresponds to each of the two density cases.

V. CHAR RECOVERY CYCLONE SYSTEM

Figure 1 System Sketch



NOTE: SYSTEM IS TO BE DESIGNED FOR TWO CASES OF CHAR
 PARTICLE DENSITIES: (a) 20 LBS/FT³, (b) 60 LBS/FT³.

NOMENCLATURE: □ = STREAM NUMBER.

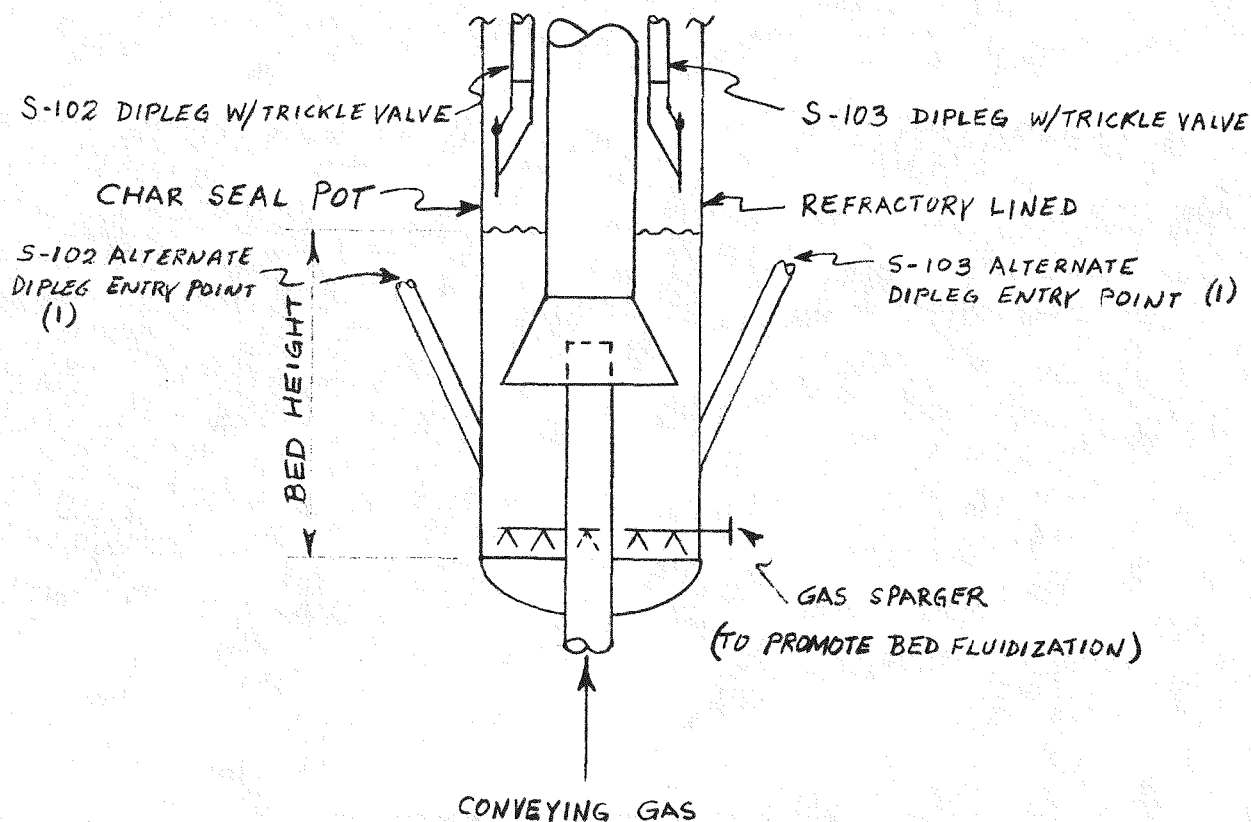
CHAR GREATER THAN:

- a) 186 MICRONS (TO EQUIPMENT BY OTHERS)
 WHEN PARTICLE DENSITY IS 20 LBS/FT³.
- b) 100 MICRONS (TO EQUIPMENT BY OTHERS)
 WHEN PARTICLE DENSITY IS 60 LBS/FT³.

V. CHAR RECOVERY CYCLONE SYSTEM (CONT'D)

Figure 2

Details for Dipleg Discharges of S-102 and S-103



Notes:

1. Cyclones S-102 and S-103 discharge to the same Char Seal Pot.
2. Char Seal Pot will be supplied by others.
3. Char Seal Pot design temperature is 2150°F; expected operating temperature approximately 1600 to 2000°F.
4. The Char Seal Pot is to be maintained at a pressure approximately equal to the Hopper/Dipleg flange pressure at the first of the cyclones that discharge into it. (i.e. for the S-102 and S-103 cyclones, the Char Seal Pot will be maintained at about the Hopper/Dipleg flange pressure of the S-102 cyclone).

VI. BASIS OF DESIGN

(1)	A.	Design Gas Feed Data		
			<u>1</u>	<u>3</u>
	1.	Type of Fluid	Gasifier Effluent Gas	Recycle Gas
		Vol % H ₂ S + COS	0.5	0.5
(1)		Vol % H ₂	12.4	15.0
	2.	Operating Temperature °F	1800 (See Note 2)	800
	3.	Inlet Pressure, PSIG	440	430
		(Atmospheric Pressure = 14.0 PSIA)		
	4.	Total Gas Flow		
(1)	a.	LBS/HR	197,783	69,500
(1)	b.	SCFM (60°F, 14.7 psia)	50,489	17,750
(1)	c.	ACFM	7,109	1,427
(1)	5.	Average Molecular Weight	24.77	24.72
(1)	6.	Density, LBS/FT ³ @ op. cond.	0.4637	0.812
	7.	Viscosity, CPS @ op. cond.	0.044	0.030
	8.	Compressibility Factor	1.0	1.0
	B.	Solids Feed Data	<u>1</u>	<u>3</u>
	1.	Type of Solids	Char from Coal Gasification	
	2.	Char Flowrate		
	a.	Normal, LBS/HR	34,150	Vendor to advise
	b.	Design, LBS/HR	40,000	(See Note 1)
	3.	Dust Loading		
	a.	Normal, Grains/ACF	573.8	Vendor to advise
	b.	Design, Grains/ACF	672.1	(See Note 1)

Note 1: Flowrates and dust loading to S-110 are to be based on vendor efficiencies for S-102 & S-103. Only those particles less than 186 microns go to S-110 for a particle density of 20 LBS/FT³. For the particle density case of 60 LBS/FT³, only those particles less than 100 microns go to S-110.

Note 2: It may be necessary to also operate the S-102 and S-103 cyclones at 2100°F, continuously. Under such operation, the total gas flow would be about 183,000 LBS/HR and would contain about 20,600 LBS/HR of Char, having the same size distribution as in the 1800°F case. Gas viscosity at 2100°F is 0.05 cps and mol weight is 24.9. Vendor is to confirm that Char losses, under 2100°F operation, will not exceed the guaranteed values for the 1800°F operation.

VI. BASIS OF DESIGN (Cont'd)

B. Solids Feed Data

4. Inlet Particle Size Distribution (same for both density cases).
a. To S-102 (stream No. 1. Also see Section VI-E)

	<u>Micron Size</u>	<u>Pounds Per Hour</u>	
		<u>Normal Case</u>	<u>Design Case</u>
(1)	<0.5	0	0
(1)	0.5 to 1.79	20	23
(1)	1.79 to 3.78	51	61
(1)	3.78 to 9.77	350	416
(1)	9.77 to 13.28	252	300
(1)	13.28 to 32.02	1682	2001
(1)	32.02 to 64.32	3699	4399
(1)	64.32 to 100	4035	4800
(1)	100 to 109.49	1009	1201
(1)	109.49 to 186	6558	7800
(1)	186 to 212	1848	2198
(1)	212 to 276	3700	4400
(1)	276 to 358	2018	2400
(1)	358 to 416	1009	1201
(1)	416 to 582	2018	2400
(1)	582 to 2000	5380	6400
(1)	TOTAL	33,629	40,000

- b. To S-103: To be determined by vendor.
c. To S-110: To be determined by vendor based on vendor efficiencies for S-102 and S-103 and the fact that all Char particles in this stream are either less than 186 microns or 100 microns depending on whether the particle density is 20 LBS/FT³ or 60 LBS/FT³, respectively.

5. Char Densities - Two Cases

- a. Minimum Density Case
(1) Particle Density: 20 LBS/FT³
(2) Bulk Density: 6 LBS/FT³
b. Maximum Density Case
(1) Particle Density: 60 LBS/FT³
(2) Bulk Density: 19 LBS/FT³

VI. BASIS OF DESIGN (cont'd)

C. Cyclone Data

1. Minimum Required Overall Efficiencies for all flow and particle density cases:
 - a. From the inlet of S-102 to the outlet of S-103; the required efficiency is 98.30%.
 - b. Solids out of S-110 shall not exceed 250 LBS/HR for any case.
 - c. Vendor to advise and employ maximum practical cyclone efficiencies.
2. Pressure Drop Across Each Cyclone
 - a. Inlet flange to outlet flange:
Vendor to Advise
 - b. Inlet flange to Dipleg flange:
Vendor to Advise
 - c. Pressure drop from Hopper-Dipleg flange of S-102 to Hopper-Dipleg flange of S-103 not to exceed 2.0 psi.
3. Cyclone Outlet to Inlet Area Ratios:
Vendor to Advise
4. Allowable Cyclone Inlet Velocities, FT/SEC:
Vendor to Advise
5. Cyclone Dimensions: Vendor to Advise

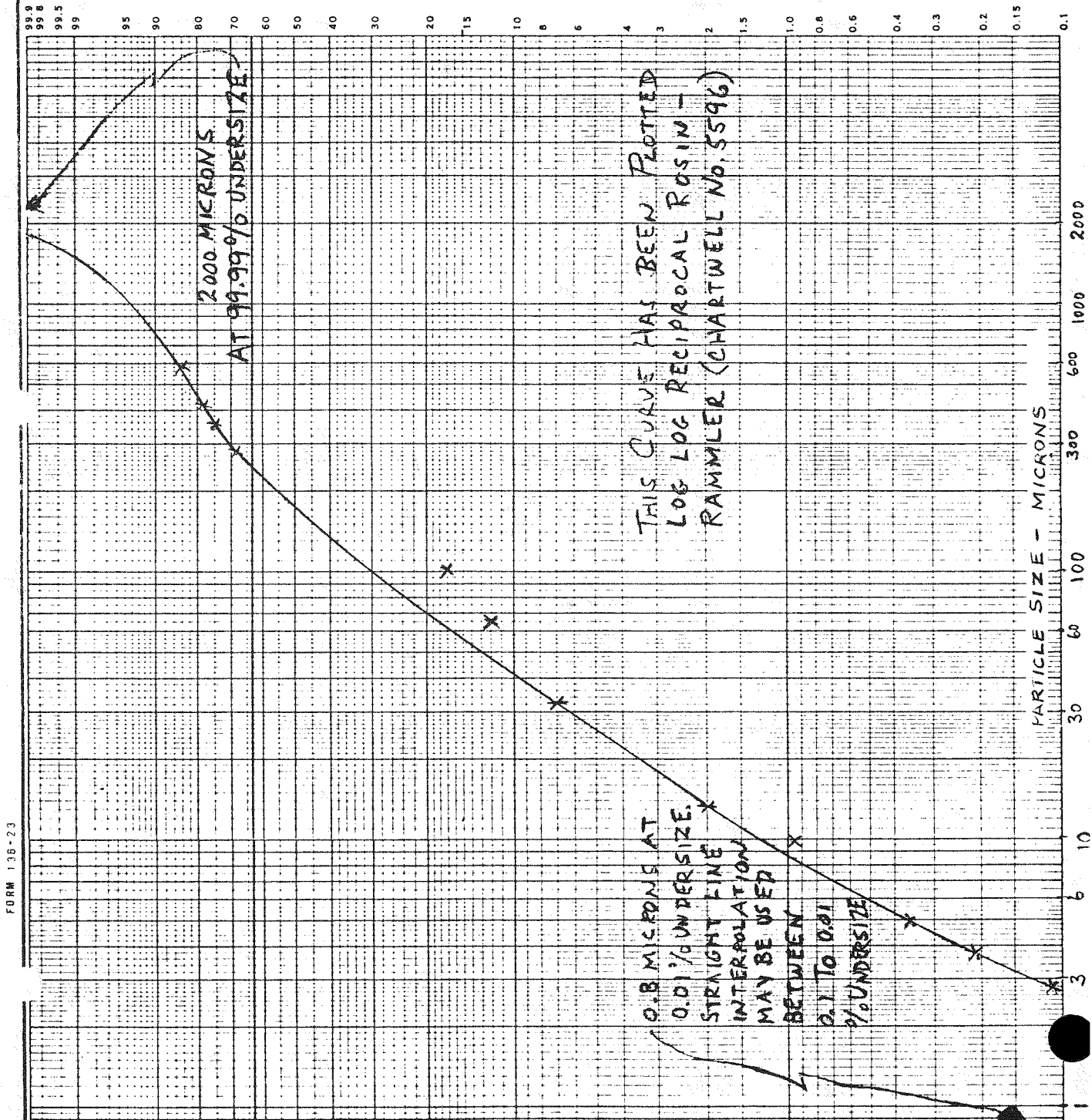
D. Dipleg Discharge Conditions (Note: See Section V, Figure 2)

1. Diplegs from S-102 and S-103.
 - a. Discharge Pressure: See Note 4 on Figure 2.
 - b. Characteristics of Receiver Vessel: See Figure 2.
2. Solids outlet from S-110
 - a. Discharge Pressure: 441 psia
 - b. Characteristics of Receiver Vessel: Storage Vessel
 - c. Dipleg: None required. Hopper flange is to be standard type as normally provided when discharging to a rotary valve. Hopper flange will be face to face with that of receiver vessel. Cyclone vendor to advise flange size.

VI. BASIS OF DESIGN (Cont'd)

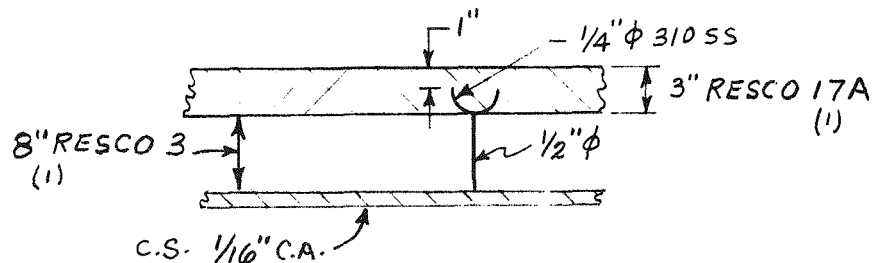
E. Design Basis for Char particle size distribution in Gasifier Effluent Gas

WT. PER CENT. UNDERSIZE



VII. MECHANICAL REQUIREMENTS

- A. All cyclones are to be external to the vessels that they service.
- B. Design Pressures and Temperatures
1. S-102: 500 PSIG and 2150°F
 2. S-103: 500 PSIG and 2150°F
 3. S-110: 500 PSIG and 900°F
- C. Materials of Construction
1. S-102: a. Shell - carbon steel, ASTM A515 Grade 70 as a minimum requirement, 1/16" corrosion allowance.
b. Lining - Internal Refractory lining, per sketch below. Refractory lining shall be supplied and installed by the vendor.



- c. Internals - All internal metal parts in contact with the Process Stream shall be Hastelloy 188, with sufficient corrosion/erosion allowance for 10,000 hours of operation.
2. S-103: Same as Item S-102.
 3. S-110: a. Shell - carbon steel, ASTM A515 Grade 70 as a minimum requirement, 1/16" corrosion allowance.
b. Lining - Internal Refractory Lining, similar to sketch for Item S-102 except that material shall be 3" thick Resco 17A and 3" thick Resco 3 gunned on 1 1/4% Cr - 1/2% Mo clips.
c. Internals - All internal metal parts in contact with the process gas shall be 1 1/4% Cr - 1/2% Mo with sufficient corrosion/erosion allowance for 10,000 hours of operation.

D. Alternate Materials of Construction

Vendor may submit an alternate quotation with different materials of construction based on previous successful experience in similar application.

E. Connections

1. All cyclone connections shall be flanged.
2. All trickle valve connections shall be welded.

F. Code

All cyclones shall be ASME coded and stamped, except for internal non-pressure withstanding metal parts.

G. Hydrostatic Tests

All cyclones shall be hydrostatically tested by the vendor per ASME code prior to the installation of refractory lining.

H. Inspection Connections

Cyclone design shall incorporate suitable flanged connections to provide easy access to its interior for inspection and or maintenance.

VIII. TURNDOWN CAPACITY

The gasifier in this plant is of the entrained flow type. It will generally be operated at approximately the same gas velocity over the full plant operating range. Required reactor and hence cyclone pressure will therefore generally be directly proportional to plant throughput (i.e. at minimum plant capacity of 40% required cyclone pressure will be approximately 165 PSIG).

Vendor to advise effect of turndown on cyclone efficiency.

IX. SITE CONDITIONS

- | | |
|--|------------|
| 1. Altitude (above sea level) | 1315 Ft. |
| 2. Atmospheric Pressure | 14.0 PSIA |
| 3. Design Temperature / winter (for winterizing) | (-) 25°F |
| summer | (+) 93°F |
| 4. Extreme Ambient Temp./winter | (-) 30°F |
| summer | (+) 100°F |
| 5. Location | Outdoors |
| 6. Type of Operation | Continuous |
| 7. Relative Humidity | 76% |
| 8. Earthquake Zone | I |
| 9. Wind Loading | |
| 0-29 | 20 PSF |
| 30-49 | 25 PSF |
| 50-99 | 30 PSF |
| 100-499 | 40 PSF |

X. GUARANTEE:

- A. Performance Guarantee - Based on information supplied, the subject equipment shall be unconditionally guaranteed to perform within the limits of its service conditions.

Vendor shall guarantee all equipment and material furnished by him and the system designed by him will meet the following requirements:

1. Rated capacity of the system as specified in each sub-section, including delivery of solids discharges from cyclones to receiving vessels.
2. Overall system efficiencies as specified in Section VI-C-1.
3. Pressure drop across each cyclone per Section VI-C-2.

Acceptance of the system will be based on satisfactory performance of a running test of the system. Tests shall be run in the presence of a representative of Foster Wheeler Energy Corp.

In the event that the system does not perform in accordance with the above requirements, vendor shall take the necessary steps, at his expense, to make the system meet guaranteed performance.

MATERIAL REQUISITION



FOSTER WHEELER CORPORATION

PAGE 1 OF 1

FORM 135-20

FOR OFFICE OF COAL RESEARCH(OCR) F.W. REF. 15-1591	REQUISITION NUMBER	DATE
SITE SIOUX FALLS, SOUTH DAKOTA	1591-1351A	3/21/75
MATERIAL SOLID FEEDING SYSTEM FOR	SUPERSEDED BY CHANGE NO.:	
COAL, LIMESTONE, RECYCLE CHAR	C1 5/28/75	C4
CONTRACT NO. OCR-1432-0001-1521	C2 6/24/75	C5
LOCATION NSP-LAWRENCE STATION-SIOUX FALLS, S.D.	C3 4/21/76	C6

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 - B. Coal to Petrocarb B.L.
 - C. Coal from Petrocarb B.L.
 - D. Coal Transport & Pressurizing Medium
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 - C. Limestone from Petrocarb B.L.
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 - F. Char Vessel Sizes
 - G. Char Feed System Flow Diagrams
 - H. Char Particle Distribution Chart for 20 lbs/ft³ particle density
 - I. Char Particle Distribution Chart for 60 lbs/ft³ particle density
 - J. Depressurization
 - K. Coal Particle Size Distribution Chart
- V. MECHANICAL SPECIFICATIONS
 - A. General
 - B. Start-Up
 - C. Site Condition
- VI. GENERAL SPECIFICATIONS
 - A. General
 - B. General Notes
 - C. General Notes

BY: TD1F

P.O. NO.

SUPPLIER:

Petrocarb

GENERAL

This is a contract for the supply of Engineering of specialized feed systems into a high pressure gasifier (by others). Also this contract includes the supply & delivery of equipment and specialty items to the site location of Northern States Power, Lawrence Generating Station, Sioux Falls, South Dakota.

Erection of equipment, material & specialty items is excluded from this contract.

The detailed process & mechanical requirements are as outlined below.

I. SCOPE

This requisition covers the design and supply of a package item dealing with three (3) solids feeding systems for the operation of a pressurized coal gasification pilot plant. FW and/or Petrocarb to provide all P&I's as required with symbols and notes to indicate the responsibility of lines, valves, and fittings. Petrocarb to furnish all special process valves, process pipe and process fittings. In process lines, where standard pipe, valves and fittings are required, FW shall supply, per Petrocarb's engineering. All process interconnecting standard piping design including pipe stress analysis and pipe support requirements shall be performed by Foster Wheeler; however, stress allowable at vessels, tanks, nozzles, etc., will be specified by Petrocarb. Petrocarb shall review the layout of the Foster Wheeler piping, making modifications as required, to insure its workability and controllability.

The scope of supply includes all instruments and controls for operation. Petrocarb to supply separate control panel with accessories and logic system for operations (Type of logic; relays/solid state; has not yet been determined). Electronic (not pneumatic) instrumentation to be used on this project. The instrumentation should be compatible with the FW instrumentation for the rest of the plant.

All drawings, inquiries, purchase orders and quotations must be identified by ERDA Contract Number ERDA-14-32-0001-1521 and the Requisition Number 1591-1351-A.

SYSTEMS

- A. Coal Feed
- B. Limestone Feed
- C. Recycle Char Feed

RESPECTIVE ITEMS (ENGINEERED & SUPPLIED BY PETROCARB)

A. Coal Feeding System

<u>Item No.</u>	<u>Description</u>
CR-102	Pulverized Coal Screw Conveyor
CR-104	Pulverized Coal Feeder
CR-110	Coal Weigh Element
CR-111	Coal Scalping Screen
D-101	Coal Storage Injector
D-102	Coal Primary Injector
TK-101	Pulverized Coal Surge Bin

B. Limestone Feeding System

<u>Item No.</u>	<u>Description</u>
CR-103	Limestone Feeder
CR-112	Limestone Scalping Screen
D-108	Limestone Storage Injector
D-109	Limestone Primary Injector
TK-104	Limestone Storage Bin
S-112	Limestone Receiver - Collector
D-130	Limestone Transfer Injector

C. Char Recycle Feeding Systems

<u>Item No.</u>	<u>Description</u>
S-115	Char Trim Cyclone
CR-113	Char Trim Cooler
D-104	Primary Char Receiver (Bottom only)
D-105	Primary Char Storage Injector
D-106	Char Primary Injector
D-119	Char Trim Storage Injector
D-120	Char Trim Primary Injector
D-210	Deleted
D-211	Deleted
D-123	First Stage Char Receiver
D-124	First Stage Char Storage Injector
D-205	Deleted
D-206	Deleted
TK-103	Char Storage Bin
S-107	Char Trim Receiver Collator
F-105	Char Trim Bag Filter
B-101	Char Filter Exhaust Fan
CR-126	Startup Char Scalping Screen

II. PULVERIZED COAL FEEDING SYSTEM

A. Coal Specification

1. Identification: Illinois No. 6 (Design Basis)
2. Bulk Density (See also II-E)
Maximum 50 lbs/ft³ (Design value for Structure & Foundation)
Minimum 35 lbs/ft³ (Design value for volumetric sizing)
3. Size
Pulverized coal is 70 wt. % through 200 mesh, maximum 85% through 200 mesh Tyler; further maximum 65% through 325 mesh. A desired approximate size distribution is given in Figure 2 (page 16). Final size distribution to be provided by Foster Wheeler as obtained from pulverizer vendor. (For info only)
4. Moisture
Surface Moisture: nil %
Total Moisture: 2.0 wt % max.

