

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

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DESIGN REPORT

VOLUME 6
SECTION 400 — SULFUR RECOVERY



FOSTER WHEELER ENERGY
CORPORATION

MASTER

PREPARED FOR
THE UNITED STATES ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

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SECTION 400

SULFUR RECOVERY

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Section 1

INTRODUCTION

1.1 SCOPE

Section 400 of the Coal Gasification/Combined Cycle Pilot Plant is designed to recover 1355 lb/h of molten sulfur by the Claus process. The sulfur is recovered from the sour water stripper gas of Section 200 (Water Wash, Sour Water Stripping, and Sludge Removal Unit) and from the acid gas of Section 300 (Selexol™ Unit).

The unit basically consists of the following major components:

- An air blower
- An air and acid gas preheater
- A muffle furnace
- A waste heat exchanger
- Four reactors and four condensers
- Three reactor feed heaters
- A sulfur pit and a sulfur storage tank
- A sulfur scrubber
- Three sulfur pumps.

1.2 DESIGN BASIS

1.2.1 Molten Sulfur Product

Battery Limit Conditions:

Pressure (lb/in ²)*	0
Temperature (°F)	275
Flow Rate (lb/h)	1355

1.2.2 Acid Gas Feed (from Section 300)

<u>mol %</u>	<u>Design Case</u>	<u>Expected Case</u>
H ₂	0.04	---
H ₂ O	5.19	5.12
CO	0.07	0.08
N ₂	0.07	0.08
CO ₂	78.33	76.98
H ₂ S	14.94	16.15
COS	1.21	1.38
CH ₄	0.11	0.13
NH ₃	<u>0.04</u>	<u>0.08</u>
Total	100.00	100.00

Flow Rate:

lb•mol/h	281.2	240.2
lb/h	11,612	9,899

Battery Limit Conditions:

Pressure (lb/in ²)	11
Temperature (°F)	110

*All pressures are gauge unless otherwise indicated.

1.2.3 Sour Water Stripper Gas Feed (from Section 200)

<u>mol %</u>	<u>Design Case</u>	<u>Expected Case</u>
H ₂	0.25	0.11
H ₂ O	25.37	27.49
CO	0.50	0.21
N ₂	0.50	0.21
CO ₂	32.59	31.32
H ₂ S	1.00	3.82
CH ₄	0.25	0.11
NH ₃	<u>39.54</u>	<u>36.73</u>
Total	100.00	100.00

Flow Rate:

lb•mol/h	40.2	94.2
lb/h	1,058	2,490

Battery Limit Conditions:

Pressure (lb/in ²)	12
Temperature (°F)	201

1.2.4 Turndown Operation

The unit is designed to be capable of stable operation at 43 percent of the design case operation.

1.3 DESIGN COMMENTS

1.3.1 Flow Scheme

The sulfur recovery unit design is based on information licensed from the Amoco Production Company (AMOCO). Particular attention has been paid to the design of the muffle furnace, so that it will handle the ammonia contained in the sour water stripper gas feed, and to the design of the first reactor in which most of the carbonyl sulfide and carbon disulfide produced in the furnace are converted to hydrogen sulfide.

The unit is designed for two operating cases. The expected case defines the most likely feed gas composition and represents the maximum ammonia flow to the unit. The design case defines the minimum ammonia flow to the unit. In general it has been used for the design of equipment, because this case requires more supplementary fuel gas to the furnace, resulting in larger mass flows through the unit. Four catalytic reactors are provided to obtain an overall sulfur recovery efficiency of 92 percent for the expected case.

1.3.2 Muffle Furnace

A specifically designed muffle furnace has been developed in conjunction with Amoco Production Company to ensure that the ammonia contained in the sour water stripper gas stream is reduced to a suitable level in the furnace effluent. Operating experience indicates that by combusting the ammonia under proper conditions plugging problems caused by ammonium salt formation and deposition can be avoided.

AMOCO has found that the ammonia can be converted to nitrogen and water vapor in the furnace by carefully controlling the furnace temperature, the residence time, and the hydrogen sulfide:sulfur dioxide ratio. A two-zone furnace design has therefore been developed. All the sour water stripper gas feed from Section 200, all the combustion air, and part of the acid gas feed from Section 300 are fed to the first zone, where ammonia conversion takes place. To obtain the required temperature in this zone, the acid gas and air are preheated. A supplementary fuel gas burner is provided, because the acid gas has a low hydrogen sulfide concentration. The balance of the acid gas feed from Section 300 is fed to the second zone of the furnace, where it is combined with the effluent from the first zone to produce a gas stream which has a standard hydrogen sulfide:sulfur dioxide ratio of 2:1 after the first reactor.

1.3.3 Air and Acid Gas Preheater

A heater is provided to preheat the air, sour water gas, and acid gas fed to the furnace to 800°F. This heater is normally fired with fuel gas, but provision has been made for fuel oil firing when fuel gas is not available.

1.3.4 First Reactor

AMOCO has made extensive studies on the hydrolysis of carbonyl sulfide and carbon disulfide to hydrogen sulfide and carbon dioxide. These by-products, carbonyl sulfide and carbon disulfide, are characteristically produced in the furnace of a sulfur unit. Based on the AMOCO data, a "hot" reactor, operating at 700°F, has been provided immediately downstream of the waste heat exchanger to maximize the carbonyl sulfide and carbon disulfide hydrolysis and improve the overall sulfur recovery efficiency. A Rhone Progil catalyst, type CRS-21, has been selected for this first reactor since this catalyst has been specifically developed to promote carbonyl sulfide and carbon disulfide hydrolysis.

1.3.5 Second, Third, and Fourth Reactors

A total of four catalytic reactors has been provided to maximize the overall sulfur recovery efficiency. The second, third, and fourth reactors are designed for a dew-point approach of 25°F. As high-pressure steam is available at the plant, steam-heated exchangers have been selected to reheat the feed gas to each of the reactors, since this method also maximizes the sulfur recovery efficiency. The second and third reactors contain Rhone Progil catalyst, type CR, which has proved to have a high activity and good mechanical properties. Rhone Progil catalyst type CR-32 has been specified for the fourth reactor, since this catalyst has high activity for the Claus reaction and shows low sensitivity to sulfate poisoning.

1.3.6 Sulfur Scrubber

A sulfur scrubber is provided downstream of the final condenser to cool the tail gas to 280°F and thus maximize the sulfur recovery efficiency.

1.3.7 Sulfur Storage and Loading

The liquid sulfur produced in the unit is collected in a storage pit and then transferred to a 20-day sulfur storage tank. A 200 gal/min loading pump is provided to transfer the sulfur product from this tank to tank cars.

1.4 PROCESS DESCRIPTION

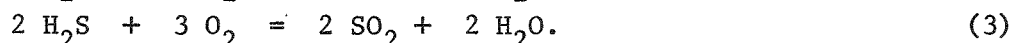
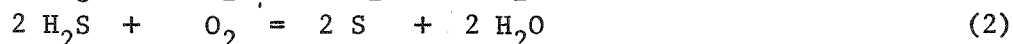
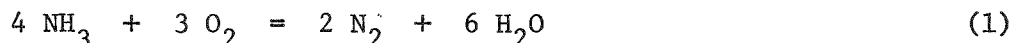
The process flow through the unit is shown schematically on Process Flow Diagram 1521-1-50-63, page 17.

Acid gas from Section 300 flows to the Acid Gas Knockout Drum (D-401), where condensed entrainment will be knocked out. Dry acid gas is allowed to flow to the acid gas coil of the Air and Acid Gas Preheater (H-402).

Sour water stripper gas from Section 200 flows to the SWS Gas Knockout Drum (D-402) where condensed entrainment will be knocked out. Dry SWS gas is allowed to flow to the SWS gas coil of the air and acid gas preheater.

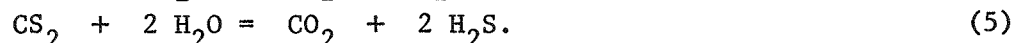
Process air from the Air Blower (C-401) is divided into two streams. One stream is ratio-controlled by the combined acid gas and SWS gas flows to supply oxygen needed for the stoichiometric combustion of these sulfur-containing gases. This airstream flows to the air coil of the air and acid gas preheater. [Another airstream flows to the Fuel Gas Burner (BR-402).]

All three streams of acid gas, SWS gas, and process air are heated to 800°F in separate coils in the air and acid gas preheater. About 55 percent of the hot acid gas, mixed with the hot SWS gas, is burned with the hot air through the Acid Gas Burner (BR-401). The flame in Zone 1 of the Muffle Furnace (H-401) is boosted to 2600°F to burn off the ammonia by the hot flame from the fuel gas burner, while part of the hydrogen sulfide is oxidized to sulfur and sulfur dioxide.



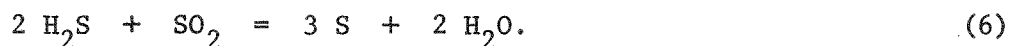
The remaining hot acid gas (about 45 percent) goes through a flow-control valve and enters Zone 2 of the muffle furnace. When it is mixed with the hot flame from Zone 1, its ammonia content will be almost completely eliminated when the furnace effluent leaves at about 2270 to 2280°F.

The hot furnace effluent is cooled to about 700°F after passing through the Waste Heat Exchanger (E-401), wherein 250-lb/in² steam is generated. This steam is sent to the 150-lb/in² heater. The waste heat exchanger effluent flows through the First Reactor (R-401), wherein most of the carbonyl sulfide and carbon disulfide are converted to hydrogen sulfide and sulfur vapor.



Most of the sulfur vapor is condensed in the First Sulfur Condenser (E-402). The molten sulfur is drained by gravity to the Sulfur Pit (TK-401).

The condenser effluent gas is heated to 401°F in the Second Reactor Feed Heater (E-406) before entering the Second Reactor (R-402), wherein more sulfur is formed from the reaction between hydrogen sulfide and sulfur dioxide.



Sulfur vapor is condensed in the Second Sulfur Condenser (E-403). Molten sulfur is drained to the sulfur pit, and effluent gas flows to the Third Reactor Feed Heater (E-407). In a similar manner, the hydrogen sulfide and sulfur dioxide gases flow through the Third and Fourth Reactor (R-403 and R-404) system and more sulfur is recovered.

The effluent gas from the Final Sulfur Condenser (E-405) is scrubbed with a countercurrent flow of molten sulfur in the Sulfur Scrubber (T-401) to condense as much sulfur vapor as possible. The molten sulfur is circulated from the sulfur pit to the sulfur scrubber by the Sulfur Circulating Pump (P-401). After scrubbing, the molten sulfur flows by gravity back to the pit. The scrubbed gas is vented to the Incinerator (H-701) in Section 700 (Support Facilities).

Molten sulfur from all four condensers, 1.51 gal/min or 2174 gal/d, is collected in the sulfur pit, which has a capacity of 8420 gal or 3.87 days' production. Sulfur in the pit is transferred to the Sulfur Storage Tank (TK-402) by the Sulfur Transfer Pump (P-402), which has a capacity of 10 gal/min and can empty half a pit in 7 hours.

The sulfur storage tank has a capacity of 44,600 gal or 20.5 days' production. It is connected to the 200-gal/min-capacity Sulfur Loading Pump (P-403). A tankful of product sulfur, or 298 long tons, can be loaded into tank cars or tank trucks in 3.72 hours.

1.5 MATERIAL BALANCES AND PROCESS FLOW DIAGRAM

Material balances for the design and expected cases are tabulated in two sets, four pages each.

Following the material balance tables is Process Flow Diagram 1521-1-50-63 showing operating pressures and temperatures for the design and expected cases.

STREAM NO. & UNITS	1	2	3	4	5	6
STREAM DESCRIPTION	ACID GAS FROM SELEXOL™ UNIT	GAS FROM SOUR WATER STRIPPER	TOTAL FUEL GAS TO (4) AND (5)	FUEL GAS TO ACID GAS PREHEATER	FUEL GAS TO MUFFLE FURNACE FUEL GAS BURNER	AIR BLOWER DISCHARGE
OPERATING CASE	DESIGN	DESIGN	DESIGN	DESIGN	DESIGN	DESIGN
FLUID STATE	GAS	GAS	GAS	GAS	GAS	GAS
COMPONENTS (lb·mol/h)						
H ₂	0.1	0.1	38.80	10.12	28.68	
H ₂ O	14.6	10.2	0.04	0.01	0.03	12.16
CO	0.2	0.2	54.75	14.27	40.48	
N ₂	0.2	0.2	148.41	38.69	109.72	310.92
O ₂						82.40
CO ₂	220.3	13.1	18.15	4.73	13.42	
H ₂ S	42.0	0.4				
SO ₂						
COS	3.4		0.04	0.01	0.03	
CS ₂						
CH ₄	0.3	0.1	11.12	2.90	8.22	
S ₂						
S ₄						
S ₆						
S ₈						
S ₁						
NH ₃	0.1	15.9				
TOTAL (lb·mol/h)	281.2	40.2	271.32	70.74	200.58	405.48
TOTAL (lb/h)	11,612	1058	6750	1760	4990	11,566
MOL. WT. OF VAPOR	41.30	26.31	24.88	24.88	24.88	28.52
DENSITY (lb/ft ³) @	0.1688	0.0965	0.2256	0.1629	0.1629	0.0978
OPER. TEMP. & PRESS.						
sft ³ /min	1779	254.3	1916	447	1469	2565
gal/min						
TEMPERATURE (°F)	110	201	95	95	95	206
PRESSURE (lb/in ²)	11	12	40	25	25	10.5

STREAM NO. & UNITS	7	8	9	10	11	12
STREAM DESCRIPTION	AIR TO ACID GAS PREHEATER	AIR TO MUFFLE FUR- NACE FUEL GAS BURNER	FIRST RE- ACTOR FEED	FIRST RE- ACTOR EFFLUENT	SECOND RE- ACTOR FEED	SECOND RE- ACTOR EFFLUENT
OPERATING CASE	DESIGN	DESIGN	DESIGN	DESIGN	DESIGN	DESIGN
FLUID STATE	GAS	GAS	GAS	GAS	GAS	GAS
COMPONENTS (lb•mol/h)						
H ₂						
H ₂ O	5.20	6.97				
CO						
N ₂	132.79	178.13				
O ₂	35.19	47.21				
CO ₂						
H ₂ S						
SO ₂						
COS						
CS ₂						
CH ₄						
S ₂						
S ₄						
S ₆						
S ₈						
S ₁						
NH ₃						
TOTAL (lb•mol/h)	173.17	232.31	891.63	890.81	887.96	883.77
TOTAL (lb/h)	4940	6626	29,226	29,226	28,800	28,800
MOL. WT. OF VAPOR	28.52	28.52	32.78	32.81	32.43	32.59
DENSITY (lb/ft ³) @	0.0970	0.0970	0.0516	0.0487	0.0632	0.0587
OPER. TEMP. & PRESS.						
sft ³ /min	1095	1469	5640	5634	5616	5590
gal/min						
TEMPERATURE (°F)	206	206	700	719	401	441
PRESSURE (lb/in ²)	10.3	10.3	5.6	4.8	4.0	3.4

STREAM NO. & UNITS	13	14	15	16	17	18
STREAM DESCRIPTION	THIRD REACTOR FEED	THIRD REACTOR EFFLUENT	FOURTH RE- ACTOR FEED	FOURTH RE- ACTOR EFFLU- ENT	SULFUR SCRUB- BER EFFLUENT GAS	FUEL GAS TO INCINERATOR*
OPERATING CASE	DESIGN	DESIGN	DESIGN	DESIGN	DESIGN	DESIGN
FLUID STATE	GAS	GAS	GAS	GAS	GAS	GAS
COMPONENTS (lb•mol/h)						
H ₂						29.72
H ₂ O					148.06	0.03
CO					9.07	41.94
N ₂					429.04	113.69
O ₂						
CO ₂					290.50	13.90
H ₂ S					1.46	
SO ₂					0.73	
COS					0.14	0.04
CS ₂					0.04	
CH ₄						8.52
S ₂						
S ₄						
S ₆					0.03	
S ₈					0.09	
S ₁					0.27	
NH ₃						
TOTAL (lb•mol/h)	880.78	880.25	879.79	879.66	879.43	207.84
TOTAL (lb/h)	28,092	28,092	27,981	27,981	27,871	5171
MOL. WT. OF VAPOR	31.89	31.91	31.80	31.81	31.69	24.88
DENSITY (lb/ft ³) @	0.0585	0.0565	0.0545	0.0540	0.0559	0.1629
OPER. TEMP. & PRESS.						
sft ³ /min	5571	5568	5565	5564	5561	1315
gal/min						
TEMPERATURE (°F)	378	383	361	362	280	95
PRESSURE (lb/in ²)	2.5	2.0	1.1	0.6	0.0	25

STREAM NO. & UNITS	19	20	21	22	23	24
STREAM DESCRIPTION	INCINERATOR EFFLUENT *	LIQUID SULFUR FROM FIRST CONDENSER	LIQUID SULFUR FROM SECOND CONDENSER	LIQUID SULFUR FROM THIRD CONDENSER	LIQUID SULFUR FROM FINAL CONDENSER	TOTAL LIQUID SULFUR PRODUCT
OPERATING CASE	DESIGN	DESIGN	DESIGN	DESIGN	DESIGN	DESIGN
FLUID STATE	GAS	LIQUID	LIQUID	LIQUID	LIQUID	LIQUID
COMPONENTS (lb·mol/h)						
H ₂	2.97					
H ₂ O	203.38					
CO	5.98					
N ₂	799.29					
O ₂	11.33					
CO ₂	358.18					
H ₂ S						
SO ₂	3.60					
COS						
CS ₂						
CH ₄						
S ₂						
S ₄						
S ₆						
S ₈						
S ₁		13.29	22.10	3.46	3.43	42.27
NH ₃						
TOTAL (lb·mol/h)	1384.74	13.29	22.10	3.46	3.43	42.27
TOTAL (lb/h)	42,586	426	709	111	110	1355
MOL. WT. OF VAPOR	30.75					
DENSITY (lb/ft ³) @	0.02417	111.1	111.1	111.1	111.1	111.8
OPER. TEMP. & PRESS.						
sft ³ /min	8759					
gal/min		0.478	0.795	0.1247	0.1232	1.510
TEMPERATURE (°F)	1200	300	300	300	300	275
PRESSURE (lb/in ²)	0.0	0.0	0.0	0.0	0.0	0.0

*Based on Claus plant tail gas only.

STREAM NO. & UNITS	1	2	3	4	5	6
STREAM DESCRIPTION	ACID GAS FROM SELEXOL™ UNIT	GAS FROM SOUR WATER STRIPPER	TOTAL FUEL GAS TO (4) AND (5)	FUEL GAS TO ACID GAS PREHEATER	FUEL GAS TO MUFFLE FURNACE FUEL GAS BURNER	AIR BLOWER DISCHARGE
OPERATING CASE	EXPECTED	EXPECTED	EXPECTED	EXPECTED	EXPECTED	EXPECTED
FLUID STATE	GAS	GAS	GAS	GAS	GAS	GAS
COMPONENTS (lb•mol/h)						
H ₂		0.1	24.85	11.53	13.32	
H ₂ O	12.3	25.9	0.02	0.01	0.01	10.40
CO	0.2	0.2	35.06	16.27	18.79	
N ₂	0.2	0.2	95.04	44.10	50.94	265.74
O ₂						70.43
CO ₂	184.9	29.5	11.62	5.39	6.23	
H ₂ S	38.8	3.6				
SO ₂			0.03	0.01	0.02	
COS	3.3					
CS ₂						
CH ₄	0.3	0.1	7.13	3.31	3.82	
S ₂						
S ₄						
S ₆						
S ₈						
S ₁						
NH ₃	0.2	34.6				
TOTAL (lb•mol/h)	240.2	94.2	173.76	80.63	93.13	346.56
TOTAL (lb/h)	9899	2490	4323	2006	2317	9885
MOL. WT. OF VAPOR	41.21	26.43	24.88	24.88	24.88	28.52
DENSITY (lb/ft ³) @	0.1684	0.0969	0.2256	0.1629	0.1629	0.0978
OPER. TEMP. & PRESS.						
sft ³ /min	1519	596	1099	510	589	2192
gal/min						
TEMPERATURE (°F)	110	201	95	95	95	206
PRESSURE (lb/in ²)	11	12	40	25	25	10.5

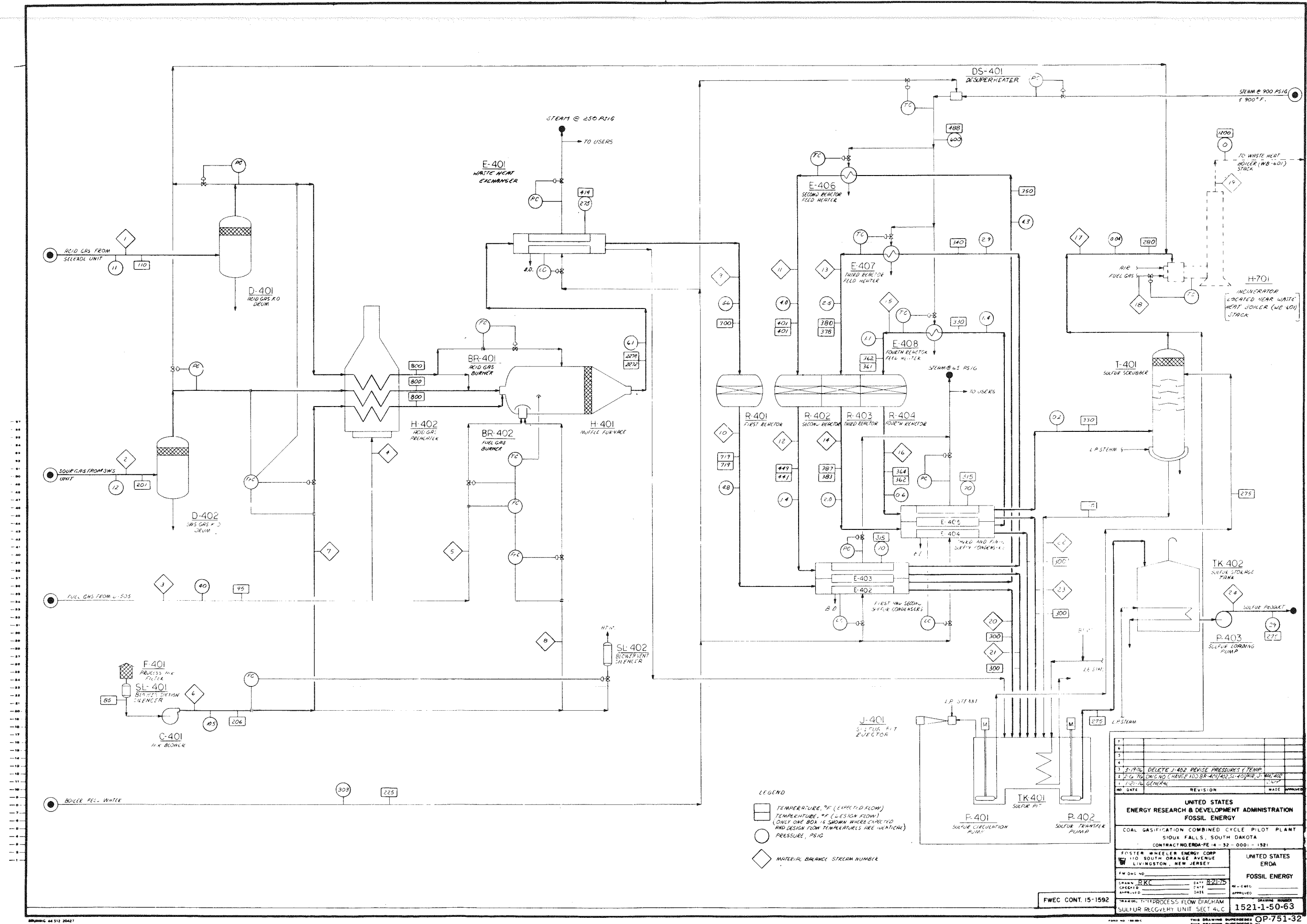
STREAM NO. & UNITS	7	8	9	10	11	12
STREAM DESCRIPTION	AIR TO ACID GAS PREHEATER	AIR TO MUFFLE FUR- NACE FUEL GAS BURNER	FIRST RE- ACTOR FEED	FIRST RE- ACTOR EFFLUENT	SECOND RE- ACTOR FEED	SECOND RE- ACTOR EFFLUENT
OPERATING CASE	EXPECTED	EXPECTED	EXPECTED	EXPECTED	EXPECTED	EXPECTED
FLUID STATE	GAS	GAS	GAS	GAS	GAS	GAS
COMPONENTS (lb•mol/h)						
H ₂						
H ₂ O	7.16	3.24				
CO						
N ₂	183.04	82.70				
O ₂	48.51	21.92				
CO ₂						
H ₂ S						
SO ₂						
COS						
CS ₂						
CH ₄						
S ₂						
S ₄						
S ₆						
S ₈						
S ₁						
NH ₃						
TOTAL (lb•mol/h)	238.71	107.86	760.13	759.48	756.77	752.50
TOTAL (lb/h)	6809	3077	24,592	24,592	24,173	24,173
MOL. WT. OF VAPOR	28.52	28.52	32.35	32.38	31.94	32.12
DENSITY (lb/ft ³) @	0.0970	0.0970	0.0510	0.481	0.0622	0.0573
OPER. TEMP. & PRESS.						
sft ³ /min	1510	682	4808	4804	4787	4760
gal/min						
TEMPERATURE (°F)	206	206	700	719	401	449
PRESSURE (lb/in ²)	10.3	10.3	5.6	4.8	4.0	3.4

STREAM NO. & UNITS	13	14	15	16	17	18
STREAM DESCRIPTION	THIRD REACTOR FEED	THIRD REACTOR EFFLUENT	FOURTH REACT- OR FEED	FOURTH REACT- OR EFFLUENT	SULFUR SCRUB- BER EFFLUENT GAS	FUEL GAS TO INCINERATOR*
OPERATING CASE	EXPECTED	EXPECTED	EXPECTED	EXPECTED	EXPECTED	EXPECTED
FLUID STATE	GAS	GAS	GAS	GAS	GAS	GAS
COMPONENTS (lb·mol/h)						
H ₂						25.80
H ₂ O					163.54	0.02
CO					6.36	36.42
N ₂					334.48	98.71
O ₂						
CO ₂					240.85	12.07
H ₂ S					1.52	
SO ₂					0.76	
COS					0.11	0.03
CS ₂					0.04	
CH ₄						7.40
S ₂						
S ₄						
S ₆					0.02	
S ₈					0.08	
S ₁					0.23	
NH ₃						
TOTAL (lb·mol/h)	749.47	748.86	748.36	748.22	748.00	180.45
TOTAL (lb/h)	23,455	23,455	23,336	23,336	23,236	4490
MOL. WT. OF VAPOR	31.30	31.32	31.18	31.19	31.06	24.88
DENSITY (lb/ft ³) @	0.0572	0.0551	0.0534	0.0515	0.0548	0.1629
OPER. TEMP. & PRESS.						
sft ³ /min	4740	4737	4733	4733	4730	1141
gal/min						
TEMPERATURE (°F)	381	387	362	364	280	95
PRESSURE (lb/in ²)	2.5	2.0	1.1	0.6	0.0	25

*Based on Claus plant tail gas only.

STREAM NO. & UNITS	19	20	21	22	23	24
STREAM DESCRIPTION	INCINERATOR EFFLUENT *	LIQUID SULFUR FROM FIRST CONDENSER	LIQUID SULFUR FROM SECOND CONDENSER	LIQUID SULFUR FROM THIRD CONDENSER	LIQUID SULFUR FROM FINAL CONDENSER	TOTAL LIQUID SULFUR PRODUCT
OPERATING CASE	EXPECTED	EXPECTED	EXPECTED	EXPECTED	EXPECTED	EXPECTED
FLUID STATE	GAS	LIQUID	LIQUID	LIQUID	LIQUID	LIQUID
COMPONENTS (lb·mol/h)						
H ₂	2.58					
H ₂ O	211.76					
CO	5.04					
N ₂	654.44					
O ₂	9.77					
CO ₂	298.24					
H ₂ S						
SO ₂	3.48					
COS						
CS ₂						
CH ₄						
S ₂						
S ₄						
S ₆						
S ₈						
S ₁		13.06	22.39	3.70	3.12	42.27
NH ₃						
TOTAL (lb·mol/h)	1185.31	13.06	22.39	3.70	3.12	42.27
TOTAL (lb/h)	35,956	419	718	119	100	1355
MOL. WT. OF VAPOR	30.33					
DENSITY (lb/ft ³) @	0.02384	111.1	111.1	111.1	111.1	111.8
OPER. TEMP. & PRESS.						
sft ³ /min	7497					
gal/min		0.470	0.805	0.1334	0.1121	1.510
TEMPERATURE (°F)	1200	300	300	300	300	275
PRESSURE (lb/in ²)	0.0	0.0	0.0	0.0	0.0	29

*Based on Claus plant tail gas only.



1.6 UTILITIES AND CATALYSTS

The following are estimated utility and catalyst requirements for the expected cases.

1.6.1 Fuel Gas

Consumption:	<u>10⁶ Btu/h</u>
Fuel Gas Burner (BR-402)	5.19*
Acid Gas Preheater (H-402)	<u>4.69*</u>
Total	9.88*

1.6.2 Electric Power

Consumption:	<u>Expected (kW)</u>	<u>No.</u>	<u>Motor Horsepower</u>
Air Blower (C-401)	128	1	250
Sulfur Circulating Pump (P-401)	5	1	7.5
Transfer Pump (P-402) (Intermittent)	(2)	1	3
Loading Pump (P-403) (Intermittent)	<u>(5)</u>	1	7.5
Total	133		

1.6.3 Steam

High-Pressure Steam

Consumption:	<u>1b/h</u>
Steam Desuperheater (DS-401)	898

Medium-Pressure Steam

Unit Medium-Pressure Steam Balance:	<u>1b/h</u>
Generated by Waste Heat Exchanger (E-401)	12,290
Consumed by Tracing/Jacketing	<u>100</u>
Net Export to Battery Limits	12,190

*The fuel gas consumptions are based on a minimum temperature of 95°F.

