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ENERGY

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COGENERATION

GRID CONNECTED INTEGRATED COMMUNITY ENERGY SYSTEM

Phase II, Final Stage 2 Report

Outline Specifications of Cogeneration Plant

March 22, 1978

Work Performed Under Contract No. EC-77-C-02-4210

University of Minnesota
Physical Plant
Minneapolis, Minnesota
and

Helmick & Lutz
Engineers
Minneapolis, Minnesota

U. S. DEPARTMENT OF ENERGY

Division of Buildings and Community Systems

MASTER

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GRID CONNECTED INTEGRATED COMMUNITY ENERGY SYSTEM

PHASE II FINAL STAGE 2 REPORT

OUTLINE SPECIFICATIONS OF COGENERATION PLANT

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March 22, 1978

UNIVERSITY OF MINNESOTA PHYSICAL PLANT
319 15th AVE. S.E.
MINNEAPOLIS, MINNESOTA 55455
612-373-4521

Prepared For
The U.S. Department of Energy
Under Contract No. EC-77-C-02-4210

South East Generating Station

Helmick & Lutz

VOLUME 5

OUTLINE SPECIFICATIONS OF COGENERATION PLANT

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The following materials represent the Capital Cost Budget, Outline Specifications and associated preliminary design drawings of the Grid-ICES by the University's prime consultant, Helmick and Lutz Company

Major equipment items were identified and specified for competitive pricing as shown in Section 5.2. Prices were received for all items based on current (1978) purchase. Selection of appropriate equipment was made and included in the budget under Equipment.

All preliminary project drawings were received and construction costs estimated based on current (1978) construction unit costs. Estimates were separately made for General, Mechanical and Electrical Construction within each project design sub-task.

The following capital cost budget summarizes the project cost content in each work category and for each project Option.

The indicated total costs are for 1978 construction. Projected costs to 1981 assume annual escalation of 7%.

It should be noted that Option I, Tunnel Construction and Lighting, was designed and estimated by the University of Minnesota Engineering Department.

PHASE II - STAGE 2 - CAPITAL COST BUDGET
UNIVERSITY OF MINNESOTA - GRID ICES

	<u>Equipment</u>	<u>General</u>	<u>Construction</u> <u>Mechanical</u>	<u>Electrical</u>	<u>Total</u>
A. Basic Plan - Steam Generation					
1. Plant Interconnections					
a. Piping					
(1) High Pressure (180#)			440,500		440,500
(2) Low Pressure (20#)			307,000		307,000
(3) Condensate			315,500		315,500
b. Fuel Oil Line			35,000		35,000
c. Coal Handling	704,000	525,000	15,000	160,000	1,404,000
d. Pipe & Conveyor Gallery		1,730,000		30,000	1,760,000
e. Railroad Track Work		330,000			330,000
f. Primary Electric Tie				240,000	240,000
Sub-Total	704,000	2,585,000	1,113,000	430,000	4,832,000
Engineering & Contingencies (12%)					579,800
2. Southeast Station Utilities					
a. Water Main			91,000		91,000
b. Sewers	50,000	80,000	10,000	10,000	150,000
Sub-Total	50,000	80,000	101,000	10,000	241,000
Engineering & Contingencies (12%)					29,000

		Construction				
		<u>Equipment</u>	<u>General</u>	<u>Mechanical</u>	<u>Electrical</u>	<u>Total</u>
3.	Southeast Fuel Systems					
	a. Coal Storage Remodeling		690,000			690,000
	b. Coal Retrieval System	388,000	270,000			658,000
	c. Coal Truck Loading	10,000	31,000			41,000
	d. Bunker Conveyors, Scales and Feeders	120,000	51,000		50,000	221,000
	e. Fuel Oil Storage and In-Plant Changes	20,000	20,000	10,000	3,000	53,000
4	Sub-Total	538,000	1,062,000	10,000	53,000	1,663,000
	Engineering & Contingencies (12%)					200,000

Construction				
<u>Equipment</u>	<u>General</u>	<u>Mechanical</u>	<u>Electrical</u>	<u>Total</u>
		60,000		60,000
	10,000	140,000		150,000
	10,000	75,000		85,000
54,000		35,000		89,000
131,000	77,000	75,000		283,000
89,000		35,000		124,000
83,000		750,000		833,000
90,000			515,000	605,000
			25,000	25,000
818,000	318,000	32,000	55,000	1,223,000
179,000	230,000	5,000		414,000
70,000	10,000			80,000
1,514,000	655,000	1,207,000	595,000	3,971,000
				477,000

	<u>Equipment</u>	<u>General</u>	<u>Construction Mechanical</u>	<u>Electrical</u>	<u>Total</u>
5. Southeast Remodeling					
a. Exterior Work		800,000		15,000	815,000
b. Roof Repair		60,000	10,000		70,000
Sub-Total		860,000	10,000	15,000	885,000
Engineering & Contingencies (12%)					106,000
6. Southeast Plant Instrumentation					
a. Boiler and System Control	127,000	22,000	10,000	60,000	219,000
b. Air Piping and Compressor	24,000		30,000		54,000
c. Electric Wiring				30,000	30,000
d. Computer Interface	40,000			25,000	65,000
e. Computer MIS	200,000			25,000	225,000
Sub-Total	391,000	22,000	40,000	140,000	593,000
Engineering & Contingencies (12%)					71,000