B. Coal to Petrocarb B.L. - i.e. to Pulverized Coal Screw Conveyor, CR-102

1. Feed Rate
Average rate 20 short tons/hr.
2. Temperature 220-250°F
3. Pressure 0.1 to 0.5 psig

C. Coal from Petrocarb B.L. - i.e. to Gasifier Stage II inlet flange

1. Flow Rate
Design 20.0 short tons/hr.
Minimum 6.7 short tons/hr.
2. Flow Pattern & Control
Total coal flow to be split between 6 operating injection lines in parallel located symmetrically about gasifier circumference. Each injection line shall have its own, flow indicator. The injection system shall maintain both an average and instantaneous rate of solids to the Gasifier within $\pm 3\%$ of the rate set on the Primary Injector rate control instrument when operated at the "design" rate. Also, for all conditions of operation as set forth in the subject inquiry, the injection system will maintain a maximum variation in the solids distribution, between any one of six (6) feed points to the gasifier, of $\pm 10\%$ of the average, provided the back pressure of each inlet flange is the same.

II. (CONT.)

G. (CONT.)

3. Temperature after mixed "tees" Petrocarb to advise.

4. Pressure

Required pressure at Gasifier Stage II inlet flange is 490 PSIG at design flow. The gasifier in this plant is of the entrained flow type. It will generally be operated at approximately the same gas velocity over the full plant operating range. Required pulverized coal feed pressure will therefore generally be directed proportional to plant throughput (i.e. at 50% coal feed rate required coal pressure to the gasifier will be approximately 238 PSIG). However, some leeway for pilot plant exploratory operation at turndown must be allowed for as shown below. Expected burner inlet pressures are:

<u>PLANT THROUGHPUT</u>	<u>PSIG AT BURNER FLANGE</u>
100	490
50	238
33-1/3	154

D. Transport & Pressurizing Medium

1. Fluid

Identification: Clean Process Gas

<u>Typical Composition</u>	<u>Mole %</u>
Hydrogen	14.31
Carbon Monoxide	20.19
Carbon Dioxide	6.64
Methane	4.10
Water Vapor	0.01
Nitrogen	54.74
Carbonyl Sulfide	0.01
	<u>100.00</u>

2. Amount Required

For Transfer)
For Pressurization) Petrocarb to advise

3. Temperature

350°F

II. (CONT.)

D. (CONT.)

4. Available Pressure

Gas to be available at 100 PSI above burner inlet pressure:

<u>Plant Thruput, %</u>	<u>PSIG</u>
100	585
50	335
33-1/3	252

5. Dew Point

A. At 585 PSIG, D.P. = + 50°F

B. At 0 PSIG, D.P. = - 27°F

E. Vessel Sizes (Petrocarb to confirm)*

<u>ITEM NO.</u>	<u>RESERVE (MINUTES)</u>	<u>BATCH (MINUTES)</u>	<u>TOTAL TONS</u>
D-102	40	20	--
D-101	--	20	--
TK-101	--	--	25

* Vessels to be sized for indicated hold-up times using minimum coal bulk density of 35 lb/ft³. Petrocarb shall advise at an early date, wherever indicated batch times should be increased and shall also indicate where decreases in any of the batch times are considered practical.

F. Depressurization

The Coal Storage Injector, D-101, is to be depressurized to essentially atmospheric pressure, with provision to save as much of this gas as practicable.

III. LIMESTONE FEEDING SYSTEM

A. Limestone Specification

1. Identification: Commercial-Grade of the "high calcium-type"
2. Bulk Density (See also III-E)

Maximum 90 lbs/ft³ (Design value for structure & foundations)
Minimum 64 lbs/ft³ (Design value for volumetric sizing)

3. Size Requirements

100% passes 14 Tyler mesh
less than 70% passes 200 mesh
less than 30% passes 325 mesh

Complete particle size distribution to be determined by Petrocarb from suppliers samples.

III. (CONT.)

4. Moisture

To be as close to zero surface moisture as is commercially available. Petrocarb to advise maximum allowable.

B. Limestone to Petrocarb B.L. - i.e. to Limestone Storage Bin, TK-104.

- | | |
|----------------|--|
| 1. Feed Rate | Pneumatic loading rate to be set later |
| 2. Pressure | Atmospheric by Pneumatic loading |
| 3. Temperature | Ambient |

C. Limestone from Petrocarb feed system - i.e. to inlet Stage I Gasifier.

1. Flow Rate

Design	1400 lbs/hr
Normal	900 "
Minimum	465 "

2. Flow Pattern & Control

Total limestone feed to be split between six (6) operating injection lines, in parallel, each of which ties in upstream of each six (6) Char burners which are located symmetrically about the gasifier circumference. Each limestone injection line shall have its own flow indicator. The injection system shall maintain both an average and instantaneous rate of solids to the Gasifier within $\pm 3\%$ of the rate set on the Primary Injector rate control instrument when operated at the "design" rate.

Also, for all conditions of operation as set forth in the subject inquiry, the injection system will maintain a maximum variation in the solids distribution, between any one of six (6) feed points to the gasifier, of $\pm 10\%$ of the average, provided the back pressure of each inlet flange is the same.

3. Temperature after "Mix-tees" - Petrocarb to advise
4. Pressure

Required pressure at Stage I Gasifier Inlet Flange 496 psig at design coal feed rate to plant, see comments II-C-4 above. Expected required pressures are:

<u>Plant Thruput-%</u>	<u>PSIG</u>
100	496
50	241
33-1/3	156

D. Transport & Pressurizing Medium

1. Fluid - Dry Air (Dew Pt. is -30°F , as measured at 570 psig)

III. (CONT.)

D. (CONT.)

2. Requirements

	For Pressurizing Injector	For Transport From Injector	For Transport From D-130
Amount Pressure	Petrocarb to advise (Generally to be available at 100 psig above gasifier stage I inlet pressure. Pressure is 570 psig at 100% plant capacity)		
Temperature	110°F		

E. Vessel Sizes (Petrocarb to confirm)*

ITEM NO.	RESERVE	BATCH	TOTAL TONS
	Minutes	Minutes	
D-109	30	30	---
D-108	--	30	---
TK-104	--	--	100

D-130 By Petrocarb

*Vessels to be sized for indicated hold up times using minimum limestone bulk density of 64 lbs/ft³. Petrocarb shall advise, at an early date, whenever indicated batch times should be increased and shall also indicate where decreases in any of the batch times are considered practical.

IV. CHAR FEEDING SYSTEM

A. Char specification

1. Identification

Char from the entrained flow gasifier is separated from the product gas and cooled in equipment outside of the Petrocarb supply package. It enters the Petrocarb's package at several different points and is recycled to the gasifier by Petrocarb as defined in Sections IV-B, C, D, H & I.

2. Char Analysis

	WT. %
Ash	17.2
Carbon	82.8
	100.0

IV. (CONT.)

A. Char Specification

3. Char Density

The char feed system is to be designed to handle char over the following full range of densities. (Also see IV-F below for vessel holdup).

Apparent particle density 20 to 60 lbs/ft³
Bulk Density

Maximum	- 19 lbs/ft ³	(Design value for struct. & found.)
Normal	- 6 lbs/ft ³	(Design value for volumetric sizing)
Minimum	- 6 lbs/ft ³	(Design value for volumetric sizing)

Note that two mutually exclusive density cases exist. Where the particle density is 20 lbs/ft³ the bulk density is estimated at 6 lbs/ft³. When the particle density is 60 lbs/ft³, the bulk density is estimated at 19 lbs/ft³.

4. Size Distribution

As defined below in tables, No. I & II, pages 13 & 14. These tables to be further refined after selection of cyclone vendor.

5. Moisture

To be as close to zero surface moisture as is possible. Petrocarb to advise maximum allowable.

B. Char Streams into Petrocarb B.L.

Two separate char streams feed into the Petrocarb system in normal operation. Total char entering the system, which must be recycled to the gasifier, is defined within a relatively narrow range under IV C. The split of the total char between the two (2) feed points, however, has a wider range because the performance of cyclones and separators, outside of Petrocarb's B.L. is affected by char density. Minimum and maximum expected char flows at the two (2) feed points are given below for the design char density range. Expected char size distribution for these conditions is given in Tables I & II.

* Feed Rate Tons/Hr	To D-105	To D-123
Minimum (for 20 lbs/ft ³ particle density)	8.0	6.6
Maximum (" ")	9.5	10.5
Minimum (for 60 lbs/ft ³ particle density)	11.8	4.7
Maximum (" ")	14.0	6.0
Normal B.L. PSIG (at design coal rate)	431	425
Normal B.L. °F	800	800
Maximum B.L. °F	850	850

*Expected char rates with 20 short tons/hr. coal feed to gasifier.
210

IV. (CONT.)

C. Char return from Petrocarb to Gasifier

1. Flow rate of char at design plant coal feed rate

Normal - 16.8 tons/hr.
Maximum - 20.0 tons/hr.

2. Flow pattern & Control - same as III-C-2
3. Size Distribution - as tables I & II
4. Required pressure at Stage I gasifier inlet flange is 496 PSIG at design coal rate.

<u>Plant Thruput %</u>	<u>PSIG to Burner</u>
100	496
50	241
33-1/3	156

5. Temperature after "Mix-tees" - Petrocarb to advise

D. Other Char Streams

1. Start-up injection

Provision is to be made to inject cold char from Char Storage Bin, TK-103, into the gasifier for normal plant start-up. Char feed to be controllable over a range of 1.67 to 5 tons/hr. at maximum discharge pressure 496 PSIG.

2. Char withdrawal
Provisions to be made to withdraw char from the hot pressurized system and transfer it to cold atmospheric storage (TK-103). System including char trim cooler, CR-113, to be capable of continuous controlled withdrawal over range 1.67 to 4 tons/hr. Provision also to be made to allow removal of char from TK-103 to char truck loading.

IV. (CONT.)

D. (CONT.)

Char withdrawal and addition will not be at the same time.

E. Transport & Pressurizing Media

<u>Normal</u> <u>Transport</u> <u>from D-105,</u> <u>D-106 to</u> <u>Gasifier</u>	<u>Char</u> <u>Addition</u> <u>to D-104</u> <u>Pressuri-</u> <u>zation</u>	<u>Char</u> <u>Addition</u> <u>to D-104</u> <u>Transport</u>	<u>Transport</u> <u>to & from</u> <u>Storage Bin</u> <u>TK-103</u>
Clean Process Gas as IID Avail. PSIG 420 Temp. °F 800	Dry Nitrogen Gas 600 350	Clean Process Gas 580 350	Dry Nitrogen Gas 100 100

Amt. req'd. - Petrocarb to advise

Start-up transport and pressurizing medium will be dry nitrogen gas for all char handling services. Properties as above.

F. Vessel Sizes (Petrocarb to confirm. See Note 1)

<u>Item No.</u>	<u>Reserve</u>	<u>Batch</u>	<u>Total Tons</u>
D-104 (Note 2)		30 min.	
D-105 (Note 2)		20 "	
D-106	20 min.	20 "	
D-123		20 min.	
D-124		20 min.	
D-119 (Note 3)			By Petrocarb
D-120			" "
TK-103			80

* Vessels should allow 3'-0" free space above apex of maximum char height to allow char discharge from bottom outlet flange of cyclone. Assume an angle of repose for the char of 45°.

IV. (CONT.)
F. (CONT.)

- Note 1. Vessels to be sized for indicated holdup times using char bulk density of 6 lbs/ft³. Petrocarb shall advise, at an early date, wherever indicated batch times should be increased and shall also indicate where decreases in any of the batch times are considered practical.
- Note 2. Although the flow rate to D-104 & D-105 is greater in the 60 lbs/ft³ particle density case; i.e., 33,662 vs. 18,800 lbs/hr., the bulk density is larger; i.e. 19 vs. 6 lbs/ft³. Consequently, volumetric flow and hence vessel sizing is still controlled by 20 lbs/ft³ particle density case; i.e. 6 lbs/ft³ particle density case.
- Note 3. During startup, char will be fed directly to the char trim storage injector, D-119. Petrocarb will accomplish this by batch feeding for short periods of time from the char storage bin, TK-103.

Table I - for 20 lb/ft³ Char Particle Density (See Note 1)
 Expected Size Distribution of Char Streams Entering &
 Leaving Petrocarb B.L.
 Char Flow Lbs/Hr in Indicated Size Range

Size Range Microns	To D-105		To D-123		Total & Return to Gasifier	
	Min.	Max.	Min.	Max.	Norm.	Max.
.5 to 1.79				23	20	23
1.79 to 3.78				61	51	61
3.78 to 9.77				416	350	416
9.77 to 13.3				300	252	300
13.3 to 32.0				2,001	1,682	2,001
32.0 to 64.3			1,507	4,399	3,699	4,399
64.3 to 100.			4,035	4,800	4,035	4,800
100. to 109.			1,009	1,201	1,009	1,201
109. to 186.			6,558	7,800	6,558	7,800
186. to 212.	1,848	2,198			1,848	2,198
212. to 276.	3,700	4,400			3,700	4,400
276. to 358.	2,018	2,400			2,018	2,400
358. to 416.	1,009	1,201			1,009	1,201
416. to 582.	2,018	2,400			2,018	2,400
582. to 2000.	5,380	6,400			5,380	6,400
> 2000	0	0			0	0
Total lbs/hr.	15,973	18,999	13,109	21,001	33,629	40,000
Total tons/hr.	8.0	9.5	6.6	10.5	16.8	20.0

Note 1. Normal and maximum flows shown define expected char range at 20 ton/hr coal feed to gasifier. Note that each cut (size range) is to have a particle density of 20 lb/ft³ and a bulk density of 6 lb/ft³.

FOSTER WHEELER CORPORATION
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Table II - For 60 lb/ft³ Char Particle Density (See Note 1)
 Expected Size Distribution of Char Streams Entering & Leaving
 Petrocarb B.L.
 Char Flow Lbs/Hr in Indicated Size Range

Size Range Microns	To D-105		To D-123		Total & Return to Gasifier	
	Min.	Max.	Min.	Max.	Norm.	Max.
.5	1.79			23	20	23
1.79	3.78			61	51	61
3.78	9.77			416	350	416
9.77	13.3			300	252	300
13.3	32.0		1,682	2,001	1,682	2,001
32.0	64.3		3,699	4,399	3,699	4,399
64.3	100.		4,035	4,800	4,035	4,800
100.	109.	1,009			1,009	1,201
109.	186.	6,558			6,558	7,800
186.	212.	1,848			1,848	2,198
212.	276.	3,700			3,700	4,400
276.	358.	2,018			2,018	2,400
358.	416.	1,009			1,009	1,201
416.	582.	2,018			2,018	2,400
582. to 2000.		5,380			5,380	6,400
2000		0			0	0
Total lbs/hr.	23,540	28,000	9,416	12,000	33,629	40,000
Total Tons/Hr.	11.8	14.0	4.7	6.0	16.8	20.0

Note 1. Normal and maximum flows shown define expected char range at 20 ton/hr coal feed to gasifier. Note that each cut (size range) is to have a particle density of 60 lb/ft³ and a bulk density of 19 lb/ft³.

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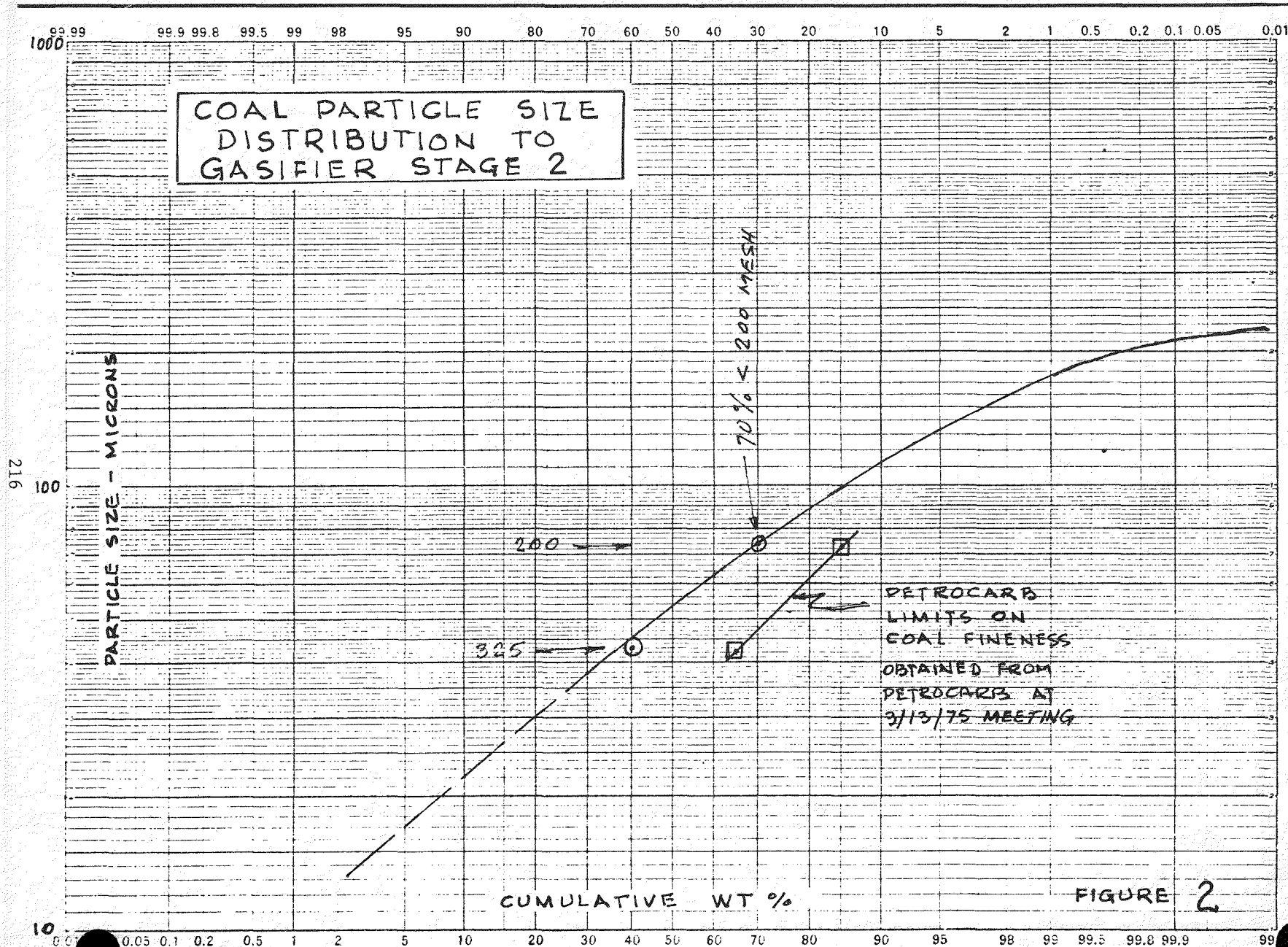


FIGURE 2

FOSTER WHEELER CORPORATION
MATERIAL REQUISITION NO.: 1591-1351A
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IV. (CONT.)

J. Depressurization

Vent gas obtained from depressurization char drums D-105 and D-124 is to be returned to the FWEC fuel gas system.

V. MECHANICAL SPECIFICATIONS

- A. The design of all equipment, piping and electrical parts of Petrocarb's supply will comply with all regulations applicable to the proposed location; i.e., Sioux Falls, South Dakota. All material to be of United States of America origin. Equipment shall be furnished in accordance with applicable provisions of the latest revisions of the following codes, specifications, etc., which may be revised to adjust classification and additions made as necessary to assure good practice.
1. Vessels - ASME UPV Code Section VIII
 2. Electrical - NEC for Class I., - Group D, Div. 2/Class II, Group F, Div. 2.
 3. Safety - Federal Register (OSHA)
 4. National Fire Codes - NFPA - 60,68,69,70,71,91,496,653
- B. Upon request from Foster Wheeler, Petrocarb will provide services of their technical staff for any consulting assistance during the start-up of equipment provided by vendor.
- C. Site Conditions
1. Altitude (above sea level) - 1315 Ft.
 2. Atmospheric Pressure - 14.0 PSIA
 3. Design Temperature/winter - (-) 25°F
summer - (+) 93°F
 4. Location - Outdoors
 5. Type of Operation - Continuous
 6. Earthquake Zone - I
 7. Wind Loading
0-29 - 20 PSF
30-49 - 25 PSF
50-99 - 30 PSF
100-499 - 40 PSF
 8. Utilities Available
 - a. Power-Motors 200 HP & above 4000 V, 3Ø, 60 HZ
3/4 HP thru 150 HP - 460V, 3Ø, 60 HZ
1/2 HP & below - 115V, 1Ø, 60 HZ
(Vendors to advise connected loads at each voltage level)
 - b. Power - controls & lighting - 115V, 1Ø, 60 HZ
(Vendor to advise quantity required)
 9. Plant Life - (Years) 5 maximum
 10. Snow Load 30 PSF

VI. A. GENERAL SPECIFICATIONS

1. Petrocarb is to furnish Foster Wheeler with preliminary and final drawings (later) copies of each) covering but not limited to the categories listed below. Item numbers will match Foster Wheeler assigned numbers. Engineering and Process Flow Sheet drawings will be on 30" x 42" size paper; Foster Wheeler will furnish example of title box information to be used in lower right hand corner. Other drawings sizes to suit:
 1. Process Flow Diagrams
 2. Instrumentation Drawings, Details & Panel Board
 3. Elevation Layout for all vessels in the three (3) systems
 4. Vessel Drawings (hoppers, cyclones, pressure vessels, etc.) including chart & data & loading diagrams.
2. The procurement of vessels, hoppers, cyclones, pressure vessels, etc., shall be made by Petrocarb with Foster Wheeler & ERDA's written approval and the following requirements of ERDA (as stated below) with Foster Wheeler having the right to:
 1. Review Bid Tabulations
 2. Refusal of Vendor Selection
 3. Review the vessel design calculations, drawings and welding procedures prior to the start of fabrication.
 4. Inspect and expedite Petrocarb vendors.
 5. Work with Petrocarb on methods of lifting of support of vessels
 6. Inspect prior to shipment

REQUIREMENT BY ERDA

No subcontract shall be on a cost-plus-a-percentage-of-cost-basis. The following clause is part of this and must be part of any subcontract purchase order which exceeds \$10,000. "This contract or purchase order pertains to the performance of Contract No. 14-32-0001-1521 between the United States & Foster Wheeler Energy Corporation and the sub-contract (later) agrees that the Contracting Officer, ERDA-USA, Department of Interior, or his authorized representative, may inspect the plant and audit the books and records of the sub-contractor with respect to work done or supplies, materials and equipment furnished under this contract or purchase order!"

3. Petrocarb shall prepare an Operating Manual for each of the three (3) feed systems. A preliminary issue shall be made for Foster Wheeler's review and approval no later than (later) before scheduling initial operation of the unit. The final approved Operating Manual shall be made no later than (later) before scheduling initial operation of the unit. (later) sets of all final approved Operating Manuals shall be furnished. Drawings and data sheets for the Operating Manual shall be reduced to eleven inches high by random using a legible reproduction method.

VI. (CONT.)

A. (CONT.)

4. Copies of recommended spare parts shall be furnished within (later) from date of final approved order. This list shall include:

1. Equipment Identification (for which parts are intended)
2. Part Number (if any)
3. Quantity of each part, or assembly, recommended
4. Price & other terms of sale. Petrocarb shall furnish these spare parts to Foster Wheeler at the price indicated with the understanding that Foster Wheeler will take a reasonable length of time to review and place an order for these parts.
5. Part description, including material & catalog description.
6. Weight (Net & shipping)
7. Delivery time

- B. General Notes for Mechanical Equipment 1590-1300B is an integral part of this requisition.

- C. General Notes for Petrocarb only 1590-1100B is an integral part of this requisition.