Low-Pressure Steam

Unit Low-Pressure Steam Balance: 1b/h

Generation:

First/Second Sulfur condensers (E-402/403)	3,440
Third/Final Sulfur condensers (E-404/405)	<u>606</u>

Total Generation 4,046

Consumption: 1b/h

Sulfur Pit Eductor (J-401)	60
Sulfur Pit Eductor (TK-401)	60
Storage Tank (TK-402)	120
Tracing and Jacketing	<u>200</u>

Total Consumption 440

Net Export 3,606

1.6.4 Water

Boiler Feedwater

Consumption: 1b/h

High-Pressure Steam Desuperheater (DS-401)	222
Waste Heat Exchanger (E-401)	12,410
First/Second Sulfur Condensers (E-402/403)	3,480
Third/Final Sulfur Condensers (E-404/405)	<u>612</u>

Total 16,724

High-Pressure Condensate

Battery Limits Conditions:

Pressure (lb/in ²)	600
Temperature (°F)	488

Return: 1b/h

Second Reactor Feed Heater (E-406)	455
Third Reactor Feed Heater (E-407)	385
Fourth Reactor Feed Heater (E-408)	<u>280</u>

Total Return 1,120

Low-Pressure Condensate

Battery Limits Conditions:

Pressure (lb/in ²)	50
Temperature (°F)	293

Return:	<u>1b/h</u>
---------	-------------

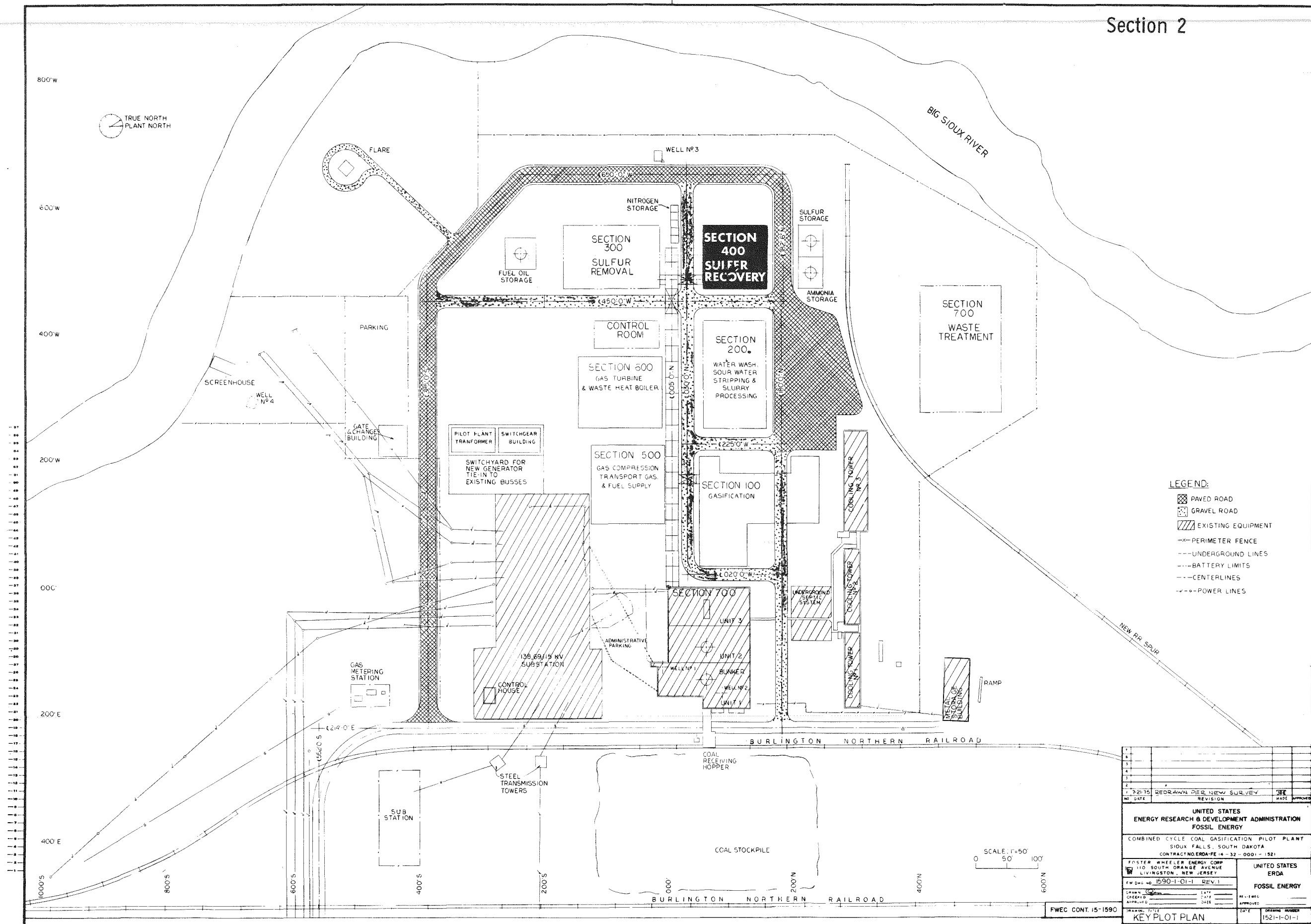
Sulfur Pit (TK-401)	60
Sulfur Storage Tank (TK-402)	120
Tracing and Jacketing	<u>200</u>

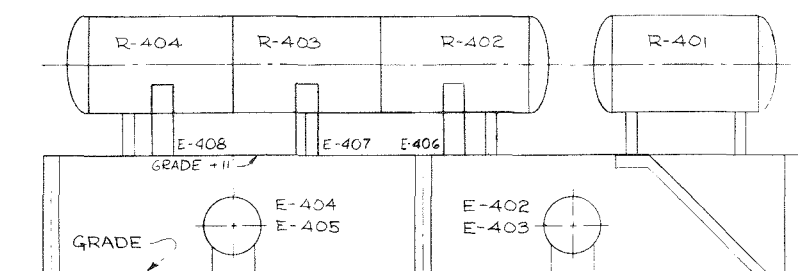
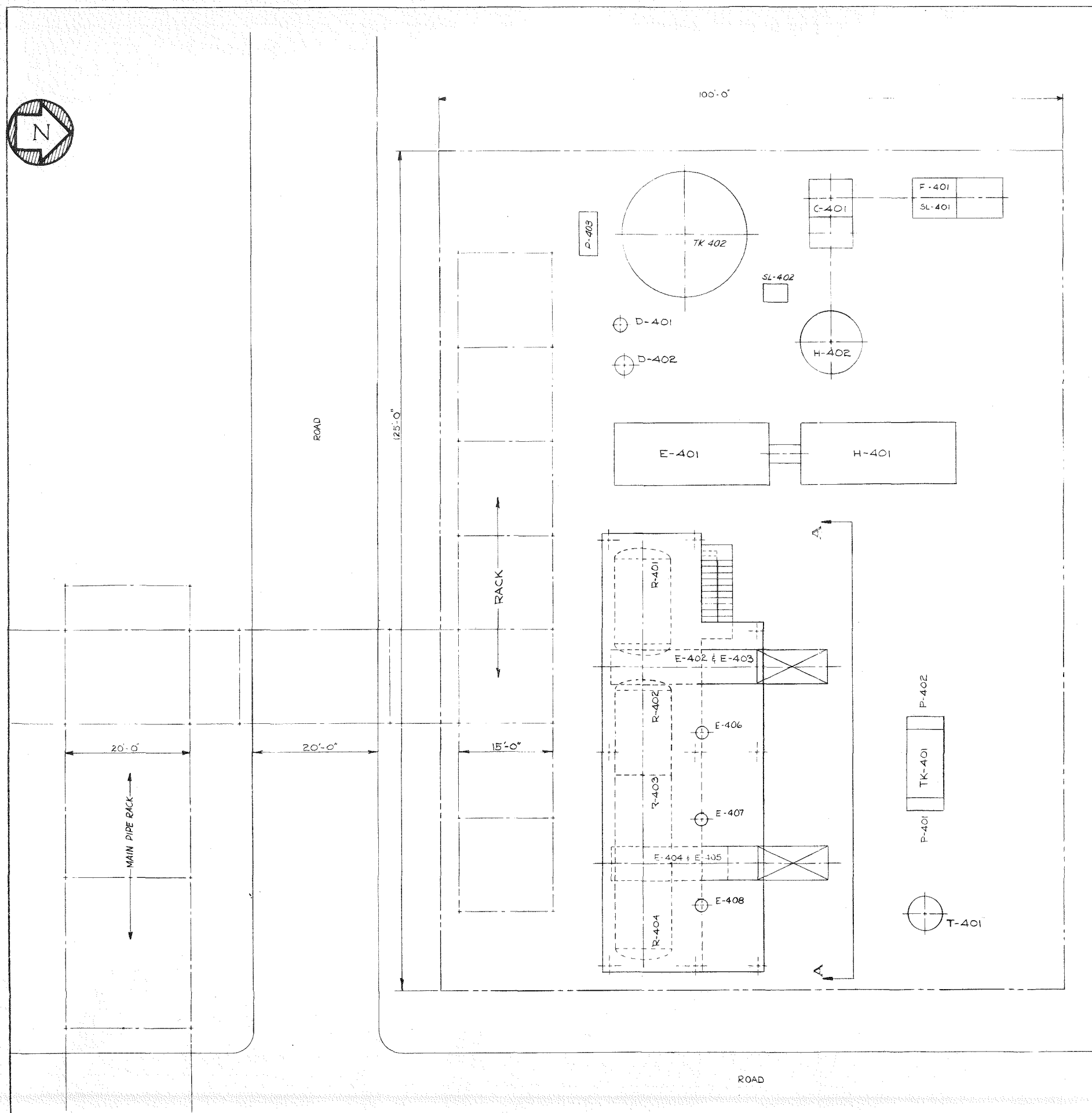
Total Return	380
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1.6.5 Catalysts

Equipment No.	R-401	R-402	R-403	R-404
Reactor	First	Second	Third	Fourth
Catalyst Capacity (ft ³)	435	435	435	435
Vendor	Rhone Progil	Rhone Progil	Rhone Progil	Rhone Progil
Identification	CRS-21	CR	CR	CRS-32
Form	Balls	Balls	Balls	Balls
Diameter (mm)	4-6	4-6	4-6	4-6

Section 2





ELEVATION A-A

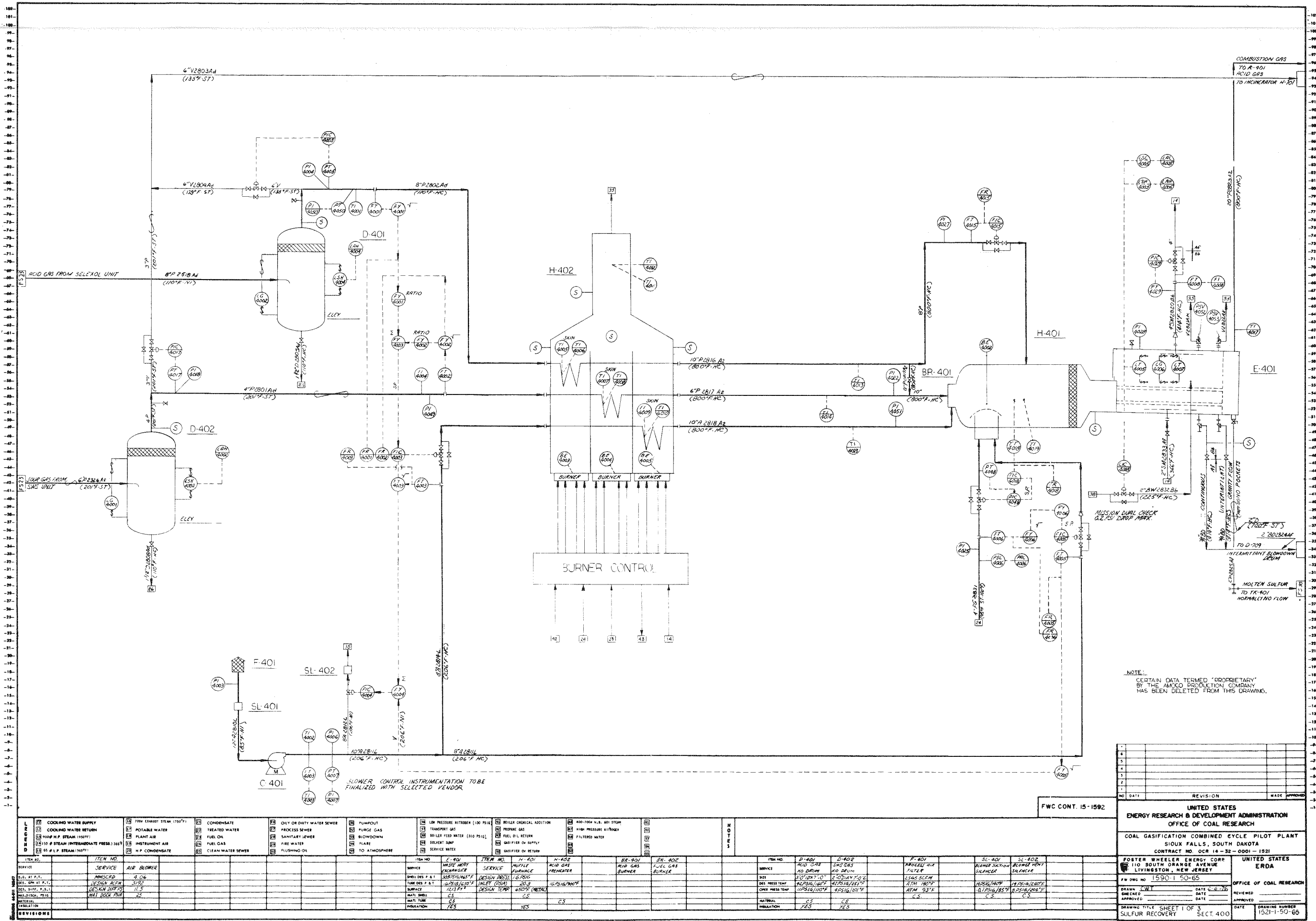
UNITED STATES
ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION
FOSSIL ENERGY
PLOT PLAN
COAL GASIFICATION COMBINED
CYCLE PILOT PLANT
CLAUS SULFUR RECOVERY SECTION 400
SIOUX FALLS SOUTH DAKOTA

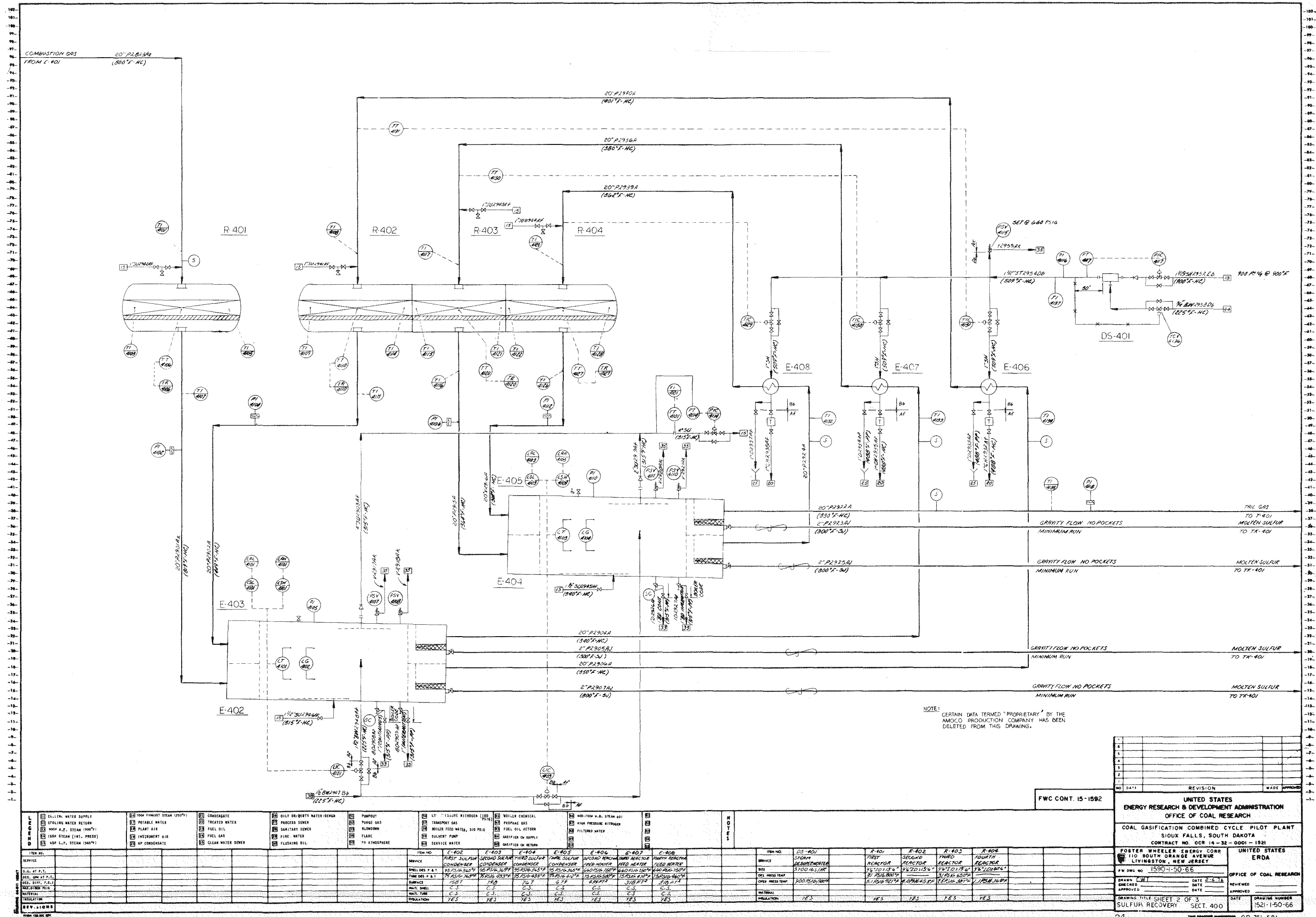


FOSTER WHEELER CORPORATION
110 SOUTH ORANGE AVENUE, LIVINGSTON, N.J.

DRAWN BY: AL SCALE: 1/8" = 1'-0" EST. NO. 15-1590

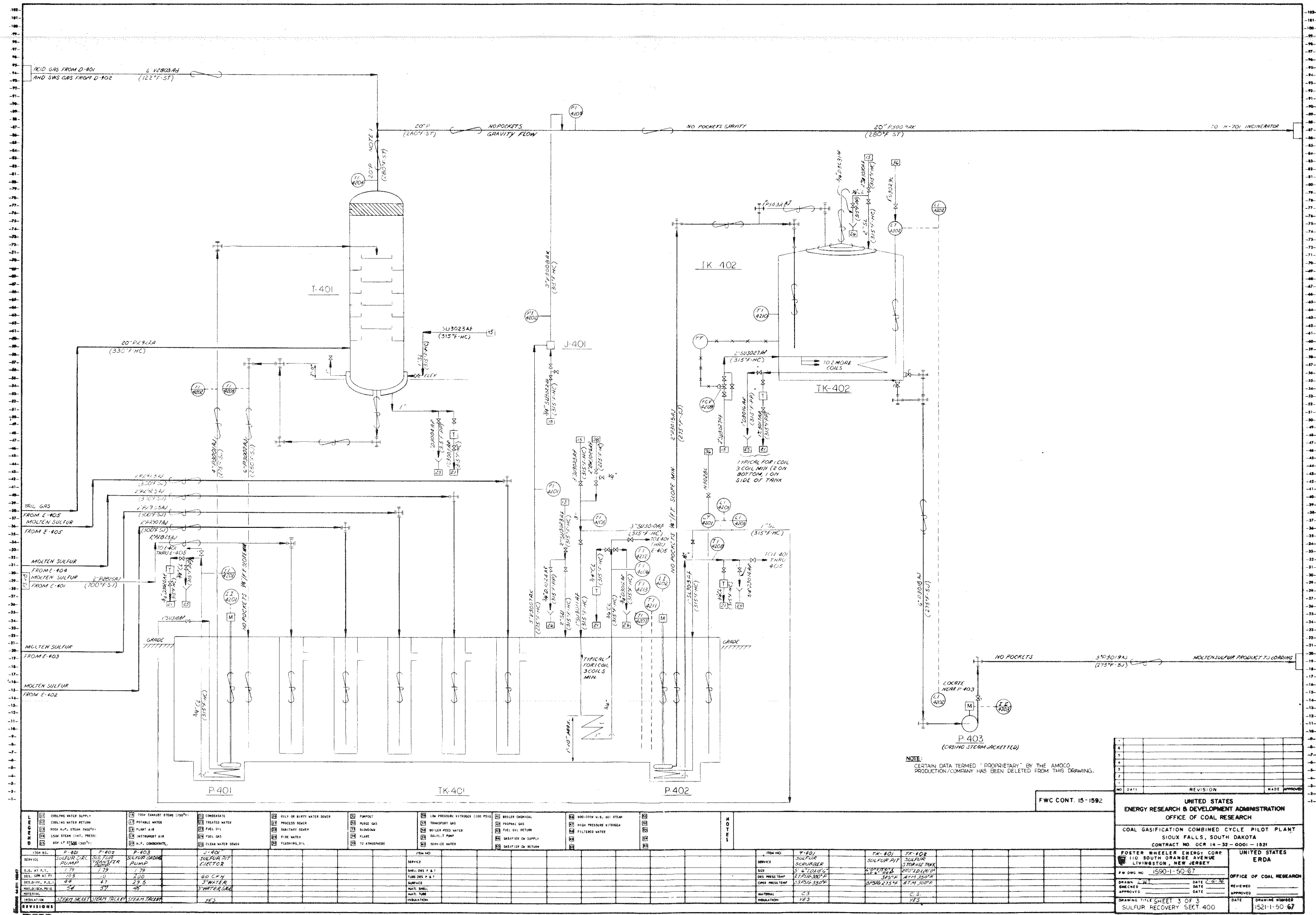
DWG. NO. 1521-2-01-5





REVISION		MADE		APPROVED	
NO.	DATE	BY	DATE	BY	DATE

UNITED STATES ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION OFFICE OF COAL RESEARCH	
COAL GASIFICATION COMBINED CYCLE PILOT PLANT SIOUX FALLS, SOUTH DAKOTA CONTRACT NO. OCR 14-32-0001-1521	
FOSTER WHEELER ENERGY CORP. 110 SOUTH ORANGE AVENUE LIVINGSTON, NEW JERSEY	UNITED STATES ERDA
DRAWN: J.W.T. DATE: 2-6-66 CHECKED: DATE: 2-6-66 APPROVED: DATE: 2-6-66	
DRAWING TITLE: SHEET 2 OF 3 SULFUR RECOVERY SECT. 400	
DATE: 1521-1-50-66 DRAWING NUMBER: 1521-1-50-66	



NO.	DATE	REVISION	MADE	APPROVED
1				
2				
3				
4				
5				
6				

UNITED STATES ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION OFFICE OF COAL RESEARCH COAL GASIFICATION COMBINED CYCLE PILOT PLANT SIOUX FALLS, SOUTH DAKOTA CONTRACT NO. OCR 14-32-0001-1521		UNITED STATES ERDA	
FOSTER WHEELER ENERGY CORP. 110 SOUTH ORANGE AVENUE LIVINGSTON, NEW JERSEY		DATE 2-8-67 DRAWN J.W. CHECKED DATE APPROVED DATE	
FW Dwg No. 1590-1-50-67		OFFICE OF COAL RESEARCH	
DRAWING TITLE SHEET 3 OF 3 SULFUR RECOVERY SECT. 400		DATE 1521-1-50-67 DRAWING NUMBER	

FOSTER WHEELER CORP. PROCESS PLANTS DIVISION				CONTRACT NO:15-1592 SECTION: 400		LINE CLASSIFICATION LIST				FLOWSHEET NUMBER DWG 1521-1-56-65				REV	BY	PAGE							
REVISION		0		1		2		3		4		5		6		7		8		9		10	
DATE		3-11-76																					
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"	P	2801	Ad	D 402	H 402		201	11			ST												
8"	P	2802	Ad	D 401	H 402		110	11			HC												
3"/6"	V	2803	Ad	P2801	H 701		201	11			ST												
6"	V	2804	Ad	P2802	V2803		110	11			NI												
1½"	D	2805	Ad	D 401	26		110	ATM			HC												
3"/6"	V	2806	Ak	P2801	V2803		201	11			ST												
6"	V	2807	Ak	P2802	V2803		110	11			ST												
1½"	D	2808	Ad	D 402	26		110	ATM			HC												
12"	A	2810	L	SL401	C 401		85				NI												
10"/8"	A	2811	L	C 401	BR401		206	11			HC												
8"	A	2812	L	A2811	SL402		206	ATM			NI												
8"	A	2814	L	A2811	H 402		206	11			HC												
3/4"	FO	2815	A	FO2828	43		50	125			SI												
10"	P	2816	Ad	H 402	H 401		800	11			HC												
6"	P	2817	Ad	H402	BR401		800	11			HC												
10"	P	2818	Ad	H 402	BR401		800	11			HC												
8"	P	2819	Ad	P2816	P2817		800	11			HC												
4"	SM	2820	Bb	E 401	14		414	150			HC												
	SM	2821	Ak	E 401	35		414	ATM			PP												
	SM	2822	Ak	E 401	35		414	ATM			PP												
20"	P	2823	A2	E 401	R 401		800	5.0			HC												
3/4/2"	BD	2824	Af	E 401	D 709		414				HC												
2"	P	2825	AJ	E 401	TK401		700	11			SJ												
3/4"	FG	2826	Ak	42	H 402		95	40			NI												
3"	FG	2827	Ak	24	H 402		95	40			NI												
3/4"	FO	2828	A	23	H 402		50	125			ST												
3/4"	SM	2829	Bb	14	H 402		414	250			HC												
3/4"	FG	2830	Ak	42	BR402		95	40			NI												
4"	FG	2831	Ak	24	BR402		95	40			NI												

Section 3

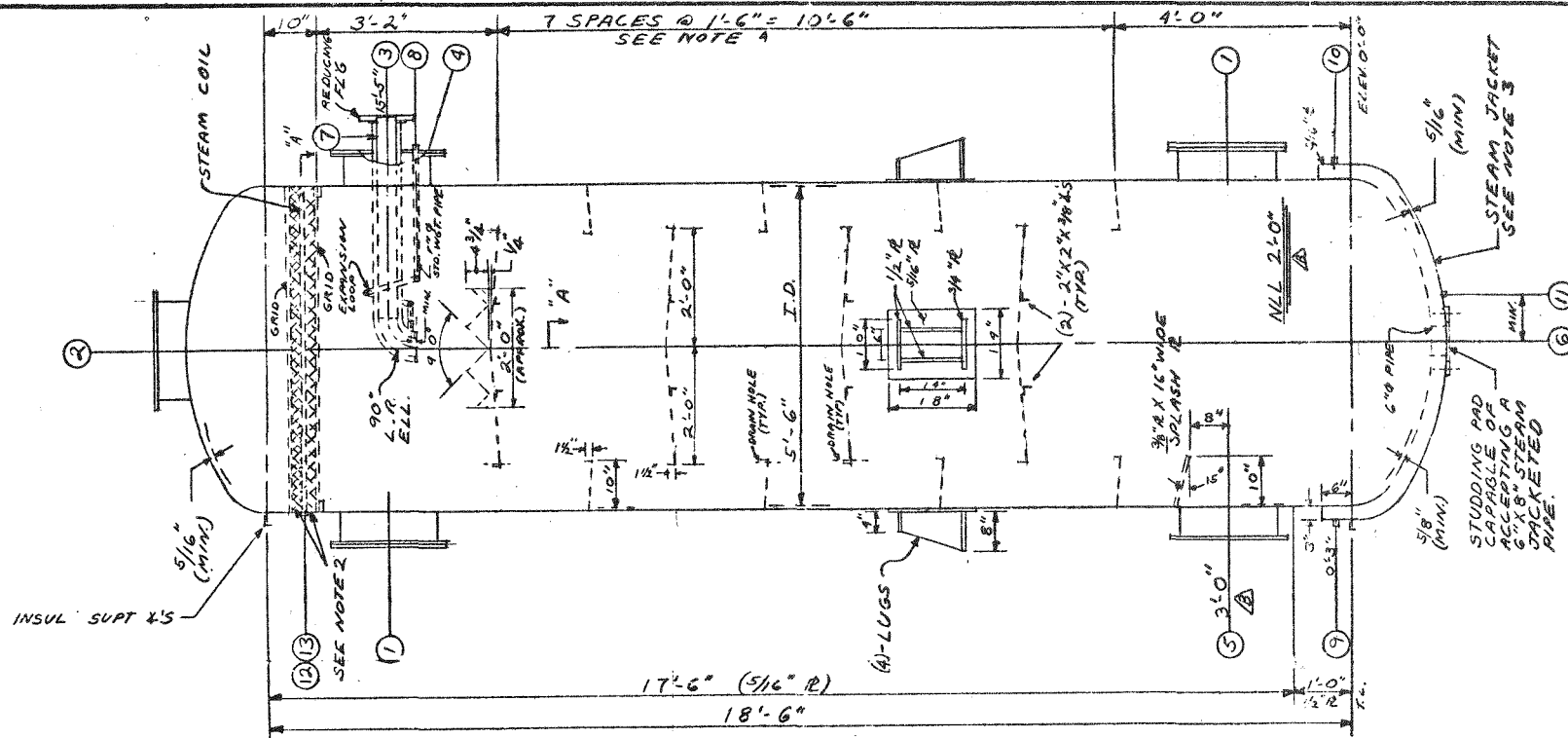
FOSTER WHEELER CORP. PROCESS PLANTS DIVISION			CONTRACT NO: 15-1592 SECTION: 400		LINE CLASSIFICATION LIST				FLOWSHEET NUMBER DWG 1521-1-50-66			REV	BY	PAGE
REVISION	0	1	2	3	4	5	6	7	8	9	10		JJS	1
DATE														
LINE NUMBER			LINE EXTREMITIES		OPERATING		DESIGN		INSULATION		PLAN OR ISO. DRAWING NO.	PIPE WALL TKN.	REMARKS	
SIZE	SERIAL	SPEC	FROM	TO	TEMP °F	PRESS PSIG	TEMP °F	PRESS PSIG	TYPE	TKN.				
20"	P	2823	A2	E 401	R 401	800	11		HC					
20"	P	2901	A2	R 401	E 402	721	5.1		HC					
20"	P	2902	A	R 402	E 403	453	4.0		HC					
4"	SU	2903	Af	E 403	15	315	65		HC					
20"	P	2904	A	E 403	E 407	340	3.5		HC					
2"	P	2905	AJ	E 403	TK401	300	3.5		SJ					
20"	P	2906	A	E 402	E 406	350	4.0		HC					
2"	P	2907	AJ	E 403	TK401	300	3.5		SJ					
1"	BD	2908	Af	E 402	33	315	65		PP					
1"	BD	2909	Af	E 403	33	315	65		PP					
1"	C	2910	Af	E 402	21	315	65		PP					
1"	D	2911	Af	E 402	26	315	65		PP					
1"	SU	2912	Af	15	E 402	315	65		HC					
1"	C	2913	Af	E 403	21	315	65		HC					
1"	D	2914	Af	E 403	26	315	ATM		HC					
20"	P	2915	A	R 403	E 404	364	2.5		HC					
20"	P	2916	A	R 404	E 405	365	0.9		HC					
	V	2917	Ak	E 403	35	315	ATM		PP					
	V	2918	Ak	E 404	35	315	ATM		PP					
2"	SU	2919	Af	E 404	SL2903	315	70		HC					
	V	2920	Ak	E 404	35	315	ATM		PP					
	V	2921	Ak	E 405	35	315	ATM		PP					
20"	P	2922	A	E 405	T 401	330	0.4		HC					
2"	P	2923	AJ	E 405	TK401	300	3.5		SJ					
20"	P	2924	A	E 404	E 408	340	2.2		HC					
2"	P	2925	AJ	E 404	TK401	300	2.2		SJ					
1"	BD	2926	Af	E 404	33	315	70		PP					
1"	BD	2927	Af	E 404	33	315	70		PP					
1"	C	2928	Af	E 404	21	315	65		PP					
1"	D	2929	Af	E 404	26	315	ATM		PP					
1"	D	2930	Af	E 405	21	315	65		HC					
1"	D	2931	Af	E 405	26	315	ATM		HC					