MATERIAL REQUISITION



FOSTER WHEELER

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FORM 135-20A

FOR <u>ERDA - FE</u>	F.W. REF. <u>15-1591</u>	REQUISITION NUMBER	DATE
SITE <u>Sioux Falls, South Dakota</u>		<u>1591-1351 B</u>	<u>3-21-75</u>
MATERIAL <u>Coal Pulverization & Drying System (A-104)</u>		SUPERSEDED BY CHANGE NO.:	
		C1 <u>2-20-76</u>	C4
Contract No. <u>ERDA - FE 14-32-0001-1521</u>		C2	C5
Location - <u>NSP, Lawrence Station, Sioux Falls, S.D.</u>		C3	C6

I. GENERAL

This requisition covers the design of a package item dealing with a coal pulverization and drying system for the operation of a pressurized coal gasification pilot plant. Vendor shall quote a complete system including all Design Engineering and the supply and delivery of equipment and specialty items required to perform the pulverization and drying duty defined herein.

All equipment shall be designed for continuous operation. The system will be installed indoors, except for cyclone, Item S-108, at the site location of Northern State Power Company, Lawrence Generating Station, Sioux Falls, South Dakota.

Erection of equipment material and specialty items will be by others.

II. SCOPE OF SUPPLY

The coal pulverization and drying system shall consist of the following equipment as a minimum:

<u>Item No.</u>	<u>Description</u>
A. <u>FD-101</u>	Rotary air lock feeder, complete with outlet hooper, inlet shut-off valve, and suitable drive with explosion proof motor and OSHA type guards, switches and controls.
B. <u>SR-101</u>	Coal pulverizer including integral classifier, explosion proof motor drive, gear, drive couplings and OSHA type guards. The pulverizer shall be furnished complete with automatic lubrication system.
C. <u>H-101</u>	Inert gas generator complete with refractory lining and combustion controls and safety equipment per NFPA.
D. <u>C-103</u>	Combustion air blower, complete with inlet screen, explosion proof motor drive, and OSHA type guards.

BY: <u>AS</u>	P.O. NO.	SUPPLIER:
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II. SCOPE OF SUPPLY (cont'd)

- E. C-104 Gas recirculation blower, complete with explosion proof motor drive and OSHA type guards.
- F. C-105 Pulverizer exhaust blower, complete with explosion proof motor drive OSHA type guards.
- G. S-108 Pulverized coal cyclone separator, equipped to deliver to a bin provided by others, with rotary valve (Item FD-102) at the solids outlet. A pulse-jet bag filter assembly (Item F-103) may also be furnished if required, and shall be complete with suitable solids discharge feeder (Item CR-101) and other accessories and controls necessary for continuous cleaning.
- H. All Dampers and valves required for the proper operation of the system.
- J. Design Engineering only for all the required interconnecting ductwork and piping in the system, including all line sizing, approval of layout and materials of construction specifications. Materials and fabrication for the ductwork and piping including insulation will be by others.
- K. Complete system controls, analog type, complete with damper drives, pressure and temperature measuring, transmitting and indicating components, included in a central free standing control panel. All local controls shall also be capable of operating by remote electronic signal from customer's control panel. All alarms and shutdown circuits shall have auxiliary contacts for remote indication in customer's control panel by others.

III. APPLICABLE SPECIFICATIONS

- A. The following Foster Wheeler Energy Corporation specifications are an integral part of this requisition.
 - 1. General Notes for Mechanical Equipment, 1590-1300A, Rev. C-1.
 - 2. Induction Motors, 1590-38A1
- B. Equipment shall be furnished in accordance with the applicable provisions of the latest revisions of the following codes, specifications, etc:
 - 1. Vessels - ASME UPV Code, Section VIII
 - 2. Electrical - NEC for Class II, Group F, Division 1.
 - 3. National Electrical Code NFPA 70
 - 4. Pulverized Fuel Systems NFPA 60
 - 5. Inerting for Fire & Explosion Prevention NFPA 69

III. APPLICABLE SPECIFICATIONS (cont'd)

- | | |
|--|----------|
| 6. Coal Preparation Plants | NFPA 653 |
| 7. Blower & Exhaust Systems | NFPA 91 |
| 8. Purged Enclosures for Electrical
Equipment | NFPA 496 |
| 9. Explosion Venting Guide | NFPA 68 |
| 10. Static Electricity | NFPA 77 |
| 11. Air Pollution Control regulations for the State of South Dakota. | |

C. NOISE SPECIFICATION

1. Noise level shall conform to the requirements of OSHA or any local, city, county or state code with more stringent requirements. Seller shall furnish data for the whole unit indicating its conformity to this requirement.
2. The following minimum requirements shall also apply:
 - a. Permissible noise level 90 DB(A)
 - b. Estimated duration of worker exposure 2 hours per day
 - c. Reference sound pressure level .0002 microbar
 - d. Worker exposure location is at 3 feet horizontal distance and at 5 feet height above floor level from any noise source located within the unit. Minor protuberances such as conduit boxes or bearing housings shall be neglected in determining these distances

IV. BASIS OF DESIGN

A. Crushed Coal Feed.

1. Identification
 - a. Design Basis: Illinois No. 6
 - b. Other Possible Feeds:
 - (1) Colstrip
 - (2) Big Horn
 - (3) Rosebud
 - (4) North Dakota Lignite
 - (5) Pittsburgh Seam No. 8
2. Feed Flowrate: Approximately 28.2 short tons per hour (includes 20% total moisture) in order to obtain a design product of 23 short tons per hour.
3. Total Moisture Content of Coal: 20 wt % (Design)
4. Proximate Analyses of Coal: See Table I on page 9 of 9
5. Ultimate Analyses of Coal: See Table I on page 9 of 9
6. Ash (Slag) Analyses and Properties:
See Table I on page 9 of 9.

IV. BASIS OF DESIGN (cont'd)

7. Feed Size Distribution: Design for 3/4" maximum.
On crusher shutdown, size would be 2" to 2 1/2"
 - . Vendor to advise on turndown required to handle this larger size coal.
8. Grindability: 50 Hardgrove scale
9. Supply Temperature: 50°F
10. Gross Heating Value: See Table I on page 9 of 9
11. Net Heating Value: See Table I on page 9 of 9
12. Angle of repose: 37°

B. Pulverized Coal Product

1. Design Flowrate: 23 short tons per hour (includes 2% total moisture).
2. Operating Temperature: 200°F (Vendor to Confirm)
3. Moisture Content
 - a. Surface Moisture: Nil
 - b. Total Moisture: 2 wt % at all times, including startup and shutdown.
4. Bulk Density
 - a. Maximum: 50 lbs/Ft³
 - b. Normal: 45 lbs/Ft³
 - c. Minimum: 35 lbs/Ft³
5. Particle Size Distribution
Pulverized coal to be 70 wt % through 200 Mesh.
Desired pulverized coal size distribution is shown on Figure I page 8 of 9. Pulverizer vendor to attempt to achieve this given size distribution and should also advise on the actual size distribution that will be produced at design and at rated capacities. (Vendor to supply a series of curves of size distribution vs. wt % cumulative, with capacity as a parameter.) Fineness limits are also specified on Figure 1.
- C. Maximum allowable oxygen content at outlet of the inert gas generator shall be 3.0% by volume. All items of equipment in system shall operate under positive pressure in order to avoid air leakage.
- D. Turndown
Minimum turndown while pulverizer is operating:
4 to 1 ratio

IV. BASIS OF DESIGN (cont'd)

E. Sparing of Equipment

Vendor to advise on any equipment in system which would require spares due to frequent outage.

F. Emissions

1. Maximum allowable particulates to atmosphere shall be 10 LBS/HR. Sum total from all components.
2. Bag Filter, F-103 shall have a minimum efficiency of 99.9%.
3. Vendor shall specify any atmospheric emissions from any component of the system.

V. DRYING OF COAL

A. Scope

The drying of the pulverized coal will be accomplished by the in-line fluidization of the coal by a recirculating hot inert gas stream. The inert gas generator is to be included in equipment provided by the vendor.

B. Fuel Required

1. Identification
 - a. Design Basis: Process Gas (Fuel Gas) with a net heating value of 141.3 BTU/SCF (60°F, 1 ATM on wet basis) or 2155.2 BTU/LB
 - b. Start-Up: No. 2 Fuel Oil
2. Fuel Consumption: Vendor to advise.
Vendor is obligated to achieve an economic optimum thermal efficiency and fuel gas consumption.

3. Approximate Fuel Gas Composition

<u>Components</u>	<u>Vol. %</u>
H ₂	14.31
CO	20.19
CO ₂	6.64
CH ₄	4.10
H ₂ O	0.01
N ₂	54.72
NH ₃	0.01
H ₂ S } COS }	.02
Total	100.00

4. Header Pressure: 40 psig

5. Temperature: 175°F

V. DRYING OF COAL (cont'd)

4. No. 2 Fuel Oil Properties
 - a. °API 35.0
 - b. Viscosity, SSU @ 100°F 32.6 - 37.9
 - c. Wt. % Sulfur 0.31
 - d. Gross Heating Value 137,810 BTU/GAL
 - e. Temperature 50°F
 - f. Pressure 100 psig

C. Inert Gas Generation and Use

1. Composition of Inert Gas Generated: Vendor to advise, however maximum oxygen content is limited to 3.0% (see Section IV-C.)
2. Inlet Gas Pressure To Pulverizer: Vendor to advise
3. Inlet Gas Temperature To Pulverizer: Vendor to advise
4. Gas Flow, ACFM: Vendor to advise
5. ΔP across pulverizer: Vendor to advise
6. ΔP across pulverized coal cyclone: Vendor to advise
7. Exit Gas Temperature from Inert Gas Generator: Vendor to advise.

VI. SITE CONDITIONS

1. Altitude (above sea level) 1315 Ft.
2. Atmospheric Pressure 14.0 psia
3. Design Temperature / winter (for winterizing) (-) 25°F
summer (+) 93°F
4. Extreme Ambient Temp./winter (-) 30°F
summer (+) 100°F
5. Location Indoors
6. Type of Operation Continuous
7. Blower Suction Temp. From Atmosphere (-) 20°F Winter
8. Relative Humidity 76%
9. Earthquake Zone I
10. Wind Loading

0-29	20 PSF
30-49	25 PSF
50-99	30 PSF
100-499	40 PSF
11. Utilities Available
 - a. Power-Motors 200 hp & above 4000 V, 3Ø, 60 HZ
3/4 HP thru 150 hp - 460V, 3Ø, 60 HZ
1/2 HP & below - 115V, 1Ø, 60 HZ
(Vendors to advise connected loads at each voltage level)
 - b. Power - controls & lighting - 115V, 1Ø, 60 HZ
 - c. Instrument air (Dew Point. = (-) 30°F, measured at 100 PSIG)
(Vendor to advise quantity required)
 - d. No. 2 Fuel oil, see Section V-B-4
 - e. Cooling Water

Supply Pressure/Return Pressure	55 PSIG/40 PSIG
Supply Temp./Return Temp.	85°F/110°F
Fouling Factor	0.002

VII. INTERFACE CONTROL

1. Available plot area may be assumed to be 60 feet wide by 60 feet long.
2. Pulverized coal discharge flange shall be assumed to be 180 feet above mill base and approximately 50 feet to one side.
3. Ducting to be sized based upon the system allowable pressure drop, and shall be based on vendor's optimum equipment layout drawing.

VIII. MATERIALS OF CONSTRUCTION

- A. Materials of construction for Item S-108 shall be ASTM 516 Gr. 55. Welding procedure shall be approved by Foster Wheeler Energy Corporation.
- B. Materials of construction for all other equipment shall be specified by the vendor.

IX. MISCELLANEOUS DATA REQUIRED FROM VENDOR

- A. Vendor shall specify the maximum downtime for repairs for continuous operation (especially for grinding components).
- B. Vendor to specify any atmospheric emissions from the system.
- C. Vendor shall submit with his quotation a schematic drawing of the system including proposed instrumentation. All instruments and controls shall be subject to Purchaser's review and approval.

X. GUARANTEES

- A. Performance Guarantee - Based on information supplied, the subject equipment shall be unconditionally guaranteed to perform within the limits of its service conditions.

Vendor shall guarantee all equipment and material furnished by him and the system designed by him will meet the following requirements:

1. Rated capacity of the system as specified in each sub-section.
2. Product quality (size, fines and moisture) as specified in Sect. IV-B.
3. Purity (max. O₂ content by volume) of inerting medium as specified in Sect. IV-C.

Acceptance of the system will be based on satisfactory performance of a running test of the system. Tests shall be run in the presence of a representative of Foster Wheeler Energy Corp.

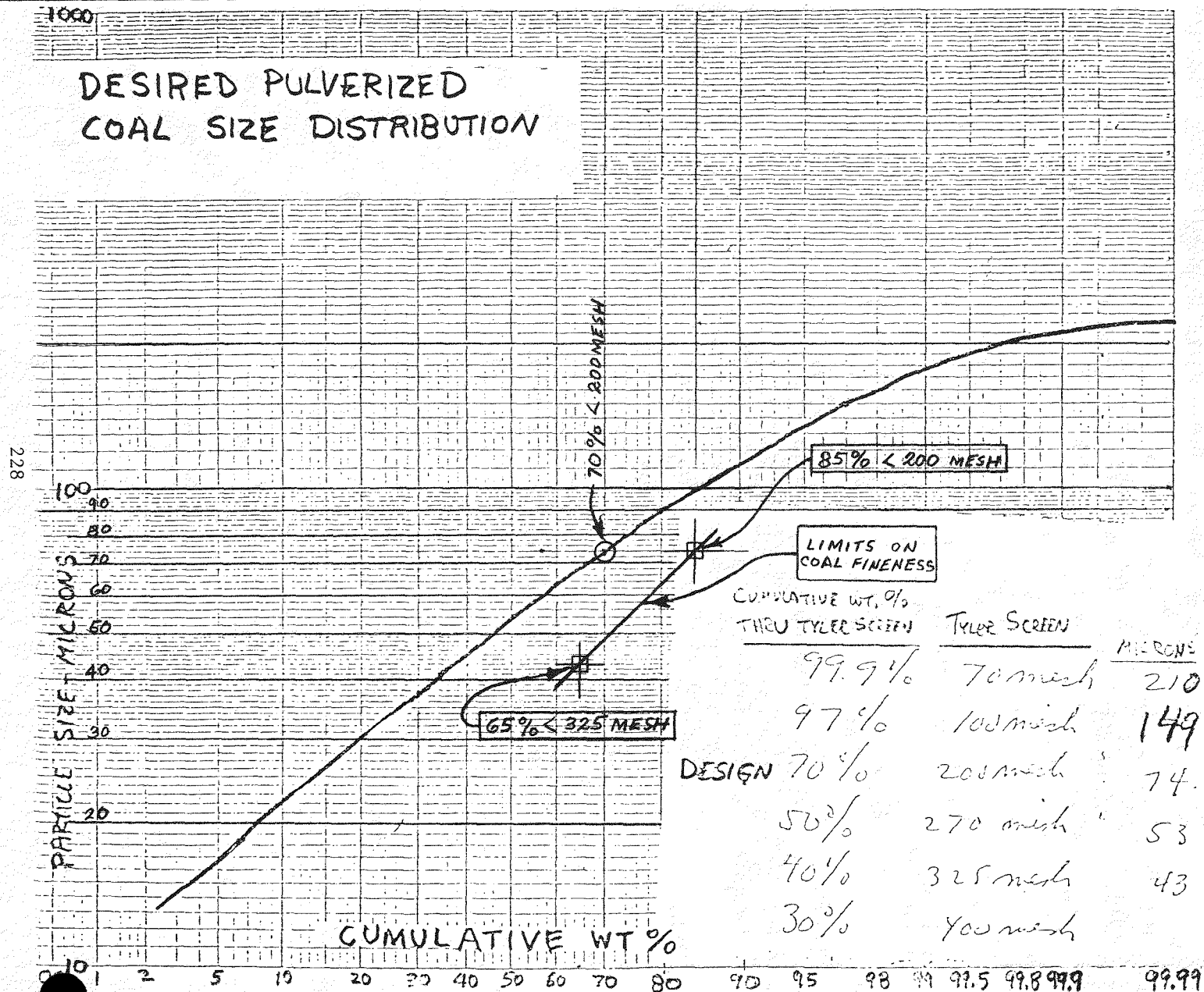
In the event that the system does not perform in accordance with the above requirements, vendor shall take the necessary steps, at his expense, to make the system meet guaranteed performance.

(1)

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MATERIAL REQUISITION NO.: 1591-1351B
CHANGE NO. 1

PAGE 8

XI., DESIRED PULVERIZED COAL SIZE DISTRIBUTION
FIGURE 1



COAL PROPERTIES

	<u>Illinois No. 6</u>		<u>Colstrip Montana</u>		<u>Big Horn</u>		<u>Rosebud</u>		<u>North Dakota Lignite*</u>		<u>Pitt. Seam No. 8</u>	
	<u>Pulverized</u>	<u>Dry</u>	<u>Received</u>	<u>Dry</u>	<u>Received</u>	<u>Dry</u>	<u>Received</u>	<u>Dry</u>	<u>Received</u>	<u>Dry</u>	<u>Received</u>	<u>Dry</u>
Proximate Analysis, Percent by Weight:												
Moisture	4.2	0	28.0	0	22.96	0	22.43	0	34.73	0	3.53	0
Volatiles	34.2	35.70	27.8	39.0	32.26	41.88	30.98	39.94	25.59	39.21	37.88	39.63
Fixed Carbon	52.0	54.28	35.2	49.5	40.57	52.66	39.97	51.53	31.68	48.54	50.21	52.59
Ash	9.6	10.02	9.0	11.5	4.21	5.46	6.62	8.53	8.00	12.25	7.36	7.71
Ultimate Analysis, Percent by Weight (Moisture and Ash Free):												
Hydrogen	5.9		5.08		4.92		4.93		4.88		5.25	
Carbon	77.4		76.84		75.13		77.57		73.45		79.39	
Nitrogen	1.4		0.79		1.14		0.79		1.25		1.71	
Oxygen	11.0		16.16		18.18		16.06		19.84		2.88	
Sulfur	4.3		1.13		0.59		0.60		0.56		3.07	
Chlorine	(0.04)		-----		0.04		0.05		0.02		-----	
Gross Heating Value, Btu/lb	12,330†		11,160		11,928 (dry)		12,086 (dry)		11,180 (dry)		14,017 (dry)	
Net Heating Value, Btu/lb	11,803†											
Hardgrove Grindability	50		50		40		55		37-81§		64	

SLAG PROPERTIES

	<u>Assume Jackson</u>	<u>Northern State Power's Coal</u>	<u>Unknown County and Bed</u>	<u>Assume Richmond DO</u>	<u>Baukol-Noonen</u>	<u>Consolidated Loveridge Slack</u>
Analysis, Percent by Weight:						
Silicon Dioxide	49.3	32.0	22.1	21.9	26.0	39.62
Aluminum Trioxide	22.3	21.0	15.5	13.8	13.1	22.01
Iron Trioxide	19.5	0.5	6.4	5.9	6.6	20.72
Titanium Dioxide	1.2	0.5	1.2	0.7	0.3	0.84
Phosphorous Pentoxide	0.06	6.0	0.11	0.46	0.1	0.74
Calcium Oxide	1.7	17.0	18.9	31.4	21.9	7.60
Magnesium Oxide	0.8	4.0	6.6	10.4	5.5	1.38
Sodium Oxide	0.4	0.3	1.0	0.3	11.3	2.11
Potassium Oxide	2.2	0.3	0.4	0.3	0.4	-----
Sulphur Trioxide	1.0	16.5	26.2	12.6	12.8	0.46
Unaccounted for	1.54	1.9	1.59	2.24	2.0	4.52
Ash Temperatures, °F:						
Initial Deformation	2130	<u>Reducing</u> 2150 <u>Oxidizing</u> 2220	2260	2450	2202	2020
Softening (Tcv)	2180	2200 2280	2380	2490	2250	2080
Fluid	2470	2250 2320	2470	2540	2324	2280
Silicon, Ratio T	69.1	54.2	40.9	31.47	43.33	
Average Molecular Weight	71.18	64.74	65.53	58.00	50.19	
Viscosity at 2600°F, Poises	150	19	3	1	3	
Specific Gravity			1.47	1.47	1.58	

*Average of 100 coals

†For coal containing moisture and ash

§Depends on moisture content

MATERIAL REQUISITION



FOSTER WHEELER ENERGY CORPORATION

PAGE 1 OF 9

FORM 135-2

FOR <u>E.R.D.A.-F.E.</u>	F.W. REF. <u>15-1591</u>	REQUISITION NUMBER	DATE
SITE <u>NSP-LAWRENCE STATION-SIOUX FALLS, S.D.</u>		<u>1591-1351D</u>	<u>04/18/75</u>
MATERIAL <u>SLAG HANDLING SYSTEM (A-105)</u>	SUPERSEDED BY CHANGE NO.:		
ENERGY RESEARCH & DEVELOPMENT ADMIN.-FOSSIL ENERGY	C1	<u>10/15/75</u>	C4
ERDA-FE CONT. NO. <u>14-32-0001-1521</u>	C2	<u>3/22/76</u>	C5
FWEC CONT. NO. <u>15-1590</u>	C3		C6

INDEX

- I SCOPE
- II BASIS OF DESIGN
- III MECHANICAL SPECIFICATION
- IV SITE CONDITIONS
- V UTILITIES AVAILABLE
- VI BID QUOTATION REQUIREMENTS
- VII SPECIFICATION REFERENCES

BY: <u>[Signature]</u>	P.O. NO.	SUPPLIER:
------------------------	----------	-----------

I. SCOPE

This requisition covers the design, fabrication and supply of a package item dealing with a slag handling system for the operation of a pressurized Coal Gasification Pilot Plant, location Sioux Falls, South Dakota. Vendor shall quote a complete package, including all equipment required to perform the crushing, dewatering and collecting of slag as defined herein. A typical slag handling scheme is presented in Figure 1. The corresponding equipment for this scheme is listed below.

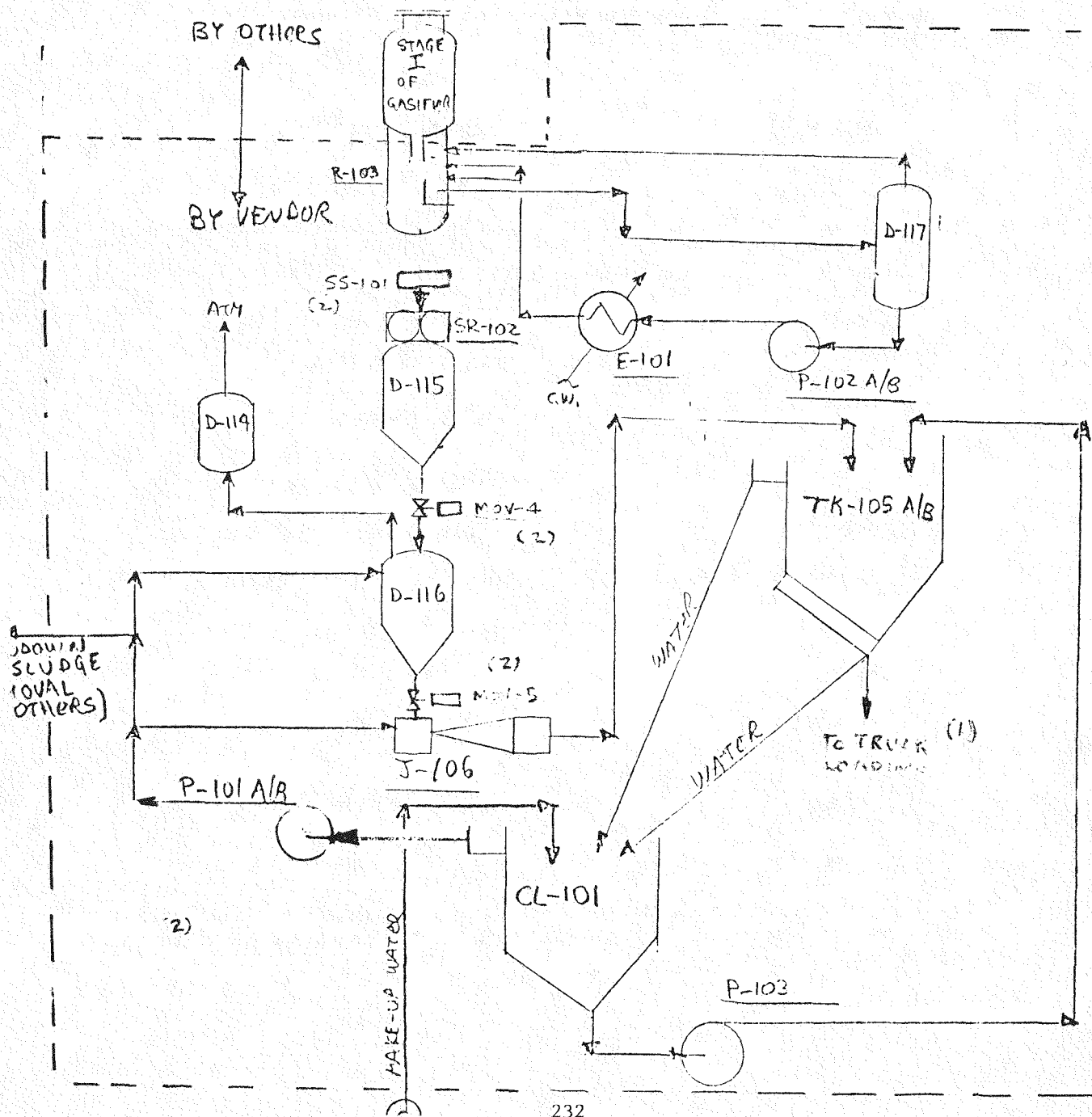
	<u>ITEM NO.</u>	<u>DESCRIPTION</u>
	R-103	Slag Quench Vessel
	D-114	Slag Water Disengaging Drum
	D-115	Slag Storage Drum
	D-116	Slag Injector Drum
	D-117	Slag Water Surge Drum
	TK-105 A/B	Slag Hydrobins
(2)	MOV-4	
(2)	MOV-5	
	P-101 A/B	Transport Water Pump & Spare
	P-102 A/B	Quench Water Pump & Spare
(1)	P-103	Slag Slurry Pump
	E-101	Quench Water Cooler
	CL-101	Slag Water Clarifier
(1)		
	J-106	Slag Drum Eductor
	SR-102	Slag Crusher
(2)	SS-101	Slag Swiper

Vendor may offer an alternate scheme. Erection of equipment material will be by others. The scope of supply includes all instruments and controls for operation.

I. SCOPE (Cont'd)

PRELIMINARY

Figure 1: Proposed Slag Handling Scheme



	Illinois #6	Colstrip Montana	Big Horn Montana	Rosebud	No. Dakota Lignite*
Slag Properties	Assume	Northern State	Unknown County	Assume	Baukol - Noonal
Analysis, Wt. %	Jackson	Power's Coal	and Bed	Richmond DO	
SiO ₂	49.3	32.0	22.1	21.9	26.0
Al ₂ O ₃	22.3	21.0	15.5	13.8	13.1
Fe ₂ O ₃	19.5	.5	6.4	5.9	6.6
TiO ₂	1.2	.5	1.2	.7	0.3
P ₂ O ₅	0.06	6.0	0.11	.46	0.1
CaO	1.7	17.0	18.9	31.4	21.9
MgO	.8	4.0	6.6	10.4	5.5
Na ₂ O	.4	.3	1.0	.3	11.3
K ₂ O	2.2	.3	0.4	.3	.4
SO ₃	1.0	16.5	26.2	12.6	12.8
Unaccounted for	1.54	1.9	1.59	2.24	2.0
Ash Temperatures, °F		Reducing Oxidizing			
Initial Deformation	2130	2150 2220	2260	2450	2202
Softening (Tev)	2180	2200 2280	2380	2490	2250
Fluid	2470	2250 2320	2470	2540	2324
Silicon Ratio, T	69.1	54.2	40.9	31.47	43.33
Average Molecular Weight	71.18	64.74	65.53	58.00	50.19
Viscosity at 2600°F, Poises	150	19	3	1	3
Specific Gravity			1.47	1.47	1.58
	*For coal containing Moisture and Ash			*Average of 100 coals	

Pittsburg Seam 8 Coal

Silicon Dioxide	Wt. %
Iron Oxide	39.62
Alumina	20.72
Calcium Oxide	22.01
Magnesium Oxide	7.60
Sulfur Trioxide	1.38
Titanium Dioxide	0.46
Phosphorus Pentoxide	0.84
Sodium Oxide	0.74
Potassium Oxide	2.11

Temp, °F

Ash Fusion:	
Initial Deformation	2020
Softening Temperature	2080
Fluid Temperature	2280

II. BASIS OF DESIGN

A. Slag Feed

- (1) 1. Identification of Coal from which slag is derived.
- a. Design basis: Illinois No. 6
 - b. Other possible coals from which slag is derived:
 - (1) Colstrip
 - (2) Big Horn
 - (3) Rosebud
 - (4) North Dakota Lignite
 - (5) Pittsburgh Seam No. 8
2. Slag Analyses and Slag Properties: See Attached Table I on sheet # 4.
3. Flowrates of Dry Fluxed Slag (these flowrates include slag derived from coal ash, limestone added as a fluxing agent and carbon carried out with the char).
- a. Normal, lbs/hr.

ASH	3520
Carbon	405
Flux	<u>905 (as CaCO₃)</u>
- TOTAL SLAG 4830 lbs/hr.
- b. Design, lbs/hr: 6000 lbs/hr or total slag.
4. Grindability of slag: The slag crusher should be preformably a "Heavy Duty Crusher" of the reversing roller-type with a "Fluid Drive" or equal. Consideration should be given to the possibility of iron modules contained in the slag, due to the reducing atmosphere in Stage I, when designing the Crusher.
5. Slag temperature to top of R-103
- a. Normal: 2800°F
 - b. Maximum: 3000°F
6. Design Pressure of R-103: 500 PSIG
7. Slag Densities
- a. Particle Density, lbs/ft³: 95 to 170
 - b. Bulk Density or Slag Frit
 - (1) 75 lbs/ft³, to be used for volumetric vessel sizing
 - (2) 120 lbs/ft³, to be used for foundations.
- (1) 8. Size Distribution

Vendor to advise on size of slag particles after they come in contact with quench water. There may be a possibility of formation of large clinkers. Vendor to advise on the necessity of mechanical beard breakers.

II. BASIS OF DESIGN (Cont'd)

9. Angle of repose of a wet non-compacted slag: 45° in air.

- (1) 10. Temperature of slag-water exiting bottom of R-103: 160°F
(vendor to confirm)

B. Slag Product

1. Size: Vendor to advise
2. Water Content: Vendor to advise
3. Use of Product: Slag product to be used exclusively for landfill,

C. Emissions

1. Vendor to specify atmospheric gaseous emissions, particularly from:
 - a. Slag water surge drum, D-117 (if vented to atmosphere)
 - b. Slag water disengaging drum, D-114
2. Vendor to give flowrate, composition and solids content of the blowdown from the transport water system to the sludge removal unit (By others). The blowdown is to be delivered at a 50 PSIG battery limit pressure.

D. Vessel Sizes

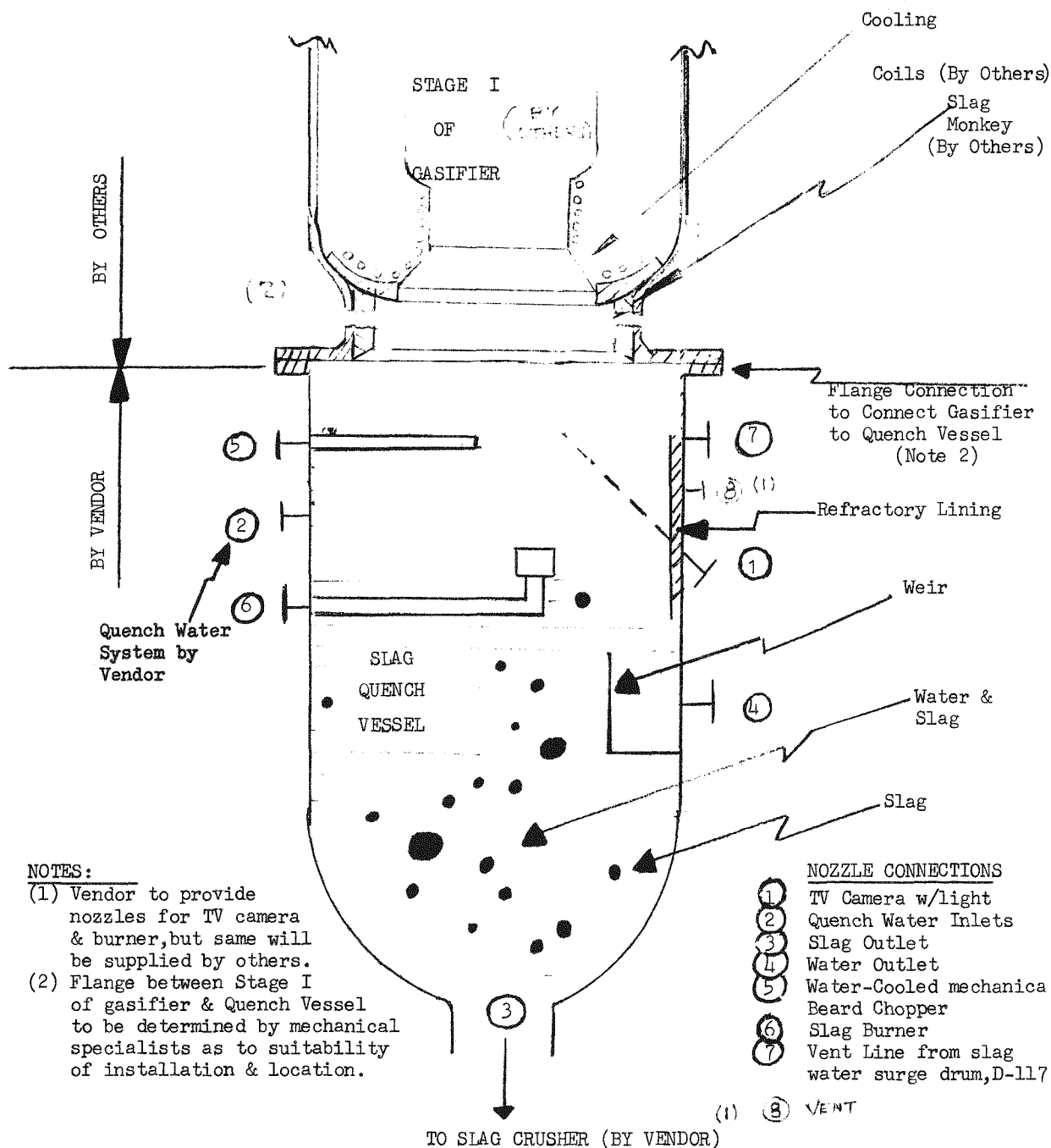
Vendor to advise hold-up times of all vessels in his scope of supply.

III. MECHANICAL SPECIFICATIONS

- A. The design of all equipment, piping and electrical parts of vendors supply will comply with all regulations applicable to the proposed location, i.e. Sioux Falls, South Dakota. All materials to be of United States origin. Equipment shall be furnished in accordance with applicable provisions of the latest revisions of the following codes, specifications, etc., which may be revised to adjust classification and addition made necessary to assure good practice.
1. Vessels - ASME UPV - Code Section VIII
 2. Electrical - NEC for Class I - Group D, Division 2
Class II - Group F, Division 2
 3. Safety - Federal Register (OSHA)
 4. National Fire Codes - Appropriate requirements for flammable liquids, gasses, and solids.
 5. Noise Specification - U.S. Dept. of Labors Occupational Safety & Health Standard.
 6. Other - State & Local Requirements.
- B. Design or the Slag Quench Vessel, R-103 (See Figure 2 on sheet 10)
1. Design Temperature of shell: by mechanical specialists (top of vessel should be refractory lined)
 2. Design pressure: 500 PSIG
 3. Special Nozzles
 - a. Vendor to provide nozzle for a closed-circuit television camera and light (by others), the camera nozzle should be directed at the slag monkey of Stage I of the Gasifier. FWEC to advise on details of nozzle later.
 - b. Vendor to provide nozzle for a slag burner (by others), the burner should be directed at the slag monkey, FWEC to advise on details of nozzle later.
 4. Mechanical clinker breaker - arm: Vendor to advise on the need for a water-cooled mechanical arm to break slag beards.
 5. Mechanical specialists to determine the suitability of installation and location of the flange connecting stage I of the gasifier to the slag quench vessel.
 6. Vendor to advise of any required venting of slag quench vessel to a lower pressure in order to promote and/or insure continuous slag flow through the monkey.
 7. Vendor to specify materials of construction.
 8. All equipment shall be designed for 24 hours a day continuous service, seven day's a week.
 9. General notes 1590-1100B shall be considered part of the requisition.
 10. General notes 1590-1300B shall be considered part of the requisition.

III. MECHANICAL SPECIFICATIONS (Cont'd)

Figure 2. Proposed Slag Quench Vessel, R-103



NOTES:

- (1) Vendor to provide nozzles for TV camera & burner, but same will be supplied by others.
- (2) Flange between Stage I of gasifier & Quench Vessel to be determined by mechanical specialists as to suitability of installation & location.

IV. SITE CONDITIONS

- | | | |
|--------------------------------|---|-----------------------|
| 1. Altitude (above sea level) | - | 1315 ft. |
| 2. Atmospheric Pressure | - | 14.0 PSIA |
| 3. Design Temperature - winter | - | (-) 25°F |
| - summer | - | (+) 93°F |
| 4. Location | - | Outdoors |
| 5. Type of Operation | - | Continuous |
| 6. Earthquake Zone | - | I |
| 7. Wind Loading | | (See Spec. 1530-40A1) |

V. UTILITIES AVAILABLE

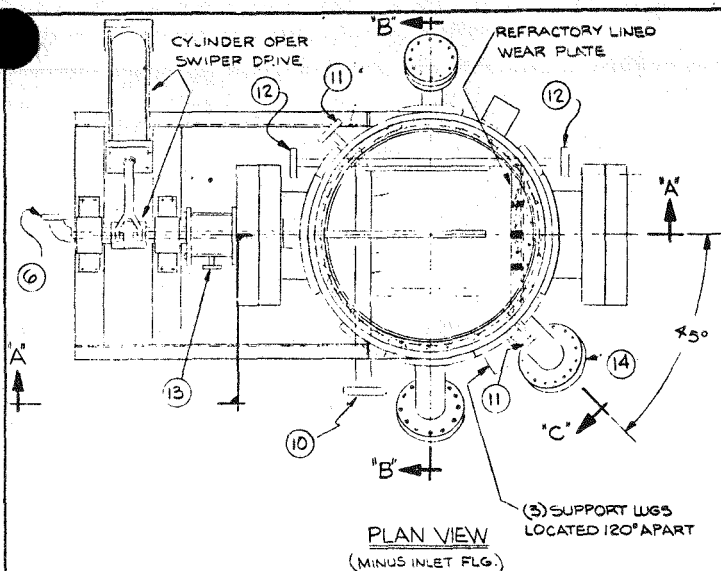
- | | |
|--|---------------------|
| 1. Power-Motors | |
| 200 HP & Above | - 4000V, 3 Ø, 60 HZ |
| 3/4 HP thru 150 HP | - 460V, 3 Ø, 60 HZ |
| 1/2 HP & Below | - 115V, 1 Ø, 60 HZ |
| (Vendor to advise connected loads at each voltage level) | |
| 2. Power-controls & lighting - 115V, 1 Ø, 60 HZ | |
| 3. Instrument Air (Dew Point (-) 40°F, 100 PSIG) | |
| (Vendor to advise quantity required) | |

VI. BID QUOTATION REQUIREMENTS

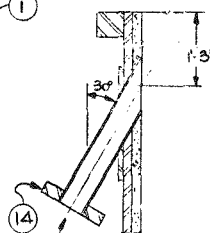
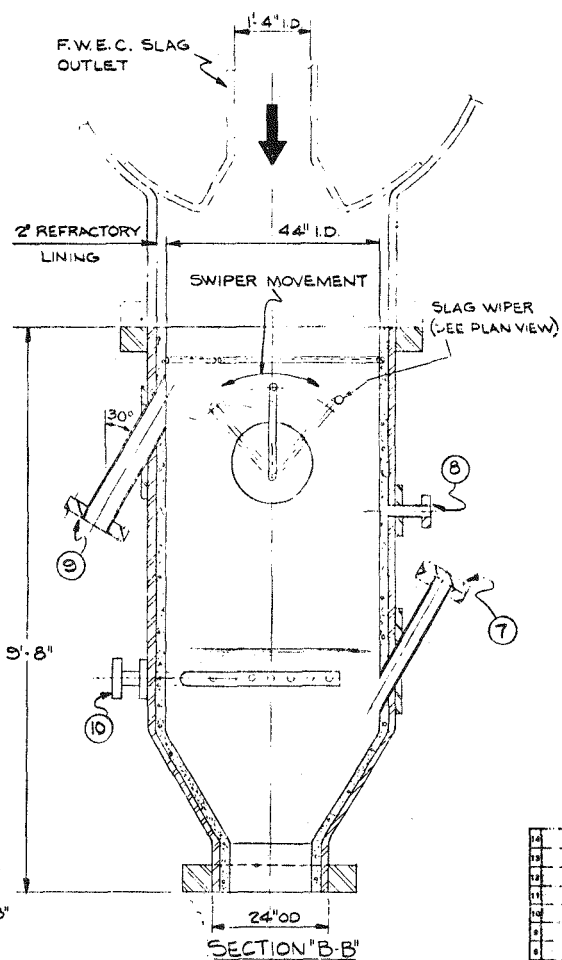
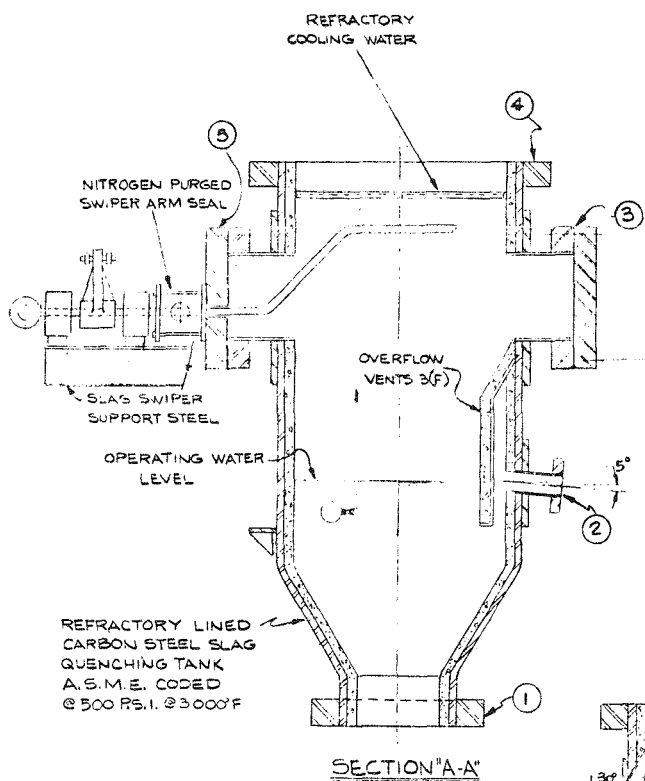
1. Equipment arrangement drawings showing equipment layout, overall dimensions, unit dimensions, support details & unit weights.
2. Electrical schematic drawings
3. Complete description list of all items for the installation & operation of the system that must be supplied by others and a list of items provided by vendor.
4. Spare parts lists, safety instruction sheets & other data as required.

VII. SPECIFICATION REFERENCES

- | | |
|-----------|---|
| 1590-10A1 | Welded Unfired Pressure Vessel |
| 1590-31A1 | Centrifugal Pumps |
| 1590-38A1 | Induction Motors |
| 1590-40A1 | Wind & Earthquake Loading |
| 1590-50A2 | Gaskets & Surface Finish for Bolted Flanged Joints |
| 1590-50A4 | Dim. of Non-Std. Gaskets & Surfaces for Compression |
| 1590-60A1 | Instrumentation Standards |
| 1590-70A1 | Electrical |
| 1590-83A1 | Painting |



NOZZLE CHART				
CONN#	SIZE	RATING	SERVICE	#REQD
1	24"	600°	TO SR-102	1
2	4"		OVERFLOW CONNECTION TO D-117	1
3	18"		MANWAY	1
4	48"		TO R-102	1
5	18"		SWIPER ARM SEAL	1
6	2 1/2"		NITROGEN SUPPLY TO SWIPER	1
7	4"		POKE HOLE CONNECTION	1
8	2"		VENT CONNECTION TO D-117	1
9	6"		T.V. CONNECTION	1
10	2 1/2"		DISINTEGRATING HEADER	1
11	1"		REFRACTORY COOLING WATER	2
12	1 1/2"		WIPER WATER SUPPLY	2
13	1/2"		NITROGEN PURGE	1
14	6"		SLAG BURNER	1



SLAG BURNER CONN. MUST
BE DIRECTED TOWARDS
CENTER OF SLAG MONKEY

SECTION "C"

GENERAL REVISION

GRAPHIC SCALE - 1" = 1'-0"

DESIGN APPROVED

NOTE

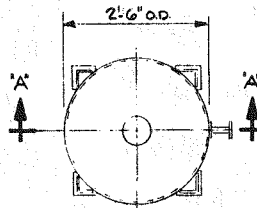
THE
ALLEN-SHERMAN-HOFF
COMPANY ACCEPTS
NO RESPONSIBILITY FOR
INTERFERENCES OR
OBSTRUCTIONS NOT
SHOWN ON THIS
DRAWING

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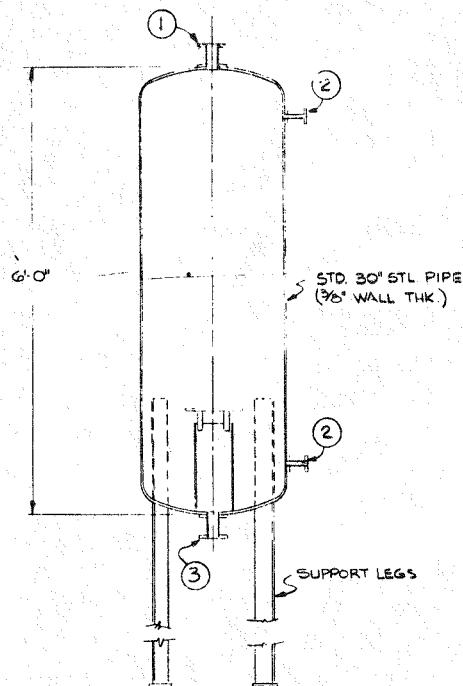
THE ALLEN-SHERMAN-HOFF CO.
WYNNEWOOD, PENNA.
SLAG QUENCHING
VESSEL R-103
FOR FOSTER WHEELER ENERGY CORP.
COAL GASIFICATION PROJECT
N.S.P. LAWRENCE STA. SIOUX FALLS, SD

DATE: 3-1-76
DRAWN: J.S.
TRACED:
CHECKED:
CONTRACT NO. 5201
5201-H1A

NOZZLE CHART				
CONN#	SIZE	RATING	SERVICE	#REQ
1	2"	150#	VENT TO FLARE & ATMOSPHERE	1
2	1/2"	150#	LEVEL INDICATOR	2
3	2"	600#	EQUALIZING CONN D-115 & D-116	1



PLAN VIEW

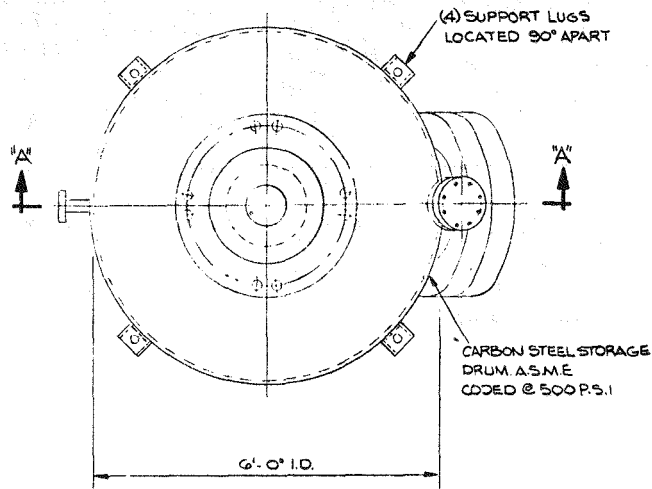


GENERAL REVISION

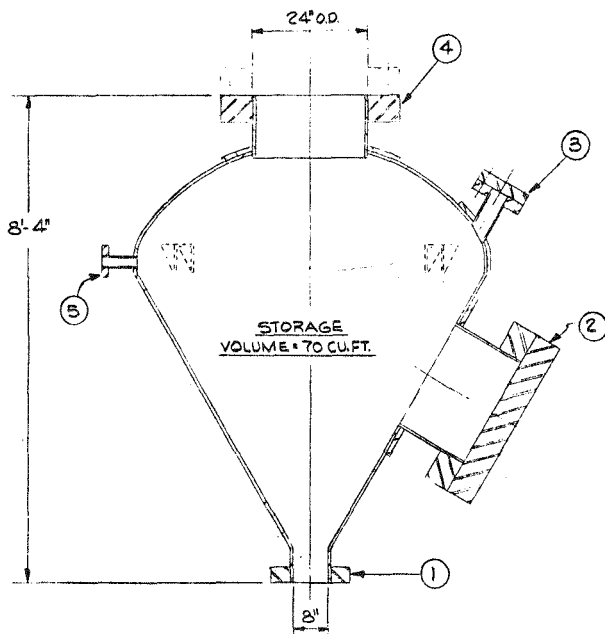
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GRAPHIC SCALE - 1/4"			
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NOTE		THE ALLEN-SHERMAN-HOFF CO.		DATE 3-9-76	
THE ALLEN-SHERMAN-HOFF COMPANY ACCEPTS NO RESPONSIBILITY FOR INTERFERENCES OR OBSTRUCTIONS NOT SHOWN ON THIS DRAWING		WYNNEWOOD, PENNA.		DRAWN <i>SS</i>	
		SLAG WATER DEGASSING DRUM D-114 FOR FOSTER WHEELER ENERGY CORP COAL GASIFICATION PROJECT N.S.P. LAWRENCE STA. SIOUX FALLS, S.D.		TRACED	
				CHECKED	
				CONTRACT NO. 5201	
				5201-H5	
				REV. A	
A		REVISED P&R ENG. M.P.		SCALE 3/4" = 1'-0"	
MARK		REVISIONS		DATE CHECKED	

NOZZLE CHART				
CONN#	SIZE	RATING	SERVICE	#REQD
1	8"	600#	TO D-116	1
2	24"		MANWAY	1
3	4"		POKE HOLE	1
4			FROM SR-102	1
5			TO D-114	1



PLAN VIEW



SECTION 'A-A'

GENERAL REVISION



DESIGN APPROVED *LC* PROJ. MGR. STRUCT. ELEC. PRINT DIST.