[illegible]

[illegible]

FW ENERGY CORPORATION PROCESS PLANTS DIVISION		CONTRACT 15-1592	SECTION 400	EQUIPMENT LIST		TYPE OF UNIT COAL GASIFICATION PROJECT			PAGE	OF
CUSTOMER ERDA-FE				REVISION	6	7	8	3	4	5
LOCATION SIOUX FALLS, SOUTH DAKOTA				DATE	1/14/76	4/7/76	4/26/76	9/2/75	9/15/75	12/11/75
CLASS	ITEM NO.	DESCRIPTION	FD #	REQ'N. NO.	P.O. NO.	ELEVATION				
TOWER REACTORS	T-401	Sulfur Scrubber		1113-A						
	R-401	First Reactor		1121A						
	R-402	Second Reactor		1122A						
	R-403	Third Reactor		1123A						
	R-404	Fourth Reactor		1124A						
DRUMS	D-401	Acid Gas KO Drum		1131AA						
	D-402	SWS Gas KO Drum		1131AB						
TANKS	TK-401	Sulfur Pit		1141H						
	TK-402	Sulfur Storage Tank		1141J						
EXCHANGERS	E-401	Waste Heat Exchanger		1211M						
	E-402	First Sulfur Condenser		1211N						
	E-403	Second Sulfur Cond.		1211P						
	E-404	Third Sulfur Cond.		1211Q						
	E-405	Final Sulfur Cond.		1211R						
	E-406	Second Reactor Feed Heater		1211S						
	E-407	Third Reactor Feed Heater		1211T						
	E-408	Fourth Reactor Feed Heater		1211U						
HEATERS	H-401	Muffle Furnace		1241C						
	H-402	Air and Acid Gas Preheater		1241D						
	BR-401	Acid Gas Burner		1241E						
	BR-402	Fuel Gas Burner		1241F						
PUMPS	P-401	Sulfur Circ. Pump		1311R						
	P-402	Sulfur Transfer Pump		1311S						
	P-403	Sulfur Loading Pump		1311T						
COMPRESSORS	C-401	Air Blower		1323A						
	F-401	Process Air Filter		1349F						
FILTERS MISC.	DS-401	HP Steam Desuperheater		1292A						
	J-401	Sulfur Pit Ejector		1272A						
	SL-401	Blower Suction Silencer		1344A						
	SL-402	Blower Vent Silencer		1344C						

Section 4



NOTES:

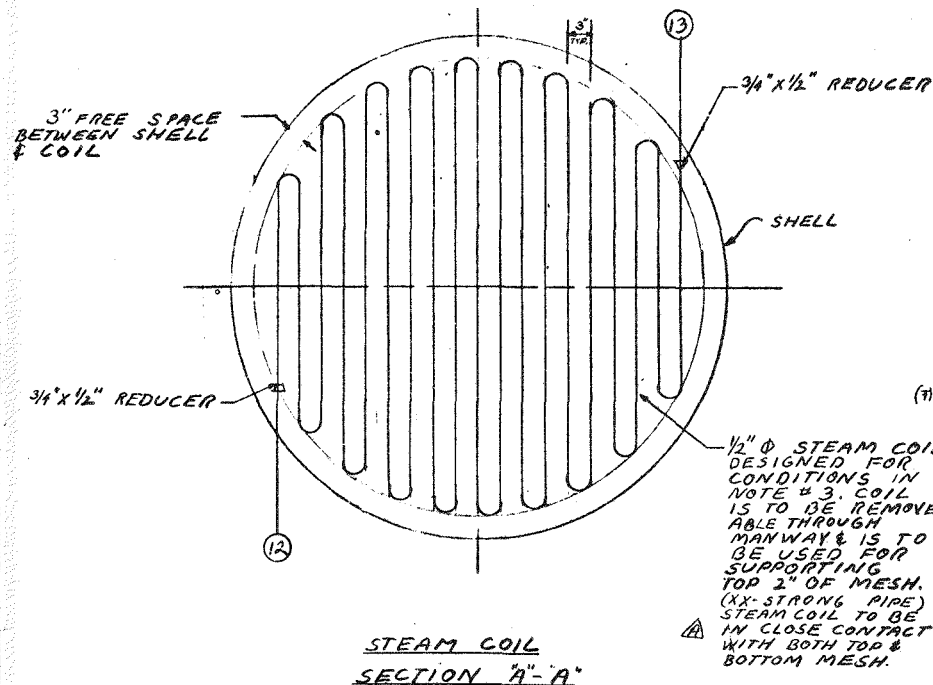
1. VENDOR TO SUPPLY 8 - 3/16" THK 11/13% CR TRAYS ALL WELDED IN CONSTRUCTION. EACH WITH 4 - 3/4" DRAIN HOLES. EACH DISC TRAY TO HAVE APPROX. 50 EQUALLY SPACED WEIR NOTCHES. THE WEIR OF EACH DONUT TRAY TO HAVE APPROX. 45 EQUALLY SPACED NOTCHES. THE NOTCHES TO BE 90° "V" NOTCHES. ALL TRAYS TO BE SLOPED 1" PER FOOT.
2. 2" THK MIST ELIMINATORS ON TOP & BOTTOM OF STEAM COIL, INCL. LT. WGT. GRIDS TOP & BOTTOM PER F.W. ENG STD. 10B15.1 MAT'L OF MESH: CARPENTER 20CB3
3. STEAM CONDITIONS
 65 PSIG OPER. PRESSURE
 90 PSIG DESIGN PRESSURE
 308 °F OPER. TEMPERATURE
 358 °F DESIGN TEMPERATURE
4. THIS AREA TO BE STEAM TRACED WITH 1" TUBING SPACED 6" APART AND THERMONIZED IN THE FIELD BY OTHERS.

REFERENCE DRAWINGS, REQUISITIONS, STANDARDS

1590-10A1 1590-83A1
 1590-1100B
 1590-90A1 10B13.2 OP-764-605
 1590-50A2 10B14.1
 1590-82A1 10B15.1

B 3/4" DIA. ELEV. OF CONN. 5'		RJM	
A 3/4" DIA. REV'D AS NOTED		RJM	
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	
FW ENG NO. OP-764-604-B		FOSSIL ENERGY	
DRAWN RJM CHECKED APPROVED	DATE 5/1/76 DATE DATE	REVIEWED APPROVED	DRAWING NUMBER
DRAWING TITLE: SULFUR SCRUBBER T-401			
FWEC CONT. 15-1592		REQ'N NO. 1590-11/3-A	





STEAM COIL
SECTION "A-A"

(F)

CONN. #	SERVICE	PIPE SIZE	JACKET SIZE	REDUCING FLANGE
3	LIQUID INLET	4"-SCH.80	6"-SCH.80	4"x11" O.D.-150"

RELEASES

DWG. 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

CONN. NO.	SIZE	USAS. RATING	SERVICE	NO. REQD.
1	20"	150" RF	MANWAY 40AVIT	2
2	20"		GAS OUTLET	1
3	4"x6"		LIQUID INLET	1
4	18"		SLEEVE FOR CONN. 3	1
5	20"		GAS INLET	1
6	6"x8"		LIQ. OUTLET (STUBBING PAD)	1
7	1"	COND. FROM CONN. 3	STEAM TO CONN. 3	1
8	1"		COND. FROM CONN. 3	1
9	1"		STEAM TO JACKET	1
10	1"		VENT FROM JACKET	1
11	1"		COND. FROM JACKET	1
12	3/4"		STEAM COIL INLET	1
13	3/4"		CONDENSATE OUTLET	1

VESSEL DATA

1	ITEM NO:	T-401	NO. REQD:	ONE
2	SERVICE:	SULFUR SCRUBBER		
3				
4	DIAMETER: (INSIDE)	5'-6"		
5	TARGET LENGTH:	18'-6"		
6	OPER. PRESSURE:	NORM.: 0.3 (TOP) PSIG		
7	ABOVE LIQUID LEVEL, MAX.:	0.4 PSIG		
8	DESIGN PRESSURE:	27 PSIG		
9	OPER. LIQUID HOLD-UP PRESS:	1.6 PSI		
10	OPER. PRESS. DROP THRU VESSEL:	0.1 PSI		
11	MAX. BELIEVING PRESS. @ TOP HD.:	25 PSIG		
12	MAX. OPER. TEMPERATURE:	330°F		
13	DESIGN TEMPERATURE:	380°F		
14	SPECIFIC GRAVITY (PROCESS FLUID):	1.78 @ 298°F		
15	CODE:	ASME SEC VIII DIV. 1 STAMPED: YES		
16	P.W.H.T.: FOR CODE:	NO	FOR PROCESS:	NO
17	RADIOGRAPHED:	SPOT		
18	JOINT EFFICIENCY:	85%		
19	CORROSION ALLOWANCE: SHELLS:	1/8" HEADS: 1/8"		
20	MATL. SHELL:	SA-285 G.P.C.		
21	MATL. HEADS:	SA-285 G.P.C.		
22	MATL. SUPPORTS:	SA-285 G.P.C.		
23	TYPE OF HEADS:	2:1 ELLIPTICAL		
24	EXTERNAL BOLTING:	SA-193-B7/SA-194-2H		
25	INTERNAL BOLTING:	S.S.		
26	GASKETS:	COMP. ASBESTOS		
27	BOLT HOLES:	STRADDLE VESSEL CENTERLINE		
28	PAINT:	YES, PER 1590-83A1		
29	INSULATION:	YES (2" THK) BY OTHERS		
30	SHIPMENT:	ONE PIECE		
31				
32	EMPTY WGT.:	10600	LBS	
33	WATER WGT.:	30100	LBS	
34	TRAYS WGT.:	-	LBS	
35	INSULATION WGT.:	1000	LBS	
36	GRUITE WGT.:	-	LBS	
37	OPER. LIQUID WGT.:	3100	LBS	
38	* FOR STEAM JACKET = 1/16"			
39	* INSUL. SUP'T'S BY VESSEL VENDOR			
40				
41	HYDROTEST: SHOP:	FIELD:	PSI	
42	GAGE LOCATION:			
43	MAX. ALLOW. PRESS. (HEV & 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

FW DWS NO. OP-764-605-A

DRAWN: AJM DATE: 3/3/76
CHECKED: DATE:
APPROVED: DATE:

REVIEWED:
APPROVED:

DRAWING TITLE:
SULFUR SCRUBBER T-401

DRAWING NUMBER:

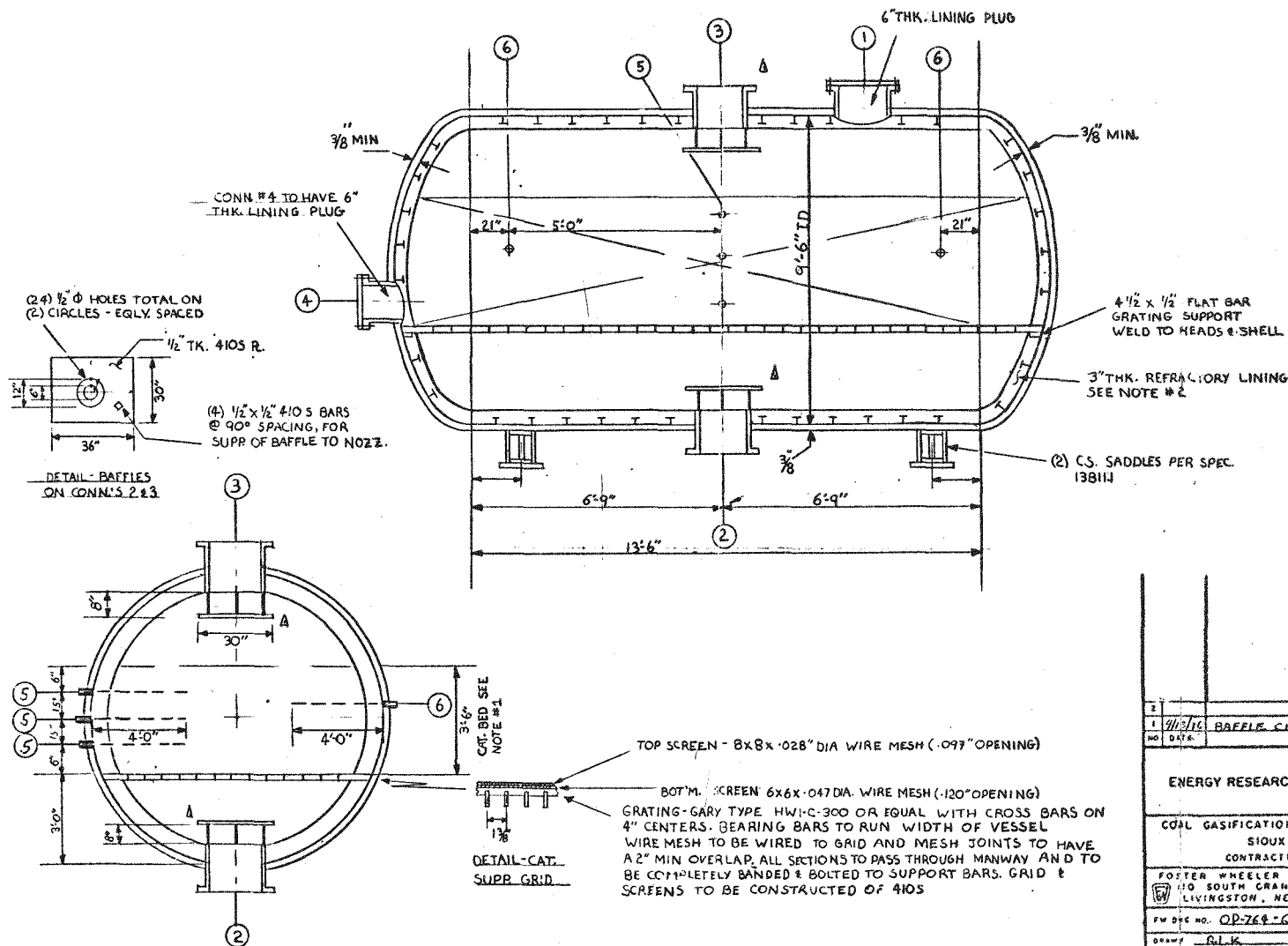
FWEC CONT. 15-1592

REQ'N NO.
1590-1113-A

REFERENCE DRAWINGS, REQUISITIONS, STANDARDS

OP-764-604





REFERENCE DRAWINGS, REQUISITIONS, STANDARDS

1590-10A1 87A2 OP-764-636
1590-1100B 138114
1590-50A2
1590-83A1

2					
1	4/2/16	BAFFLE CHANGE	RLK	MADE	APPROVED
NO DATE		REVISION			
UNITED STATES ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION FOSSIL ENERGY					
COAL GASIFICATION COMBINED CYCLE PILOT PLANT SIOUX FALLS, SOUTH DAKOTA CONTRACT NO. ERDA-PE 14-32-0001-1521					
FOSTER WHEELER ENERGY CORP 110 SOUTH CRANFORD AVENUE LIVINGSTON, NEW JERSEY			UNITED STATES ERDA		
FW DYS NO. OP-764-635-1			FOSSIL ENERGY		
DRAWN	RLK	DATE	3/23/79	REVIEWED	
CHECKED		DATE		APPROVED	
DRAWING TITLE					
FIRST REACTOR R-401					
FWEC CONT. 15-1590				REQ'N #2	



TO BE
CONFIRMED

1. REACTOR TO CONTAIN 434 FT³ OR CRS-21 CATALYST
MADE BY RHONE-POGIL (1/4" - 1/2" M. BALLS) W: 45#/FT³
2. LINING (LOW IRON REFRACTORY) TO BE "HAYDITE
LUMNITE" (MIXED #11) CASTABLE OR EQUAL.
LINING APPLIED IN ACCORDANCE WITH FW SPEC 87A2
3. THERMAL WELLS TO BE RETRACTABLE TYPE
4. NO COPPER OR ITS ALLOYS TO BE USED
5. NOZZLES EXTENDED INTO LINING TO HAVE 3"x1/4"
RETAINING RING



RELEASES

DWG. 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

CORN. NO.	SIZE	USAS. RATING	SERVICE	NO. REQD
1	20"	150# RE	MANWAY W/DAVIT	1
2	20"		GAS OUTLET	1
3	20"		GAS INLET	1
4	18"		CAT. DUMP	1
5	1"	6000# CPG	TI	3
6	1"	6000# CPG	TI	2

VESSEL DATA

1	ITEM NO:	R-401	NO. REQ'D:	ONE
2	SERVICE:	FIRST REACTOR		
3				
4	DIAMETER:	9'-6" ID		
5	TARGET LENGTH:	13'-6"		
6	OPER. PRESSURE:	NORM.: 51	PSIG	
7	ADD'L LIQUID LEVEL, MAX.:		PSI	
8	DESIGN PRESSURE:	31	PSIG	
9	OPER. LIQUID HOLD-UP PRESS:		PSI	
10	OPER. PRESS. DROP THRU VESSEL:	-8 A	PSIG	
11	MAX. RELIEVING PRESS. @ TOP NO.:	30	PSIG	
12	MAX. OPER. TEMPERATURE:	721°F		
13	DESIGN TEMPERATURE:	SHELL 650°/CRD 800° F		
14	SPECIFIC GRAVITY (PROCESS FLUID):			
15	CODE: ASME SECT VIII DIV I	STAMPED: YES		
16	P.W.N.Y.: FOR CODE:	NO	FOR PROCESS:	NO
17	RADIOGRAPHED:	SPOT		
18	JOINT EFFICIENCY:	85%		
19	CORROSION ALLOWANCE: SHELLS:	1/8" HEADS: 1/8"		
20	MATL. SHELL:	SA-285-C		
21	MATL. HEADS:	SA-285-C		
22	MATL. SUPPORTS:	SA-285-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-HEAT CONS. (BY OTHERS)		
30	SHIPMENT:	ONE PIECE		
31				
32	EMPTY WGT.:	57000	LBS	
33	WATER WGT. (ONLY)	73664	LBS	
34	TRAYS WGT.:		LBS	
35	INSULATION WGT.:		LBS	
36	GUNITE WGT.:		LBS	
37	OPER. LIQUID WGT.:		LBS	
38	CAT. WGT:	20845	LBS	
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-7E 16-32-11001-1521

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

UNITED STATES
ERDA

FW DWG NO. OP-764-636-1

FOSSIL ENERGY

DRAWN: R.K. DATE: 3/23/76
CHECKED: DATE: 3/23/76
APPROVED: DATE: 3/23/76

REVIEWED: DATE: 3/23/76
APPROVED: DATE: 3/23/76

DRAWING TITLE
FIRST REACTOR R-401

DRAWING NUMBER

FWLC CONT. 15-1590

REQ'N NO

REFERENCE DRAWINGS, REQUISITIONS, STANDARDS

OP-764-635

NOTES

1. EACH REACTOR TO CONTAIN 435 FT³ OF CATALYST MADE BY RHONE-POULANC FOR R-402 (R-403, CR TYPE CATALYST (8-6 MM SIZE BALLS); BULK DENSITY = 44.5 #/FT³); R-404 CRS-32 TYPE CATALYST (5-10 MM SIZE BALLS; BULK DENSITY: 50.5 #/FT³)
2. THERMAL WELLS TO BE RETRACTABLE TYPE
3. NO COPPER OR ITS ALLOYS TO BE USED
4. PARTITION PLATES TO HAVE 1/2" Ø PRESSURE EQUALIZATION HOLE ABOVE & BELOW CAT BED AS SHOWN IN DWG.
5. REFRACTORY LINING TO BE CASTABLE "HAYDITE LUMNITE" (MIXED 4:1) OR EQUAL. LINING TO BE APPLIED IN ACCORDANCE WITH E.W. STD. 87A2
6. NOZZLES EXTENDED INTO LINING TO HAVE 3"x1/4" RETAINING RING

TO BE
CONFIRMED

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

CONN. NO.	SIZE	USAS. RATING	SERVICE	NO. REQ.
1	20"	150# RF	MANWAY W/DAVIT	3
2	20"		GAS OUTLET R-402	1
3	20"		GAS INLET R-403	1
4	20"		GAS OUTLET R-403	1
5	20"		GAS INLET R-404	1
6	20"		GAS OUTLET R-404	1
7	20"		GAS INLET R-402	1
8	18"		CATALYST DUMP	3
9	1"	6000# CPLG	TI	9
10	1"	6000# CPLG	TI	6

VESSEL DATA

1	ITEM NO. R-402/R-403/R-404 NO. REQ'D: ONE
2	SERVICE: SECOND, THIRD, & FOURTH REACTORS
3	
4	DIAMETER: 96" ID
5	TANGENT LENGTH: 40'6"
6	OPER. PRESSURE: NORM.: 5.0 PSIG
7	ABOVE LIQUID LEVEL, MAX.: PSI
8	DESIGN PRESSURE: 31 PSIG
9	OPER. LIQUID HOLD-UP PRESS: PSI
10	OPER. PRESS. DROP THRU VESSEL: 6 A PSIG
11	MAX. RELIEVING PRESS. @ TOP NO.: 30 PSIG
12	MAX. OPER. TEMPERATURE: 453/389/369 °F
13	DESIGN TEMPERATURE: 650 °F
14	SPECIFIC GRAVITY (PROCESS LIQUID): —
15	CODE: ASME SECTION VIII STAMPED: YES
16	P.W.M.T.: FOR CODE: NO FOR PROCESS: NO
17	RADIOGRAPHED: SPOT
18	JOINT EFFICIENCY: 85%
19	CORROSION ALLOWANCE: SHELLS: 1/16" HEADS: 1/8"
20	MATL., SHELL: SA-285-C
21	MATL., HEADS: SA-285-C TO BE CONFIRMED
22	MATL., SUPPORTS: SA-285-C CONFIRMED
23	TYPE OF HEADS: 2:1 ELLIP
24	EXTERNAL BOLTING: SA-193-B7/SA-194-3H
25	INTERNAL BOLTING:
26	GASKETS: ASB, COMP
27	BOLT HOLES: STRADDLE VESSEL CENTERLINE
28	PAINT: PER SPEC 1590-83A1
29	INSULATION: YES (HEAT CON.) BY OTHERS
30	SHIPMENT: ONE PIECE
31	
32	EMPTY WGT.: 45000 LBS
33	WATER WGT.: (ONLY) 183600 LBS
34	TRAYS WGT.: LBS
35	INSULATION WGT.: LBS
36	GUNITES WGT.: LBS
37	OPER. LIQUID WGT.: LBS
38	CATALYST WGT.: 60683 LBS
39	
40	
41	HYDROTEST: SHOP: FIELD: PSI
42	GAGE LOCATION:
43	MAX. ALLOW. PRESS. (HEAT & COOL): 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-764-628-1

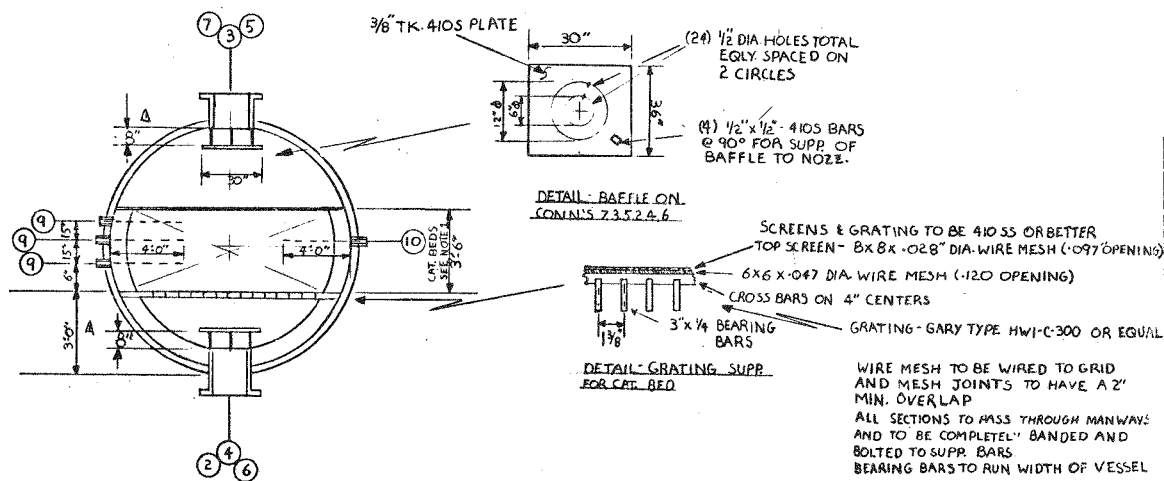
DRAWN: R.L.K. DATE: 3/18/76
CHECKED: DATE: 3/18/76
APPROVED: DATE: 3/18/76

DRAWING TITLE: R-402/R-403/R-404
SECOND, THIRD, & FOURTH REACTORS

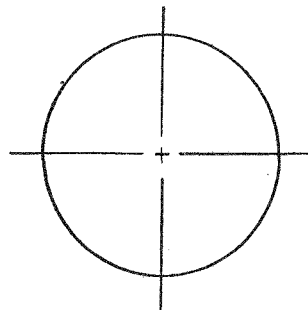
FWEC CONT. 15-1590

REQ'N NO.

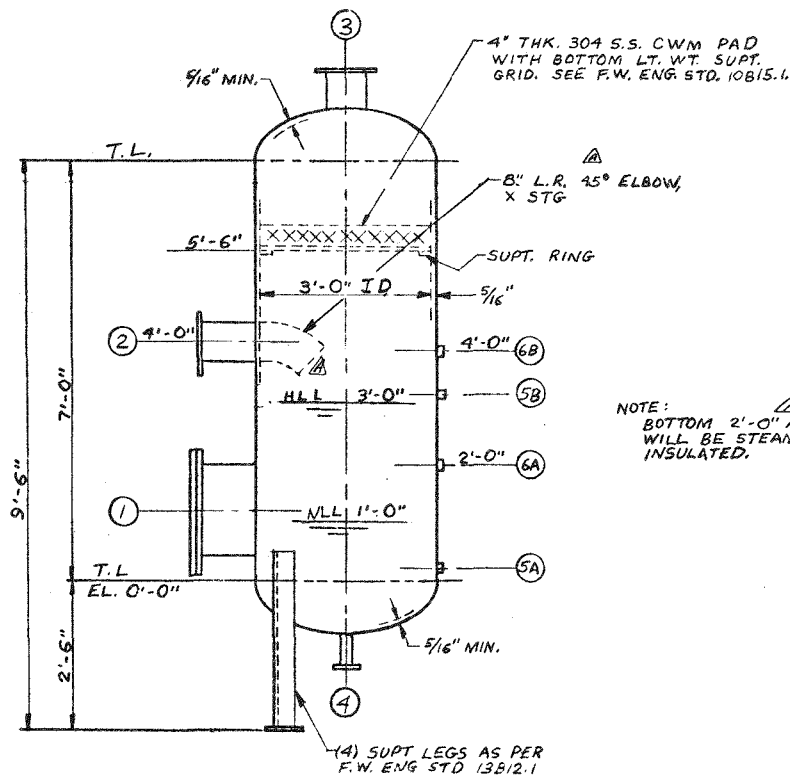
REFERENCE DRAWINGS, REQUISITIONS, STANDARDS
OP-764-629



2											
1	1/13/72	NOTE: BUFF. DETAIL			RLK						
NO	DATE	REVISION			MADE						
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 <table border="1" style="width: 100%;"> <tr> <td style="width: 60%;"> FOSTER WHEELER ENERGY CORP 110 SOUTH ORANGE AVENUE LIVINGSTON, NEW JERSEY FW DWS NO. <u>OP-764-GL9-1</u> </td> <td style="width: 40%;"> UNITED STATES ERDA FOSSIL ENERGY </td> </tr> </table> <table border="1" style="width: 100%;"> <tr> <td style="width: 60%;"> DRAWN <u>RLK</u> DATE <u>3/18/72</u> CHECKED _____ DATE _____ APPROVED _____ DATE _____ DRAWING TITLE: <u>R402/R-403/R-404</u> <u>SECOND, THIRD, & FOURTH REACTORS</u> </td> <td style="width: 40%;"> REVIEWED _____ APPROVED _____ TRAINING NUMBER _____ </td> </tr> </table> <table border="1" style="width: 100%;"> <tr> <td style="width: 50%;">FWEC CONT. 15-1590</td> <td style="width: 50%;">REQ'N N2</td> </tr> </table>						FOSTER WHEELER ENERGY CORP 110 SOUTH ORANGE AVENUE LIVINGSTON, NEW JERSEY FW DWS NO. <u>OP-764-GL9-1</u>	UNITED STATES ERDA FOSSIL ENERGY	DRAWN <u>RLK</u> DATE <u>3/18/72</u> CHECKED _____ DATE _____ APPROVED _____ DATE _____ DRAWING TITLE: <u>R402/R-403/R-404</u> <u>SECOND, THIRD, & FOURTH REACTORS</u>	REVIEWED _____ APPROVED _____ TRAINING NUMBER _____	FWEC CONT. 15-1590	REQ'N N2
FOSTER WHEELER ENERGY CORP 110 SOUTH ORANGE AVENUE LIVINGSTON, NEW JERSEY FW DWS NO. <u>OP-764-GL9-1</u>	UNITED STATES ERDA FOSSIL ENERGY										
DRAWN <u>RLK</u> DATE <u>3/18/72</u> CHECKED _____ DATE _____ APPROVED _____ DATE _____ DRAWING TITLE: <u>R402/R-403/R-404</u> <u>SECOND, THIRD, & FOURTH REACTORS</u>	REVIEWED _____ APPROVED _____ TRAINING NUMBER _____										
FWEC CONT. 15-1590	REQ'N N2										



ORIENTATION



NOTE:
 BOTTOM 2'-0" AND BTM HEAD
 WILL BE STEAM TRACED AND
 INSULATED.