NOTE

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MARK	REVISIONS	DATE	CHECKED	DESIGN
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A	REVISED PER ENG. M.P.	4-27-76	<i>LC</i>	<i>LC</i>

THE ALLEN-SHERMAN-HOFF CO.
WYNNEWOOD, PENNA.

SLAG STORAGE
DRUM D-115
FOR FOSTER WHEELER ENERGY CORP.
COAL GASIFICATION PROJECT
NSP LAWRENCE STA. SIOUX FALLS, S.D.
SCALE 3/4" = 1'-0"

DATE: 3-5-76

DRAWN *LC*

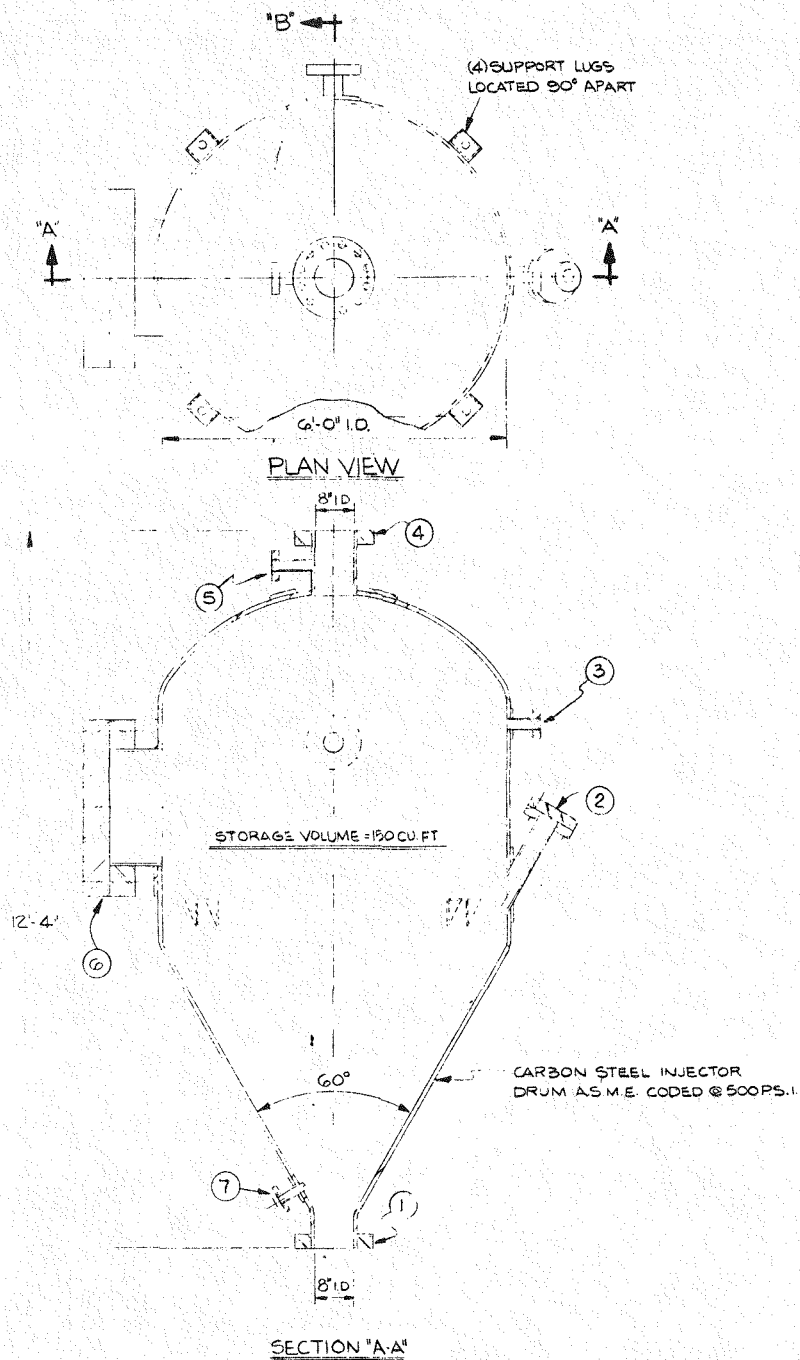
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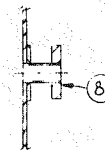
CONTRACT NO. 5201

5201-H3

REV. A

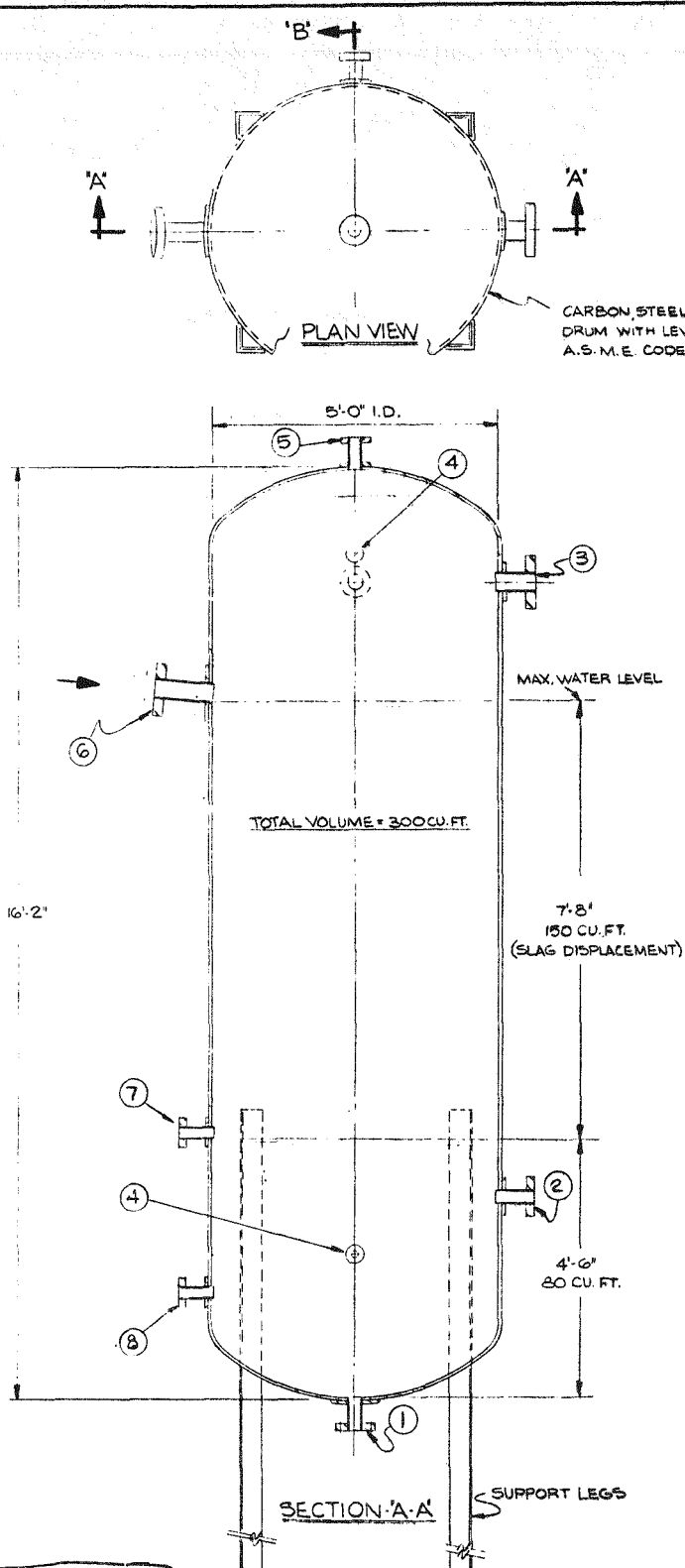


NOZZLE CHART				
CONN#	SIZE	RATING	SERVICE	#REQ'D
1	8"	600*	TO EDUCTOR	1
2	4"		POKE HOLE	1
3	2"		BLOWDOWN FROM D-117	1
4	8"		FROM STORAGE DRUM D-115	1
5	2"		OVERFLOW FROM D-114 & D-115	1
6	24"		MANWAY	1
7	1 1/2"		FLUSHING NOZZLE	1
8	4"		WATER SUPPLY	1



PARTIAL SECTION "B"

NOTE THE ALLEN-SHERMAN-HOFF COMPANY ACCEPTS NO RESPONSIBILITY FOR INTERFERENCES OR OBSTRUCTIONS NOT SHOWN ON THIS DRAWING		GENERAL REVISION A REVISED PER ENG. M.P.	4-21-76 LK	THE ALLEN-SHERMAN-HOFF Co. WYNEWOOD, PENNA. SLAG INJECTOR DRUM D-116 FOR FOSTER WHEELER ENERGY CORP. COAL GASIFICATION PROJECT N.S.P. LAWRENCE STA. SIOUX FALLS S.D.	DATE 3-8-76 DRAWN 88 TRACED CHECKED CONTRACT NO. 5201	5201-44 A
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NOZZLE CHART				
CONN#	SIZE	RATING	SERVICE	*REQ'D
1	3"	600#	SEDIMENT REMOVAL TO CL-101	1
2	3"		OUTLET TO P-102 A/B	1
3	1 1/2"		EMERGENCY FILL	1
4	1/2"		LEVEL INDICATOR	2
5	2"		VENT	1
6	4"		OVERFLOW FROM R-103	1
7	2"		BLOWDOWN TO D-116	1
8	2"		STEAM OUT	1
9	2"		VENT TO R-103	1

GENERAL REVISION

NOTE
THE ALLEN-SHERMAN-HOFF COMPANY ACCEPTS NO RESPONSIBILITY FOR INTERFERENCES OR OBSTRUCTIONS NOT SHOWN ON THIS DRAWING.

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A	REVISED PER ENG. M.P.

THE ALLEN-SHERMAN-HOFF CO.
WYNNWOOD, PENNA.
SLAG WATER SURGE DRUM D-117
FOR FOSTER WHEELER ENERGY CORP.
COAL GASIFICATION PROJECT
NS.R LAWRENCE STATION
SIOUX FALLS, SOUTH DAKOTA

DATE 3-27-76
DRAWN J.S.
TRACED
CHECKED
CONTRACT NO. 5201
REV. 1
5201-H21A

NOTICE
 NO PART OF THIS DRAWING IS TO BE REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS, ELECTRONIC OR MECHANICAL, WITHOUT PERMISSION IN WRITING FROM THE ENGINEER OF RECORD. ANY VIOLATION OF THIS NOTICE SHALL BE CONSIDERED A VIOLATION OF THE PROFESSIONAL ETHICS OF THE ENGINEER OF RECORD.

REFERENCE DWGS.

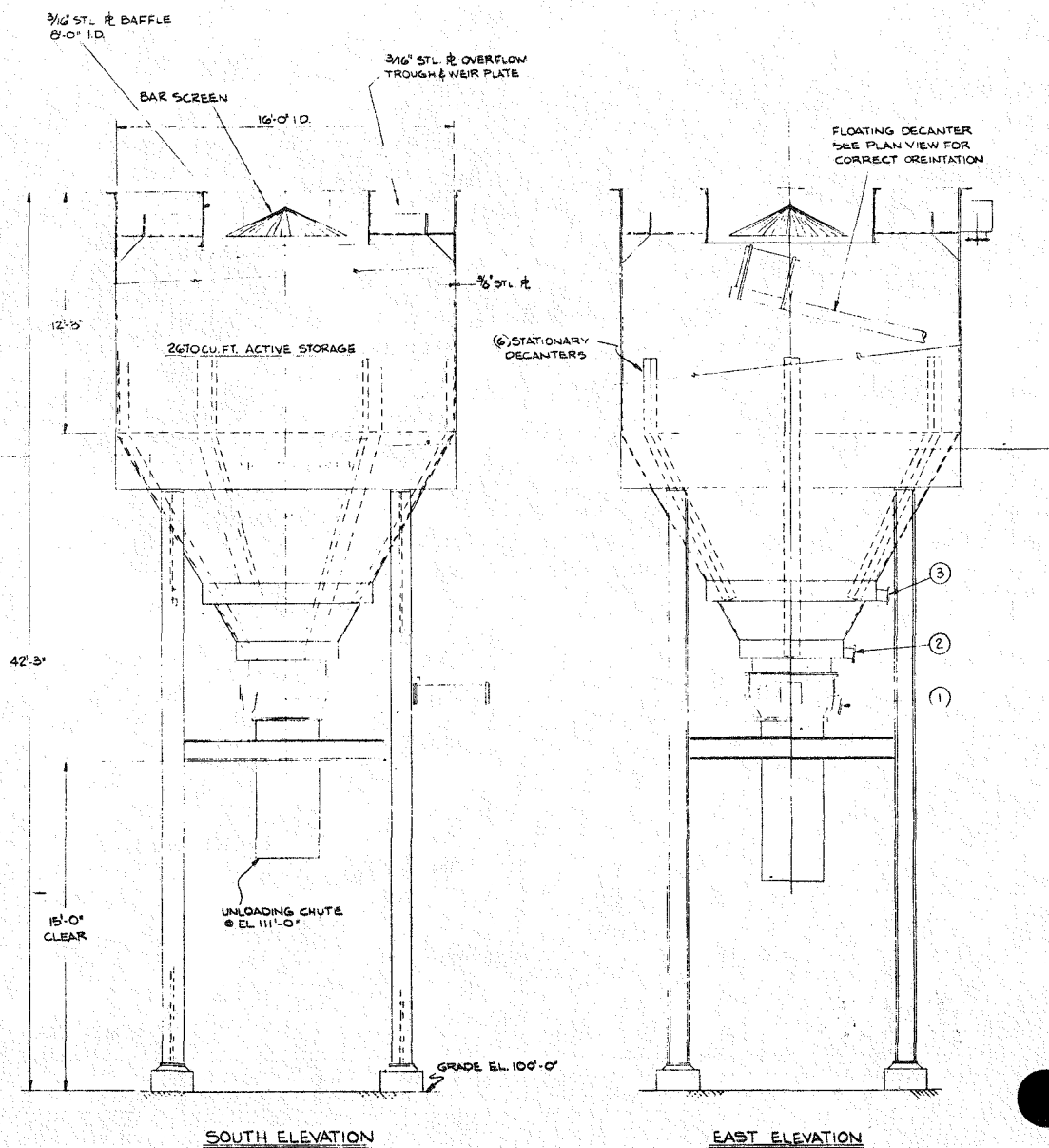
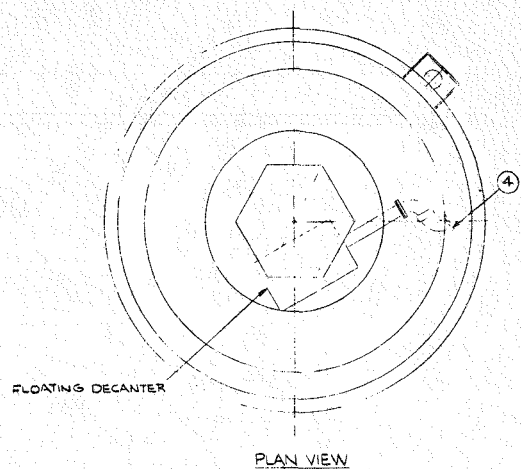
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THE ALLEN-SHERMAN-HOFF CO.
 ENGINEERS
 1000 G. ST. N.E.
 WASHINGTON, D.C. 20002
 DATE: 3-10-78
 DRAWN: [Signature]
 CHECKED: [Signature]
 PROJECT: [Signature]
 CONTRACT NO. 3301

NO.	SIZE	QUANTITY	DESCRIPTION	REMARKS
1	4"	1500	GATE DRAIN	
2	4"		STA. AT DR. JR. DR.	
3	10"		HYDROBIN OVERFLOW	
4	6"		FLOATING DECANTER DRAIN	



FORM 135-3

FOR ERDA-FE-14-32-0001-1521 F.W. CONTRACT 15-1591
 SITE NSP LAWRENCE STATION, SIOUX FALLS, SOUTH DAKOTA
 SERVICE TRANSPORT WATER PUMPS & SPARE
 NO. REQ'D 2 ITEM NOS. P-101A/B

NO. OF MOTORS REQ'D. 2 : ITEM NOS. P-101A SUPPLIED BY PUMP MFG. MOUNTED BY PUMP MFG.

NO. OF TURBINES REQ'D. 2 : ITEM NOS. P-101B SUPPLIED BY PUMP MFG. MOUNTED BY PUMP MFG.

PUMP MFR. INGERSOLL-RAND SIZE & MODEL 3GT

NO. STAGES 2

OPERATING CONDITIONS, EACH PUMP:

LIQUID WATER U.S.GPM @ PT: MIN. 700 NORM. 700 RTD.
 DISCH. PSIG 229 RTD.
 P.T. °F. (MAX. 1) SUCT. PSIG (MAX. 4) RTD.
 SP. GR. AT PT 1.0 DIFF. PSI 225
 VAP. PSIA @ PT 2.9 TOTAL DIFF. HEAD, FT. 520
 VIS. @ PT 32 SSU NPSHA, FT. 30
 CORR./EROS. FROM _____ HYD HP. _____

PERFORMANCE

PROPOSAL CURVE NO. 3GTH
 RPM 3550 NPSHR (WATER), FT. 18
 MIN. CONTINUOUS U.S.GPM 140
 ROTATION, VIEWING FROM COUPLING CW

WITH RATED IMPELLER:

EFFICIENCY AT RATED POINT, % 71
 IF EFF. IS VISCOUS, WATER EFF. = _____
 BHP: RATED 130 NORM 130 MAX 140
 IF HP IS VISC., RATED WATER BHP = _____
 MAX. TOTAL HEAD, FT. 650
 MAX. POSSIBLE DISCH. PRESS.: _____ PSIG
 WITH RATED SUCT. PRESS. = _____
 WITH MAX. SUCT. PRESS. = _____

CONSTRUCTION

NOZZLES	SIZE	ANSI RATING	FACING	LOCATION
SUCTION	<u>5</u>	<u>125</u>	<u>F.F.</u>	<u>SIDE</u>
DISCHARGE	<u>3</u>	<u>250</u>	<u>F.F.</u>	<u>SIDE</u>

CASE-MOUNT ☐ CENTERLINE ☐ FOOT ☒ BRACKET ☐ IN-LINE ☐

-SPLIT: ☒ AXIAL ☐ RADIAL

-VOLUTE: ☒ SINGLE ☐ DOUBLE ☐ DIFFUSER ☐

-DESIGN: 375 PSIG @ 300°F. HYDRO TEST 575 PSIG

-AUX. CONNECTS: ☒ VENTS ☒ DRAINS ☒ GAGES ☐

IMPELLER: DIA.: RATED 9 1/4, MAX. 10 1/4, MIN. 9. TYPE CLOSED

MOUNTING ☒ BETWEEN BEARINGS ☐ OVERHUNG ☐

WEAR RINGS: ☐ INLET ONLY ☐ BOTH SIDES ☒ CASE ONLY ☐ CASE & IMPELL.

BEARINGS: TYPE: RADIAL = BALL, THRUST = BALL

LUBE: ☒ RING ☐ FLOOD ☐ FLINGER ☐ MIST ☐ PRESSURE

COUPLING: MFR: FALK .MODEL: _____

DRIVER 1/2 MTD BY: ☒ PUMP MFR. ☐ DRIVER MFR. ☐ PURCH.

GUARD TYPE: OSHA

PACKING: MFR & TYPE I.R. OPTION SIZE _____ NO. RINGS _____

MECH. SEAL: MFR & MODEL _____ MFR'S CODE _____ API CODE _____

SHOP TESTS:

	REQUIRED	WITNESSED
PERFORMANCE	<u>NOVE</u>	
NPSHR	<u>NOVE</u>	
DISMANTLE & INSPECT		
HYDROTEST CASE		
HYDROTEST BOWLS		
SURFACE INSP.	<u>YES</u>	

MATERIALS:

☐ PUMP API CLASS _____
☐ CAST IRON CASE
 BRONZE IMPELLER
 BRONZE RINGS
 STEEL SHAFT

AUXILIARY PIPING:

C.W. PIPE PLAN NO, WITH ☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPE

TOTAL C.W. REQ'D. _____ GPM. INCLUDE: ☐ FLOW INDIC. ☐ VALVE "C"

PACKING INJECTION: FLUID = WATER @ 85°F. REQ'D = 2 GPM @ 20 PSIG

SEAL FLUSH PLAN NO, WITH ☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPE

EXT. FLUSH FLUID = _____ @ _____°F. REQ'D = _____ GPM @ _____ PSIG

AUX. SEAL PLAN _____, WITH ☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPE

QUENCH FLUID = _____

MOTOR DRIVERS:

HP 150, S.F. I.D. RPM 3550, FRAME 445T, 460V 3PH/60HZ

MFR. I.R. option BEARINGS BALL, LUBE GREASE

TYPE HORIZ .INSUL. CLASS B AMPS, FULL LOAD _____

ENCL. T.E.F.C. .RISE °C _____ AMPS, LOCKED ROTOR _____

VERT. UNITS: ☐ VSS ☐ VHS THRUST CAP., LBS. _____ UP _____ DN.

TURBINE DRIVERS:

☐ IF BY PUMP VENDOR SEE PAGE _____ ATTACHED

☐ IF BY OTHERS: MFR. _____ MODEL _____ BHP _____

APPLICABLE DOCUMENTS: NOVE

APPROX. WEIGHTS

	(LBS NET EACH)
PUMP ONLY	<u>700</u>
MOTOR	<u>1725</u>
BASE	<u>600</u>
TURBINE	

SITE DATA

AMBIENT _____°F MAX TO _____°F MIN.

INSTALLED ☐ OUTDOORS ☐ INDOORS

☐ CL _____GR _____DIV _____ ☐ NON-HAZARDOUS

COOLING WATER: TYPE _____

_____°F & _____PSIG IN, _____°F MAX & _____PSIG OUT

FOSTER WHEELER CORPORATION

CENTRIFUGAL PUMPS

PAGE 1 OF 1

FORM 135-80

FOR ERDA-FE-14-32-0001-1521 F.W. CONTRACT 15-1591 REQUISITION NO. 1591-1351D DATE 4/30/76
 SITE NSP-LAWRENCE STATION, SIOUX FALLS, SOUTH DAKOTA SUPERSEDED BY CHANGE NO. _____
 SERVICE QUENCH WATER PUMP & SPARE C1 _____ C3 _____ C5 _____
 NO. REQ'D 2 ITEM NOS. P-102A/B C2 _____ C4 _____ C6 _____

NO. OF MOTORS REQ'D 2 : ITEM NOS. P102A SUPPLIED BY PUMP MFR MOUNTED BY PUMP MFR

NO. OF TURBINES REQ'D _____ : ITEM NOS. P102B SUPPLIED BY PUMP MFR MOUNTED BY PUMP MFR

PUMP MFR. JINGERSOLL RAND SIZE & MODEL 2X10 A NO. STAGES 1

OPERATING CONDITIONS, EACH PUMP:

LIQUID WATER U.S.GPM @ PT: MIN _____ NORM 235 RTD. _____
 DISCH. PSIG 575 RTD. _____
 P.T. °F. (MAX) 200 SUCT. PSIG (MAX) 450 RTD. _____
 SP. GR. AT PT 1.0 DIFF. PSI 125 RTD. _____
 VAP. PSIA @ PT _____ TOTAL DIFF. HEAD, FT. 288 _____
 VIS. @ FT 32 SSU NPSHA, FT. 500 PSI _____
 CORR./EROS. FROM _____ HYD HP. _____

PERFORMANCE

PROPOSAL CURVE NO. 2X10-G
 RPM 3550 NPSHR (WATER), FT. 7
 MIN. CONTINUOUS U.S.GPM 50
 ROTATION, VIEWING FROM COUPLING CCW

WITH RATED IMPELLER:

EFFICIENCY AT RATED POINT, % 62
 IF EFF. IS VISCOUS, WATER EFF. = _____
 BHP: RATED 28 NORM 28 MAX 33
 IF HP IS VISC., RATED WATER BHP = _____
 MAX. TOTAL HEAD, FT. 340
 MAX. POSSIBLE DISCH. PRESS.: _____ PSIG
 WITH RATED SUCT. PRESS. = _____
 WITH MAX. SUCT. PRESS. = _____

CONSTRUCTION

NOZZLES	SIZE	ANSI RATING	FACING	LOCATION
SUCTION	<u>4</u>	<u>300</u>	<u>R.F.</u>	<u>END</u>
DISCHARGE	<u>2</u>	<u>300</u>	<u>R.F.</u>	<u>TOP</u>

CASE-MOUNT ☒ CENTERLINE ☐ FOOT ☐ BRACKET ☐ IN-LINE ☐

-SPLIT: ☐ AXIAL ☒ RADIAL

-VOLUTE: ☒ SINGLE ☐ DOUBLE ☐ DIFFUSER ☐

-DESIGN: 600 PSIG @ 650 °F. HYDRO TEST _____ PSIG

-AUX. CONNECTS: ☐ VENTS ☒ DRAINS ☒ GAGES ☐

IMPELLER: DIA.: RATED 8 3/4, MAX. 10 3/16 MIN. 7 1/2 TYPE CLOSED

MOUNTING ☐ BETWEEN BEARINGS ☒ OVERHUNG ☐

WEAR RINGS: ☐ INLET ONLY ☒ BOTH SIDES ☐ CASE ONLY ☒ CASE & IMPELL.

BEARINGS: TYPE: RADIAL = BALL, THRUST = BALL

LUBE: ☒ RING ☐ FLOOD ☐ FLINGER ☐ MIST ☐ PRESSURE

COUPLING: MFR: WALDRON MODEL: SPACER

DRIVER 1/2 MTD BY: ☐ PUMP MFR. ☐ DRIVER MFR. ☐ PURCH.

GUARD TYPE: OSHA

PACKING: MFR & TYPE _____ SIZE _____ NO. RINGS _____

MECH. SEAL: MFR & MODEL DURA PTD MFR'S CODE _____ API CODE BSTFL

SHOP TESTS:

	REQUIRED	WITNESSED
PERFORMANCE	<u>NONE</u>	_____
NPSHR	<u>NONE</u>	_____

DISMANTLE & INSPECT

	YES	NO
HYDROTEST CASE	_____	_____
HYDROTEST BOWLS	_____	_____
SURFACE INSP.	<u>YES</u>	_____

MATERIALS:

☒ PUMP API CLASS S-1
☐ STEEL CASE
 C.I. IMPELLER
 C.I. RINGS

AUXILIARY PIPING:

C.W. PIPE PLAN NONE WITH ☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPE
 TOTAL C.W. REQ'D 2 GPM. INCLUDE: ☐ FLOW INDIC. ☐ VALVE "C"

PACKING INJECTION: FLUID= _____ @ _____ °F. REQ'D= _____ GPM @ _____ PSIG

SEAL FLUSH PLAN 21 WITH ☐ C.S. ☒ S.S. ☒ TUBING ☐ PIPE

EXT. FLUSH FLUID= _____ @ _____ °F. REQ'D= _____ GPM @ _____ PSIG

AUX. SEAL PLAN _____ WITH ☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPE

QUENCH FLUID= _____

MOTOR DRIVERS:

HP 40 S.F. 10 RPM 3550 FRAME 32AT 460V 3PH 60HZ

MFR. I.P. OPTION BEARINGS BALL LUBE GREASE

TYPE HORIZ INSUL. CLASS B AMPS, FULL LOAD _____

EXCL. T.E.F.C. RISE °C _____ AMPS, LOCKED ROTOR _____

VERT. UNITS: ☐ VSS ☐ VHS THRUST CAP., LBS. _____ UP _____ DN. _____

TURBINE DRIVERS:

☐ IF BY PUMP VENDOR SEE PAGE _____ ATTACHED

☐ IF BY OTHERS: MFR. _____ MODEL _____ BHP _____

APPLICABLE DOCUMENTS: _____

APPROX. WEIGHTS (LBS NET EACH)

PUMP ONLY	<u>425</u>	MOTOR	<u>555</u>
BASE	<u>400</u>	TURBINE	_____

SITE DATA

AMBIENT _____ °F MAX TO _____ °F MIN.
 INSTALLED ☐ OUTDOORS ☐ INDOORS
☐ CL-GR-DIV ☐ NON-HAZARDOUS
 COOLING WATER: TYPE _____
 °F & PSIG IN, °F MAX & PSIG OUT

FOSTER WHEELER CORPORATION

CENTRIFUGAL PUMPS

PAGE 1 OF 1

FOR ERDA-FE-14-32-0001-1521 F.W. CONTRACT 1591

SITE NSP LAWRENCE STATION, SIOUX FALLS, SOUTH DAKOTA

SERVICE SLAG SLURRY PUMP

NO. REQ'D 1 ITEM NOS. P-103

NO. OF MOTORS REQ'D 1 : ITEM NOS. P-103 SUPPLIED BY PUMP MFR MOUNTED BY PUMP MFR

NO. OF TURBINES REQ'D : ITEM NOS. SUPPLIED BY MOUNTED BY

PUMP MFR. INGERSOLL RAND SIZE & MODEL 40 MIR

NO. STAGES 1

OPERATING CONDITIONS, EACH PUMP:

LIQUID SLUDGE U.S.GPM @ PT: MIN NORM 100 RTD.

DISCH. PSIG 39 RTD.

P.T. °F. (MAX) 140 SUCT. PSIG (MAX) 4 RTD.

SP.GR. AT PT 1.1 DIFF. PSI 35

VAP. PSIA @ PT 2.8 TOTAL DIFF. HEAD, FT. 81

VIS. @ PT 32 SSU NPSHA, FT. 30

CORR./EROS. FROM ASH HYD HP

CONSTRUCTION

NOZZLES	SIZE	ANSI RATING	FACING	LOCATION
SUCTION	2	150	FF	END
DISCHARGE	1 1/2	150	FF	TOP

CASE-MOUNT ☐ CENTERLINE ☒ FOOT ☐ BRACKET ☐ IN-LINE ☐-SPLIT: ☐ AXIAL ☒ RADIAL-VOLUTE: ☒ SINGLE ☐ DOUBLE ☐ DIFFUSER ☐

-DESIGN: 150 PSIG @ °F. HYDRO TEST 150 PSIG

-AUX. CONNECTS: ☐ YENTS ☐ DRAINS ☐ GAGES ☐ NONE

IMPELLER: DIA.: RATED 8.8, MAX. 8.8, MIN. 8.8. TYPE CLOSED

MOUNTING ☐ BETWEEN BEARINGS ☒ OVERHUNG ☐WEAR RINGS: ☐ INLET ONLY ☐ BOTH SIDES ☐ CASE ONLY ☐ CASE & IMPELL.

BEARINGS: TYPE: RADIAL = ROLLER, THRUST = ROLLER

LUBE: ☐ RING ☐ FLOOD ☐ FLINGER ☐ MIST ☐ PRESSURE GR

COUPLING: MFR: N/A .MODEL: N/A

DRIVER 1/2 MTD BY: ☐ PUMP MFR. ☐ DRIVER MFR. ☐ PURCH.

GUARD TYPE: BELT GUARD

PACKING: MFR & TYPE YES SIZE NO. RINGS

MECH. SEAL: MFR & MODEL MFR'S CODE API CODE

AUXILIARY PIPING:

C.W. PIPE PLAN WITH ☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPETOTAL C.W. REQ'D. GPM. INCLUDE: ☐ FLOW INDIC. ☐ VALVE "C"

PACKING INJECTION: FLUID= °F. REQ'D= GPM @ PSIG

SEAL FLUSH PLAN WITH ☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPE

EXT. FLUSH FLUID= 1 1/2 @ 85°F. REQ'D= 1 1/2 GPM @ 50 PSIG

AUX. SEAL PLAN WITH ☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPE

QUENCH FLUID=

MOTOR DRIVERS:

HP 7 1/2, S.F. 1.0, RPM 3550, FRAME 213T, 460V/1/3PH/60HZ

MFR. I.R. OPTION BEARINGS BALL, LUBE GREASE

TYPE HORIZ. INSUL. CLASS B

AMPS, FULL LOAD

ENCL. T.E.F.C. RISE °C

AMPS, LOCKED ROTOR

VERT. UNITS: ☐ VSS ☐ VHS THRUST CAP., LBS. UP DN.

TURBINE DRIVERS:

☐ IF BY PUMP VENDOR SEE PAGE ATTACHED☐ IF BY OTHERS: MFR. MODEL BHP

APPLICABLE DOCUMENTS:

REQUISITION NO.

DATE

1591-1351D 4/30/76

SUPERSEDED BY CHANGE NO.

C1 C3 C5

C2 C4 C6

PERFORMANCE

PROPOSAL CURVE NO. 40 MIRCF

RPM 2000 NPSHR (WATER), FT. 14

MIN. CONTINUOUS U.S.GPM 20

ROTATION, VIEWING FROM COUPLING CW

WITH RATED IMPELLER:

EFFICIENCY AT RATED POINT, % 45

IF EFF. IS VISCOUS, WATER EFF. =

BHP: RATED 5 NORM 5 MAX 7 1/2

IF HP IS VISC., RATED WATER BHP =

MAX. TOTAL HEAD, FT.

MAX. POSSIBLE DISCH. PRESS.: PSIG

WITH RATED SUCT. PRESS. =

WITH MAX. SUCT. PRESS. =

SHOP TESTS:

PERFORMANCE REQUIRED WITNESSED

NPSHR NONE

DISMANTLE & INSPECT

HYDROTEST CASE

HYDROTEST BOWLS

SURFACE INSP. YES

MATERIALS:

☐ PUMP API CLASS☐ NI-HARD CASE & IMPELLER

BASE PLATE

VERTICAL PUMPS

THRUST, LBS. UP, DOWN

OTHER DETAILS PER PAGE NO.

APPROX. WEIGHTS

(LBS NET EACH)

PUMP ONLY 275 MOTOR 150

BASE 75 TURBINE

SITE DATA

AMBIENT °F MAX TO °F MIN.

INSTALLED ☐ OUTDOORS ☐ INDOORS☐ CL ☐ GR ☐ DIV ☐ NON-HAZARDOUS

COOLING WATER: TYPE

°F & PSIG IN, °F MAX & PSIG OUT

MATERIAL REQUISITION

FOSTER WHEELER ENERGY CORPORATION
110 SOUTH ORANGE AVENUE, LIVINGSTON, N. J.

SHELL & TUBE
EXCHANGERS

PAGE 1 OF 1

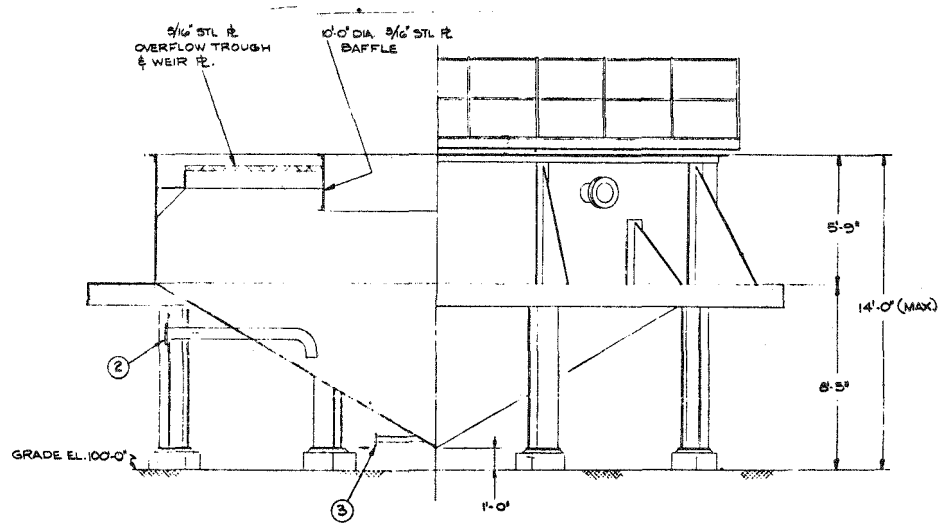
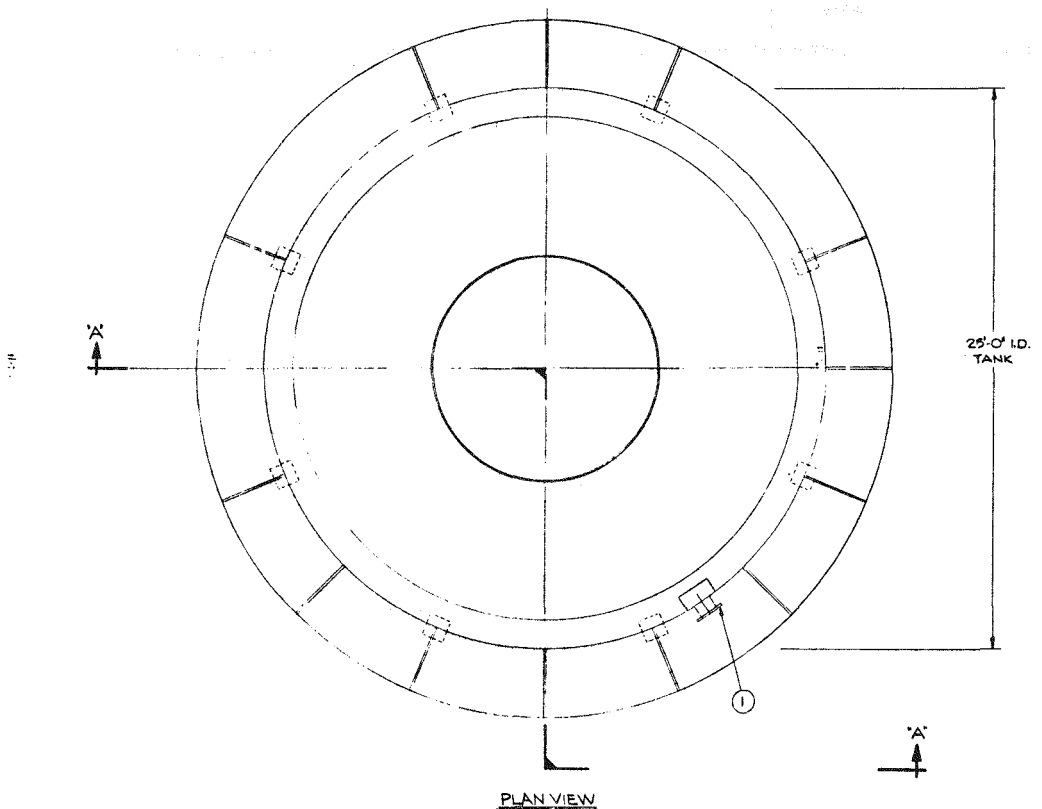
CONTRACT NO. <u>15-1591</u>		REQ'N. NO. <u>1591-1351D</u>		DATE <u>4-30-76</u>	
CUSTOMERS NAME <u>ERDA-FE-14-32-0001-1521</u>		LOCATION <u>SILVER FALLS, SOUTH DAKOTA</u>			
SUPERSEDED BY					
CHANGE NO.	C-1	C-2	C-3	C-4	C-5
DATE					
SERVICE OF UNIT <u>WATER / WATER HEAT EXCHANGER</u> ITEM NO. <u>E-101</u>					
SIZE <u>21-6-336</u>	TYPE <u>BEM</u>		CONNECTED IN		
SQ. FT. SURF./UNIT ^(GROSS) _(EFF) <u>1984</u>	SHELLS/UNIT <u>1</u>		SQ. FT. SURF./SHELL ^(GROSS) _(EFF) <u>1984</u>		
PERFORMANCE OF ONE UNIT					
	SHELL SIDE			TUBE SIDE	
FLUID CIRCULATED	<u>WATER</u>			<u>WATER</u>	
TOTAL FLUID ENTERING	<u>(235 GPM) 117,500 LB/HR</u>			<u>(816 GPM) 407,750 LB/HR</u>	
VAPOR	LB/HR			LB/HR	
LIQUID	<u>116,500 LB/HR</u>			<u>407,750 LB/HR</u>	
STEAM	LB/HR			LB/HR	
NON-CONDENSABLES	LB/HR			LB/HR	
FLUID (VAPORIZED)(CONDENSED)	LB/HR			LB/HR	
STEAM CONDENSED	LB/HR			LB/HR	
GRAVITY	<u>1</u>			<u>1</u>	
VISCOSITY	<u>.53</u>			<u>.72</u>	
MOLECULAR WEIGHT					
SPECIFIC HEAT	<u>1</u> BTU/LB-°F			<u>1</u> BTU/LB-°F	
THERMAL CONDUCTIVITY	<u>.37</u> BTU/HR-FT-°F			<u>.36</u> BTU/HR-FT-°F	
LATENT HEAT	BTU/LB			BTU/LB	
TEMPERATURE IN	<u>160</u> °F			<u>85</u> °F	
TEMPERATURE OUT	<u>90</u> °F			<u>110</u> °F	
OPERATING PRESSURE. INLET	<u>700</u> (PSIA)(PSIG)			<u>100</u> (PSIA)(PSIG)	
NO. PASSES PER SHELL	<u>1</u>			<u>1</u>	
VELOCITY	FT/SEC			<u>2.5</u> FT/SEC	
PRESSURE DROP - ALLOW. CALC'D.	PSI <u>6.5</u> PSI			PSI <u>2.1</u> PSI	
FOULING RESISTANCE, MIN.	<u>.001</u>			<u>.001</u>	
HEAT EXCHANGED - BTU/HR.	<u>7,000,000</u>			MTD CORRECTED-OF <u>19.5</u>	
TRANSFER RATE - SERVICE	<u>202</u>			CLEAN <u>340</u>	
CONSTRUCTION OF ONE SHELL					
DESIGN PRESSURE	<u>800</u> PSIG			<u>150</u> PSIG	
TEST PRESSURE	<u>1200</u> PSIG			<u>225</u> PSIG	
DESIGN TEMPERATURE	<u>200</u> °F			<u>150</u> °F	
TUBES <u>ADMIRALTY NO. 239</u>	O.D. <u>3/4"</u>		BWG <u>16</u> (AYS) LENGTH <u>230"</u> PITCH <u>1 5/16"</u> Δ		
SHELL <u>C. STEEL</u>	I.D.		SHELL COVER (INTG)(REMOV)		
CHANNEL OR BONNET <u>C. STEEL</u>	CHANNEL COVER				
TUBESHEET - STATIONARY <u>C. STEEL</u>	TUBESHEET - FLOATING				
BAFFLES - CROSS <u>C. STL</u> TYPE <u>1/4 SED. CUT</u>	FLOATING HEAD COVER				
BAFFLES - LONG <u>—</u> TYPE	IMPINGMENT PROTECTION				
TUBE SUPPORTS <u>C. STEEL</u>					
TUBE TO TUBESHEET JOINT					
GASKETS <u>ASBESTOS</u>					
CONNECTIONS - SHELL SIDE	IN <u>6" R.F.</u>		OUT <u>6" R.F.</u>		RATING <u>300# ANSI</u>
CONNECTIONS - TUBE SIDE	IN <u>10" R.F.</u>		OUT <u>10" R.F.</u>		RATING <u>150# ANSI</u>
CORROSION ALLOWANCE - SHELL SIDE	<u>1/8</u> IN.		TUBE SIDE		<u>—</u> IN.
CODE REQUIREMENTS <u>ASME VIII</u>	TEMA CLASS <u>"R"</u>				
REMARKS: (1) NOZZLE & SUPPORT LOCATION TO BE AS NOTED ON F.W. STD. 21B11.1					
(2) FOR GENERAL NOTES REFER TO REQ'N. WHICH IS AN INTEGRAL PART OF THIS REQ'N					