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. REQ.
1	18"	150# R.F.	MANWAY W/DAVIT	1
2	8"		GAS INLET	1
3	8"		GAS OUTLET	1
4	1 1/2"		CONDENSATE OUTLET	1
5	3/4"	6000# CPLG	LG	2
6	1"		LA	2

VESSEL DATA

1	ITEM NO:	D-401	NO. REQ'D:	CNE
2	SERVICE:	ACID GAS K.O. DRUM		
3				
4	DIAMETER:	3'-0" ID		
5	TANGENT LENGTH:	7'-0"		
6	OPER. PRESSURE:	NORM.: 11 PSIG		
7	(ABOVE LIQUID LEVEL) MAX.:	11 PSIG		
8	DESIGN PRESSURE:	44 PSIG		
9	OPER. LIQUID HOLD-UP PRESS:	1.6 PSIG		
10	OPER. PRESS. DROP THRU VESSEL:	PSI		
11	MAX. RELIEVING PRESS. @ TOP NO.:	42 PSIG		
12	MAX. OPER. TEMPERATURE:	110°F		
13	DESIGN TEMPERATURE:	160°F		
14	SPECIFIC GRAVITY (PROCESS FLUID):	0.99 @ 109°F		
15	CODE: ASME SECT VIII DIV 1	STAMPED: YES		
16	P.W.H.T.: FOR CODE:	NO FOR PROCESS: YES		
17	RADIOGRAPHED:	SPOT		
18	JOINT EFFICIENCY:	0.85		
19	CORROSION ALLOWANCE: SHELLS:	1/8" HEADS: 1/8"		
20	MAT'L. SHELL:	SA-285 GPC		
21	MAT'L. HEADS:	SA-285 GRC		
22	MAT'L. SUPPORTS:	SA-36		
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 CENTER LINE		
28	PAINT:	AS PER SPEC 1590-83A1		
29	INSULATION:	YES-BY OTHERS (SEE NOTE)		
30	SHIPMENT:	ONE PIECE		
31				
32	EMPTY WGT.:	2300 LBS		
33	WATER WGT.:	3740 LBS		
34	TRAYS WGT.:	LBS		
35	INSULATION WGT.:	LBS		
36	GURITE WGT.:	LBS		
37	OPER. LIQUID WGT.:	1620 LBS		
38				
39				
40				
41	HYDROTEST: SHOP:	FIELD:	PSI	
42	GAGE LOCATION:			
43	MAX. ALLOW. PRESS. (REV & CORR.):		PSI	

UNITED STATES
ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION
FOSSIL ENERGY

COAL GASIFICATION COMBINED CYCLE PILOT PLANT
SIOUX FALLS, SOUTH DAKOTA
CONTRACT NO. ERDA-FE 18-32-0001-1521

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

UNITED STATES
ERDA
FOSSIL ENERGY

F.W. DWG. NO. AP-764-620-A

DRAWN MS DATE 3/17/76
CHECKED _____ DATE _____
APPROVED _____ DATE _____

DRAWING TITLE:
ACID GAS K.O. DRUM D-401

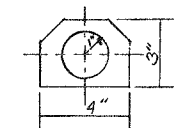
F.W. ENG. CONT. 15-1592

REQ'N NO. 1592-1131-AA

REFERENCE DRAWINGS, REQUISITIONS, STANDARDS

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



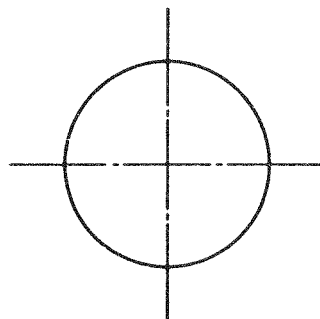
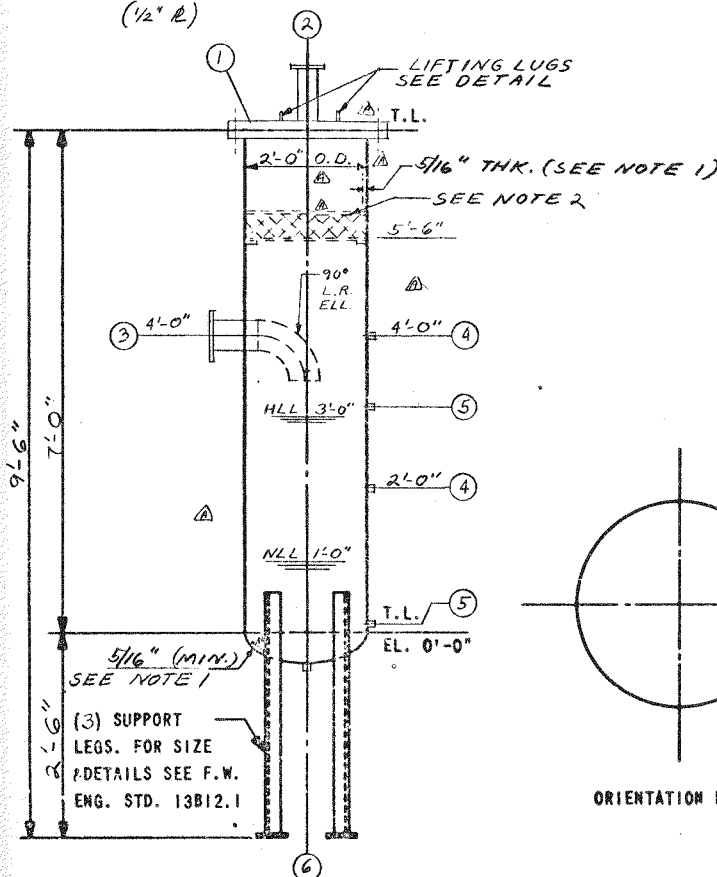


LIFTING LUGS

(1/2" R)

NOTES:

1. VENDOR TO QUOTE ON 24" STD. WGT PIPE AND CAPS IF MORE ECONOMICAL FOR SHELL & HEADS
2. VENDOR TO SUPPLY 4" THK. MIST ELIMINATOR INCL. LT. WGT. GRIDS PER F.W. STD. 10B15.1. MAT'L 304 S.S. OR 316 S.S.
3. THE ENTIRE DRUM IS TO BE STEAM TRACED AND INSULATED IN FIELD BY OTHERS.



ORIENTATION PLAN

RELEASES

DWG. 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. REQD.
1	24"	150" RF	SHELL ELL. BLIND	1
2	4"		GAS OUTLET	1
3	6"		GAS INLET	1
4	1"	6000# G.P.L.G.	LEVEL ALARM CONN.	2
5	3/4"		L.G.	2
6	1 1/2"		COND. OUTLET	1

VESSEL DATA

1	ITEM NO.	D-402	NO. REQ'D	ONE
2	SERVICE	SWS GAS K.O. DRUM		
3				
4	DIAMETER	2'-0"	O.D.	
5	TANGENT LENGTH	7'-0"		
6	OPER. PRESSURE	NORM.	1.2	PSIG
7	ABOVE LIQUID LEVEL, MAX.		1.3	PSIG
8	DESIGN PRESSURE		4.4	PSIG
9	OPER. LIQUID HOLD-UP PRESS.			PSI
10	OPER. PRESS. DROP THRU VESSEL		1.26	PSI
11	MAX. RELIEVING PRESS. @ TOP HD.		4.2	PSIG
12	MAX. OPER. TEMPERATURE		201°F	
13	DESIGN TEMPERATURE		260°F	
14	SPECIFIC GRAVITY (PROCESS FLUID)	0.76 @ 201°F		
15	CODE	ASME SEC VIII DIV 1	STAMPED	YES
16	P.W.M.T. FOR CODE	NO	FOR PROCESS	YES
17	RADIOGRAPHED	SPOT		
18	JOINT EFFICIENCY	85%		
19	CORROSION ALLOWANCE: SHELLS	1/8"	HEADS	1/8"
20	MAT'L. SHELL	SA-285 GRC		
21	MAT'L. HEADS	SA-285 GRC		
22	MAT'L. SUPPORTS	SA-36		
23	TYPE OF HEADS	2:1 ELL. BDM / FLAT TOP		
24	EXTERNAL BOLTING	SA-193-37" / SA-194-38"		
25	INTERNAL BOLTING			
26	GASKETS	COMP. ASBESTOS		
27	BOLT HOLES	STRADDLE VESSEL CENTERLINE		
28	PAINT	YES PER 1590-83A1		
29	INSULATION	YES (SEE NOTE 3)		
30	SHIPMENT	ONE PIECE		
31				
32	EMPTY WGT.	1400	LBS	
33	WATER WGT.	1500	LBS	
34	TRAYS WGT.		LBS	
35	INSULATION WGT.	40	LBS	
36	GRATE WGT.		LBS	
37	OPER. LIQUID WGT.	700	LBS	
38				
39	INSUL. SPT'S BY VESSEL FAB.			
40				
41	HYDROTEST: SHOP	FIELD	PSI	
42	GAGE LOCATION			
43	MAX. ALLOW. PRESS. (HEV & COLD)		PSI	

UNITED STATES
ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION
FOSSIL ENERGY

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

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

UNITED STATES
ERDA
FOSSIL ENERGY

FW DWG NO. OP-769-610-A

DRAWN: AJM DATE: 4/1/76

CHECKED: DATE: 4/1/76

APPROVED: DATE: 4/1/76

DRAWING TITLE: D-402

SWS GAS K.O. DRUM

FWEC CONT. 15-1592

REQ'N NO. 1592-113-43

REFERENCE DRAWINGS, REQUISITIONS, STANDARDS

1590-10A1	13B12.1	10B14.2
1590-83A1	10B15.1	
1590-50A2	1590-82A1	
1590-1100A		



MATERIAL REQUISITION



FOSTER WHEELER

PAGE 1 OF 3

FORM 135-201

FOR <u>ERDA-FE</u>	F.W. REF. <u>15-1592</u>	REQUISITION NUMBER	DATE
SITE <u>SIOUX FALLS, SOUTH DAKOTA</u>		<u>1592-1431A</u>	<u>4/13/76</u>
MATERIAL <u>SULFUR PIT (TK 401)</u>	SUPERSEDED BY CHANGE NO.:		
<u>ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION</u>	C1	<u>4-27-76</u>	C4
<u>FOSSIL ENERGY - LOCATION - NSP LAWRENCE STATION</u>	C2		C5
<u>SIOUX FALLS, S.D.</u>	C3		C6

INDEX

- I SCOPE
- II GENERAL
- III MECHANICAL SPECIFICATIONS
- IV SITE CONDITIONS
- V STANDARDS AND SPECIFICATIONS

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

I. SCOPE

This requisition covers the design and construction of a Sulfur Storage Pit, TK 401, of 1200 ft.³ capacity for the storage of molten sulfur. Duty requirements and a schematic of the storage pit are supplied, and using these guidelines the vendor shall supply the architectural design for approval by the buyer.

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 standards noted in Part V of this specification as well as the applicable provisions of the latest revisions of the following codes, specifications, etc., which may be revised to adjust classification and addition made as necessary to assume good practice.

1. Safety - Federal Register (OSHA)
2. Other - State & local requirements

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 14-32-001-1521 between the United States and Foster Wheeler Energy Corporation and the subcontractor 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. MECHANICAL SPECIFICATIONS

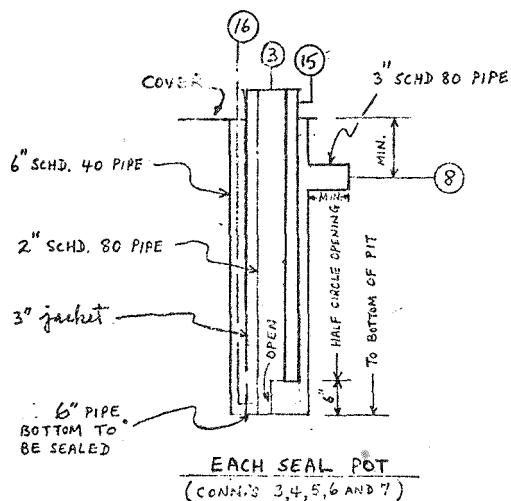
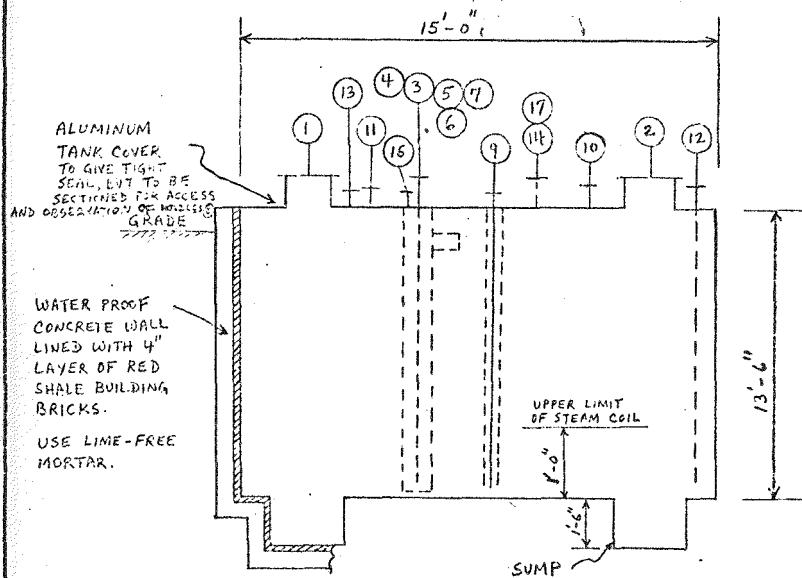
- A. A schematic cross sectional sketch of the sulfur storage pit is attached showing the configuration of the pit, tank cover, pump locations, as specified in the layout plan, heating coils, and nozzles. The contractor will provide the architectural design of the pit and cover for the buyers approval.
- B. The pit shall be constructed of acid resistant concrete and lined with brick.
- C. A sectional aluminum cover will enclose the tank and provide a vapor tight seal to the concrete.
- D. The tank cover will make provision for mounting a sulfur circulation pump (P-401) and a sulfur transfer pump (P-402).
- E. The tank will contain three oval type steam coils fixed to the bottom and tank walls to prevent the sulfur from solidifying and have a total surface area of 170 ft.²
- F. All sulfur transfer piping shall be steam jacketed.

IV. SITE CONDITIONS

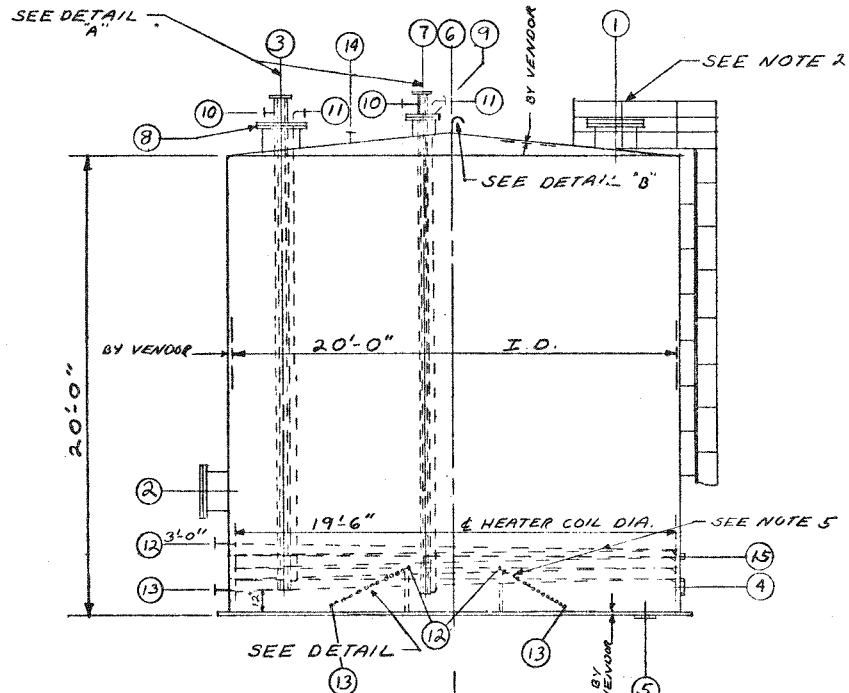
1. Altitude (above sea level)	-	1315 ft
2. Atmospheric Pressure	-	14.0 PSIA
3. Design Temp. Summer	-	93 ^o F
Winter	-	-25 ^o F
4. Location	-	Outdoors
5. Type of Operation	-	Continuous
6. Earthquake Zone	-	I
7. Wind Loading		
0 - 29 ft	-	20 PSF
30 - 49 ft	-	25 PSF
50 - 99 ft	-	30 PSF
100 - 499 ft	-	40 PSF

V. STANDARDS AND JOB SPECIFICATIONS

- A. The following documents shall be considered as an integral part of this requisition:
 - 1. 1590-50A2 Gaskets and Surface
 - 2. 1590-43A1 Foundation Standard
 - 3. 1590-43D1 Foundations, Construction
 - 4. 1590-83A1 Painting
 - 5. 1590-92A1 Preparation for shipment
 - 6. 1590-1200B General Notes



RELEASES				VESSEL DATA	
SWG. REV.	DATE	ISSUED FOR	1	ITEM NO.	NO. REQ'D
		③ PURCHASE SHELL AND HEAD MATERIAL. PREPARE BUT DO NOT SUBMIT SHOP DETAIL DRAWINGS.	2	SERVICE	SULFUR PIT
		③ 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	DIAMETER	6'-0" X 15'-0" X 13'-6" DEPT.
		③ VENDOR'S DRAWING RETURNED	4	TANGENT LENGTH	(RECTANGULAR TANK)
		③ FIELD CONSTRUCTION	5	OPER. PRESSURE	0 PSIG
		③	6	ABOVE LIQUID LEVEL MAX.	PSI
			7	DESIGN PRESSURE	PSI
			8	OPER. LIQUID HOLD PRESS	9.7 LBS/IN ² PSI
			9	OPER. PRESS. DROP TO VESSEL	PSI
			10	MAS. RELIEVING PRESS. & TOP NO.	PSI
			11	MAX. OPER. TEMPERATURE	300°F
			12	DESIGN TEMPERATURE	
			13	SPECIFIC GRAVITY PROCESS FLUID	1.78 @ 275°F
			14	CODE	STAMPED:
			15	P.W.H.T. FOR CODE	FOR PROCESS:
			16	RADIOGRAPHED:	
			17	JOINT EFFICIENCY	
			18	CORROSION ALLOWANCE SHELLS: HEADS:	
			19	MAT'L. SHELL / ACID RESISTANT CONCRETE	
			20	MAT'L. HEADS ALUMINUM	TANK COVER
			21	MAT'L. SUPPORTS	
			22	TYPE OF HEADS:	
			23	EXTERNAL BOLTING	
			24	INTERNAL BOLTING	
			25	GASKETS:	
			26	BOLT HOLES: STRADDLE VESSEL CENTERLINE	
			27	PAINT:	
			28	INSULATION:	NO
			29	SHIPMENT:	
			30	EMPTY WGT.:	LBS
			31	WATER WGT.:	LBS
			32	TRAYS WGT.:	LBS
			33	INSULATION WGT.:	LBS
			34	CONCRETE WGT.:	LBS
			35	OPER. LIQUID WGT.:	LBS
			36	MIN. DESIGN PRESS. (AT TOP)	1.0 PSIG
			37	NORMAL OP. TEMP. (AT TOP)	275 °F
			38	REFERENCE DRAWINGS: REQUISITIONS, STANDARDS	
			39	DRAWN: FMR/7/75	CONTRACT NO: 15-1592
			40	CHECKED:	REQUISITION NO: 1592-1431A
			41	APPROVED:	DRAWING NO:
			42	REVISIONS	
			43	SULFUR PIT TK-401	
			44	SULFUR RECOVERY UNIT	
			45	ERDA-FE	
				SIOUX FALLS	SOUTH DAKOTA



RELEASES

DWG. 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

CONN. NO.	SIZE	USAS. RATING	SERVICE	NO. REQD.
1	2.0"	API-650	ROOF MANWAY	1
2	2.0"		SHELL MANWAY	1
3	2x3"	150" R.F.	MOLTEN SULFUR INLET (JACKETED)	1
4	6x8"		MOLTEN SULFUR OUTLET (STUDDING OUT)	1
5	5x3"		DRAIN (STUDDING)	1
6	2x6"		VENT (QUIET)	1
7	1x2"		BLEED DEPTH GAUGE	1
8	2.0"	API-650	SLEEVE FOR CONN. #3	1
9	2.0"		SLEEVE FOR CONN. #7	1
10	3/4"	150" R.F.	JACK STEAM INLET	2
11	3/4"		JACK COND. OULET	3
12	1"		STEAM COIL INLET	3
13	1"		COND. OULET	3
14	2"		L.P. SNUFFING STEAM	1
15	3/4"		TEMP. CONN.	1

VESSEL DATA

1	ITEM NO.:	TK-402	NO. REQ'D:	ONE
2	SERVICE:	SULFUR STORAGE TANK		
3				
4	DIAMETER: (INSIDE)	20'-0"		
5	TARGET LENGTH:	20'-0"		
6	OPER. PRESSURE:	NORM.:	0 PSIG	
7	ABOVE LIQUID LEVEL, MAX.:		PSI	
8	DESIGN PRESSURE:	ATM.	PSIG	
9	OPER. LIQUID HOLD-UP PRESS:	15.5	PSI	
10	OPER. PRESS. DROP THRU VESSEL:		PSI	
11	MAX. RELIEVING PRESS. @ TOP HD.:	ATM.	PSIG	
12	MAX. OPER. TEMPERATURE:	300°F		
13	DESIGN TEMPERATURE:	350°F		
14	SPECIFIC GRAVITY (PROCESS FLUID):	1.78 @ 225°F		
15	CODE:	API-650	STAMPED:	YES
16	P.W.H.T.: FOR CODE:	NO	FOR PROCESS:	NO
17	RADIOGRAPHED:	SPOT		
18	JOINT EFFICIENCY:	85%		
19	CORROSION ALLOWANCE: SHELLS:	1/16" HEADS: 1/16"		
20	MATL., SHELL:	SA-283 GRC		
21	MATL., HEADS:	SA-283 GRC		
22	MATL., SUPPORTS:	SA-36		
23	TYPE OF HEADS:	CONE TOP FLAT BTM.		
24	EXTERNAL BOLTING:	SA-193-B1/SA-199-2H		
25	INTERNAL BOLTING:	A-307 GR B		
26	GASKETS:	COMP. ASBESTOS		
27	BOLT HOLES:	STRADDLE VESSEL CENTERLINE		
28	PAINT:	YES PER 1590-83A1		
29	INSULATION:	YES (2" THK)		
30	SHIPMENT:	KNOCKED DOWN		
31				
32	EMPTY WGT.:	BY VENDOR	LBS	
33	WATER WGT.:		LBS	
34	TRAYS WGT.:		LBS	
35	INSULATION WGT.:		LBS	
36	QUIBITE WGT.:		LBS	
37	OPER. LIQUID WGT.:		LBS	
38				
39	INSUL. SUPT'S BY VESSEL FAB.			
40				
41	HYDROTEST: SHOP:	FIELD:	PSI	
42	GAGE LOCATION:			
43	MAX. ALLOW. PRESS. (REF & 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

UNITED STATES
ERDA
FOSSIL ENERGY

FW DWG NO. OP-764-621-A

DRAWN: AJM DATE: 3/1/80
CHECKED: DATE: 3/1/80
APPROVED: DATE: 3/1/80

DESIGN SHEET: TK-402
SULFUR STORAGE TANK

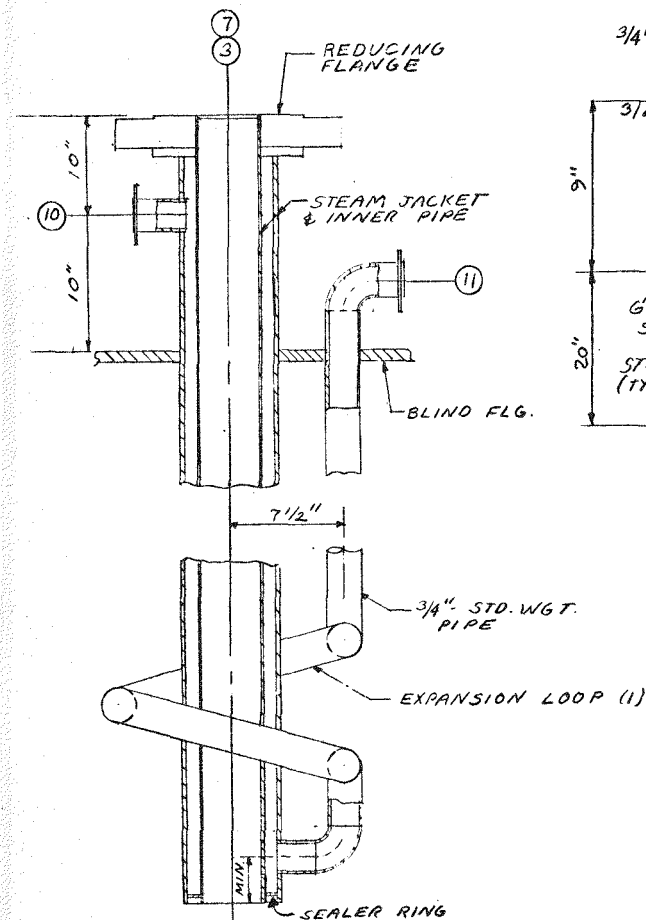
FWEC CONT. 15-1592

REQ'N NO. 1590-1141-J

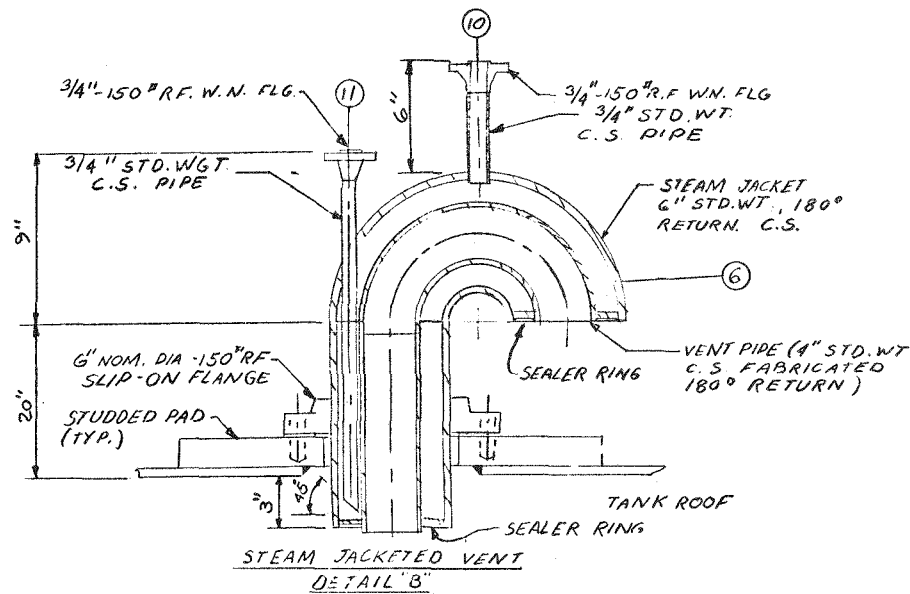
REFERENCE DRAWINGS, REQUISITIONS, STANDARDS

1590-83A1
1590-1100B
1590-5042
1590-14A1
OP-764-622 & 623

SULFUR INLET & BLEED DEPTHGAGE
STEAM JACKETING DETAIL "A"



CONN. #	SERVICE	PIPE SIZE	JACKET SIZE	REDUCING FLANGE
3	SULFUR INLET	2" XX-STG	3" XX-STG	2" X 7 1/2" O.D. - 150"
7	BLEED DEPTH GAUGE	1" SCH. 80	2" SCH. 80	1" X 6" O.D. - 150"



NOTES:

- TANK TO BE DESIGNED BY TANK FABRICATOR
- VENDOR TO SUPPLY CAGED LADDER & PLATFORM
- STEAM CONDITIONS
 - 65 PSIG OPERATING PRESSURE
 - 90 PSIG DESIGN PRESSURE
 - 308 °F OPERATING TEMPERATURE
 - 358 °F DESIGN TEMPERATURE
- ENTIRE ROOF OF TANK TO BE STEAM TRACED & INSULATED IN FIELD BY OTHERS.
- VENDOR TO PROVIDE (3) - THREE STEAM COILS, 2 COILS ON BOTTOM OF TANK ONE ALONG TANK SIDE WITH A TOTAL APPROXIMATE HEATING SURFACE OF 320 FT.² COILS ARE TO BE DESIGNED FOR CONDITIONS IN NOTE 3.
- ALL SHELL NOZZLES SHOULD BE WELDED INSIDE & OUT.

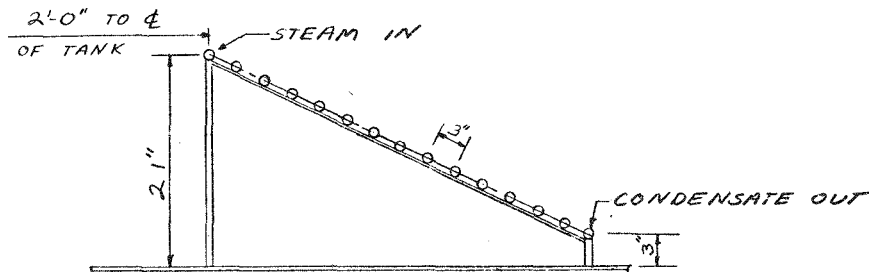
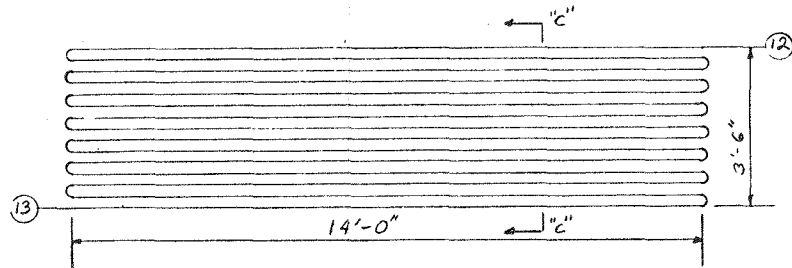
NOTES CONT OP-764-623

REFERENCE DRAWINGS, REQUISITIONS, STANDARDS
OP-764-621 & 623

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 14-32-0001-1321			
FOSTER WHEELER ENERGY CORP 110 SOUTH ORANGE AVENUE LIVINGSTON, NEW JERSEY		UNITED STATES ERDA	
FW DWS NO. OP-764-622		FOSSIL ENERGY	
DRAWN BY: JAC	DATE: 3/16/74	REVIEWED	
CHECKED	DATE	APPROVED	
DRAWING TITLE: TK-102		DRAWING NUMBER	
SULFUR STORAGE TANK			
FWEC CONT. 15-1592		REQ. N. 1590-1111-J	

DETAIL OF BOTTOM HEATING COIL

(TYP.) (SEE NOTE 5)



SECTION "C-C"

NOTES: CON'T

7. PROVIDE REINFORCEMENT PADS AT ALL STEAM COIL CONNECTIONS
8. THREADS ON STUDDED PADS ARE NOT TO GO THROUGH.

CONV. #	PROCESS LINE SIZE	JACKET SIZE & PAD SIZE
4	6"	8"
5	2"	3"

REFERENCE DRAWINGS, REQUISITIONS, STANDARDS

OP-764-621 & 622

NO.		DATE		REVISION		MADE BY		APPROVED	
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			
P.W.D. NO. <u>OP-764-623</u>						DATE <u>5/11/76</u>			
DRAWN <u>ATM</u>						CHECKED _____			
APPROVED _____						DATE _____			
DRAWING TITLE: <u>TR-402</u>						DRAWING NUMBER _____			
SULFUR STORAGE TANK						REQ'N NO. <u>1590-1141-J</u>			
FWEC CONT. 15-1592						FWEC CONT. 15-1592			



MATERIAL REQUISITION



FOSTER WHEELER

PAGE 1 OF 6

15-1592-JA

FOR <u>ERDA-FE</u>	F.W.REF. <u>15-1592</u>	REQUISITION NUMBER	DATE
SITE <u>SIOUX FALLS, SOUTH DAKOTA</u>		<u>1592-1211M</u>	<u>4/9/76</u>
MATERIAL <u>WASTE HEAT EXCHANGER (E-401)</u>		SUPERSEDED BY CHANGE NO.:	
<u>ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION</u>		C1 <u>4-26-76</u>	C4
<u>FOSSIL ENERGY - LOCATION - NSP LAWRENCE STATION</u>		C2	C5
<u>SIOUX FALLS, S.D.</u>		C3	C6

INDEX

- I SCOPE
- II GENERAL
- III BASIS OF DESIGN
- IV MECHANICAL SPECIFICATIONS
- V SITE CONDITIONS
- VI STANDARDS AND SPECIFICATIONS

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

I. SCOPE

This requisition covers the design, fabrication, and supply of a Waste Heat Exchanger (E-401) which will receive the hot gases from a Claus Plant Muffle Furnace (H-401). Duty requirements and a schematic of the exchanger is supplied and using this basis the vendor shall supply the detailed mechanical design for buyer approval.

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, 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 as well as the applicable provisions of the latest revisions of the following codes, specifications, etc., as noted below which may be revised to adjust classification and addition made as necessary to assume good practice.

1. Safety - Federal Register (OSHA)
2. Other - State & Local requirements

- 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

- A. The Acid Gas throughput on the tube side of Exchanger and the water/steam throughput on the shell side of the Exchanger as well as design temperatures and pressures are summarized on the attached Specification Sheet.

IV. MECHANICAL SPECIFICATIONS

- A. A schematic cross section drawing of the exchanger (DWG 1592-1211M-1) is attached indicating the approximate shell size and nozzles required. The vendor will provide the design for buyer approval defining the specifics of the exchanger.
- B. Additional design requirements are noted below:
1. The shell will be externally insulated for heat conservation except for those areas which have internal refractory lining.
 2. Inlet and outlet channels will be internally refractory lined so that the shell metal temperature is maintained between 350-500°F. The refractory brick shall have an alumina content >92%, iron content <1.0%, and service temperature of 3000°F.
 3. All refractory lined surfaces to have three coats of sodium silicate.
 4. Refractory lined areas shall be painted with thermal painting to show when the metal temperature exceeds 500°F. These areas may be caged for personnel protection.
 5. Inlet channel diameter to be sized to mate with and coordinated with the design of Muffle Furnace H-401.
 6. Shell to slope down towards exit end as shown.
 7. No copper or its alloys to be used.
 8. All tubes to be rolled in tubesheet and seal welded. Alumina ferrules shall be used on the tube inlets and outlets.
 9. Outlet channel to be provided with a removable cover, and seal welded.
 10. The corrosion allowance on the shell shall be 1/8", the 1 1/4" Cr-1/2 Mo tubes .05" corrosion allowance, and the refractory lined inlet channel and tube sheet 1/8" corrosion allowance.
 11. The shell layout will be sized to prevent steam blanketing the tubes and provide sufficient disengaging space for the steam.
 12. The Sulfur Drain (Conn. #3) shall be a pad type suitable for a 2" x 3" steam jacketed line.

V. 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	-	Outdoors
5.	Type of Operation	-	Continuous
6.	Earthquake Zone	-	I
7.	Wind Loading		
	0 - 29 ft	-	20 PSF
	30 - 49 ft	-	25 PSF
	50 - 99 ft	-	30 PSF
	100 - 499 ft	-	40 PSF

VI. STANDARDS AND JOB SPECIFICATIONS

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

1.	1590-10A1	Vessels
2.	1590-50A2	Gaskets and Surface
3.	1590-82A1	External Insulation
4.	1590-83A1	Painting
5.	1590-87A1	Internal Insulation
6.	1590-92A1	Preparation for Shipment
7.	1590-1200B	General Notes

MATERIAL REQUISITION

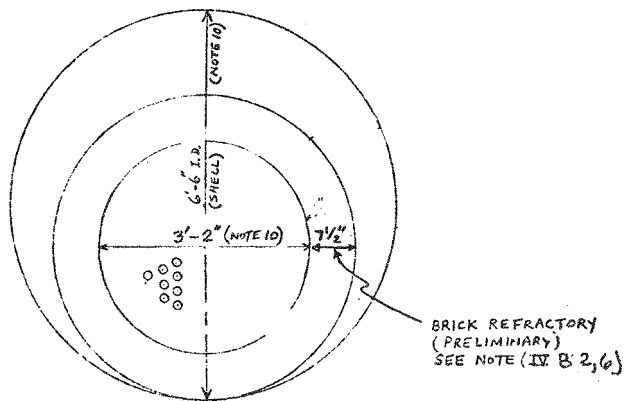
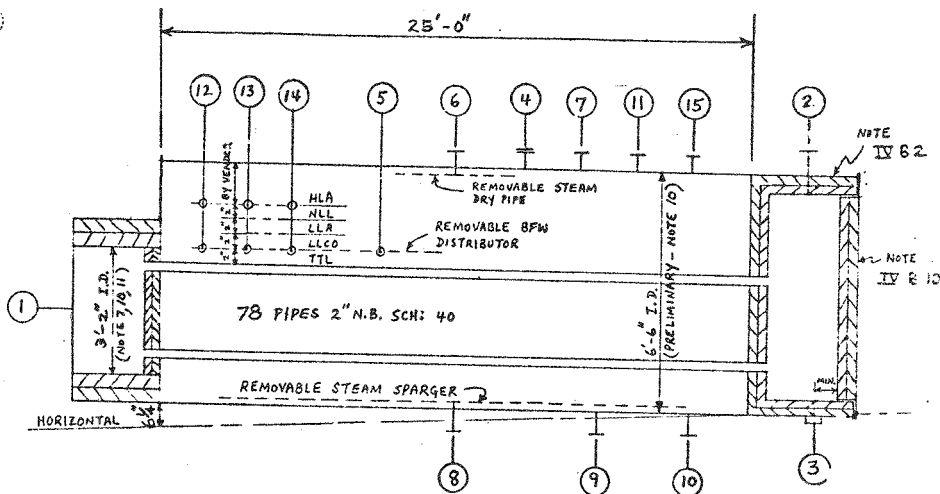
FOSTER WHEELER ENERGY CORPORATION

110 SOUTH ORANGE AVENUE, LIVINGSTON, N. J.

SHELL & TUBE
EXCHANGERS

PAGE 5 OF 6

CONTRACT NO. 15-1592		REQ'N. NO. 1592-1211M		DATE 4-10-76	
CUSTOMERS NAME ERDA-FE		LOCATION SIOUX FALLS, SOUTH DAKOTA			
SUPERSEDED BY					
CHANGE NO.	C-1	C-2	C-3	C-4	C-5
DATE	4-26-76				
SERVICE OF UNIT WASTE HEAT EXCHANGER				ITEM NO. E-401	
SIZE	TYPE SPECIAL		(HORIZ) (12) CONNECTED IN		
SQ. FT. SURF./UNIT (GROSS) (EFF)	1213	SHELLS/UNIT ONE	SQ. FT. SURF./SHELL (GROSS) (EFF) 1213		
PERFORMANCE OF ONE UNIT					
		SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED		BFW / STEAM		ACID GAS	
TOTAL FLUID ENTERING		14307 (3)	LB/HR	29226	LB/HR
VAPOR		—	LB/HR	26816	LB/HR
LIQUID		14307	LB/HR	—	LB/HR
STEAM		—	LB/HR	2410	LB/HR
NON-CONDENSABLES		—	LB/HR	—	LB/HR
FLUID (VAPORIZED)(CONDENSED)		14164	LB/HR	—	LB/HR
STEAM CONDENSED		—	LB/HR	—	LB/HR
GRAVITY LIQUID		.85 @ 414°F			
VISCOSITY LIQUID		.13 @ 414°F			
MOLECULAR WEIGHT IN/OUT		18.0		32.63 / 32.78	
SPECIFIC HEAT		1.04 @ 320°F	BTU/LB-°F	0.313	BTU/LB-°F
THERMAL CONDUCTIVITY			BTU/HR-FT-°F		BTU/HR-FT-°F
LATENT HEAT		812.3 @ 414°F	BTU/LB		BTU/LB
TEMPERATURE IN		225	°F	2272	°F
TEMPERATURE OUT		414	°F	700	°F
OPERATING PRESSURE, INLET		289 (PSIA) (28.9)		20.3 (PSIA) (2.03)	
NO. PASSES PER SHELL		1		1	
VELOCITY			FT/SEC		FT/SEC
PRESSURE DROP - ALLOW. CALC'D.		NEG1	PSI	0.72	PSI
FOULING RESISTANCE, MIN.					
HEAT EXCHANGED - BTU/HR.		14,324,000		MTD CORRECTED-°F	
TRANSFER RATE - SERVICE				CLEAN	
CONSTRUCTION OF ONE SHELL					
DESIGN PRESSURE		305	PSIG	16	PSIG
TEST PRESSURE			PSIG		PSIG
DESIGN TEMPERATURE		465	°F	650 (4)	°F
TUBES CS	NO. 78	2.0 N.B. 2"	BWG SCH 40 (AYS) MIN	LENGTH 25'-0"	PITCH (5)
SHELL CS		I.D.		SHELL COVER	(INTEG)(REMOV)
CHANNEL OR BONNET CS IV B2				CHANNEL COVER CS IV B2	
TUBESHEET - STATIONARY CS IV B2				TUBESHEET - FLOATING	
BAFFLES - CROSS TYPE				FLOATING HEAD COVER	
BAFFLES - LONG TYPE				IMPINGMENT PROTECTION	
TUBE SUPPORTS					
TUBE TO TUBESHEET JOINT					
GASKETS					
CONNECTIONS - SHELL SIDE IN SEE PAGE 6 OUT SEE PAGE 6 RATING					
CONNECTIONS - TUBE SIDE IN SEE PAGE 6 OUT SEE PAGE 6 RATING					
CORROSION ALLOWANCE - SHELL SIDE NOTE IV, B, 10 IN. TUBE SIDE NOTE IV, B, 10 IN.					
CODE REQUIREMENTS ASME J & LOCAL CODES 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) INCLUDES 1% BLOW DOWN					
(4) DESIGN TEMPERATURE FOR METAL					
(5) TUBE PITCH TO BE SELECTED BY VENDOR TO PREVENT STEAM BLANKETING TUBES					



DETAILS OF INLET CHANNEL
(INLET CHANNEL CAN BE CONCENTRIC IF ECONOMICAL.)

RELEASES

DATE	ISSUED FOR
DATE OF ORDER	PURCHASE SHELL AND HEAD MATERIAL. PREPARE BUT DO NOT SUBMIT SHOP DETAIL DRAWINGS.
	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.
	VENDOR'S DRAWING RETURNED
	FIELD CONSTRUCTION

NOZZLE CHART

NO.	SIZE	USAS. RATING	SERVICE	NO. REQD.
1	2 1/2"		GAS INLET	1
2	20"		GAS OUTLET	1
3	2"x3"	PAD TYPE	DRAIN	1
4	20"		MANWAY	1
5	2"		BFW INLET	1
6	4"		STEAM OUTLET	1
7	2"		VENT	1
8	2"		STEAM SPARGE	1
9	1"		BLOWDOWN (INTERMITTENT)	1
10	1"		BLOWDOWN (CONTINUOUS)	1
11			PSV	2
12			LG/LAH/LAL	2
13			LG	2
14			LLCO	2
15			PI	1

VESSEL DATA

1	ITEM NO.	E-401	NO REQD. ONE
2	SERVICE	WASTE HEAT EXCHANGER	
3			
4	DIAMETER	6'-6" I.D. PRELIMINARY - VENDOR DESIGN	
5	TANGENT LENGTH	25'-0" (SEE SKETCH)	
6	OPER. PRESSURE	NORM. SEE PAGE 5	PSI
7	ABOVE LIQUID LEVEL MAX.	—	PSI
8	DESIGN PRESSURE	SEE PAGE 5	PSI
9	OPER. LIQUID HOLD-UP PRESS.	—	PSI
10	OPER. PRESS. DROP THROUGH VESSEL	SEE PAGE 5	PSI
11	MAX. RELIEVING PRESS. & TOP NO.	—	PSI
12	MAX. OPER. TEMPERATURE	SEE PAGE 5	
13	DESIGN TEMPERATURE	SEE PAGE 5	
14	SPECIFIC GRAVITY (PROCESS FLUID)	—	
15	CODE	ASME I & LOCAL	STAMPED:
16	P.W.H.T. FOR CODE		FOR PROCESS:
17	RADIOGRAPHED:		
18	JOINT EFFICIENCY		
19	CORROSION ALLOWANCE SHELLS: (IV B 10)	HEADS: (IV B 1)	
20	MAT'L. SHELL	SEE PAGE 5	
21	MAT'L. HEADS		
22	MAT'L. SUPPORTS		
23	TYPE OF HEADS		
24	EXTERNAL BOLTING		
25	INTERNAL BOLTING		
26	GASKETS		
27	BOLT HOLES	STAPDOLE VESSEL CENTERLINE	
28	PAINT		
29	INSULATION	YES - SEE NOTE (IV B 1)	
30	SHIPMENT		
31			
32	EMPTY WGT.		LBS
33	WATER WGT.		LBS
34	TRAYS WGT.		LBS
35	INSULATION WGT.		LBS
36	GUNITE WGT.		LBS
37	OPER. LIQUID WGT.		LBS
38			
39			
40			
41	HYDROTEST: SHOP	FIELD:	PSI
42	GAGE LOCATION		
43	MAX. ALLOW. PRESS. (NEW & COLD)		PSI
44	LIMITED BY		
45			

REFERENCE DRAWINGS, REQUISITIONS, STANDARDS

PAGE 6 OF 6

CONTRACT NO.

15-1592

REQUISITION NO:

1592-1211M

DRAWING NO:

1592-1211M-1

THIS Dwg. WAS:

REV.	DATE	BY	DESCRIPTION
			REVISIONS

WASTE HEAT EXCHANGER E-401
SULFUR RECOVERY UNIT
ERDA - FE

SIOUX FALLS

SOUTH DAKOTA

MATERIAL REQUISITION

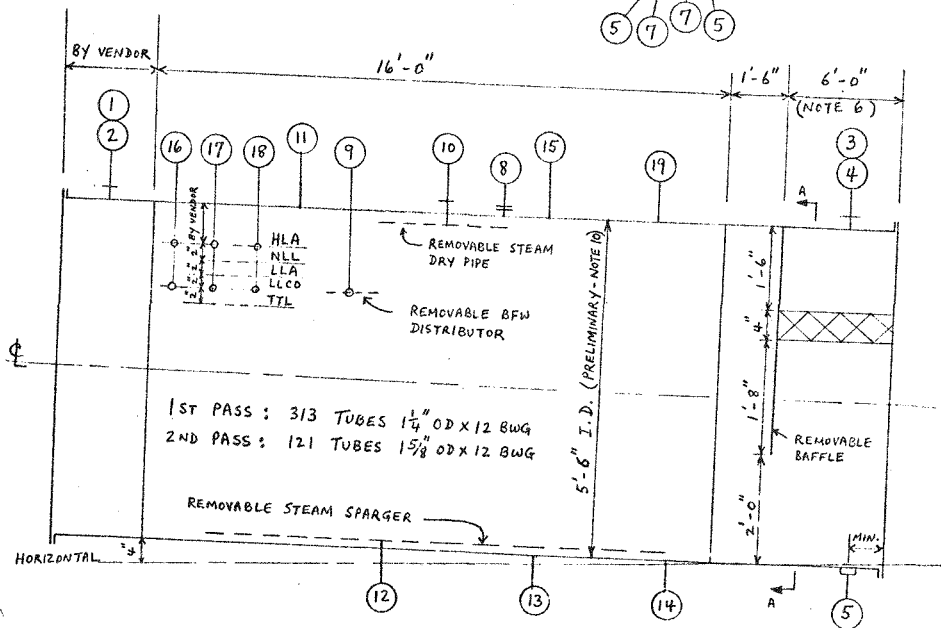
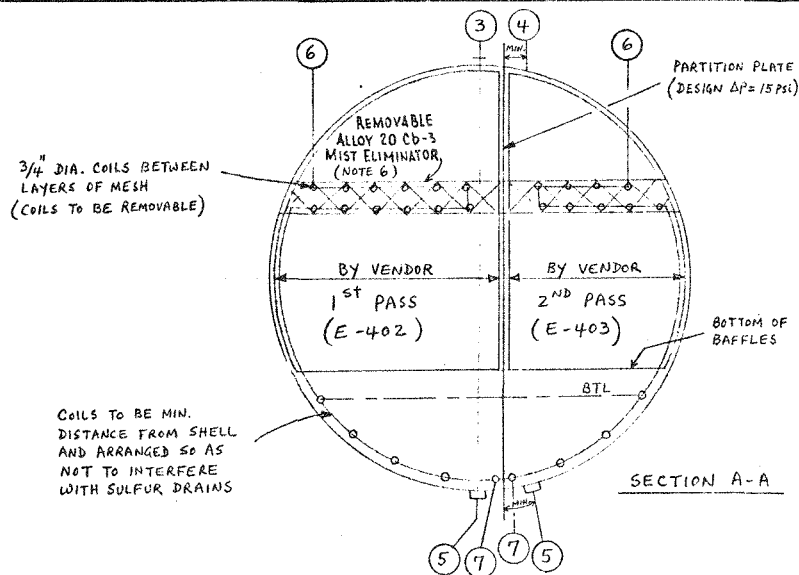
FOSTER WHEELER ENERGY CORPORATION

110 SOUTH ORANGE AVENUE, LIVINGSTON, N. J.

SHELL & TUBE
EXCHANGERS

PAGE 1 OF 2

CONTRACT NO. 15-1592		REQ'N. NO. 1592-1211 N/P		DATE 4-7-76	
CUSTOMERS 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					
SERVICE OF UNIT FIRST AND SECOND SULFUR CONDENSERS				ITEM NO. E-402/403	
SIZE 66-192 (10)	TYPE SPECIAL - "CEN" (HORIZ)		CONNECTED IN -		
SQ. FT. SURF./UNIT (EFF) 1587/798	SHELLS/UNIT ONE		SQ. FT. SURF./SHELL (EFF) 2385		
PERFORMANCE OF ONE UNIT					
	SHELL SIDE		TUBE SIDE		
FLUID CIRCULATED	BFW / STEAM		ACID GAS		
TOTAL FLUID ENTERING	3858 (3)	LB/HR	28,562	28,122	LB/HR
VAPOR		LB/HR	26,208	25,518	LB/HR
LIQUID	3858	LB/HR			LB/HR
STEAM		LB/HR	2,354	2,604	LB/HR
NON-CONDENSABLES		LB/HR			LB/HR
FLUID (VAPORIZED)(CONDENSED)	3820 (VAPZ.)	LB/HR	440	700 (COND.)	LB/HR
STEAM CONDENSED		LB/HR			LB/HR
GRAVITY (Liq.)	0.91 @ 315°F				
VISCOSITY Cps (Liq.)	0.18 @ 315°F				
MOLECULAR WEIGHT LN / OUT	18.016		32.9 / 32.49	32.66 / 31.95	
SPECIFIC HEAT	1.035	BTU/LB-°F	0.259	0.262	(4) BTU/LB-°F
THERMAL CONDUCTIVITY		BTU/HR-FT-°F			BTU/HR-FT-°F
LATENT HEAT	898.5 @ 315°F	BTU/LB			BTU/LB
TEMPERATURE IN	225	°F	718	442	°F
TEMPERATURE OUT	315	°F	350	340	°F
OPERATING PRESSURE, INLET	70 (PSIG)		4.8	3.5 (PSIG)	
NO. PASSES PER SHELL	CROSS		ONE	ONE	
VELOCITY		FT/SEC			FT/SEC
PRESSURE DROP - ALLOW. CALC'D.	NEG'L.	PSI	0.5	0.5	(5) PSI
FOULING RESISTANCE, MIN.					
HEAT EXCHANGED - BTU/HR.	2,935,000 / 855,000		MTD CORRECTED-°F		
TRANSFER RATE - SERVICE	CLEAN				
CONSTRUCTION OF ONE SHELL					
DESIGN PRESSURE	95	PSIG	75	75	PSIG
TEST PRESSURE	PER CODE	PSIG	PER CODE		PSIG
DESIGN TEMPERATURE	365	°F	768	492	°F
TUBES C.S.	NO. 313 / 121	O.D. 1 1/4" / 1 5/8" BWG 12	LENGTH 16'	PITCH 1.5 (O.D.) Δ	
SHELL C.S.	I.D. 66"	SHELL COVER		(INTEG)(REMOV)	
CHANNEL C.S.		CHANNEL COVER	C.S.		
TUBESHEET - STATIONARY	C.S. (USE THIN TUBESHEET)	TUBESHEET - FLOATING			
BAFFLES - CROSS	TYPE	FLOATING HEAD COVER			
BAFFLES - LONG	TYPE	IMPINGMENT PROTECTION			
TUBE SUPPORTS	C.S.				
TUBE TO TUBESHEET JOINT	ROLLED AND STRENGTH WELDED				
GASKETS					
CONNECTIONS - SHELL SIDE	IN 1 1/2"	OUT 4"	RATING 150 LBS RF		
CONNECTIONS - TUBE SIDE	IN 20" / 20"	OUT 20" / 20"	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 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) INCLUDES 1% BLOWDOWN. (4) GAS @ OUTLET. (5) ΔP INCLUDES INTERNAL BAFFLES & MIST ELIMINATOR. (6) CROSS					
SECTIONAL AREAS FOR MESH MIST ELIMINATORS LN OUTLET CHANNEL: E-402 = 11.5 FT²; E-403 = 11.0 FT². (7) MESHES, COILS, & BAFFLES					
LN OUTLET CHANNEL TO BE REMOVABLE. (8) SULFUR DRAINS (CONN. #5) TO BE PAD TYPE SUITABLE FOR 2"x3" STEAM JACKETED LINE.					
(9) UNIT TO SLOPE TOWARDS EXIT END (AS SHOWN). (10) VENDOR TO DETERMINE FINAL SHELL SIZE & LAYOUT, PROVIDE DISENGAGING SPACE FOR STEAM					



RELEASES

DWG. 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

CONN. NO.	SIZE	USAS. RATING	SERVICE	NO. REQ'D
1	20"		GAS INLET (1 ST PASS)	1
2	20"		GAS INLET (2 ND PASS)	1
3	20"		GAS OUTLET (1 ST PASS)	1
4	20"		GAS OUTLET (2 ND PASS)	1
5	2"x3"	PAD TYPE	SULFUR OUTLET	2
6	1"		STEAM INLET	2
7	1"		CONDENSATE OUTLET	2
8	20"		MANWAY	1
9	1 1/2"		BFW INLET	1
10	4"		STEAM OUTLET	1
11	2"		VENT	1
12	1 1/2"		STEAM SPARGE	1
13	1"		BLOWDOWN (INTERMITTENT)	1
14	1"		BLOWDOWN (CONTINUOUS)	1
15			PSV	2
16			LC/LAH/LAL	2
17			LG	2
18			LLCO	2
19			PI	1

VESSEL DATA

1	ITEM NO: E-402/3	NO. REQ'D: ONE
2	SERVICE: FIRST AND SECOND SULFUR	
3	CONDENSERS	
4	DIAMETER: 5'-6" I.D. (PRELIMINARY - VENDOR DESIGN)	
5	TANGENT LENGTH: 16'-0"	
6	OPER. PRESSURE: NORM: SEE PAGE 1	PSI
7	(ABOVE LIQUID LEVEL) MAX: SEE PAGE 1	PSI
8	DESIGN PRESSURE: SEE PAGE 1	PSI
9	OPER. LIQUID HOLD-UP PRESS: SEE PAGE 1	PSI
10	OPER. PRESS. DROP THRU VESSEL: SEE PAGE 1	PSI
11	MAS. RELIEVING PRESS. & TOP NO: SEE PAGE 1	PSI
12	MAX. OPER. TEMPERATURE: SEE PAGE 1	
13	DESIGN TEMPERATURE: SEE PAGE 1	
14	SPECIFIC GRAVITY (PROCESS FLUID):	
15	CODE: ASME VIII & TEMA R	STAMPED:
16	P.W.H.T. FOR CODE: FOR PROCESS:	
17	RADIOGRAPHED:	
18	JOINT EFFICIENCY:	
19	CORROSION ALLOWANCE SHELLS: 1/8" HEADS: 1/8"	
20	MAT'L. SHELL: SEE PAGE 1	
21	MAT'L. HEADS:	
22	MAT'L. SUPPORTS:	
23	TYPE OF HEADS:	
24	EXTERNAL BOLTING:	
25	INTERNAL BOLTING:	
26	GASKETS:	
27	BOLT HOLES: STRADDLE VESSEL CENTERLINE	
28	PAINT:	
29	INSULATION: YES (H.C.)	
30	SHIPMENT:	
31		
32	EMPTY WGT.:	LBS
33	WATER WGT.:	LBS
34	TRAYS WGT.:	LBS
35	INSULATION WGT.:	LBS
36	GUNITE WGT.:	LBS
37	OPER. LIQUID WGT.:	LBS
38		
39		
40		
41	HYDROTEST SHOP: FIELD:	PSI
42	GAGE LOCATION:	
43	MAX. ALLOW. PRESS. (NEW & COLD):	PSI
44	LIMITED BY:	
45		

REFERENCE DRAWINGS, REQUISITIONS, STANDARDS

PAGE 2 OF 2

REV.	DATE	BY	DESCRIPTION
			REVISIONS

FIRST AND SECOND SULFUR CONDENSERS E-402/3
SULFUR RECOVERY UNIT
ERDA-FE

SIOUX FALLS

SOUTH DAKOTA

DRAWN	PNR	8/19/75
CHECKED		
APPROVED		

CONTRACT NO:
15-1592
REQUISITION NO:
1592-1211-N/P
DRAWING NO.

THIS DWG WAS



MATERIAL REQUISITION

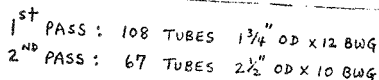
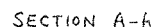
FOSTER WHEELER ENERGY CORPORATION

110 SOUTH ORANGE AVENUE, LIVINGSTON, N. J.

SHELL & TUBE
EXCHANGERS

PAGE 1 OF 2

CONTRACT NO. 15-1592		REQ'N. NO. 1592-1211 Q/R		DATE 4-7-76	
CUSTOMERS 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					
SERVICE OF UNIT THIRD AND FINAL SULFUR CONDENSERS				ITEM NO. E-404/405	
SIZE 66-192 (10)	TYPE SPECIAL - "CEN" (HORIZ)		CONNECTED IN -		
SQ. FT. SURF./UNIT (EFF) 767/679	SHELLS/UNIT ONE		SQ. FT. SURF./SHELL (EFF) 1446		
PERFORMANCE OF ONE UNIT					
	SHELL SIDE		TUBE SIDE		
	BFW / STEAM		ACID GAS		
FLUID CIRCULATED					
TOTAL FLUID ENTERING	647 (3)	LB/HR	27,422	27,312	LB/HR
VAPOR		LB/HR	24,786	24,669	LB/HR
LIQUID	647	LB/HR			LB/HR
STEAM		LB/HR	2,636	2,643	LB/HR
NON-CONDENSABLES		LB/HR			LB/HR
FLUID (VAPORIZED)(CONDENSED)	640 (VAPZ.)	LB/HR	110	107 (COND.)	LB/HR
STEAM CONDENSED		LB/HR			LB/HR
GRAVITY (LIQ.)	0.91 @ 315°F				
VISCOSITY (PS (LIQ.))	0.18 @ 315°F				
MOLECULAR WEIGHT IN / OUT	18.016		31.98/31.86	31.87/31.75	
SPECIFIC HEAT	1.035	BTU/LB-°F	0.263	0.263	(4) BTU/LB-°F
THERMAL CONDUCTIVITY		BTU/HR-FT-°F			BTU/HR-FT-°F
LATENT HEAT	898.5 @ 315°F	BTU/LB			BTU/LB
TEMPERATURE IN	225	°F	383	362	°F
TEMPERATURE OUT	315	°F	330	330	°F
OPERATING PRESSURE, INLET	70 (PSIG)		2.2	0.9 (PSIG)	
NO. PASSES PER SHELL	CROSS		ONE	ONE	
VELOCITY		FT/SEC			FT/SEC
PRESSURE DROP - ALLOW. CALC'D.	NEG'L. PSI	PSI	0.5	0.4 (5)	PSI
FOULING RESISTANCE, MIN.					
HEAT EXCHANGED - BTU/HR.	400,000 / 235,000		MTD CORRECTED-°F		
TRANSFER RATE - SERVICE			CLEAN		
CONSTRUCTION OF ONE SHELL					
DESIGN PRESSURE	95	PSIG	75	75	PSIG
TEST PRESSURE	PER CODE	PSIG	PER CODE	PER CODE	PSIG
DESIGN TEMPERATURE	365	°F	433	412	°F
TUBES C.S.	NO. 108 / 67	O.D. 1 3/4" / 2 1/2" BWG 12 / 10 (MIN)	LENGTH 16'	PITCH 1.5 (O.D.) Δ	
SHELL C.S.	I.D. 66"	SHELL COVER		(INTG)(REMOV)	
CHANNEL C.S.	CHANNEL COVER		C.S.		
TUBESHEET - STATIONARY	C.S. (USE THIN TUBESHEET)	TUBESHEET - FLOATING			
BAFFLES - CROSS	TYPE	FLOATING HEAD COVER			
BAFFLES - LONG	TYPE	IMPINGMENT PROTECTION			
TUBE SUPPORTS	C.S.				
TUBE TO TUBESHEET JOINT ROLLED & STRENGTH WELDED					
GASKETS					
CONNECTIONS - SHELL SIDE	IN 1"	OUT 2"	RATING 150 LBS RF		
CONNECTIONS - TUBE SIDE	IN 20" / 20"	OUT 20" / 20"	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 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) INCLUDES 1% BLOWDOWN. (4) GAS @ OUTLET. (5) ΔP INCLUDES INTERNAL BAFFLES & MIST ELIMINATORS. (6) CROSS SECTIONAL AREAS FOR MIST ELIMINATORS IN OUTLET CHANNEL: E-404 = 11.0 FT²; E-405 = 11.0 FT². (7) MESHES, COILS, & BAFFLES IN OUTLET CHANNEL TO BE REMOVABLE. (8) SULFUR DRAINS (CONN #5) TO BE PAD TYPE SUITABLE FOR 2"x3" STEAM JACKETED LINE. (9) UNIT TO SLOPE TOWARDS EXIT END (AS SHOWN). (10) VENDOR TO DETERMINE FINAL SHELL SIZE & LAYOUT. PROVIDE DISENGAGING SPACE FOR STEAM.					