NOTICE
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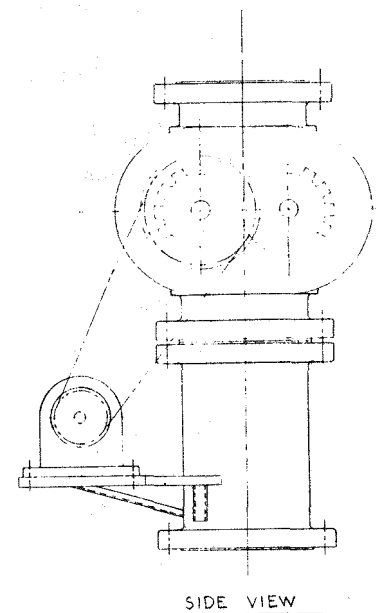
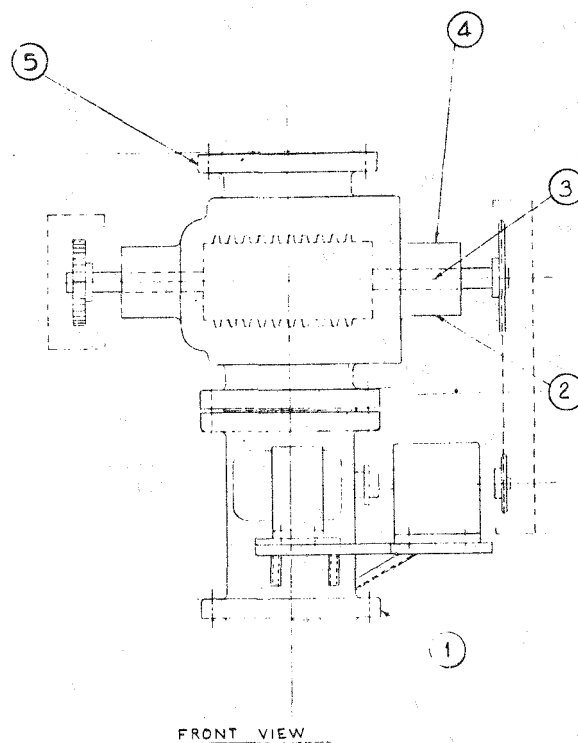
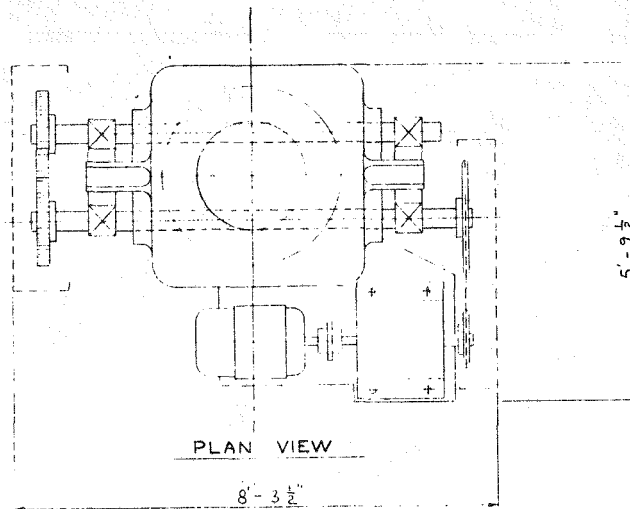
REFERENCE DWGS.	NOTES
	CLARIFIER TO BE LOCATED IN SECTION 100 (SAG RECOVERY AREA)

NOTE
ALLEN-SHERMAN-HOFF COMPANY RESPONSIBILITY FOR INTERFERENCES OR OBSTRUCTIONS NOT

THE ALLEN-SHERMAN-HOFF CO.
 WYNNWOOD, PENNA.
 SAG V-A-E-C-CLARIFIER (CL-101)
 FOR FORTER-HILLER ENERGY CORP.
 COAL GASIFICATION PROJECT
 N. S. P. LAWRENCE, ST.
 DATE 3/18/76
 DRAWN BY
 CHECKED
 CONTRACT NO. 3201



NOZZLE CHART				
CONN"	SIZE	RATING	SERVICE	FREQ'D
1	10"	150#	OVERFLOW	1
2	6"	1	TO P. 101A/B	1
3	3"	1	TO P. 103	1



NOZZLE CHART					
CONN #	SIZE	RATING	SERVICE	#REQD	
1	24"	600 #	TO P-115	1	
2	1/2"	600 #	DRAIN	1	
3	1/2"	600 #	FLUSH	1	
4	1/2"	600 #	SEAL	4	
5	24"	600 #	TO R-103	1	

NOTE

THE
ALLEN-SHERMAN-HOFF
COMPANY ACCEPTS
NO RESPONSIBILITY FOR
INTERFERENCES OR
OBSTRUCTIONS NOT
SHOWN ON THIS
DRAWING

H
G
F
E
D
C
B
A

REVD AS PER M/P

REVISIONS

4-12-76 NW
DATE CHECKED

DESIGN APPROVED

SCALE N.T.S.

THE ALLEN-SHERMAN-HOFF CO.
WYNNEWOOD, PENNA.
SLAG CRUSHER SR-102
FOR FOSTER WHEELER ENERGY CORP.
COAL GASIFICATION PROJECT
N.S.P. LAWRENCE STA. SIOUX FALLS, S.D.

DATE 4-7-76
DRAWN W. GATE
TRACED
CHECKED
CONTRACT NO.
5201-H9 A

MATERIAL REQUISITION



FOSTER WHEELER

PAGE 1 OF 1

FORM 135-20A

FOR	ERDA-FOSSIL ENERGY	F.W. REF. 15-1591	REQUISITION NUMBER	DATE
SITE	SIOUX FALLS, SOUTH DAKOTA		1591-1351D	1/28/76
MATERIAL	QUENCH WATER		SUPERSEDED BY CHANGE NO.:	
	FILTER & SPARE F-106A/B		C1	C4
	(PART OF PACKAGE A-105)		C2	C5
			C3	C6

A. SCOPE

Allen-Sherman-Hoff shall furnish two cartridge type filters which shall meet the following specifications:

Type	Internal epoxy coated drum with replacable cartridge.
------	--

1. PROCESS DATA

Fluid Handled	Water & Crushed Slag
Flow	235 GPM
Operating Pressure	450 PSIG
Operating Temperature	140°F
Pressure Drop	
Clean	By Allen-Sherman-Hoff
Dirty	By Allen-Sherman-Hoff
Particle Size	100 Micron
Contaminant Loading	45 Lb/Hr. (Max.)
Material Weight	55 Lb/Ft. ³ / 125 lb./ft. ³

2. CONNECTIONS

Inlet	4"
Outlet	4"
Drain	2"
Vent	3/4"
Design Pressure	550
Design Temperature	200°F
Cartridge Material	Stainless Steel

BY:	P.O. NO.	SUPPLIER:
-----	----------	-----------

MATERIAL REQUISITION



FOSTER WHEELER ENERGY CORPORATION

PAGE 1 OF 6

FORM 135-

FOR <u>ERDA-FE</u>	F.W. REF. <u>15-1591</u>	REQUISITION NUMBER	DATE
SITE <u>SIoux FALLS, SOUTH DAKOTA</u>		<u>1591-1343-B</u>	<u>7/28/75</u>
MATERIAL <u>RECYCLE GAS SCRUBBER AND PUMPS (A-106)</u>		SUPERSEDED BY CHANGE NO.:	
<u>ENERGY RESEARCH AND DEVELOPMENT ADMIN.-FOSSIL ENERGY</u>		C1	<u>8/8/75</u> C4
<u>LOCATION-NSP-LAWRENCE STATION, SIOUX FALLS, S.D.</u>		C2	<u>8/18/75</u> C5
<u>ERDA-FE - CONTRACT NO. 14-32-0001-1521</u>		C3	<u>5/12/75</u> C6

INDEX

- I SCOPE
- II GENERAL
- III BASIS OF DESIGN
- IV PRODUCT SPECIFICATIONS
- V VENDOR INFORMATION REQUIRED
- VI TURNDOWN
- VII DESIGN/MECHANICAL CONSIDERATIONS
- VIII AVAILABLE UTILITIES
- IX SITE CONDITIONS
- X REFERENCES

BY: <u>DA7</u>	P.O.NO.	SUPPLIER:
----------------	---------	-----------

I SCOPE

This requisition covers the design, fabrication and supply of equipment and required instrumentation for a recycle gas scrubbing system to remove the residual char dust particles from the recycle gas stream. The requisition shall include the following equipment:

C-3

- A. S-109 Recycle Gas Scrubber
- B. P-106A/B Recycle Gas Scrubber - Circulating Pump & Spare

II GENERAL

A. The design of all equipment of vendor's supply will comply with all regulations applicable to the proposed location i.e. Sioux Falls, South Dakota. All materials to be of United States origin. Equipment shall be furnished in accordance with the provisions of the latest revisions of the applicable codes and the Foster Wheeler Energy Corp. Standards (see Section X References).

B. The following is required by ERDA-FE:

No subcontract shall be on a cost-plus -a-percentage-basis. "This contract or purchase order pertains to the performance of ERDA-FE contract number 14-32-0001-1521 between the United States and Foster Wheeler Energy Corporation and the sub contractor agrees that the contracting officer, ERDA-Fossil Energy or his authorized representative may inspect the plant and audit the books and records of the subcontractor with respect to work done or supplies, material and equipment furnished under this contract or purchase order."

Such requirements shall not apply to competitively advertised procurements, or standard "Off the Shelf" purchases of equipment or the subcontract or purchase order which is \$10,000 or less.

C. All instruments and controls furnished as part of this requisition shall be identified as to make and model and be subject to purchase approval.

III. BASIS OF DESIGN

A. Gas Properties

1. Composition

	<u>MOLE %</u>
H ₂ O	0.44
H ₂	13.91

C-3

III. BASIS OF DESIGN (Cont'd)

A. Gas Properties (Cont'd)

1. Composition (Cont'd)

	<u>MOLE %</u>
CO	19.70
CO2	7.87
CH4	4.06
N2	53.48
COS	Nil
NH3	0.27
H2S	0.27
	<u>100.00</u>

C-3

2. Normal Flowrate:

- a. 67,500 lbs/hr. (Includes 96 lbs/hr. of condensed water)
- b. 17,833 SCFM @ 60°F, 14.7 PSIA)
- c. 691 ACFM @ inlet conditions

C-3

- 3. Density 1.63 lbs/ft³ @ inlet conditions
- 4. Viscosity 0.023 cps @ inlet conditions
- 5. Compressibility Factor: 1.0
- 6. Inlet Temperature: 120°F
- 7. Inlet Pressure: 410 PSIG
- 8. Molecular Weight: 23.9

B. Dust to Scrubber

C-3

1. Densities

- a. Case 1 - 20 lbs/ft³ particle density
- b. Case 2 - 60 lbs/ft³ particle density

2. Design Solids Flowrate: 300 lbs/hr.

C-3

3. Particle Size Distribution

<u>Micron Size</u>	<u>WT. %</u>
0.5	0
0.5 - 1.8	1.64
1.8 - 3.8	4.26
3.8 - 9.8	29.08
9.8 - 32	60.26
32 -100	<u>4.76</u>
	100.0

4. Design Dust Loading 50.7 Gr/ACF

C-3

IV. PRODUCT SPECIFICATIONS

A. Scrubbed Vapor

1. The clean scrubbed vapor from the unit should contain not more than 0.1 grains of Char Dust per actual cubic foot. C-3
2. Over 90 wt % of the Char Dust should be less than two (2) micrometers (microns) and 99.9 wt % less than five (5) microns.

V. VENDOR TO SUPPLY FOLLOWING INFORMATION

- A. To confirm scrubber pressure drop (VII-3)
- B. Water make-up to scrubber, GPM (VIII A-6)
- C. Scrubber liquid circulation rate, lbs/hr. C-3
- D. Blowdown (purge) GPM
- E. Venturi throat velocity, ft./sec.
- F. Outlet Temperature °F
- G. Weight percent of char dust in blowdown (purge)

VI. TURNDOWN

Scrubber must be capable to handle 33 1/3% of normal mass flowrate at an inlet pressure of 150 PSIG.

VII. DESIGN/MECHANICAL CONSIDERATIONS

1. Temperature: 170°F
2. Pressure: 440 PSIG C-3
3. Maximum allowable pressure drop of gas 15 PSI
(Vendor to confirm, see V-A)
4. Material of Construction - 5/64" - 410 S Clad over CS

VIII. AVAILABLE UTILITIES

A. Make-up Water

1. Water Type Semi-clean process water
2. Supply temperature 150°F
3. Supply pressure 500 PSIG
4. Dissolved Gases 400 PPM NH₃. Also traces of H₂S and CO₂.
5. Dissolved Solids 50 PPM TDS
6. Quantity Available 3000 lbs/hr (6 GPM) Maximum

VIII AVAILABLE UTILITIES (Cont'd)

B. Power - Motors

1/2 HP and below - 115 V, 1 ϕ , 60 HZ

3/4 HP to 150 HP - 460 V, 3 ϕ , 60 HZ

Class I - Group D - Division 2

Class II - Group F - Division 2

IX. SITE CONDITIONS

- | | | | |
|----|----------------------------|---|-----------------------|
| 1. | Altitude (above sea level) | - | 1315 FT |
| 2. | Atmospheric Pressure | - | 14.0 PSIA |
| 3. | Design Temp. Summer | - | 93°F |
| | Winter | - | - 25°F |
| 4. | Location | - | Outdoor |
| 5. | Type of Operation | - | Continuous |
| 6. | Earthquake & Wind Loading | - | (SEE SPEC. 1590-40A1) |

X. REFERENCES

(Shall be considered part of this requisition)

- | | |
|------------|--|
| 1590-10A1 | Welded Unfired Pressure Vessels |
| 1590-31A3 | Centrifugal Pumps |
| 1590-38A3 | Induction Motors |
| 1590-40A1 | Wind, Snow & Earthquakes Loading |
| 1590-50A2 | Gaskets & Surface Finish for Bolted Flange Joints |
| 1590-50A4 | Dim. of Non-Std. Gaskets & Surface finish for proper Compression |
| 1590-92A1 | Preparation of Shipment |
| 1590-96A2 | Equipment Noise Control |
| 1590-1100B | General Notes - Vessels |
| 1590-1300B | General Notes - Mechanical |

FOSTER WHEELER CORPORATION

CENTRIFUGAL PUMPS

PAGE 6 OF 6

FORM 5-80

FOR <u>ERDA-FE</u>	F.W. CONTRACT <u>15-1591</u>	REQUISITION NO. <u>1591-1343-B</u>	DATE <u>7/28/75</u>
SITE <u>STOUX FALLS, SOUTH DAKOTA</u>	SUPERSEDED BY CHANGE NO.		
SERVICE <u>RECYCLE GAS SCRUBBER-CIRCULATING PUMP & SPARE</u>	C1	C3 <u>5-11-76</u>	C5
NO. REQ'D <u>2</u> ITEM NOS. <u>P-106 A/B</u>	C2	C4	C6

NO. OF MOTORS REQ'D. 2 : ITEM NOS. M-106A/B SUPPLIED BY _____ MOUNTED BY _____
NO. OF TURBINES REQ'D _____ : ITEM NOS. _____ SUPPLIED BY _____ MOUNTED BY _____

PUMP MFR. _____ SIZE & MODEL _____

NO. STAGES _____

OPERATING CONDITIONS, EACH PUMP:

LIQUID _____ U.S.GPM @ PT: MIN _____ NORM _____ RTD. _____
DISCH. PSIG _____ RTD. _____
P.T. °F. (MAX _____) SUCT. PSIG (MAX. _____) RTD. _____
SP.GR. AT PT _____ DIFF. PSI _____
VAP. PSIA @ PT _____ TOTAL DIFF. HEAD, FT. _____
VIS. @ PT _____ NPSHA, FT. _____
CORR./EROS. FROM _____ HYD HP. _____

PERFORMANCE

PROPOSAL CURVE NO. _____
RPM _____ NPSHR (WATER), FT. _____
MIN. CONTINUOUS U.S.GPM _____
ROTATION, VIEWING FROM COUPLING _____
WITH RATED IMPELLER:
EFFICIENCY AT RATED POINT, % _____
IF EFF. IS VISCOUS, WATER EFF. = _____
BHP: RATED _____ NORM _____ MAX _____
IF HP IS VISC., RATED WATER BHP = _____
MAX. TOTAL HEAD, FT. _____
MAX. POSSIBLE DISCH. PRESS.: _____ PSIG
WITH RATED SUCT. PRESS. = _____
WITH MAX. SUCT. PRESS. = _____

CONSTRUCTION

NOZZLES	SIZE	ANSI RATING	FACING	LOCATION
SUCTION				
DISCHARGE				

CASE-MOUNT ☐ CENTERLINE ☐ FOOT ☐ BRACKET ☐ IN-LINE ☐-SPLIT: ☐ AXIAL ☐ RADIAL-VOLUTE: ☐ SINGLE ☐ DOUBLE ☐ DIFFUSER ☐

-DESIGN: _____ PSIG @ _____ °F. HYDRO TEST _____ PSIG

-AUX. CONNECTS: ☐ VENTS ☐ DRAINS ☐ GAGES ☐

IMPELLER: DIA.: RATED _____, MAX. _____, MIN. _____ TYPE _____

MOUNTING ☐ BETWEEN BEARINGS ☐ OVERHUNG ☐WEAR RINGS: ☐ INLET ONLY ☐ BOTH SIDES ☐ CASE ONLY ☐ CASE & IMPELL.BEARINGS: TYPE: RADIAL = _____, THRUST = _____
LUBE: ☐ RING ☐ FLOOD ☐ FLINGER ☐ MIST ☐ PRESSURE

COUPLING: MFR: _____ MODEL: _____

DRIVER 1/2 MTD BY: ☐ PUMP MFR. ☐ DRIVER MFR. ☐ PURCH.

GUARD TYPE: _____

PACKING: MFR & TYPE _____ SIZE _____ NO. RINGS _____

MECH. SEAL: MFR & MODEL _____ MFR'S CODE _____ API CODE _____

SHOP TESTS:

	REQUIRED	WITNESSED
PERFORMANCE		
NPSHR		
DISMANTLE & INSPECT		
HYDROTEST CASE		
HYDROTEST BOWLS		

MATERIALS:

☐ PUMP API CLASS _____☐

AUXILIARY PIPING:

C.W. PIPE PLAN _____, WITH ☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPETOTAL C.W. REQ'D. _____ GPM. INCLUDE: ☐ FLOW INDIC. ☐ VALVE "C"

PACKING INJECTION: FLUID= _____ @ _____ °F. REQ'D= _____ GPM @ _____ PSIG

SEAL FLUSH PLAN _____, WITH ☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPE

EXT. FLUSH FLUID= _____ @ _____ °F. REQ'D= _____ GPM @ _____ PSIG

AUX. SEAL PLAN _____, WITH ☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPE

QUENCH FLUID= _____

MOTOR DRIVERS:

HP _____, S.F. _____, RPM _____, FRAME _____, 460 V/ 3 PH/ 60 HZMFR. _____ BEARINGS Ball, LUBE GreaseTYPE Sq. Cage INSUL. CLASS B AMPS, FULL LOAD _____

ENCL. _____ RISE °C _____ AMPS, LOCKED ROTOR _____

VERT. UNITS: ☐ VSS ☐ VHS THRUST CAP., LBS. _____ UP _____ DN.

TURBINE DRIVERS:

☐ IF BY PUMP VENDOR SEE PAGE _____ ATTACHED☐ IF BY OTHERS: MFR. _____ MODEL _____ BHP _____

BASE PLATE

VERTICAL PUMPS

THRUST, LBS. _____ UP, _____ DOWN

OTHER DETAILS PER PAGE NO. _____

APPROX. WEIGHTS

(LBS NET EACH)

PUMP ONLY _____ MOTOR _____

BASE _____ TURBINE _____

SITE DATA

AMBIENT 93 °F MAX TO 25 °F MIN.INSTALLED ☒ OUTDOORS ☐ INDOORS☒ CL I - GR D-DIV 2. ☐ NON-HAZARDOUS

COOLING WATER: TYPE _____

°F & PSIG IN, °F MAX & PSIG OUT

APPLICABLE DOCUMENTS: 1590-31A31590-38A1

MATERIAL REQUISITION



FOSTER WHEELER

PAGE 1 OF 1

FORM 135-20A

FOR <u>E.R.D.A. - FE</u>	F.W.REF. <u>15-1591</u>	REQUISITION NUMBER	DATE
SITE <u>NSP Lawrence Station Sioux Falls, S.D.</u>		<u>1591-1349A</u>	<u>3/28/76</u>
MATERIAL <u>Start-up Gas Scrubbing System (A-107)</u>		SUPERSEDED BY CHANGE NO.:	
	C1	<u>5/17/76</u>	C4
	C2		C5
	C3		C6

INDEX

- I. Scope
- II. Basis of Design
- III. Vendor Information
- IV. Design/Mechanical Information
- V. Utilities
- VI. Site Conditions
- VII. Bid Requirements
- VIII. References

BY: <u>ML</u>	P.O.NO.	SUPPLIER:
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I. SCOPE

This requisition covers the design, fabrication and supply of a venturi scrubber assembly, to remove char particles from the gasifier effluent gas during start-up of a Coal Gasification Pilot Plant located at Sioux Falls, South Dakota. Vendor shall quote a complete package, including all of the equipment required to perform the scrubbing operation as outlined herein and listed below.

<u>Item No.</u>	<u>Description</u>	C-1
S-116	First Start-up Scrubber	
S-117	Second Start-up Scrubber (Vendor to advise if required)	
P-116	First Start-up Scrubber Pump	
P-117	Second Start-up Scrubber Pump (Vendor to advise if required)	

Vendor may offer an alternate scheme. Erection of equipment will be by others. The scope of supply includes all instruments & controls for operation.

II. BASIS OF DESIGN

A. Gas Properties

1. Fluid Type: Effluent gas from a coal gasifier during start-up.

2. Compositions	Coal Case (Case A)	Char Case (Case B)	Light-off Case (Case C)	C-1
<u>Components</u>	<u>Volume %</u>	<u>Volume %</u>	<u>Volume %</u>	
H ₂ O	55.39	66.56	67.72	
H ₂	4.56	4.06	3.91	
CO	5.25	1.42	1.39	
CO ₂	5.60	6.46	6.23	
N ₂	27.22	21.20	20.75	
CH ₄	1.51	0	0	
H ₂ S	.24	0	0	
COS	.03	0	0	
NH ₃	.20	0	0	
TOTAL	100.00	100.00	100.00	

II. BASIS OF DESIGN (Continued)

	Local Case (Case A)	Char Case (Case B)	Lightoff Case (Case C)
3. Flowrate			
a. Pounds/Hour:	153,250	142,850	73,210
b. Moles/Hour:	6,964	6,707	3,451
c. ACFM @ Inlet:	5,260	5,471	8,833
4. Operating Inlet Temp, °F:	321	343	269
5. Operating Inlet Press, PSIA:	176	176	56
6. Density, Lbs./Ft ³ @ Inlet:	0.49	0.44	0.14
7. Viscosity, CPS @ Inlet:	0.017	0.017	0.017
8. Compressibility Factor @ Inlet:	0.97	0.97	0.99
9. Gas Molecular Wt.:	22.0	21.3	21.2
B. Solids Properties	(Case A)	(Case B)	(Case C)
1. Design Flowrates, Lbs./Hr.	8,930	3,730	1,840
2. Design Dust Loading @ Inlet, Grains/ACF:	198	80	24
3. Particle Density	20 Lbs./Ft ³ to 60 Lbs./Ft ³ for all three cases.		
4. Particle Size Distribution for Design Flow Rates:			
	Lbs./Hour		
<u>Micron Size</u>	<u>(Case A)</u>	<u>(Case B)</u>	<u>(Case C)</u>
0.5 to 0.5	0	0	0
0.5 to 1.79	8	3	2
1.79 to 3.78	20	6	4
3.78 to 9.77	135	52	28
9.77 to 13.28	97	37	20
13.28 to 32.02	647	249	133
32.02 to 64.32	1423	547	293
64.32 to 100	1553	597	320
100 to 109.49	388	149	80
109.49 to 186	2524	970	520
186 to 212	711	273	147
212 to 278	1424	-	-
212 to 283	-	-	293
212 to 298	-	847	-
	8930	3730	1840

II. BASIS OF DESIGN (Continued)

C. Tars, Oils & Naphtha

C-1

The feed to the scrubber may contain traces of tars and oils. The feed to the scrubber will contain 180 lbs/hr naphtha.

D. Product Specification

The clean scrubbed vapor from the unit should contain not more than 1.0 grains/ACF.