KBF 12 0153 2-23 TEM 1104:

MATERIAL REQUISITION

FOSTER WHEELER ENERGY CORPORATION

110 SOUTH ORANGE AVENUE, LIVINGSTON, N. J.

SHELL & TUBE
EXCHANGERS

PAGE 1 OF 1

CONTRACT NO. 15-1592		REQ'N. NO. 1592-1211-S		DATE 3-24-76	
CUSTOMERS 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					
SERVICE OF UNIT SECOND REACTOR FEED HEATER				ITEM NO. E-406	
SIZE 26-72	TYPE BEM		CONNECTED IN -		
SQ. FT. SURF./UNIT (EFF) 499	SHELLS/UNIT ONE		SQ. FT. SURF./SHELL (EFF) 499		
PERFORMANCE OF ONE UNIT					
		SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED		600 PSIG STEAM		ACID GAS	
TOTAL FLUID ENTERING		934 LB/HR		28,800 LB/HR	
VAPOR		LB/HR		26,426 LB/HR	
LIQUID		LB/HR		LB/HR	
STEAM		934 LB/HR		2,374 LB/HR	
NON-CONDENSABLES		LB/HR		LB/HR	
FLUID (VAPORIZED)(CONDENSED)		LB/HR		LB/HR	
STEAM CONDENSED		934 LB/HR		LB/HR	
GRAVITY					
VISCOSITY Cps		0.024			
MOLECULAR WEIGHT		18.016		32.43	
SPECIFIC HEAT		BTU/LB-°F		BTU/LB-°F	
THERMAL CONDUCTIVITY		BTU/HR-FT-°F		BTU/HR-FT-°F	
LATENT HEAT		728.5 BTU/LB		BTU/LB	
TEMPERATURE IN		488 °F		350 °F	
TEMPERATURE OUT		488 °F		441 (3) °F	
OPERATING PRESSURE, INLET		600 (PSIG)		4.2 (PSIG)	
NO. PASSES PER SHELL		ONE		ONE	
VELOCITY		FT/SEC		96 FT/SEC	
PRESSURE DROP - ALLOW. CALC'D.		NEG'L PSI		0.3 PSI	
FOULING RESISTANCE, MIN.		0.001		0.001	
HEAT EXCHANGED - BTU/HR.		680,000 (3)		MTD CORRECTED-°F 84.5	
TRANSFER RATE - SERVICE		16.1		CLEAN	
CONSTRUCTION OF ONE SHELL					
DESIGN PRESSURE		660 PSIG		75 PSIG	
TEST PRESSURE		PER CODE PSIG		PER CODE PSIG	
DESIGN TEMPERATURE		750 °F		500 °F	
TUBES C.S.	NO. 345	O.D. 1.0"	BWG 14 (MIN)	LENGTH 6'	PITCH 1 1/4" Δ
SHELL C.S.		I.D. 26"	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"	OUT 1"	RATING 600 LBS RF	
CONNECTIONS - TUBE SIDE		IN 20" (AXIAL)	OUT 20" (AXIAL)	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 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) NORMAL DUTY IS 383,000 BTU/hr WITH PROCESS OUTLET TEMP. OF 401 °F (4) PROVIDE EXPANSION JOINT ON SHELL.					

MATERIAL REQUISITION

FOSTER WHEELER ENERGY CORPORATION

110 SOUTH ORANGE AVENUE, LIVINGSTON, N. J.

SHELL & TUBE
EXCHANGERS

PAGE 1 OF 1

CONTRACT NO. 15-1592		REQ'N. NO. 1592-1211-T		DATE 3-24-76	
CUSTOMERS 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					
SERVICE OF UNIT THIRD REACTOR FEED HEATER				ITEM NO. E-407	
SIZE 26-48	TYPE BEM		(VERT)	CONNECTED IN -	
SQ. FT. SURF./UNIT (EFF) 318	SHELLS/UNIT ONE		SQ. FT. SURF./SHELL (EFF) 318		
PERFORMANCE OF ONE UNIT					
	SHELL SIDE			TUBE SIDE	
FLUID CIRCULATED	600 LBS STEAM			ACID GAS	
TOTAL FLUID ENTERING	790	LB/HR		28,092	LB/HR
VAPOR		LB/HR		25,464	LB/HR
LIQUID		LB/HR			LB/HR
STEAM	790	LB/HR		2,628	LB/HR
NON-CONDENSABLES		LB/HR			LB/HR
FLUID (VAPORIZED)(CONDENSED)		LB/HR			LB/HR
STEAM CONDENSED	790	LB/HR			LB/HR
GRAVITY					
VISCOSITY CPS	0.024				
MOLECULAR WEIGHT	18.016			31.89	
SPECIFIC HEAT		BTU/LB-°F			BTU/LB-°F
THERMAL CONDUCTIVITY		BTU/HR-FT-°F			BTU/HR-FT-°F
LATENT HEAT	728.5	BTU/LB			BTU/LB
TEMPERATURE IN	488	°F		340	°F
TEMPERATURE OUT	488	°F		418 (3)	°F
OPERATING PRESSURE, INLET	600	(PSIA)(PSIG)		2.8	(PSIA)(PSIG)
NO. PASSES PER SHELL	ONE			ONE	
VELOCITY		FT/SEC		101	FT/SEC
PRESSURE DROP - ALLOW. CALC'D.	NEGL.	PSI		0.3	PSI
FOULING RESISTANCE, MIN.	0.001			0.001	
HEAT EXCHANGED - BTU/HR.	575,000 (3)	MTD CORRECTED-°F		104.2	
TRANSFER RATE - SERVICE	17.4	CLEAN			
CONSTRUCTION OF ONE SHELL					
DESIGN PRESSURE	660	PSIG		75	PSIG
TEST PRESSURE	PER CODE	PSIG		PER CODE	PSIG
DESIGN TEMPERATURE	750	°F		470	°F
TUBES C.S.	NO. 345	O.D. 1.0"	BWG 14	LENGTH 4'	PITCH 1.25" Δ
SHELL C.S.	I.D. 26"	SHELL COVER		(INTEG)(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"	OUT 1"	RATING 600 LBS RF		
CONNECTIONS - TUBE SIDE	IN 20" (AXIAL)	OUT 20" (AXIAL)	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 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) NORMAL DUTY IS 280,000 BTU/HR WITH PROCESS OUTLET TEMPERATURE OF 378°F. (4) PROVIDE					
EXPANSION JOINT ON SHELL.					

MATERIAL REQUISITION

FOSTER WHEELER ENERGY CORPORATION

110 SOUTH ORANGE AVENUE, LIVINGSTON, N. J.

SHELL & TUBE
EXCHANGERS

PAGE 1 OF 1

CONTRACT NO. 15-1592		REQ'N. NO. 1592-1211-U		DATE 3-24-76	
CUSTOMERS 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					
SERVICE OF UNIT FOURTH REACTOR FEED HEATER				ITEM NO. E-408	
SIZE 26-48	TYPE BEM		(VERT)	CONNECTED IN -	
SQ. FT. SURF./UNIT (EFF)	318	SHELLS/UNIT	ONE	SQ. FT. SURF./SHELL (EFF)	318
PERFORMANCE OF ONE UNIT					
		SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED		600 LBS STEAM		ACID GAS	
TOTAL FLUID ENTERING	718	LB/HR		27,981	LB/HR
VAPOR		LB/HR		25,321	LB/HR
LIQUID		LB/HR			LB/HR
STEAM	718	LB/HR		2,660	LB/HR
NON-CONDENSABLES		LB/HR			LB/HR
FLUID (VAPORIZED)(CONDENSED)		LB/HR			LB/HR
STEAM CONDENSED	718	LB/HR			LB/HR
GRAVITY					
VISCOSITY Cps	0.024				
MOLECULAR WEIGHT	18.016			31.86	
SPECIFIC HEAT		BTU/LB-°F			BTU/LB-°F
THERMAL CONDUCTIVITY		BTU/HR-FT-°F			BTU/HR-FT-°F
LATENT HEAT	728.5	BTU/LB			BTU/LB
TEMPERATURE IN	488	°F		330	°F
TEMPERATURE OUT	488	°F		401 (3)	°F
OPERATING PRESSURE, INLET	600	(PSIG)		1.4	(PSIG)
NO. PASSES PER SHELL	ONE			ONE	
VELOCITY		FT/SEC		100	FT/SEC
PRESSURE DROP - ALLOW. CALC'D.	NEG'L	PSI		0.3	PSI
FOULING RESISTANCE, MIN.	0.001			0.001	
HEAT EXCHANGED - BTU/HR.	523,000 (3)	MTD CORRECTED-°F		119	
TRANSFER RATE - SERVICE	13.8	CLEAN			
CONSTRUCTION OF ONE SHELL					
DESIGN PRESSURE	660	PSIG		75	PSIG
TEST PRESSURE	PER CODE	PSIG		PER CODE	PSIG
DESIGN TEMPERATURE	750	°F		460	°F
TUBES C.S.	NO. 345	O.D. 1.0"	BWG 14 (MIN)	LENGTH 4'	PITCH 1.25" Δ
SHELL C.S.		I.D. 26"	SHELL COVER		(INTEG)(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"	OUT 1"	RATING 600 LBS RF		
CONNECTIONS - TUBE SIDE	IN 20" (AXIAL)	OUT 20" (AXIAL)	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 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) NORMAL DUTY IS 226,000 BTU/HR. WITH PROCESS OUTLET TEMP. OF 361°F. (4) PROVIDE EXPANSION JOINT ON SHELL.					

MATERIAL REQUISITION



FOSTER WHEELER

PAGE 1 OF 5

10.11.19.20.21

FOR ERDA-FE	F.W. REF. 15-1592	REQUISITION NUMBER	DATE
SITE SIOUX FALLS, SOUTH DAKOTA		1592-1241C	4/7/76
MATERIAL MUFFLE FURNACE (H-401)		SUPERSEDED BY CHANGE NO.:	
ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION	C1	4-26-76	C4
FOSSIL ENERGY - LOCATION - NSP LAWRENCE STATION	C2		C5
SIOUX FALLS, S.D.	C3		C6

INDEX

- I SCOPE
- II GENERAL
- III MECHANICAL SPECIFICATIONS
- IV SITE CONDITIONS
- V STANDARDS AND SPECIFICATIONS

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

I. SCOPE

This requisition covers the design, fabrication, and supply of a Claus Plant Muffle Furnace (H-401). Duty requirements and a schematic of the Muffle Furnace are supplied, and using this basis the vendor shall supply the detailed mechanical design for approval by the buyer.

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 standards noted in Part V of this specification, as well as the applicable provision of the latest revisions of the following codes, specifications, etc., which may be revised to adjust classification and addition made as necessary to assume good practice.

1. Safety - Federal Register (OSHA)
2. Other - State & local requirements

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 14-32-001-1521 between the United States and Foster Wheeler Energy Corporation and the subcontractor 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. MECHANICAL SPECIFICATION

A. The Muffle Furnace shall be sized to received the Acid Gas Burner BR-401, and the Fuel Gas Burner, BR-402, and the Flame Scanners.

B. A schematic cross sectional drawing of the Muffle Furnace on (page 5) shows the configuration of the shell, refractory liner, nozzles, burners, and temperature control. The vendor will provide the design for the buyers approval defining the specifics of the muffle furnace.

C. Furnace design conditions

Design pressure	16 PSIG
Inlet pressure	20.3 PSIA
Design temperature	650 ⁰ F (metal)

D. Material of construction

Carbon steel shell

The refractory brick facing shall be >92% alumina, <1.0 % iron, and have a service rating of 3300⁰F.

E. The furnace shall be sized to connect with the E-401 Waste Heat Exchanger and supported to allow for thermal expansion.

F. The checker firebrick wall shall be designed to allow access to the front tube sheet of the Waste Heat Exchanger.

G. The ultra-violet scanner will be directed to measure the Acid Gas Burner Flame. The infra red scanner will be directed to monitor the Fuel Gas Burner Flame.

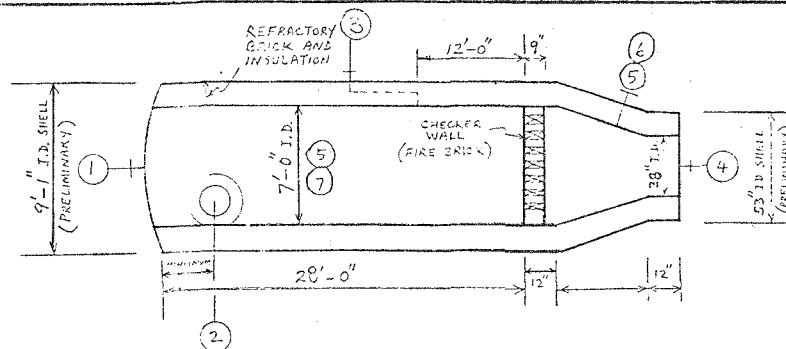
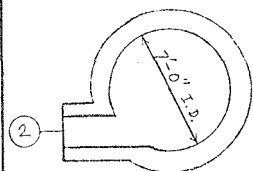
IV. SITE CONDITIONS

1. Altitude (above sea level)	-	1315 ft
2. Atmospheric Pressure	-	14.0 PSIA
3. Design Temp. Summer	-	93 ⁰ F
Winter	-	-25 ⁰ F
4. Location	-	Outdoors
5. Type of Operation	-	Continuous
6. Earthquake Zone	-	I
7. Wind Loading		
0 - 29 ft	-	20 PSF
30 - 49 ft	-	25 PSF
50 - 99 ft	-	30 PSF
100 - 499 ft	-	40 PSF

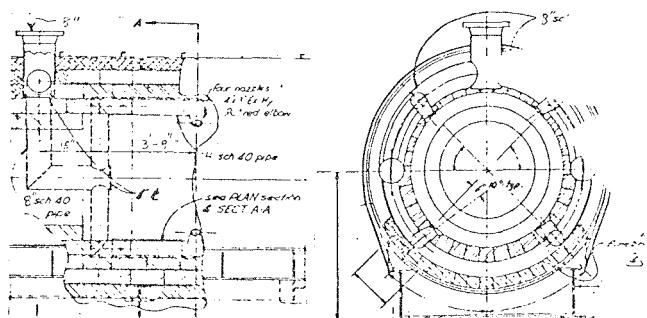
V. STANDARDS AND JOB SPECIFICATIONS

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

- | | | |
|----|------------|--------------------------|
| 1. | 1590-10A1 | Vessel Specifications |
| 2. | 1590-50A2 | Gaskets and Surface |
| 3. | 1590-82A1 | External Insulation |
| 4. | 1590-83A1 | Painting |
| 5. | 1590-87A1 | Internal Insulation |
| 6. | 1590-92A1 | Preparation for shipment |
| 7. | 1590-1200B | General Notes |

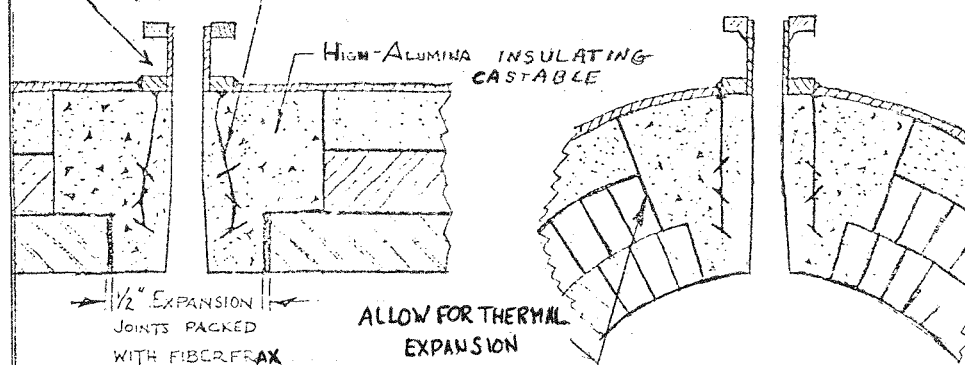
DETAILS OF
CONNECTION NO. ②

DETAILS OF CONNECTION NO. ③



SKETCH OF SIGHT PORT REFRACTORY FOR RADIATION PYROMETER

347 SS. PAD. 347 SS ANCHORS



RELEASES				VESSEL DATA	
DWG. REV.	DATE	ISSUED FOR	1	ITEM NO:	H 401
	DATE OF ORDER	(A) PURCHASE SHELL AND HEAD MATERIAL. PREPARE BUT DO NOT SUBMIT SHOP DETAIL DRAWINGS.	2	SERVICE:	MUFFLE FURNACE
		(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:	9' 1"
		(D) FIELD CONSTRUCTION	5	TARGET LENGTH:	SEE SKETCH
		(E)	6	OPER. PRESSURE:	NORM.: PSI
			7	ADDS LIQUID LEVEL. MAX.: PSI	
			8	DESIGN PRESSURE:	16 PSI
			9	OPER. LIQUID HOLD-UP PRESS:	PSI
			10	OPER. PRESS. DROP THRU VESSEL:	PSI
			11	MAX. RELIEVING PRESS. @ TOP NO.:	PSI
			12	MAX. OPER. TEMPERATURE:	
			13	DESIGN TEMPERATURE:	650°F (METAL)
			14	SPECIFIC GRAVITY (PROCESS FLUID):	
			15	CODE:	STAMPED:
			16	P.W.H.T.: FOR CODE:	FOR PROCESS:
			17	RADIOGRAPHED:	
			18	JOINT EFFICIENCY:	
			19	CORROSION ALLOWANCE SHELLS:	HEADS:
			20	MATL. SHELL:	BY VENDOR
			21	MATL. HEADS:	" "
			22	MATL. SUPPORTS:	" "
			23	TYPE OF HEADS:	" "
			24	EXTERNAL BOLTING:	
			25	INTERNAL BOLTING:	
			26	GASKETS:	
			27	BOLT HOLES:	STRADDLE VESSEL CENTERLINE
			28	PAINT:	
			29	INSULATION:	YES
			30	SHIPMENT:	
			31		
			32	EMPTY WGT.:	LBS
			33	WATER WGT.:	LBS
			34	TRAYS WGT.:	LBS
			35	INSULATION WGT.:	LBS
			36	GUMITE 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
			44	LIMITED BY:	
			45		
REFERENCE DRAWINGS, REQUISITIONS, STANDARDS					
C-1 4/30 JJS ADDED NOZZLE DETAILS			CONTRACT NO: 15-1592		
REV.	DATE	BY	DESCRIPTION	REQUISITION NO: 1592-1241C	
				DRAWING NO: 1592-1241C-1	
REVISIONS				THIS DWG. WAS:	
MUFFLE FURNACE H-401					

MATERIAL REQUISITION



FOSTER WHEELER ENERGY CORPORATION

PAGE 1 OF

FORM 135-20

FOR	ERDA-FE	F.W. REF. 15-1592	REQUISITION NUMBER	DATE
SITE	SIOUX FALLS, SOUTH DAKOTA		1592-1241 G	4-21-76
MATERIAL	AIR AND ACID GAS PREHEATER		SUPERSEDED BY CHANGE NO.:	
	ITEM H-402		C1	C4
	ENERGY RESEARCH & DEVELOPMENT ADMIN. FOSSIL ENERGY		C2	C5
	LOCATION-NSP LAWRENCE STATION, SIOUX FALLS, S.D.		C3	C6

I. SCOPE

Design, furnish material and deliver one (1) Air and Acid Gas Preheater Item H-402 in accordance with the following requirements. Fired Heater data sheets must be completed by vendor and submitted with Heater Quotation. Shop fabrication is to be maximized. Field erection by others.

II. SPECIFICATIONS

Design requirements shall be in accordance with the following Foster Wheeler Job Specifications:

- | | |
|--|------------|
| 1. Direct Fired Process Heaters-Design & Fabrication Basis | 1590-24A1 |
| 2. Induction Motors | 1590-38A1 |
| 3. Wind & Earthquake Loading | 1590-40A1 |
| 4. Steel Structures - Design & Construction | 1590-46A1 |
| 5. Gaskets & Surface Finishes for Flanged Joints | 1590-50A2 |
| 6. Equipment Painting | 1590-83A1 |
| 7. Preparation of Material for Shipment | 1590-92A1 |
| 8. Equipment Noise Control | 1590-96A2 |
| 9. General Notes Requisition for Heat Exchangers & Fired Heaters | 1590-1200A |

III. GENERAL

- A. The design of all equipment of vendors supply will comply with all regulations applicable to the proposed location, Sioux Falls, S.D.
- B. The design should be based on the expected operating life of 12 to 18 months.
- C. All materials to be of United States origin.

BY: RP

P.O. NO.

SUPPLIER:

IV. MISCELLANEOUS REQUIREMENTS FOR VENDORS BID

- A. Number of prefabricated components shall be listed.
- B. All process coils shall be hydrotested before shipment.
- C. The number and location of all field welds in piping shall be listed.
- D. The approximate sizes and weights of components shall be listed.
- E. Vendor to provide estimate of erection manhours.

V. PROCESS REQUIREMENTS

- 1. Feed Gas Composition:

	CASE D		CASE E	
	SWS Off-Gas Mol %	Selexol Unit Off-Gas Mol %	SWS Off-Gas Mol %	Selexol Unit Off-Gas Mol %
H ₂	0.25	0.04	0.11	
H ₂ O	25.37	5.19	27.49	5.12
CO	0.50	0.07	0.21	0.08
N ₂	0.50	0.07	0.21	0.08
CO ₂	32.59	78.33	31.32	76.98
H ₂ S	1.00	14.94	3.82	16.15
COS	--	1.21	--	1.38
CH ₄	0.25	0.11	0.11	0.13
NH ₃	39.54	0.04	36.73	0.08
TOTAL	100.00	100.00	100.00	100.00

- 2. Unit to be capable of operation for both cases. Each coil shall be fired in a separate cell.
- 3. Barometric pressure = 14.0 PSIA
- 4. Fuel Gas Composition as follows:

H ₂ O	0.01
H ₂	14.30
CO	20.18
COS	0.01
CO ₂	6.69
CH ₄	4.10
N ₂	54.71
	<u>100.00</u>

Normal operation will be on Fuel Gas. However, startup and shut-down will be with No. 2 Fuel Oil. Combination burners required.

API FIRED HEATER DATA SHEET

Revision No. 0 Date 4-21-76

Purchaser/Owner ERDA-FE Manufacturer _____
 Location Sioux Falls, South Dakota Item No. H-402
 Unit _____ Reference _____
 Service Air & Acid Gas Preheater
 Number Required One Type Optional
 *Total Duty per Heater, MM Btu per Hr Absorbed 3.28

CASE E

PROCESS DESIGN CONDITIONS

	Coil #1	Coil #2	Coil #3
*Heater Section	SWS	Selexol	
*Service	Off-Gas	Off-Gas	Air
*Heat Absorption, MM Btu per Hr	.558	1.692	1.033
*Fluid	NH ₃ + CO ₂	CO ₂ + H ₂ S	Air
*Flow Rate, Lb per Hr	2490	9899	6809
Flow Rate, BPD			
*Pressure Drop, psi (Allowable)	.5	.5	.5
Pressure Drop, psi (Calculated)			
*Average Flux Density, Btu per Hr per Sq Ft (Allowable)			
Average Flux Density, Btu per Hr per Sq Ft (Calculated)			
Maximum Flux Density, Btu per Hr per Sq Ft			
Velocity Limitation			
Maximum Allowable Inside Film Temperature, Deg F			
Fouling Factor			
Corrosion or Erosion Characteristics			
Inlet Conditions:			
*Temperature, Deg F	201	110	206
*Pressure, (psia) (psig)	21.5	24.0	21.4
*Liquid Flow, Lb per Hr	-	-	-
*Vapor Flow, Lb per Hr	2490	9899	6809
*Liquid, (Deg API) (Sp Gr at 60 F)	-	-	-
*Vapor, Molecular Weight	26.43	41.21	28.52
*Liquid Viscosity, Cp	-	-	-
Outlet Conditions:			
*Temperature, Deg F	800	800	800
*Pressure, (psia) (psig)	21	23.5	20.9
*Liquid Flow, Lb per Hr			
*Vapor Flow, Lb per Hr	2490	9899	6809
*Liquid, (Deg API) (Sp Gr at 60 F)	-	-	-
*Vapor, Molecular Weight	26.43	41.21	28.52
*Liquid Viscosity, Cp			
Remarks and Special Requirements:			
*1. Distillation Data or Composition Attached			

COMBUSTION DESIGN CONDITIONS

	Oil		
*Type of Fuel			
*Excess Air, Percent	15	15	
Guaranteed Efficiency, Percent (LHV) (See Note)	--	70% Min.	-
Calculated Efficiency, Percent (LHV)			
Radiation Loss, Percent of Heat Release (LHV)			
Flue Gas Temperature, Deg F, Leaving Radiant Section			
Flue Gas Temperature, Deg F, Leaving Convection Section			
Flue Gas Mass Velocity Through Convection Section, Lb/Sq Ft/Sec			

API FIRED HEATER DATA SHEET

Purchaser/Owner ERDA-FE Revision No. 0 Date 4-21-76
 Location Sioux Falls, South Dakota Manufacturer H-402
 Unit _____ Item No. _____
 Service Air & Acid Gas Preheater Reference _____
 Number Required One Type Optional
 *Total Duty per Heater, MM Btu per Hr Absorbed 2.98

PROCESS DESIGN CONDITIONS

CASE D

	Coil #1	Coil #2	Coil #3
*Heater Section	SWS	Selexol	
*Service	Off-Gas	Off-Gas	Air
*Heat Absorption, MM Btu per Hr	.246	1.984	.75
*Fluid	NH ₃ + CO ₂	CO ₂ + H ₂ S	Air
*Flow Rate, Lb per Hr	1058	11612	4940
Flow Rate, BPD	-	-	-
*Pressure Drop, psi (Allowable)	.5	.5	.5
Pressure Drop, psi (Calculated)			
*Average Flux Density, Btu per Hr per Sq Ft (Allowable)			
Average Flux Density, Btu per Hr per Sq Ft (Calculated)			
Maximum Flux Density, Btu per Hr per Sq Ft			
Velocity Limitation			
Maximum Allowable Inside Film Temperature, Deg F			
Fouling Factor			
Corrosion or Erosion Characteristics			
Inlet Conditions:			
*Temperature, Deg F	201	110	206
*Pressure, (psia) (psig)	21.5	24.0	21.4
*Liquid Flow, Lb per Hr	-	-	-
*Vapor Flow, Lb per Hr	1058	11612	4940
*Liquid, (Deg API) (Sp Gr at 60 F)	-	-	-
*Vapor, Molecular Weight	26.31	41.30	28.52
*Liquid Viscosity, Cp			
Outlet Conditions:			
*Temperature, Deg F	800	800	800
*Pressure, (psia) (psig)	21	23.5	20.9
*Liquid Flow, Lb per Hr	-	-	-
*Vapor Flow, Lb per Hr	1058	11612	4940
*Liquid, (Deg API) (Sp Gr at 60 F)	-	-	-
*Vapor, Molecular Weight	26.31	41.30	28.52
*Liquid Viscosity, Cp			
Remarks and Special Requirements:			
*1. Distillation Data or Composition Attached			

COMBUSTION DESIGN CONDITIONS

*Type of Fuel	
*Excess Air, Percent	15%
Guaranteed Efficiency, Percent (LHV) (See Note)	
Calculated Efficiency, Percent (LHV)	70% min.
Radiation Loss, Percent of Heat Release (LHV)	
Flue Gas Temperature, Deg F, Leaving Radiant Section	
Flue Gas Temperature, Deg F, Leaving Convection Section	
Flue Gas Mass Velocity Through Convection Section, Lb/Sq Ft/Sec	

COMBUSTION DESIGN CONDITIONS (CONT'D)

Page 5

*Type of Fuel	Oil	Gas		
Draft at Bridge Wall, In. H ₂ O				
Draft at Burners, In. H ₂ O				
*Ambient Air Temperature, Deg F	-25 +93			
*Altitude, Ft Above Sea Level	1315			
Calculated Heat Release, MM Btu per Hr (LHV)				
Volumetric Heat Release, Btu per Hr per Cu Ft				

Note: A fuel saving of _____ MM Btu per hr will offset a \$1,000 increase in furnace cost (erected).

FUEL CHARACTERISTICS

*Type of Fuel	Oil	Gas		
*Heating Value: HHV Btu/lb.	19430			
LHV Btu/scf		147		
*Specific Gravity	35° API			
*H/C Ratio (by Weight)				
*Temperature at Burner, Deg F	100	175		
*Viscosity: At 100 F cp	1.7 - 3.1			
At _____ F				
*Fuel Pressure Available at Burner, psig	25	25		
*Atomizing Steam Pressure, psig				
*Vanadium Content, ppm	} for Liquid Fuels			
*Sodium Content, ppm				
*Sulfur Content, Percent by Weight	.31	.028		
*Gas: Molecular Weight		24.88		
Composition, Mole Percent				

MECHANICAL DESIGN CONDITIONS

General

*Plot Limitations	*Stack Limitations
*Tube Limitations	Other Limitations
*Required Drawings	
*Structural Design Data: Wind Load	Seismic Factor
*List of Applicable Standards or Specifications: 1.	3.
2.	4.

Coil Design

*Heater Section			
*Design Pressure, psig	16	16	16
*Design Fluid Temperature, Deg F			
*Corrosion Allowance: Tubes TMT < 1200°F	1/8	1/8	1/8
Fittings	1/8	1/8	1/8
Hydrostatic Test Pressure, psig			
Number of Passes			
Overall Tube Length, Ft			
Effective Tube Length, Ft			
Bare Tubes: Number			
Total Exposed Surface, Sq Ft			
Extended Surface Tubes: Number			
Total Exposed Surface, Sq Ft			
Tube Spacing, Center to Center, In. (Staggered) (In Line)			
Tube Center to Furnace Wall, In. Min.			
*Stress Relieve	100%	100%	100%
*Weld Inspection Requirements, X-Ray or Other			

Coil Design (Cont'd)

	Coil #1	Coil #2	Coil #3
*Heater Section			
Tubes			
Vertical or Horizontal			
*Tube Material (ASTM Specification and Grade)	A-335	P-11	
Outside Diameter, In.			
Wall Thickness, (Minimum) (Average), In.			
Maximum Tube Wall Temperature, Deg F (Calculated)			
Inside Film Coefficient (Calculated)			
Maximum Tube Wall Temperature, Deg F (Design)			
Design Basis for Tube Wall Thickness		RD-530 (1976 Edition)	
Description of Extended Surface:			
Type			
Fin or Stud Material			
Fin or Stud Dimensions			
Fin or Stud Spacing			
Maximum Fin or Stud Temperature			
Extension Ratio			
Plug-Type Headers			
Manufacturer and Type		None	
*Material (ASTM Specification and Grade)			
Nominal Rating			
*Location			
*Welded or Rolled			
Return Bends			
Manufacturer and Type		WUB	
*Material (ASTM Specification and Grade)	A-335	P-11	--
Nominal Rating or Schedule			
*Location			
Terminals			
Manufacturer and Type	-	Flanged	-
*Material (ASTM Specification and Grade)	A-182	F-11	-
Nominal Rating	150 RF	150 RF	150 RF
*Location			
*Welded or Rolled			
Flange: Size and Rating			
Location			
Crossovers			
*Welded or Flanged		None	
*Pipe Material (ASTM Specification and Grade)			
Pipe Size and Wall Thickness			
Location			
Flange Rating			
Tube Supports			
Ends, Top, Bottom:			
Material			
Thickness			
Type and Thickness of Insulation			
Insulation Reinforcement			
Intermediate:			
Material			
Spacing, Ft			
Type and Thickness of Coating			
Guides: Location			
Material			

Header Boxes

Location _____ Material C.S. Thickness _____
 Insulation: Material _____ Thickness _____
 Anchoring Material _____
 Are Header Box Doors Bolted or Hinged? _____

Burners

Manufacturer and Type _____ Combination * Size _____ Number _____
 Location _____
 Size and Type of Pilots Propane
 Heat Release per Burner at Design Excess Air and Draft:
 Normal _____ MM Btu per Hr; Maximum _____ MM Btu per Hr
 Minimum Distance Burner Centerline to Tube Centerline:
 Horizontal _____ Vertical _____

Settings**Exposed Vertical Walls:**

Thickness _____ Hot-Face Temperature: Design _____ Calculated _____
 Wall Construction _____

 Outside Casing: Thickness _____ Material _____ Outside Temperature _____
 Tieback Material _____
 Support Material _____
 Method of Fastening Tiebacks to Structure _____

Shielded Vertical Walls:

Thickness _____ Hot-Face Temperature: Design _____ Calculated _____
 Wall Construction _____

 Outside Casing: Thickness _____ Material _____ Outside Temperature _____
 Tieback Material _____
 Support Material _____
 Method of Fastening Tiebacks to Structure _____

Arch:

Thickness _____ Hot-Face Temperature: Design _____ Calculated _____
 Arch Construction _____

 Outside Casing: Thickness _____ Material _____ Outside Temperature _____
 Tieback Material _____
 Support Material _____
 Method of Fastening Tiebacks to Structure _____

Floor:

Thickness _____ Hot-Face Temperature: Design _____ Calculated _____
 Floor Construction _____

 Minimum Floor Elevation _____
 Outside Casing: Thickness _____ Material _____ Outside Temperature _____

Convection Section:

Thickness _____ Design Hot-Face Temperature _____
 Construction _____

 Outside Casing: Thickness 3/16" Material C.S. Outside Temperature 200

* Oil to be used for startup and may be used to supplement
 fire with gas.

Settings (Cont'd)

Tieback Material _____
 Support Material _____
 Method of Fastening Tiebacks to Structure _____

Internal Wall:

Type _____ Required _____ Dimensions _____ Material _____

Stack

Number _____ one _____ Self-Supporting or Guyed _____ S.S. _____ Location _____ Integral
 Material _____ C.S. _____ Thickness _____ Minimum Thickness _____ 3/16
 Inside Metal Diameter _____ Height Above Grade _____ Stack Length _____
 Lining: Material _____ LHV _____ Thickness _____
 Type of Material or Reinforcement _____
 Extent of Lining _____ Full _____

Dampers

Location: Stack or Bottom Air Plenum _____
 Material _____ Multiple or Single Leaf _____
 Description of Provision for Operation from Grade _____

Hot Ducts, Breeching, Flues, and Collectors

Material _____ ASTM Specification _____ Size _____
 Insulation: Type _____ Thickness _____
 Type of Anchoring Material _____
 Size of Access Door into Breeching _____

Cold-Air Ducts and Plenum

Material _____ ASTM Specification _____ Size _____

Miscellaneous

Overall Dimensions of Furnace _____
 Platforms: Location _____
 Width _____
 Type of Floor _____
 Stairs: Location _____
 Ladders: Location _____

Access Doors: Location and Size _____

Observation Doors: Location and Size _____

Miscellaneous Connections (Number and Size):

Draft _____ Flue Gas Sample _____
 Temperature _____ Smothering Steam _____
 Header Box Drain _____ Stack Drain _____
 Coil Drains _____ Other _____

Painting and Galvanizing Requirements _____

Are Painter's Trolley and Rail Included? _____ No _____

Extent of Tube-Handling Facilities _____ Brackets _____

Explosion Doors: Location and Size _____

Special Equipment (Soot Blowers, Air Preheaters, Noise Suppressors, Fans, Etc.) _____ None _____

MATERIAL REQUISITION



FOSTER WHEELER

PAGE 1 OF 3

FOR	ERDA-FE	F.W. REF. 15-1592	REQUISITION NUMBER	DATE
SITE	SIOUX FALLS, SOUTH DAKOTA		1592-1241E	4/7/76
MATERIAL	ACID GAS BURNER (BR-401)		SUPERSEDED BY CHANGE NO.:	
	ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION	C1	C4	
	FOSSIL ENERGY - LOCATION - NSP LAWRENCE STATION	C2	C5	
	SIOUX FALLS, S.D.	C3	C6	

INDEX

- I SCOPE
- II GENERAL
- III BASIS OF DESIGN
- IV MECHANICAL SPECIFICATIONS
- V STANDARDS AND SPECIFICATIONS

BY: P.O. NO. SUPPLIER:

I SCOPE

This requisition defines the design, test, and supply of a burner assembly to be installed in the H-402 Muffle Furnace.

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 standards noted in Part V of this specification as well as the applicable provisions of the latest revisions of the following codes, specifications, etc., which may be revised to adjust classification and addition made as necessary to assume good practice.

1. Electrical - NEC - Class I - Group D, Division -2
Class II- Group F, Division -2
2. Safety - Federal Register (OSHA)
3. Other - State & local requirements

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 subcontractor 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

A. The burner shall be used to effect the partial combustion of a gas containing hydrogen sulfide. The burner shall be suitable for operation on the acid gases in all three cases described as follows:

Case	<u>D</u>		<u>E</u>		<u>N</u>	
<u>lb mols/hr</u>	<u>acid gas</u>	<u>air</u>	<u>acid gas</u>	<u>air</u>	<u>acid gas</u>	<u>air</u>
H2	0.15	--	0.10		0.19	
H2O	18.23	5.20	32.66	7.16	32.86	7.14
CO	0.31	--	0.31		0.38	
N2	0.31	132.79	0.31	183.04	0.38	182.53
O2	--	35.19		48.51		48.37
CO2	134.26	--	131.19		182.32	
H2S	23.50	--	24.94		39.08	
COS	1.87	--	1.81		3.13	
CH4	0.26	--	0.26		0.38	
NH3	15.95		34.71		34.79	
Total	194.84	173.18	226.29	238.71	293.51	238.04

B.

Inlet temperature 800°F (both gas and air)
Inlet pressure 20.8 PSIA (both gas and air)
Allowable pressure drop 0.5 PSI (both gas and air)

IV. MECHANICAL DESIGN

1. The burner shall have design pressure of 16 PSIG.
2. The burner tile shall have a minimum service temperature rating of 3300°F.
3. The burner and throat assemblies are to be sized to fit in the H-401 Muffle Furnace and in proximity to the BR-402 so that the BR-402 flame will ignite the BR-401 during startup.
4. The burners will be equipped with a purged peephole.

V. STANDARDS AND JOB SPECIFICATIONS

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

- | | |
|---------------|--------------------------|
| 1. 1590-50A2 | Gaskets and Surface |
| 2. 1590-83A1 | Painting |
| 3. 1590-92A1 | Preparation for shipment |
| 4. 1590-1900B | General Notes |

MATERIAL REQUISITION



FOSTER WHEELER

PAGE 1 OF 4

FOR	ERDA-FE	F.W. REF. 15-1592	REQUISITION NUMBER	DATE
SITE	SIOUX FALLS, SOUTH DAKOTA		1592-1241F	4/7/76
MATERIAL	FUEL GAS BURNER (BR-402)		SUPERSEDED BY CHANGE NO.:	
	ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION	C1	C4	
	FOSSIL ENERGY - LOCATION - NSP LAWRENCE STATION	C2	C5	
	SIOUX FALLS, S.D.	C3	C6	

INDEX

- I SCOPE
- II GENERAL
- III BASIS OF DESIGN
- IV MECHANICAL SPECIFICATIONS
- V STANDARDS AND SPECIFICATIONS

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

I. SCOPE

This requisition defines the design, test and supply of a fuel burner assembly to be installed in the H-402 Muffle Furnace.

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 standards noted in Part V of the latest revisions of the following codes, specifications, etc., which may be revised to adjust classification and addition made as necessary to assume good practice.

1. Electrical - NEC - Class I - Group D, Division -2
2. Safety - Federal Register (OSHA)
3. Other - State & local requirements

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 14-32-001-1521 between the United States and Foster Wheeler Energy Corporation and the subcontractor 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

A. The burner shall be used to obtain the stoichiometric combustion of fuel gas having the following composition

<u>Fuel Gas Composition</u>		<u>Air Composition</u>	
<u>Component</u>	<u>Mol %</u>	<u>Component</u>	<u>Mol %</u>
H2	14.30	N2	76.68
CO	20.18	O2	20.32
N2	54.71	H2O	3.00
CO2	6.69		
CH4	4.10		
COS	0.01		
H2	<u>0.01</u>		
Total	100.00	Total	100.00

B. The flow rate of gas and air are 200.6 and 2323 lb mols/hr respectively. The burner shall be designed to handle from 20% to 120% of the expected flow rate.

C.	<u>Gas</u>	<u>Air</u>
Inlet temperature °F	175	206
Inlet pressure PSIA	20.8	20.8
Allowable pressure drop PSI	0.5	0.5

IV. MECHANICAL DESIGN

- The burner shall have design pressure of 16 PSIG.
- The burner tile shall have a minimum service temperature rating of 3300°F.
- The burner and throat assemblies are to be sized to fit in the H-401 Muffle Furnace and in proximity to the BR-402 so that the BR-402 flame will ignite the BR-401 during startup.
- The burners shall be equipped with the following auxiliary parts:

one	Propane Gas Pilot
one	Ultra violet flame scanner
one	Infra red flame scanner
one	Flame detection relay
one	Purged peephole assembly
one	Pilot ignition system complete with ignition transformer.

V. STANDARDS AND JOB SPECIFICATIONS

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

- | | |
|---------------|--------------------------|
| 1. 1590-50A2 | Gaskets and Surface |
| 2. 1590-83A1 | Painting |
| 3. 1590-92A1 | Preparation for shipment |
| 4. 1590-1900B | General Notes |

FOR <u>ERDA FE-14-32-0001-1521</u>		F.W. CONTRACT <u>15-1592</u>		REQUISITION NO. <u>1592-1311-R</u>	DATE <u>3-4-76</u>
SITE <u>ASP LAWRENCE STATION, SIOUX FALLS, SOUTH DAKOTA</u>				SUPERSEDED BY CHANGE NO.	
SERVICE <u>SULFUR CIRCULATION PUMP</u>				C1	C3
NO. REQ'D <u>1</u> ITEM NOS. <u>P-401</u>				C2	C4
				C5	C6

NO. OF MOTORS REQ'D. 1 : 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 MOLTEN SULFUR U.S.GPM @ PT: MIN _____ NORM 103 RTD. 103
 DISCH. PSIG _____ RTD. 44
 P.T. °F. (MAX 275) 275 SUCT. PSIG (MAX. 10) RTD. 0
 SP.GR. AT PT 1.79 DIFF. PSI 44
 VAP. PSIA @ PT 3.0 TOTAL DIFF. HEAD, FT. 57
 VIS. @ PT 4.75 CKS NPSHA, FT. 12
 CORR./EROS. FROM DISSOLVED H₂S HYD HP 2.65

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 ☒ SUMP-SPLIT: ☐ AXIAL ☒ RADIAL-VOLUTE: ☒ SINGLE ☐ DOUBLE ☐ DIFFUSER ☐ _____

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

-AUX. CONNECTIONS: ☒ 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 = SLEEVE, THRUST = BALLLUBE: ☐ 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:

PERFORMANCE YES NO

NPSHR _____

DISMANTLE & INSPECT

HYDROTEST CASE YES NO

HYDROTEST BOWLS _____

MATERIALS:

☒ PUMP API CLASS S-4☐ _____

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 13 PH 60 HZ

MFR. _____ BEARINGS _____ LUBE _____

TYPE IND. INSUL. CLASS B AMPS, FULL LOAD _____ENCL. TEFC 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: 1590-1300A, 1590-38A1, 1590-50A2, 1590-50A4, 1590-92A11590-31A2

NOTES: ① SHAFT AND DISCHARGE PIPE TO BE STEAM JACKETED WITH 65 PSIG STEAM.

② MOLTEN SULFUR CONTAINS DISSOLVED H₂S

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 I-GRD-DIV 2. ☐ NON-HAZARDOUS

COOLING WATER: TYPE _____

°F & PSIG IN, °F MAX & PSIG OUT



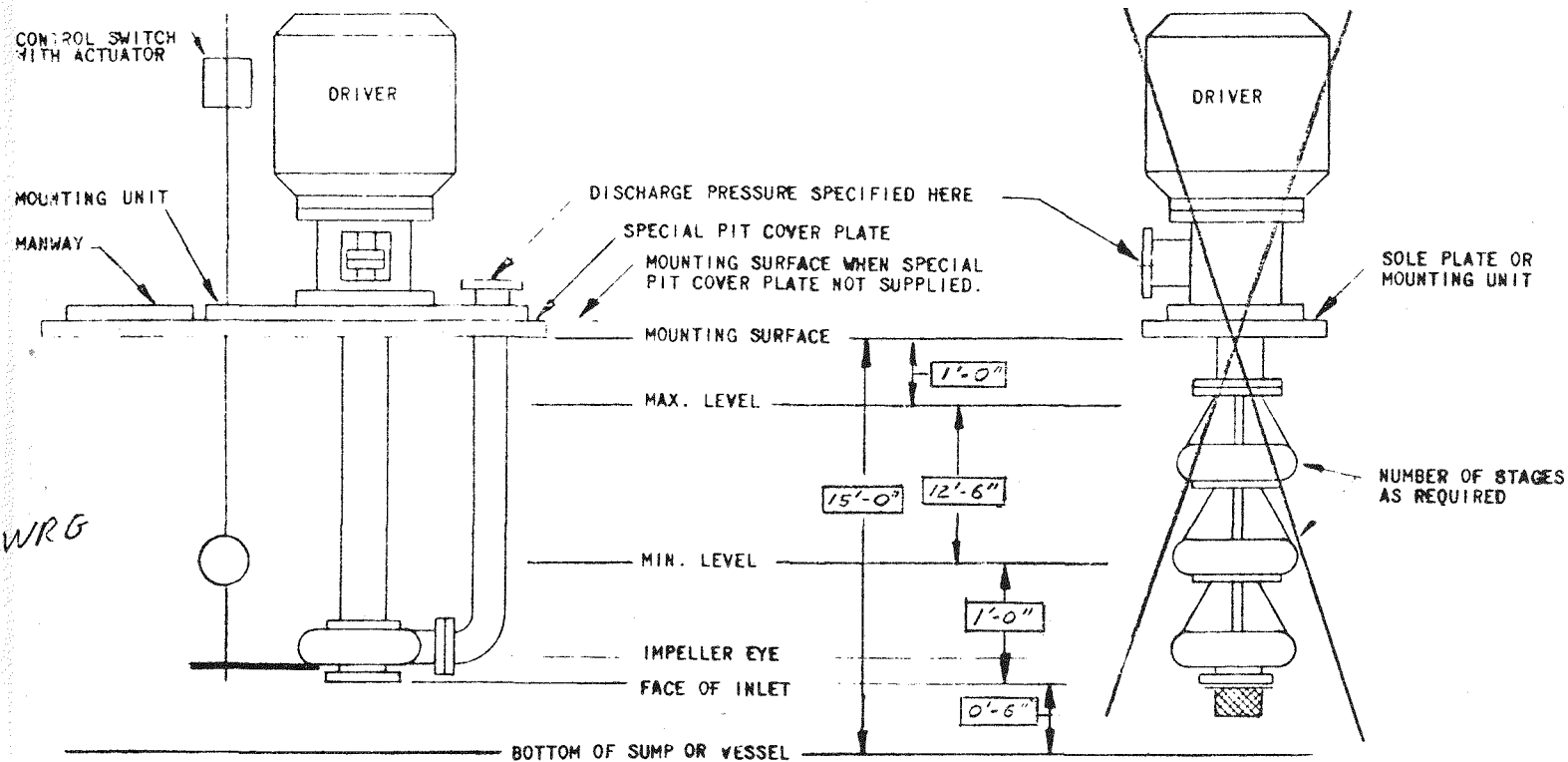
FOSTER WHEELER

VERTICAL CENTRIFUGAL PUMPS

PAGE 2 OF 2

FOR ERDA-FE-14-32-0001-1521 F.W. CONTRACT 15-1592
 SITE NSP LAWRENCE STATION, SIOUX FALLS, SOUTH DAKOTA
 ITEM NO. P-401

REQUISITION NO.	DATE
1592-1311-R	3-4-76
SUPERSEDED BY CHANGE NO.	
C1	C3
C2	C4
	C5
	C6



TYPE "S" (DISCHARGE PIPE EXTERNAL TO COLUMN)

TYPE "T" (DISCHARGE INSIDE COLUMN)

VENDOR COMPLETE MISSING DIMENSIONS ABOVE TO SPECIFY EQUIPMENT AND REQUIREMENTS: IMPELLER EYE LOCATION REQUIRED ONLY

WHEN NPSH IS LIMITED OR NPSHA TEST REQUIRED. VENDOR ALSO COMPLETE DATA BELOW WHEN IN SCOPE OF SUPPLY.

PURCHASER'S FLUID CONTAINER TYPE: CONCRETE SUMP (BRICK LINED) PURCHASER'S MOUNTING SURFACE: ALUMINUM OR STEEL PLATE

ARRANGEMENT ☒ TYPE "S" ☐ TYPE "T" COVER CONSTRUCTION: ☐ OPEN ☐ RAIN TIGHT ☒ GAS TIGHT ☐

MOUNTING COLUMN: ☒ FLANGED ☐ SCREWED MATERIALS _____

DISCHARGE PIPING: ☒ FLANGED ☐ SCREWED MATERIALS _____

INCLUDE: ☒ MOUNTING UNIT = ☒ VENDOR'S STD. ARRGT. ☐ SOLE PLATE MAT'L. _____

☐ SPECIAL PIT COVER = ☐ VENDOR'S STD. ARRGT. ☐ SOLE PLATE ☐ MANWAY MAT'L. _____

☐ INLET STRAINER = ☐ VENDOR'S STD. ARRGT. ☐ MESH MAT'L. _____

☐ LEVEL CONTROL ACTUATOR = TYPE _____ MAT'L. _____

☐ LEVEL CONTROL SWITCH = ☐ START-STOP ☐ ALTERNATOR ☐ _____

_____ VOLT- _____ PH.- _____ HZ. ENCLOSURE _____

☐ _____

☐ _____

FOR <u>ENR-1-FE-14-32-0001-1521</u>	F.W. CONTRACT <u>15-1592</u>	REQUISITION NO. <u>1592-1311-S</u>	DATE <u>3-4-76</u>
SITE <u>NEL LAWRENCE STATION, SIOUX FALLS, SOUTH DAKOTA</u>		SUPERSEDED BY CHANGE NO.	
SERVICE <u>SULFUR TRANSFER PUMP</u>		C1	C3
NO. REQ'D <u>1</u> ITEM NOS. <u>P-402</u>		C2	C4
		C5	C6

NO. OF MOTORS REQ'D. 1 : ITEM NOS. _____ SUPPLIED BY P.MFR MOUNTED BY P.MFR

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

PUMP MFR. _____ SIZE & MODEL _____ NO. STAGES _____

OPERATING CONDITIONS, EACH PUMP:

LIQUID MOLTEN SULFUR U.S.GPM @ PT: MIN _____ NORM 10 RTD. 10 PROPOSAL CURVE NO. _____
 DISCH. PSIG _____ RTD. 47 RPM _____ NPSHR (WATER), FT. _____
 P.T. °F. (MAX 275) 275 SUCT. PSIG (MAX. 10) RTD. 0 MIN. CONTINUOUS U.S.GPM _____
 SP.GR. AT PT 1.79 DIFF. PSI _____ ROTATION, VIEWING FROM COUPLING _____
 VAP. PSIA @ PT 3.0 TOTAL DIFF. HEAD, FT. 61 WITH RATED IMPELLER: _____
 VIS. @ PT 4.75 NPSHA, FT. 12 EFFICIENCY AT RATED POINT, % _____
 CORR./EROS. FROM DISSOLVED H₂S HYD HP. 275 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				<u>BOTTOM</u>
DISCHARGE			<u>RF</u>	<u>TOP</u>

CASE-MOUNT ☐ CENTERLINE ☐ FOOT ☐ BRACKET ☐ IN-LINE ☒ SUMP
 -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 = SLEEVE, THRUST = BALL

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 _____

AUXILIARY PIPING:

C.W. PIPE PLAN _____, WITH ☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPE

TOTAL 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 13 PH 60 HZ

MFR. _____ BEARINGS _____, LUBE _____

TYPE IND INSUL. CLASS B AMPS, FULL LOAD _____

ENCL. TEFC 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, 1520-38A1, 1520-50A2, 1520-50A4, 1520-92A1
1520-31A2

NOTES: ① SHAFT AND DISCHARGE PIPE TO BE STEAM JACKETED WITH 65 PSIG STEAM.

② MOLTEN SULFUR CONTAINS DISSOLVED H₂S

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-4

☐ _____

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 - GRD - DIV 2 ☐ NON-HAZARDOUS

COOLING WATER: TYPE _____

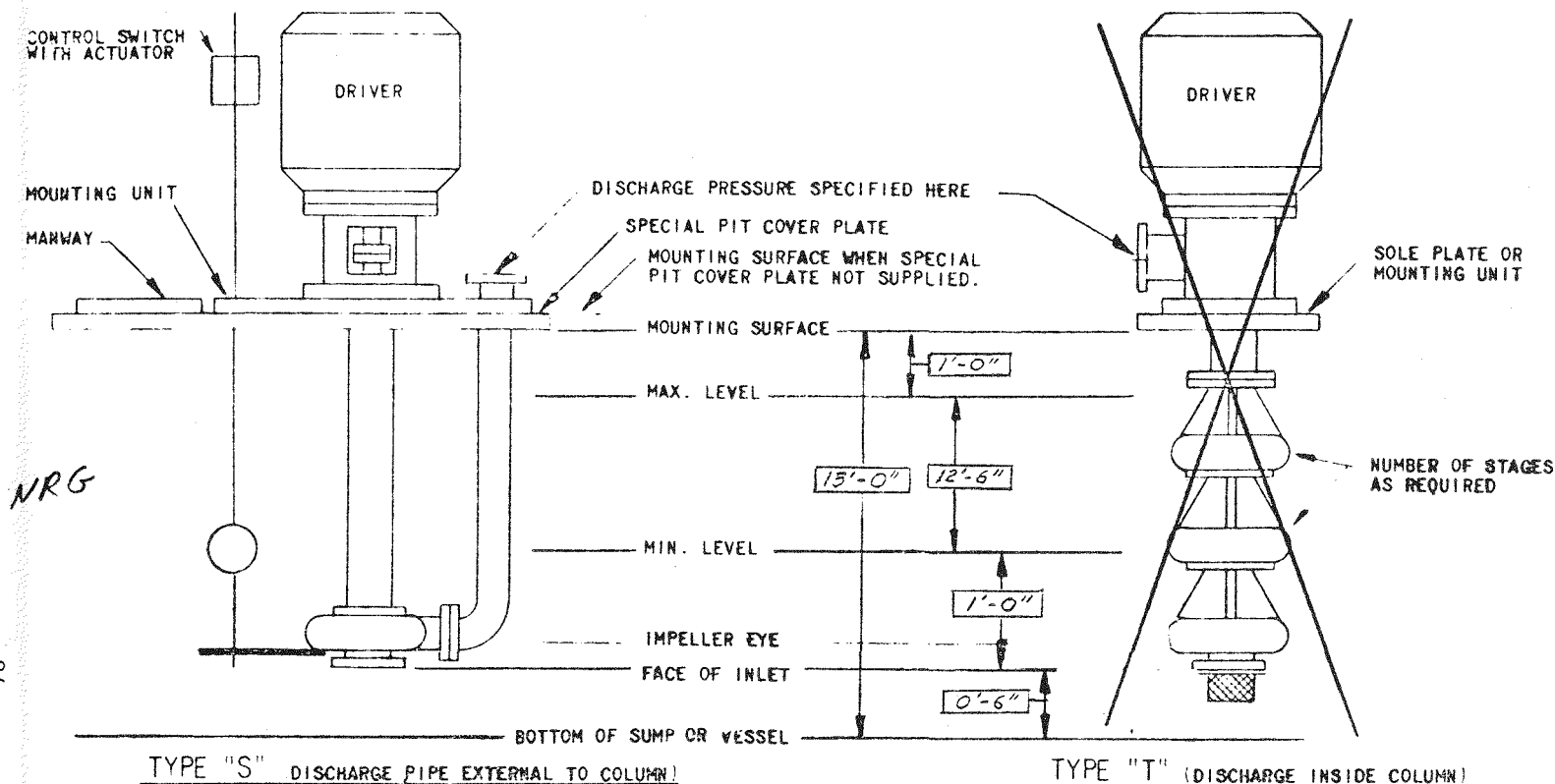
°F & PSIG IN, °F MAX & PSIG OUT



FOSTER WHEELER

VERTICAL CENTRIFUGAL PUMPS

PAGE 2 OF 2



TYPE "S" (DISCHARGE PIPE EXTERNAL TO COLUMN)

TYPE "T" (DISCHARGE INSIDE COLUMN)

VENDOR COMPLETE MISSING DIMENSIONS ABOVE TO SPECIFY EQUIPMENT AND REQUIREMENTS: IMPELLER EYE LOCATION REQUIRED ONLY

WHEN NPSH IS LIMITED OR NPSHA TEST REQUIRED. VENDOR ALSO COMPLETE DATA BELOW WHEN IN SCOPE OF SUPPLY.

PURCHASER'S FLUID CONTAINER TYPE: CONCRETE SUMP (BRICK LINED) PURCHASER'S MOUNTING SURFACE: ALUMINUM OR STEEL PLATEARRANGEMENT ☒ TYPE "S" ☐ TYPE "T"COVER CONSTRUCTION: ☐ OPEN ☐ RAIN TIGHT ☒ GAS TIGHT ☐MOUNTING COLUMN: ☒ FLANGED ☐ SCREWED

MATERIALS

DISCHARGE PIPING: ☒ FLANGED ☐ SCREWED

MATERIALS

INCLUDE: ☒ MOUNTING UNIT = ☒ VENDOR'S STD. ARRGT. ☐ SOLE PLATE MAT'L.☐ SPECIAL PIT COVER = ☐ VENDOR'S STD. ARRGT. ☐ SOLE PLATE ☐ MANWAY MAT'L.☐ INLET STRAINER = ☐ VENDOR'S STD. ARRGT. ☐ MESH MAT'L.☐ LEVEL CONTROL ACTUATOR = TYPE MAT'L.☐ LEVEL CONTROL SWITCH = ☐ START-STOP ☐ ALTERNATOR ☐

____ VOLT- ____ PH.- ____ HZ. ENCLOSURE

REQUISITION NO.	DATE
1592-1311-5	3-4-76
SUPERSEDED BY CHANGE NO.	
C1	C3
C2	C4
	C5
	C6

FOR 80

FOR ERDA-FE-14-32-0001-1521 F.W. CONTRACT 15-1592
 SITE MSP LAWRENCE STATION, SIOUX FALLS, SOUTH DAKOTA
 SERVICE SULFUR LOADING PUMP
 NO. REQ'D 1 ITEM NOS. P-403

REQUISITION NO.		DATE	
1592-1311-T		3-4-76	
SUPERSEDED BY CHANGE NO.			
C1	4-20-76	C3	C5
C2		C4	C6

NO. OF MOTORS REQ'D. 1 : ITEM NOS. SUPPLIED BY P.MFR MOUNTED BY P.MFR.

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

PUMP MFR. SIZE & MODEL

NO. STAGES

OPERATING CONDITIONS, EACH PUMP:

LIQUID MOLTEN SULFUR U.S.GPM @ PT: MIN NORM 200 RTD. 200
 DISCH. PSIG RTD. 29
 P.T. °F. (MAX 275) 275 SUCT. PSIG (MAX. +15.5) RTD. 0.5
 SP.GR. AT PT 1.79 DIFF. PSI 29.5
 VAP. PSIA @ PT 3.0 TOTAL DIFF. HEAD, FT. 38
 VIS. @ PT 4.9 cks NPSHA, FT. 11.5
 CORR./EROS. FROM DISSOLVED H₂S HYD HP 3.44

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 SIMILAR TO PENDING ANSI STD.

NOZZLES	SIZE	ANSI RATING	FACING	LOCATION
SUCTION			RF	SIDE
DISCHARGE			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 OPEN

MOUNTING ☐ BETWEEN BEARINGS ☐ OVERHUNG ☐

WEAR RINGS: ☐ INLET ONLY ☐ BOTH SIDES ☐ CASE ONLY ☐ CASE & IMPELL.