E. No cooling duty is required.

III. INFORMATION VENDOR TO SUPPLY

A. Vendor to confirm scrubber pressure drop (see IV C).

B. Vendor to give outlet temperature (see II E).

IV. DESIGN/MECHANICAL CONSIDERATIONS

A. Design Temperature: 450°F

B. Design Pressure: 485 psig

C-1

C. Maximum allowable pressure drip 10 psi (vendor to confirm - see IIIA).

D. Scrubber(s) to have conical bottom to aid in handling of solids slurry.

E. Scrubber(s) to each have 5 minutes of liquid holding time based on makeup water flow rate (see VA.1.a)

V. AVAILABLE UTILITIES

A. Available Utilities

1. Make-up water

a. Maximum available flow rate: 96,761 lb/hr

b. Supply temperature max.: 222°F

c. Supply pressure: 285 psia (upstream of scrubber control valve)

d. Dissolved gases: water is saturated with NH₃, COS, H₂S, CO₂ @ 222°F.

e. Dissolved solids: Trace amount of solids. Solids are similar to those described herein.

V. AVAILABLE UTILITIES (Continued)

B. Power-Motors

200 HP & Above	- 4000V, 3 ϕ , 60 HZ
3/4 HP thru 150 HP	- 460V, 3 ϕ , 60 HZ
1/2 HP & Below	- 115V, 1 ϕ , 60 HZ

Class I - Group D - Division 2

Class II - Group F - Division 2

(Vendor to advise connected loads at each voltage level)

C. Power-controls - 115V, 1 ϕ , 60 HZ.

D. Instrument Air (Dew Point (-) 40°F, 100 PSIG).

VI. SITE CONDITIONS

1. Altitude (above sea level)	- 1315 FT
2. Atmospheric Pressure	- 14.0 PSIA
3. Design Temp. Summer	- 93°F
Winter	- (-) 25°F
4. Location	- Outdoor
5. Type of Operation	- Continuous
6. Earthquake & Wind Loading	- (See Spec. 1590-40A1)

VII. BID QUOTATION REQUIREMENTS

- A. Equipment arrangement drawings showing equipment layout, overall dimensions, unit dimensions, support details & unit weights.
- B. Electrical schematic drawings.
- C. Complete description list of all items for the installation & operation of the system that must be supplied by other and a list of items provided by vendor.
- D. Spare parts lists, safety instruction sheets & other data as required.

VIII. REFERENCES

(Shall be considered part of this requisition)

1590-10A1	Welded Unfired Pressure Vessels
1590-31A3	Centrifugal Pumps
1590-38A3	Induction Motors
1590-40A1	Wind, Snow & Earthquakes Loading
1590-50A2	Gaskets & Surface Finish for Bolted Flange Joints
1590-50A4	Dim. of Non-Std. Gaskets & Surface finish for proper Compression
1590-92A1	Preparation of Shipment
1590-96A2	Equipment Noise Control
1590-1100B	General Notes - Vessels
1590-1300B	General Notes - Mechanical

MATERIAL REQUISITION



FOSTER WHEELER CORPORATION

PAGE 1 OF 12

FORM 135-20

FOR	United States ERDA-FE	F.W. REF. 15-1591	REQUISITION NUMBER	DATE
SITE	Sioux Falls, South Dakota		1591-1252-B	9/17/75
MATERIAL	Waste Heat Exchanger (D-135 & E-117) (A-108)		SUPERSEDED BY CHANGE NO.:	
	Energy Research & Development Admin.-Fossil		C1 2/25/76	C4
	Energy--Location-NSP-Lawrence Sta., Sioux Falls		C2 3/17/76	C5
			C3	C6

S.D.

- I. WASTE HEAT EXCHANGER PACKAGE
- II. STEAM DRUM D-135
- III. WASTE HEAT EXCHANGER E-117
- IV. MISCELLANEOUS REQUIREMENTS
- V. NOISE LEVEL
- VI. INSPECTION
- VII. SITE CONDITIONS
- VIII. UTILITIES AVAILABLE
- IX. JOB SPECIFICATIONS (FWEC)

I. WASTE HEAT EXCHANGER PACKAGE
 A. SCOPE

This requisition covers the design, fabrication and supply of an unfired waste heat exchanger, which upon cooling the gasifier effluent gas generates high pressure steam.

The package shall include the steam drum, Item D-135, process gas waste heat exchanger, Item E-117. The package shall also include steam/water piping, valving (stop valve, relief valves, blowdown valves per code) and instrumentation from inlet feedwater connection on steam drum to steam outlet connection from the steam drum.

All components in the steam/water circuit shall be built and stamped in accordance with ASME Code Sect. I and Power Piping ANSI B31.1. The channel side of the exchangers shall be built and stamped in accordance with ASME Code Sect. VIII.

For clarity see sketch attached to this requisition. It is to be noted that all process gas piping and controls in the process gas piping are by others, however, the sizing information of the restriction tube (RO) in the E-117 bypass and the control valve in the gas outlet of E-117 is the vendors responsibility.

BY: <u>SAB</u>	P.O. NO.	SUPPLIER:
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I. WASTE HEAT EXCHANGER PACKAGE

B. GENERAL

The process waste heat exchanger, the restriction tube bypass, and the control valve in the outlet of E-117 shall be designed to maintain an inlet gas temperature to the steam superheater E-118 (by others) of 996°F normal and maximum of 1180°F. These temperatures are to be maintained with a turndown.

For detailed process and mechanical information on E-117, see data sheet which is an integral part of this requisition.

The design of all equipment of vendors supply will comply with all regulations applicable to the proposed location; i.e., Sioux Falls, S. D. All materials to be of United States origin. Equipment shall be furnished in accordance with the applicable provisions of the latest revision of codes, specifications.

All instruments and controls furnished as part of this requisition shall be identified as to make and model number and be subject to Purchaser's approval. Generally instruments shall be electronic type rather than pneumatic.

Vendor shall supply between inlet feed water flange and outlet of steam drum flange all PSV, water column, PI's, etc. according to boiler code Section I, and Power Piping Code, the steam drum shall have a separate level control for low level alarm and low low level shut down. The main level control shall have low level and high level alarm transmitters. A separate control for high level alarm shall be furnished. Except for the above all instruments shall be by others.

II. STEAM DRUM

A. SCOPE

This steam drum will be used to separate steam from the boiler feedwater circulating through the process gas waste heat exchanger (E-117). Controls, accessories and connections required by the appropriate boiler code are to be included.

B. CAPACITY

1. Total steam generated: 79,864 lbs/hr
2. The drum shall be sized adequately to provide stable water level conditions and a minimum of 3 minutes effective steam drum residence time must be provided between normal operating level and minimum operating level.
3. Entrainment Eliminators: to be sized for 125% of normal steam flow.

II. STEAM DRUM (cont.)

C. DRUM ELEVATION

Exchanger E-117 is a thermosyphon unit that takes boiler feedwater from the steam drum and delivers steam and water back to this drum. Proper elevation difference is essential to insure natural circulation thru E-117. Vendor shall advise the required differential elevation between the steam drum D-135 and the process gas waste heat Exchanger E-117 also the size of the steam/water recirculation lines.

D. STEAM

1. Flowrate

- a. From E-117: 79,864 lbs/hr
- b. From D-135: 82,788 lbs/hr

2. Temperature: saturated at steam drum pressure (537°F)

3. Steam Drum Pressure: 930 PSIG, Operating

E. FEEDWATER

1. Flowrate: 80,671 lbs/hr

2. Temperature: 537°F

3. Treatment: The feedwater is physically deaerated and dosed with hydrazine for oxygen scavenging. The feedwater will consist of about 40% make-up from a demineralization plant with the remainder being returned condensate.

4. Make-up water analysis:

- a. Alkalinity: 1 PPM Max.
- b. Total Hardness: NIL
- c. Sulfates: NIL
- d. Chlorides: NIL
- e. Silicon (as SiO₂): 0.4 PPM Max.
- f. Total dissolved solid: 8 PPM Max.
- g. pH: 7.5-9.0
- h. Turbidity: less than 5 Jackson Units

F. CIRCULATION RATIO (MINIMUM)

20 lbs BFW/1 lbs steam (19 lbs water/1 lb steam at outlet)

II. STEAM DRUM (cont.)

G. NOZZLE CONNECTIONS

Vendor shall furnish all devices required for ASME Code Sect. I and Power Piping Code ANSI B31.1 from feed stop and check valve at the feed water inlet to steam outlet and non-return valves in the outlet. Instrumentation within inlet and outlet connection shall be supplied and engineered by vendor, including steam drum instruments.

Drum to be furnished with the required manway and nozzles and complete with the following accessories:

1. Two relief valves
2. Pressure gauge
3. Vent valve and blind flange
4. Blowdown valve set for intermittent blowdown
5. Blowdown valve set for continuous blowdown
6. Globe stop valve
7. Periscope to view water level from grade
8. Chemical feed connection
9. High and low level alarm switches
10. Level indicator
11. Water level transmitter

NOTE: Makeup water to drum is at bubble point. This water nozzle should be located so as to employ baffling provided for the steam-water risers.

H. BLOWDOWN

1. Continuous Blowdown
 - a. Continuous blowdown will be employed to maintain dissolved solids concentration in the boiler.
 - b. The boiler feedwater rate reflects a 1.0% blowdown.
2. Intermittent Blowdown

Vendor to specify quantity and intervals for intermittent blowdown.

I. OPERATION

1. The drum shall be suitable for continuous duty in outdoor installation.
2. Steam generated from E-117 may vary from 33% to 100% of design. Steam separation devices in D-135 must be adequate for the complete range of steam generation.

II. STEAM DRUM (cont.)

J. CHEMICAL TREATMENT

1. Coordinated phosphate-pH addition will be added to control corrosion in steam drum.

K. DESIGN CONDITIONS

1. Pressure: By Vendor (but not less than 1000 PSIG)
2. Temperature; By Vendor

L. REQUIRED STEAM QUALITY

Vendor to guarantee that the solids in the steam shall not exceed 1 PPM when the total solids in the drum equals 1250 PPM.

III. PROCESS WASTE HEAT EXCHANGER E-117

A. SCOPE

A single, unfired waste heat exchanger shall be designed and supplied to accomplish the duty specification given herein.

III. PROCESS WASTE HEAT EXCHANGER E-117 (cont.)

B. PROCESS GAS

The process gas with a typical composition, as given below, will flow through the tubes of the waste heat exchanger.

<u>Component</u>	<u>Vol. %</u>
H ₂ O	9.5
H ₂	12.4
CO	17.5
CO ₂	8.5
CH ₄	3.6
N ₂	47.5
H ₂ S	0.5
COS	0.5
NH ₃	
	100.0

This gas will be cooled and as a result, high pressure saturated steam will be generated. (See Heat Exchanger Specification Sheet Page 10).

C. SHELL SIDE PRESSURE DROP

Vendor shall design the shell side pressure drop in the waste heat exchanger so that the arrangement results in a circulation ratio of 20 lbs BFW/1 LB steam (19 lbs water/1 lb steam at outlet).

D. MECHANICAL BASIS OF DESIGN

The shell and tube side shall be designed and tested for concurrent operation through a full range of operating conditions from atmospheric pressure to the design pressure. In operation, the steam side may be pressured and heated up while the process side is vented to the air.

This design assumes a "dual tube sheet" cooled with boiler feedwater (1,000,000 lbs/hr entering at 225°F and exiting at 240°F)

III. PROCESS WASTE HEAT EXCHANGER E-117 (cont.)

E. HEAT FLUX

Maximum tube heat flux at hot gas inlet and for clean condition shall be based on an inlet gas temperature of 2100°F, (and a gas flow of 85% of the 1800°F flow) which is an alternate operating condition that must be covered in the mechanical design. At the alternate condition, we anticipate a mass flow through the exchanger of 183,000#/hr with a molecular weight of 24.9.

F. TUBE SIDE VELOCITY AND ENTRAINED SOLIDS

In determining tube side velocity consideration must be given to the possibility of "Salting Out" of the entrained char particles, contained in the process gas.

1. Char Properties

a. Flowrate

Normal: 580 lbs/hr
Design Max.: 1180 lbs/hr

b. Particle size distribution

<u>Microns</u>	<u>WT%</u>
<32	99.4
32 - 100	0.6
	100.0

c. Char Particle Density

20 lbs/ft³ to 60 lbs/ft³

d. Char Specific Heat: 0.42 BTU/LB-°F

2. Carbon Dust Formation

In addition to the char particles, there is a possibility of carbon formation in E-117. It is thermodynamically possible for carbon to form in E-117 by virtue of the chemical reaction: $2CO \rightarrow C + O_2$

a. Estimated formation: 600 lbs/hr

b. Particle size: less than 0.5 microns

III. PROCESS WASTE HEAT EXCHANGER E-117 (cont.)

G. TURNDOWN

The waste heat exchanger shall be designed to operate at as low as 40% capacity. The inlet tubeside pressure varies approximately linear with exchanger throughput as noted below.

<u>Inlet Gas Flow</u> <u>lbs/hr</u>	<u>Exchanger</u> <u>Capacity %</u>	<u>Inlet</u> <u>Temp., °F</u>	<u>Tubeside</u> <u>Press., PSIG</u>	<u>Gas Mol</u> <u>Weight</u>
197,783 Max.	100	1800	430	24.53
79,100 Min.	40	1800	164	24.53
183,000 Max.	96	2100	429	24.91
120,700 Min.	63	2100	288	24.91

H. Exit Process Gas Temperature Control

The unit shall be designed with a control device to maintain an exit gas temperature (996°F) sufficient to superheat the saturated steam from steam drum, D-135 to 900°F and 900 psig in a downstream steam superheater when either at design or turndown capacities and conditions.

Note that under alternate high temperature operation, with a 2100°F inlet temperature, that the outlet temperature will be approximately 1180°F.

MATERIAL REQUISITION

SHELL & TUBE

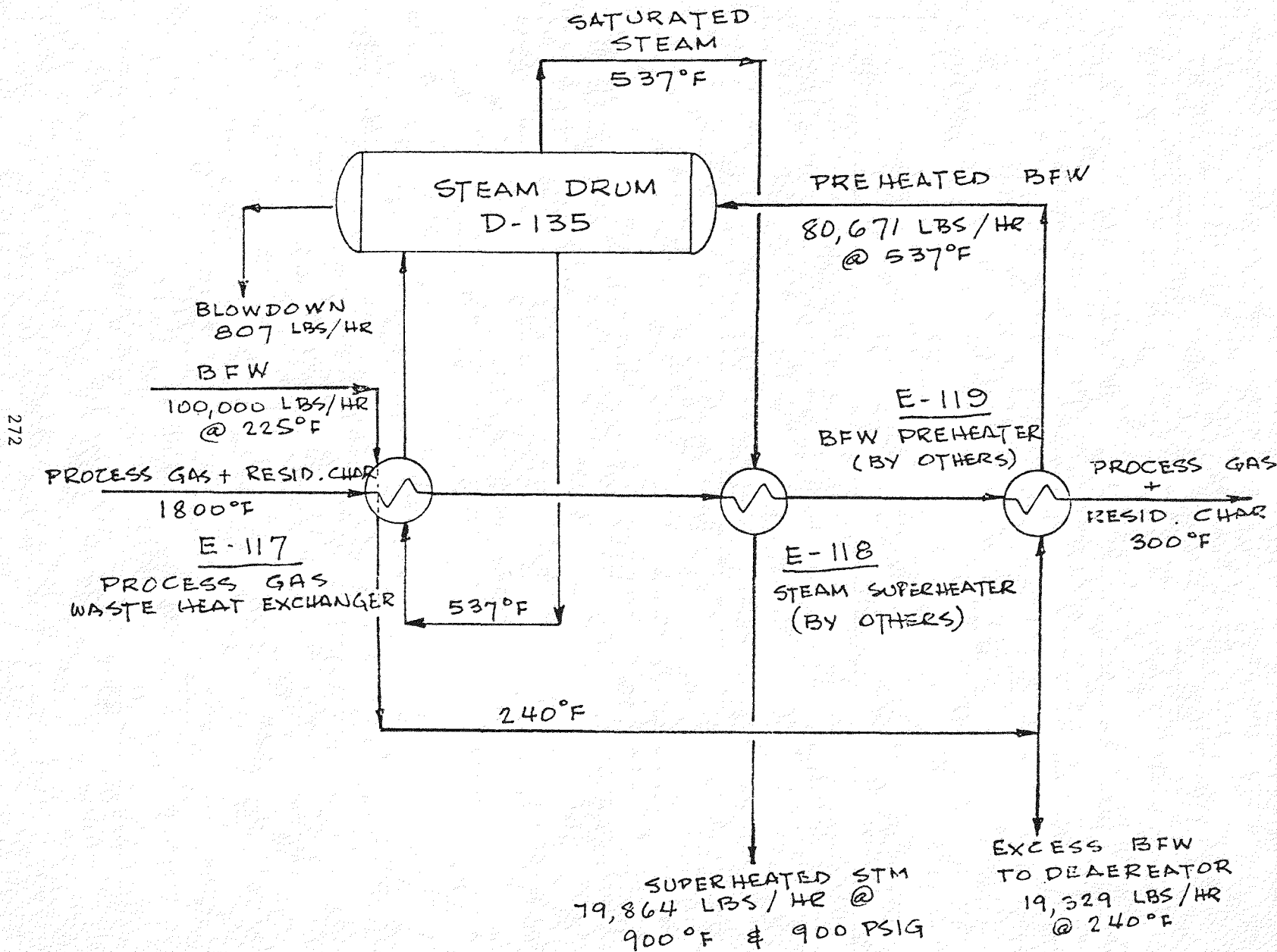
FOSTER WHEELER CORPORATION

EXCHANGERS

110 SOUTH ORANGE AVENUE, LIVINGSTON, N. J.

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CONTRACT NO. 15-1591		REQ'N. NO. 1591-1252A		DATE 2/25/76	
CUSTOMERS NAME United States E.R.D.A.		LOCATION Sioux Falls, South Dakota			
Fossil Energy		SUPERSEDED BY			
CHANGE NO.	C-1	C-2	C-3	C-4	C-5
DATE	2/25/76				
SERVICE OF UNIT Process Gas Waste Heat Exchanger				ITEM NO. E-117	
SIZE	TYPE		(HORIZ) (VERT)	CONNECTED IN	
SQ. FT. SURF./UNIT (GROSS) (EFF)	SHELLS/UNIT		SQ. FT. SURF./SHELL (GROSS) (EFF)		
PERFORMANCE OF ONE UNIT					
	SHELL SIDE (Note 5)		TUBE SIDE		
FLUID CIRCULATED	Boiler Feedwater		Process Gas		
TOTAL FLUID ENTERING	1,597,280	LB/HR	197,783	LB/HR	
VAPOR		LB/HR		LB/HR	
LIQUID	1,597,280	LB/HR		LB/HR	
STEAM		LB/HR	13,633	LB/HR	
NON-CONDENSABLES		LB/HR	184,150	LB/HR	
FLUID (VAPORIZED)(CONDENSED)	79,864	LB/HR		LB/HR	
STEAM CONDENSED		LB/HR		LB/HR	
GRAVITY					
VISCOSITY, CPS	/ 0.045		@1800°F; 0.035 @ 1000°F		
MOLECULAR WEIGHT	18		24.77 (wet gas)		
SPECIFIC HEAT		BTU/LB-°F	0.34	BTU/LB-°F	
THERMAL CONDUCTIVITY		.05 @ 1800°F; .03 @ 1020°F	BTU/HR-FT-°F		
LATENT HEAT	661.6	BTU/LB		BTU/LB	
TEMPERATURE IN	537	°F	1800	°F	
TEMPERATURE OUT	537	°F	996	°F	
OPERATING PRESSURE, INLET	935	(PSIG)	(See Sect. I.G) 430 (PSIG)		
NO. PASSES PER SHELL					
VELOCITY	FT/SEC		FT/SEC		
PRESSURE DROP - ALLOW. CALC'D.	Nat'l. Circ psi	PSI	10	PSI	
FOULING RESISTANCE, MIN.	0.001		(See Sect. I.F.)		
HEAT EXCHANGED - BTU/HR.	54,248,000 (notes)	MTD CORRECTED-°F			
TRANSFER RATE - SERVICE	(5, 6, & 7)	CLEAN			
CONSTRUCTION OF ONE SHELL					
DESIGN PRESSURE	1025	PSIG	490	PSIG	
TEST PRESSURE		PSIG		PSIG	
DESIGN TEMPERATURE	590	°F	2150°F inlet/1250 °F		
TUBES	NO.	O.D.	BWG	(AYG) (MIN)	LENGTH
SHELL	I.D.	SHELL COVER		(INTEG)(REMOV)	
CHANNEL OR BONNET	CHANNEL COVER				
TUBESHEET - STATIONARY	TUBESHEET - FLOATING				
BAFFLES - CROSS	TYPE	FLOATING HEAD COVER			
BAFFLES - LONG	TYPE	IMPINGMENT PROTECTION		(208.3-194.2) BTU/10	
(a) Shell side duty = (79,864 lbs./hr.) (661.6 BTU/hr.) + (100,000 lbs./hr.)					
(b) Tube side duty (197,783 lbs./hr. gas) (1800°F - 996°F) (.34 BTU/LB-°F) + (580 lbs./hr. CHAR) (1800°F - 996°F) x (.42 BTU/hr - F)					
CONNECTIONS - SHELL SIDE	IN	OUT	RATING		
CONNECTIONS - TUBE SIDE	IN 20" I.D.	OUT 17" I.D. Min.	RATING		
CORROSION ALLOWANCE - SHELL SIDE	Refractory	TUBE SIDE	IN.		
CODE REQUIREMENTS	TEMA CLASS				
REMARKS: (1) NOZZLE & SUPPORT LOCATION TO BE AS NOTED ON F.W. STD. 21B11.1					
(2) FOR GENERAL NOTES REFER TO REQ'N. WHICH IS AN INTEGRAL PART OF THIS REQ'N					
(3) Plus gas will contain solids. See Section I.F					
(4) Sensible heat of solids was accounted for in duty given					
(5) 100,000 lbs/hr. of BFW at 225°F enters the shell at the gas inlet and exits at 240°F for cooling of dummy tube sheet.					



IV. MISCELLANEOUS REQUIREMENTS FOR VENDORS BID

- A. Amount prefabricated piping shall be indicated.
- B. All equipment shall be hydrostatically hydrotested before shipment.
- C. The number and location of all field welds in piping shall be listed.
- D. The approximate sizes and weights of equipment shall be listed.
- E. Vendor to provide estimate of erection manhours.
- F. General arrangement drawings in plan and elevations shall be furnished with approximate dimensions. Structural steel and platforming, stairway and ladders shall be indicated.
- G. The foundations and erection of the waste heat exchanger shall not be included as part of this specification, however, vendor shall supply a preliminary loading diagram to facilitate foundation design.
- H. Provide connections so that steam drum and exchangers can be drained rapidly by gravity during shutdown for antifreeze protection. Steam lance connections shall be provided for shutdowns and startups.

IV. NOISE LEVEL

Noise levels shall be in accordance with the latest OSHA standards and FWEC Spec. 1590-96A2.

V. INSPECTION

For all equipment subject to the ASME Power Boiler Code, the vendor shall submit reports to the Chief Inspector, Process Plants Division of Foster Wheeler Energy Corporation.

VI. SITE CONDITIONS

1. Altitude (above sea level)	1315 ft.
2. Atmospheric Pressure	14.0 PSIA
3. Design Temperature - winter	(-) 25°F
- summer	(+) 93°F
4. Location	Outdoors
5. Type of Operation	Continuous
6. Earthquake Zone	I
7. Wind Loading	1590-40A1
8. Design Snow Loading	35 PSF

VII. UTILITIES AVAILABLE

Steam @ 60 psig and 250 psig

VIII. JOB SPECIFICATIONS

1590-10A1 - Welded Unfired Pressure Vessels
1590-21A1 - Tubular Exchangers
1590-40A1 - Wind, Snow & Earthquake Loading
1590-46A1 - Structural Steel
1590-46B19.1 & .2 - Platforms
1590-46B20.1 - Stairs & Rails
1590-46B21.1 & .2 - Ladders & Cages
1590-92A1 - Preparation of Shipment
1590-96A2 - Noise Spec.