BEARINGS: TYPE: RADIAL BALL IN MOTOR THRUST = BALL IN MOTOR

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 45TGL

CRANE 2 OR EQUAL

SHOP TESTS:

	REQUIRED	WITNESSED
PERFORMANCE	<u>YES</u>	<u>NO</u>
NPSHR		
DISMANTLE & INSPECT		
HYDROTEST CASE	<u>YES</u>	<u>NO</u>
HYDROTEST BOWLS		

MATERIALS:

☒ PUMP API CLASS S-4

☐

AUXILIARY PIPING:

C.W. PIPE PLAN _____ WITH ☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPE

TOTAL C.W. REQ'D. _____ GPM. INCLUDE: ☐ FLOW INDIC. ☐ VALVE "C"

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

SEAL FLUSH PLAN 13 WITH ☒ C.S. ☐ S.S. ☒ TUBING ☐ PIPE

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

AUX. SEAL PLAN 62 WITH ☐ C.S. ☐ S.S. ☐ TUBING ☐ PIPE

QUENCH FLUID= STEAM

MOTOR DRIVERS:

HP _____, S.F. _____, RPM _____, FRAME _____, 440 V/ 3 PH/ 60 HZ

MFR. _____ BEARINGS _____, LUBE _____

TYPE IND. INSUL. CLASS B AMPS, FULL LOAD _____

ENCL. TEFC 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 _____

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 - GRD - DIV 2 ☐ NON-HAZARDOUS

COOLING WATER: TYPE _____

°F & PSIG IN, °F MAX & PSIG OUT

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

1590-31A2

NOTES: ① STAFFING BOX AND PUMP CASING TO BE STEAM JACKETED WITH 65 PSIG STEAM

② MOLTEN SULFUR CONTAINS DISSOLVED H₂S

MATERIAL REQUISITION



FOSTER WHEELER CORPORATION

PAGE 1 OF 2

FORM 135-20

FOR	ERDA-FE	F.W.REF. 15-1592	REQUISITION NUMBER	DATE
SITE	SIOUX FALLS, SOUTH DAKOTA		1592-1349-F	3/24/76
MATERIAL PROCESS AIR FILTER (F-401)			SUPERSEDED BY CHANGE NO.:	
ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION			C1	C4
FOSSIL ENERGY - LOCATION - NSP LAWRENCE STATION			C2	C5
SIOUX FALLS, S.D.			C3	C6

INDEX

- I SCOPE
- II GENERAL
- III BASIS OF DESIGN
- IV MECHANICAL SPECIFICATIONS
- V SITE CONDITIONS

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

I. SCOPE

This requisition covers the design and supply of an air filter to remove dust and foreign material from air entering the suction of a centrifugal air blower, C-401.

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. The following specifications shall be considered an integral part of this requisition.

- | | |
|---------------|--------------------------|
| 1. 1590-50A2 | Gaskets and surfaces |
| 2. 1590-83A1 | Painting |
| 3. 1590-92A1 | Preparation for Shipment |
| 4. 1590-1900B | General Notes |

III. BASIS OF DESIGN

A. Process Gas Conditions

- | | |
|--|---|
| 1. Design air flow | 2565 SCFM |
| 2. Temperature | -25°F to 93°F |
| 3. Pressure at filter inlet | 14.0 PSIA |
| 4. Gas composition | Air (humidity = 3 mol %) |
| 5. Maximum allowable pressure drop, when clean | 1" water |
| 6. Efficiency at above operating conditions | Remove 99.5% of all particles down to 3 microns |

IV. MECHANICAL SPECIFICATIONS

- | | |
|-----------------------------|--------------|
| A. Outlet nozzle size | 12" |
| B. Material of construction | carbon steel |

V. SITE CONDITIONS

- | | |
|-------------------------------|--------------|
| 1. Altitude (above sea level) | - 1315 ft |
| 2. Atmospheric Pressure | - 14.0 PSIA |
| 3. Design Temp. Summer | - 93°F |
| 4. Winter | - -25°F |
| 4. Location | - Outdoors |
| 5. Type of Operation | - Continuous |
| 6. Earthquake Zone | - I |

MATERIAL REQUISITION



FOSTER WHEELER CORPORATION

PAGE 1 OF 2

FORM 135-20

FOR <u>ERDA-FE</u>	F.W.REF. <u>15-1592</u>	REQUISITION NUMBER	DATE
SITE <u>SIOUX FALLS, SOUTH DAKOTA</u>		<u>1592-1344A</u>	<u>3/24/76</u>
MATERIAL <u>BLOWER SUCTION SILENCER (SL-401)</u>	SUPERSEDED BY CHANGE NO.:		
<u>ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION</u>	C1	<u>4-6-76</u>	C4
<u>FOSSIL ENERGY - LOCATION - NSP LAWRENCE STATION</u>	C2		C5
<u>SIOUX FALLS, S.D.</u>	C3		C6

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- I SCOPE
- II GENERAL
- III BASIS OF DESIGN
- IV MECHANICAL SPECIFICATIONS
- V SITE CONDITIONS

BY:

P.O.NO.

SUPPLIER:

I. SCOPE

This requisition covers the design and supply of a suction silencer to minimize the noise from a centrifugal blower, C-401.

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. The following specifications shall be considered an integral part of this requisition.

- | | |
|---------------|--------------------------|
| 1. 1590-50A2 | Gaskets and surfaces |
| 2. 1590-83A1 | Painting |
| 3. 1590-92A1 | Preparation for Shipment |
| 4. 1590-96A2 | Noise Specification |
| 5. 1590-1900B | General Notes |

III. BASIS OF DESIGN

A. Process Air Conditions

- | | |
|----------------------------|------------------------------|
| 1. Air | Mol. Wt. 28.52 |
| 2. Pressure | -0.1 PSIG or 13.9 PSIA |
| 3. Pressure drop allowable | 3" water max. |
| 4. Temperature | -25°F to 85°F |
| 5. Flow rate | 11,566 lbs/hr
406 mols/hr |
| 6. Components | Mol % |
| | N ₂ 76.69 |
| | O ₂ 20.32 |
| | H ₂ O 2.99 |
| | 100.00 |

IV. MECHANICAL SPECIFICATIONS

1. Inlet and outlet nozzle sizes - 12", Vendor to confirm
2. Material of construction - carbon steel
3. Installation and acoustic insulation (if required) by others.

V. 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 | - | Outdoors |
| 5. Type of Operation | - | Continuous |
| 6. Earthquake Zone | - | I |

MATERIAL REQUISITION



FOSTER WHEELER CORPORATION

PAGE 1 OF 2

FORM 135-20

FOR <u>ERDA-FE</u>	F.W.REF. <u>15-1592</u>	REQUISITION NUMBER	DATE
SITE <u>STIOUX FALLS, SOUTH DAKOTA</u>		<u>1592-1344-C</u>	<u>3/24/76</u>
MATERIAL <u>BLOWER VENT SILENCER (SL-402)</u>		SUPERSEDED BY CHANGE NO.:	
<u>ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION</u>	C1		C4
<u>FOSSIL ENERGY - LOCATION - NSP LAWRENCE STATION</u>	C2		C5
<u>SIOUX FALLS, S.D.</u>	C3		C6

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- I SCOPE
- II GENERAL
- III BASIS OF DESIGN
- IV MECHANICAL SPECIFICATIONS
- V SITE CONDITIONS

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

I. SCOPE

This requisition covers the design and supply of a vent silencer to control the noise from a centrifugal blower, C-401.

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. The following specifications shall be considered an integral part of this requisition.

- | | |
|---------------|--------------------------|
| 1. 1590-50A2 | Gaskets and surfaces |
| 2. 1590-83A1 | Painting |
| 3. 1590-92A1 | Preparation for Shipment |
| 4. 1590-96A2 | Noise Specification |
| 5. 1590-1900B | General Notes |

III. BASIS OF DESIGN

A. Process Air Conditions

- | | |
|----------------|--|
| 1. Air | Mol. Wt. 28.52 |
| 2. Pressure | |
| Inlet maximum | 7.9 PSIG or 21.9 PSIA |
| Outlet | Atmospheric |
| 3. Temperature | 96° - 206°F |
| 4. Flow rate | Minimum flow rate required
by C-401 Blower
(to be provided by Blower Vendor) |
| 5. Components | Mol % |
| | N ₂ 76.69 |
| | O ₂ 20.32 |
| | H ₂ O 2.99 |
| | 100.00 |

IV. MECHANICAL SPECIFICATIONS

1. Inlet and outlet nozzle sizes - Vendor to advise
2. Material of construction - carbon steel
3. Installation and acoustic insulation (if required) by others.

V. 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 | - Outdoors |
| 5. Type of Operation | - Continuous |
| 6. Earthquake Zone | - I |

FOR ERDA-FE-14-32-0001-1521		F.W. REF. 15-1592		REQUISITION NO. 1592-1323-A		DATE 4-20-76	
SITE NSP LAWRENCE STATION, SIOUX FALLS, SOUTH DAKOTA				SUPERSEDED BY			
ITEM NO. C-401		MOTOR DRIVE ONE		TURBINE DRIVE —			
SERVICE AIR BLOWER				CHG.		CHG.	
MFR. MFG.				C1		C4	
SIZE & TYPE				C2		C5	
MO. REQ'D. ONE				C3		C6	
GENERAL NOTES REQUISITION				IS AN INTEGRAL PART OF THIS REQUISITION			
OPERATING CONDITIONS				PERFORMANCE			
GAS: AIR NOTE ①		ACFM NORMAL 2480 DES. 3192		PROPOSAL CURVE NO.			
MMSCFD (WET): 4.06		DISCH. PRESS. PSIA 25		DISCH. TEMP °F			
GAS TEMP. °F 90		SUCTION PRESS. PSIA 13.5		MECH. EFF. BHP			
M.L. WT. 28.52		DIFF. PRESS. PSI 11.5		BLOWER RPM			
				MAX. BHP @ R.V. SET. - PSIG			
				REL. VALVE (BUILT IN) (EXT.) BY			
				ROTATION FACING COUPLING END			
CORR./EROS. DUE TO				WATER COOLING			
CONSTRUCTION & MATERIALS				BEARINGS PED.			
CASING - MOUNTING (CENTERLINE) (FOOT ✓) (BRACKET) (VERTICAL)				STUFF. BOX GLAND			
SPLIT (AXIAL) (RADIAL ✓)				TOTAL WATER REQ'D. - GPM			
TYPE (GEAR, VANE, SCREW, ETC.) LOBE				STEAM JACKETS - CASE			
TAPPED OPENINGS (VENT) (DRAIN) (GAGE CONNS.)				STUFF. BOX			
NOZZLES		SIZE	ASA RATING	FACING	STEAM REQ'D. - LB./HR.		
SUCTION			125 #	FF	JACKET STEAM PSIG TEMP °F		
DISCHARGE			125 #	FF	EXHAUST PSIG		
BEARINGS - RADIAL (MFR.) (EXT.) THRUST (MFR.) (EXT.) TYPE HEAVY DUTY				JACKET MAX. ALLOW. W.P. PSIG			
BEARING LUBRICATION OIL				FLUSHING			
COUPLING & GUARD BASEPLATE COMMON FOR BLOWER + DRIVER				AUX. PIPING			
PACKING LIP SEAL							
MECH. SEAL — MFR. —							
TIMING GEARS - (MFR.) (EXT.) STEEL							
MATERIAL CODE CASING		I		INTERNALS		SHOP TESTS	
I - CAST IRON		INTERNAL	SYMBOL	REMARKS		REQUIRED	
B - BRONZE		ROTOR (S)	I			WITNESSED	
S - STEEL						YES NO	
C - 11-13% CHROME		SLEEVE (PACKED)					
A - ALLOY		SLEEVE (SEAL)					
H - HARDENED		SHAFT	S			HYDROSTATIC PSIG	
F - FACED		TIMING GEARS	S			MAX. ALLOW. W.P. PSIG °F	
X						WEIGHTS: BLOWER BASE	
						MOTOR TURBINE — GEAR	
MOTOR DRIVER BY BLOWER MFR		TURBINE DRIVER BY —		SPEED REDUCER BY BLOWER MFR			
ITEM NO.		MTD. BY BLOWER MFR		ITEM NO.		MTD. BY	
HP RPM FRAME		HP RPM MAT'L.		MFR.		RATIO	
MFR.		MFR. & TYPE		AGMA S.F.		RATED HP	
TYPE		INLET STEAM PSIG TEMP. °F		TYPE		MECH. EFF.	
ENCL. TEFC		EXHAUST		MFR. FINAL DATA (AS BUILT)			
VOLTS/PHASE/CYCLES 460/3/60		STEAM RATE - F.L. #/BHP/HR		TEST CURVE NO.			
BEARINGS BALL LUBE		BEARINGS LUBE		OUTLINE DWG. NO.			
F.L. AMPS. L.R. AMPS.		NOZZLES SIZE ASA RATING FACING POSITION		SECTIONAL DWG. NO.			
SERVICE FACTOR 1.0		INLET		SEAL DWG. NO.			
		EXHAUST		SERIAL NO.			
EQUIPMENT TO BE IN ACCORDANCE WITH: 1590-1300A, 1590-38A1, 1590-92A1, 1590-50A2, 1590-50A4							
NOTES: ① COMPOSITION (VOL %): 76.68 N ₂ , 20.32 O ₂ , 3.00 H ₂ O,							
② BLOWER TO BE INSTALLED OUTDOORS (WINTER DESIGN TEMP 10 °F)							

MATERIAL REQUISITION



FOSTER WHEELER CORPORATION

PAGE 1 OF 3

FORM 135-20 1

FOR	ERDA-FE	F.W.REF. 15-1591	REQUISITION NUMBER	DATE
SITE	SIoux FALLS, SOUTH DAKOTA		1591-1292A	3-22-76
MATERIAL	DESUPERHEATER DS-401	SUPERSEDED BY CHANGE NO.:		
	ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION	C1		C4
	FOSSIL ENERGY - LOCATION - NSP LAWRENCE STATION	C2		C5
	SIoux FALLS, S.D.	C3		C6

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- I SCOPE
- II GENERAL
- III BASIS OF DESIGN
- IV MECHANICAL SPECIFICATIONS
- V SITE CONDITIONS
- VI STANDARDS AND JOB SPECIFICATIONS

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

I. SCOPE

This specification covers the design and fabrication of a water spray type, in line, desuperheater.

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 standards noted in Part VII of this specification as well as the applicable provisions of the latest revisions of the following codes, specifications, etc., as noted below which may be revised to adjust classification and addition made as necessary to assume good practice.

1. Safety - Federal Register (OSHA)
2. Other - State & local requirements

B. The desuperheater shall be complete including spray nozzle, control valves, and water injection pump if required.

III. BASIS OF DESIGN

A. Process Conditions

1. Steam (superheated supply)

Pressure	900 PSIG
Temperature	900°F
Flow	898 lbs/hr
2. Cooling water: (boiler feed water)

Pressure	325 PSIG
Temperature	225°F
Flow	222 lbs/hr
3. Steam: (out of desuperheater)

Pressure psig min.	630 PSIG
Temperature	494°F
Flow	1120 lbs/hr
4. The desuperheater steam temperature shall be controlled such that it is no higher than 15°F above the saturation temperature. The desuperheater output shall be operable of from 370 to 3700 lbs/hr.

IV. MECHANICAL SPECIFICATIONS

- A. Steam
Design temp. Vendor to Specify
Design pressure Vendor to Specify
- B. Cooling water: (boiler feed water)
Design temp. Vendor to Specify
Design pressure Vendor to Specify
- C. Connections
Water supply 1"
Steam header 1½"
Desuperheater nozzle 1½"

All nozzle connections shall be AISI 900#RTJ Flanges

- D. Control Valves
Control valves shall operate on a 3-5 psi air signal from Purchaser's controller.
- E. Materials shall be carbon steel with all valve trim, nozzles etc. to be stainless steel. The insulation and installation will be by others.

V. 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 | - | Outdoors |
| 5. Type of Operation | - | Continuous |

VI. STANDARDS AND JOB SPECIFICATIONS

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

- | | |
|---------------|--------------------------|
| 1. 1590-50A2 | Gaskets and Surface |
| 2. 1590-92A1 | Preparation for shipment |
| 3. 1590-1900B | General Notes |

MATERIAL REQUISITION



FOSTER WHEELER CORPORATION

PAGE 1 OF 2

FORM 135-20

FOR <u>ERDA-FE</u>	F.W.REF. <u>15-1592</u>	REQUISITION NUMBER		DATE
SITE <u>SIOUX FALLS, SOUTH DAKOTA</u>		<u>1592-1272A</u>		<u>3/24/76</u>
MATERIAL <u>SULFUR PIT EJECTOR (J-401)</u>		SUPERSEDED BY CHANGE NO.:		
<u>ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION</u>	<u>C1</u>	<u>4-6-76</u>	<u>C4</u>	
<u>FOSSIL ENERGY - LOCATION- NSP LAWRENCE STATION</u>	<u>C2</u>		<u>C5</u>	
<u>SIOUX FALLS, S.D.</u>	<u>C3</u>		<u>C6</u>	

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- III BASIS OF DESIGN
- IV MECHANICAL SPECIFICATIONS
- V SITE CONDITIONS

BY:

P.O.NO.

SUPPLIER:

I. SCOPE

This requisition covers the design and supply of an ejector to move a mixture of air and hydrogen sulfide from a sulfur storage pit to a tail gas line.

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. The following specifications shall be considered an integral part of this requisition.

- | | |
|---------------|--------------------------|
| 1. 1590-50A2 | Gaskets and surfaces |
| 2. 1590-83A1 | Painting |
| 3. 1590-92A1 | Preparation for Shipment |
| 4. 1590-1900B | General Notes |

III. BASIS OF DESIGN

- | | | |
|--|---------------------------------------|-----|
| A. Hydrogen sulfide air mixture - M.W. | 34. | |
| B. Temperature | 275 ^o F | |
| C. Pressure | 14.0 PSIA (atmospheric pressure) | C-1 |
| D. Flow Rate | approximately 60 ft ³ /hr. | |

IV. MECHANICAL SPECIFICATIONS

- | | |
|----------------------------------|---------------------|
| A. Steam supply | 65 PSIG (saturated) |
| B. Discharge pressure | 3" water, gage |
| C. Material of construction | Vendor to specify |
| D. Inlet and outlet nozzle sizes | Vendor to specify |

V. SITE CONDITIONS

- | | | |
|-------------------------------|---|--------------------|
| 1. Altitude (above sea level) | - | 1315 ft |
| 2. Atmospheric Pressure | - | 14.0 PSIA |
| 3. Design Temp. Summer | - | 93 ^o F |
| Winter | - | -25 ^o F |
| 4. Location | - | Outdoors |
| 5. Type of Operation | - | Continuous |

FOSTER WHEELER ENERGY CORPORATION
INSTRUMENT PROCESS DATA

JOB NO. 15-1592
PAGE 1 OF 7
REVISION 0
DATE APRIL 22, 1976
PREPARED BY APT

ENG. FLOW SHEET NO. OP-751-580

[illegible]

FORM NO (110)-25B

Note: Certain data termed "proprietary" by the Amoco Production Company has been deleted from this page.

**FOSTER WHEELER ENERGY CORPORATION
INSTRUMENT PROCESS DATA**

JOB NO. 15-1592
PAGE 2 OF 7
REVISION 0
DATE APRIL 22, 1976
PREPARED BY APT

ENG. FLOW SHEET NO. OP-751-580

(1) ITEM NUMBER OR SERVICE	(2) NOM. LINE SIZE	(3) FLUID TYPE & STATE	(4) NORMAL lb/h	FLOW %		SP. GR. AT.		(9) MOLL. 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/°C	(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					
FT-4001 ACID GAS TO H-402	8"	9 H ₂ S V	11,610	100			41.3						110	24.14	24.08								TRANSMITTER TO BE LOCATED ABOVE LINE TO PREVENT CONDENSATE ACCUMULATION		
4002 SOUR GAS TO H-402	4"		2,490	100			26.43						201	24.85	24.57										
4003 AIR TO H-402	8"		14 AIR V	6,810	100			28.52						206	24.28	23.88									
4005 AIR TO BR-402	8"	14 AIR V	6,630	100			28.52						206	24.28	23.14										
4006 FUEL GAS TO BR-402	4"	14 FUEL V	4,990	100			24.88						175	52	50										
4015 ACID GAS TO ZONE 2	8"	9 H ₂ S V	5,230	100			41.3						800	23.183	23.125								TRANSMITTER TO BE LOCATED ABOVE LINE TO PREVENT CONDENSATE ACCUMULATION		
LAH-4002 D-402		9,3 H ₂ S/ WATER ² V,L					26.4						201	25.6									ALARM AT 3'-0"		
4004 D-401							41.3						110	24.4									ALARM AT 3'-0"		
4005 E-401			1,8 H ₂ O V,L			1		18.0					414	289									ALARM SETTING BY E-401 VENDOR		
LAL-4005 E-401					1		18.0						414	289									ALARM SETTING BY E-401 VENDOR		
LG-4001 D-402		9,3 H S/ WATER V,L			1		26.4						201	25.6											
4002 D-401						1		41.3					110	24.4											
4006 E-401			1,8 H ₂ O V,L			1		18.0					414	289											
LICV-4005 E-401 BFW	2"	8 H ₂ O L	14,307	100		1							225	324	292										

FORM NO (110)-25B

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FOSTER WHEELER ENERGY CORPORATION INSTRUMENT PROCESS DATA

JOB NO. 15-1592
PAGE 3 OF 7
REVISION 0
DATE APRIL 22, 1976
PREPARED BY APT

ENG. FLOW SHEET NO. OP-751-580

(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					
PAL-4026 FUEL GAS TO BR-402	4"	14 FUEL V.												175	54									ALARM AT 30 PSIG	

FORM NO (110)-25B

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ENG. FLOW SHEET NO. OP-751-580

[illegible]

FORM NO (110)-25B

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FOSTER WHEELER ENERGY CORPORATION
INSTRUMENT PROCESS DATA

JOB NO. 15-1592

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DATE APRIL 22, 1976

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ENG. FLOW SHEET NO. OP-751-580

[illegible]

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ENG. FLOW SHEET NO. OP-751-580

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ENG. FLOW SHEET NO. OP-751-850

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**FOSTER WHEELER ENERGY CORPORATION
INSTRUMENT PROCESS DATA**

JOB NO. 15-1592
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REVISION 0
DATE APRIL 22, 1976
PREPARED BY APT

ENG. FLOW SHEET NO. OP-751-581

(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					
FI-4101 STEAM TO 15	4"	8 STEAM V	4,050	113				18.02						315	84	82							C		
LAH-4101 E-402/403		1 WATER L												315	84									INCLINED CONDENSER	
LAH-4103 E-404/405		1 WATER L												315	84									INCLINED CONDENSER	
LAL-4101 E-402/403		1 WATER L												315	84									INCLINED CONDENSER	
LAL-4103 E-404/405		1 WATER L												315	84									INCLINED CONDENSER	
LG-4102 E-402/403		1 WATER L												315	84									INCLINED CONDENSER	
LG-4104 E-404/405		1 WATER L												315	84									INCLINED CONDENSER	
LIC-4101 E-402/403	1½"	1 WATER L	3,480	113		.999	.953							225	300	90					YES	C	LEVEL SETTING BY E-402/3 VENDOR		
LIC-4103 E-404/405	1"	1 WATER L	612	109		.999	.953							225	300	90					YES	C	LEVEL SETTING BY E-404/5 VENDOR		

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ENG. FLOW SHEET NO. OP-751-581

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**FOSTER WHEELER ENERGY CORPORATION
INSTRUMENT PROCESS DATA**

JOB NO. 15-1592
PAGE 4 OF 4
REVISION 0
DATE APRIL 22, 1976
PREPARED BY _____

ENG. FLOW SHEET NO. OP-751-581

(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					
TI-4137 DS-401 OUTLET	1½"	8 STEAM V												509	44										
TCV-4136 BFW TO DS-401	3/4"	1 WATER L	222	300	33	.999	.953							225	325	VENDOR						YES	C	TO BE PROVIDED BY DS-401 VENDOR	
TIC-4131 FEED TO R-402	20"	9 H ₂ S/SO ₂ V												401	17.95										
TICV-4131 STEAM TO E-406	1"	8 STEAM V	455	116				18.02						509	644	614							C		
TIC-4130 FEED TO R-403	20"	9 H ₂ S SO ₂ V												380	16.52										
TICV-4130 STEAM TO E-407	1"	8 STEAM V	353	109				18.02						509	644	614							C		
TIC-4129 FEED TO R-404	20"	9 H ₂ S SO ₂ V												362	15.08										
TICV-4129 STEAM TO E-408	1"	8 STEAM V	280	111				18.02						509	644	614							C		
TR-4106 R-401		9 H ₂ S SO ₂ V												719	19										
TR-4110 R-402														449	17.5										
TR-4120 R-403		9 H ₂ S SO ₂ V												387	16										
TR-4127 R-404														364	14.5										

FOSTER WHEELER ENERGY CORPORATION INSTRUMENT PROCESS DATA

JOB NO. 15-1592
PAGE 1 OF 1
REVISION 0
DATE APRIL 22, 1976
PREPARED BY APT

ENG. FLOW SHEET NO. OP-751-582

(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 Cp/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						
II-4201 P-401 MOTOR LOADING																										
4202 P-402 MOTOR LOADING																										
4203 P-403 MOTOR LOADING																										
LI-4201 TK-401 LOCAL																								0'-0" TO 13'-6"		
4201 TK-401 PANEL																								0'-0" TO 13'-6"		
4202 TK-402 LOCAL																								0'-0" TO 20'-0"		
4202 TK-402 PANEL																								0'-0" TO 20'-0"		
LT-4201 TK-401		4 SULFUR L												275	14.0									AIR BUBBLER TUBE TO BE		
4202 TK-402		4 SULFUR L												275	14.0									STEAM JACKETED		
PI-4201 TK-401 VENT	3"													275	14.00											
4202 J-401 OUTLET	3"													300	14.10											
4203 TAIL GAS TO H-701	20"													280	14.07											
TI-4202 SULFUR TO T-401	4"x6"													275	58.0											
4203 SULFUR FROM T-401	6"x8"													280	14.07											
4204 OVHD FROM T-401	20"													280	14.07											
4205 STEAM TO TK-401	3"													311	79											
4201 CONDENSATE FROM TK-401	3/4"													298	64.7									P-401 SUMP COIL		
4208 CONDENSATE FROM TK-401	3/4"													298	64.7									P-402 SUMP COIL		
4206 CONDENSATE FROM TK-401	3/4"													298	64.7									TK-401 COIL		
4212 CONDENSATE FROM TK-401	3/4"													298	64.7									TK-401 COIL		
4213 CONDENSATE FROM TK-401	3/4"													298	64.7									TK-401 COIL		
4207/11 TK-401														275	14.0											
TI-4210 TK-402														275	14.0											
TCV-4209 TK-402	2"	8 STEAM V	113					18.02						311	79											

FOSTER WHEELER CORPORATION
RELIEF VALVES
PROCESS DATA

PLANT ERDA-FE SECTION 400

SHEET NO. 1 OF 3

LOCATION SIOUX FALLS, S.D.

BY APT

DATE APR. 22, 1976

JOB NO. 15-1592

ITEM NO. (Flow Plan Symbol)			PSV- 4052	PSV- 4053
Service			E-401	E-401
Number of Valves Required			1	1
In Regular Use			1	1
As Spares				
Interlocks Required				
Fluid and State			STEAM	
Corrosive Compounds				
Flow (Total) at Relieving Conditions	gal/min			
	lb/h		14,160	
Sp. gr. at Relieving Conditions				
Molecular Weight			18.02	
Compressibility Factor				
Normal Operating Temperature, ¹ °F			414	
Relieving Temperature, ² °F			423	427
Relieving (Set) Pressure, lb/in ²			305	320
Superimposed Back Pressure, ³ lb/in ²			0	0
Built-up Back Pressure, ⁴ lb/in ²			0	0
Allowable Accumulation, %			10	10
Minimum Orifice Area Required, in ²				
Governing Conditions ⁵				
Relief Valve Type				
Relief Valve Size				
Balanced Type ⁶				
Total Orifice Area (effective) Provided				

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Form 110-16

FOSTER WHEELER CORPORATION
RELIEF VALVES
PROCESS DATA

PLANT ERDA-FE SECTION 400
LOCATION SIOUX FALLS, S.D.

BY APT

DATE APR. 22, 1976 SHEET NO. 2 OF 2
JOB NO. 15-1592

ITEM NO. (Flow Plan Symbol)		PSV- 4107	PSV- 4108	PSV- 4110	PSV- 4111
Service		E-402/403		E-404/405	
Number of Valves Required		1	1	1	1
In Regular Use		1	1	1	1
As Spares					
Interlocks Required					
Fluid and State		STEAM			
Corrosive Compounds					
Flow (Total) at Relieving Conditions	gal/min	3,820		640	
	lb/h				
Sp. gr. at Relieving Conditions					
Molecular Weight		18.02			
Compressibility Factor					
Normal Operating Temperature, ¹ °F		315			
Relieving Temperature, ² °F		334	337	334	337
Relieving (Set) Pressure, lb/in ²		95	100	95	100
Superimposed Back Pressure, ³ lb/in ²		0	0	0	0
Built-up Back Pressure, ⁴ lb/in ²		0	0	0	0
Allowable Accumulation, %		10			
Minimum Orifice Area Required, in ²					
Governing Conditions ⁵		BLOCKED FLOW			
Relief Valve Type					
Relief Valve Size					
Balanced Type ⁶					
Total Orifice Area (effective) Provided					

FOSTER WHEELER CORPORATION
RELIEF VALVES
PROCESS DATA

PLANT ERDA-FE SECTION 400 SHEET NO. 3 OF 3
LOCATION SIOUX FALLS, S.D. BY APT DATE APR. 22, 1976 JOB NO. 15-1592

ITEM NO. (Flow Plan Symbol)		PSV- 4115	PSV-	PSV-	PSV-
Service		DS-401 OUTLET			
Number of Valves Required		1			
In Regular Use		1			
As Spares					
Interlocks Required					
Fluid and State		STEAM			
Corrosive Compounds					
Flow (Total) at Relieving Conditions	gal/min				
	lb/h	PICV-4117 MAX FLOW			
Sp. gr. at Relieving Conditions					
Molecular Weight		18.02			
Compressibility Factor					
Normal Operating Temperature, ¹ °F		509			
Relieving Temperature, ² °F		900			
Relieving (Set) Pressure, lb/in ²		660			
Superimposed Back Pressure, ³ lb/in ²		0			
Built-up Back Pressure, ⁴ lb/in ²		0			
Allowable Accumulation, %		10			
Minimum Orifice Area Required, in ²					
Governing Conditions ⁵		PICV-4117 FAIL			
Relief Valve Type					
Relief Valve Size					
Balanced Type ⁶					
Total Orifice Area (effective) Provided					