	<u>Equipment</u>	<u>General</u>	<u>Construction</u> <u>Mechanical</u>	<u>Electrical</u>	<u>Total</u>
7. Total Equipment Costs					3,197,000
8. Total General Construction Costs					5,264,000
9. Total Mechanical Construction Costs					2,481,000
10. Total Electrical Construction Costs					<u>1,243,000</u>
11. Total Expected Contract Costs					12,185,000
12. Engineering & Contingencies (12%)					1,463,000
13. University Heating Plant Pollution Control (Under Contract)					2,600,000
✓ 14. Southeast Plant Acquisition					500,000
15. Site Survey and Borings					20,000
16. Site Demolition					150,000
					<hr/>
			Total, Steam Generation		16,918,000

	<u>Equipment</u>	<u>Construction</u>			
		<u>General</u>	<u>Mechanical</u>	<u>Electrical</u>	<u>Total</u>
B. Basic Plan - Electric Generation					
1. Turbine-Generator	1,550,000				1,550,000
a. Foundation		50,000			50,000
b. Erection		150,000			150,000
c. Piping	5,000		265,000		270,000
2. Switchgear and Wiring	200,000			105,000	305,000
3. Instrumentation	12,000				12,000
4. Computer Interface	10,000			5,000	15,000
Sub-Total	1,777,000	200,000	265,000	110,000	2,352,000
Engineering & Contingencies 12%					282,000
Total Electric Generation					2,634,000
C. Basic Plan - Summary					
1. Steam Generation	3,197,000	5,264,000	2,481,000	1,243,000	12,185,000
2. Electric Generation	1,777,000	200,000	265,000	110,000	2,352,000
Sub-Total	4,974,000	5,464,000	2,746,000	1,353,000	14,537,000
3. Engineering & Contingencies 12%					1,744,000
4. Site Acquisition & Contracted Costs					3,270,000
Total, Basic Plan					19,551,000

		Construction			
	<u>Equipment</u>	<u>General</u>	<u>Mechanical</u>	<u>Electrical</u>	<u>Total</u>
D. Option I - Add-On Customers					
1. Grid Connection					
a. Tunnel Construction & Lights		830,000			830,000
b. Tunnel Piping			374,000		374,000
Sub-Total		830,000	374,000		1,204,000
Engineering & Contingencies (12%)					145,000
2. Metering					
a. Augsburg College	4,000		2,000		
b. St. Mary's Hospital	4,000		2,000		
c. Fairview Hospital	4,000		2,000		
d. U of M Total Meter	4,500		2,000	3,000	
e. MIS Interface	5,000			10,000	
Sub-Total	21,500		8,000	13,000	42,500
Engineering & Contingencies (12%)					5,100
3. Augsburg College Steam					
a. Primary Connection		40,000	85,000		125,000
b. Distribution System	8,500	150,000	102,000		260,500
Sub-Total	8,500	190,000	187,000		385,500
4. Total Expected Contract Costs					1,632,000
5. Engineering & Contingencies (12%)					196,000
6. Total, Option I					1,828,000

E. Option II, Pyrolysis

1. Andco System Delivered & Erected
(Includes Engineering & Contingencies)

	Construction				
	<u>Equipment</u>	<u>General</u>	<u>Mechanical</u>	<u>Electrical</u>	<u>Total</u>
a. Gasifier	241,000	162,537	16,673	4,000	424,210
b. Secondary Combustion Chamber	234,000	179,400	6,170		419,570
c. Regenerative Towers	530,000	150,000	11,480		691,480
d. Duct Work	218,000	130,000	32,380	23,300	403,680
e. Slag Handling System	60,000	50,000	4,000	2,000	116,000
f. Electrical	215,400	75,000	2,000	76,770	369,170
g. Instrumentation	158,900	55,000	3,000	18,000	234,900
h. Air Moving Equipment	55,460	18,500	12,000	8,000	93,960
i. Piping & Cooling Water Systems	95,000	172,500	12,640		280,140
j. Refuse Feed System	24,000	19,200	2,270		45,470
k. Auxilliary Fuel Systems	54,120	30,000	8,000	3,000	95,120
l. Secondary Air Preheat	25,000	16,000	5,000	3,000	49,000
m. Slag Silo	20,000	10,000	6,000	800	36,800
n. Stairs & Platforms	85,000	57,500			142,500
o. Grout	1,800	4,500			6,300
p. Paint	12,000	26,450			38,450
q. Communication System	8,000	4,600			12,600
r. CO Monitor	12,150	4,000			16,150
Sub-Total	2,049,830	1,165,187	121,613	138,870	3,475,500
Field Management		171,100			171,100
Field Office	12,700		1,000	2,000	15,700
Storage Building	58,000	60,200	2,800	4,000	125,000
Construction Support		57,500			57,500
Spare Parts	140,000				140,000
Contingencies	175,000	175,000	10,000	15,000	375,000
Sub-Total	385,700	463,800	13,800	21,000	884,300
ANDCO TOTAL	2,435,530	1,628,987	135,413	159,870	4,359,800

	Construction				
	<u>Equipment</u>	<u>General</u>	<u>Mechanical</u>	<u>Electrical</u>	<u>Total</u>
2. Auxilliary Equipment & Andco Connections					
a. Waste Heat Boiler	351,000	9,000	90,000	20,000	470,000
b. I.D. Fan and V.S. Drive	67,000	4,000	8,500	12,500	92,000
c. Instruments & Controls	30,000		25,000		55,000
d. Pollution Control Addition	561,000	90,000	20,000	32,500	703,500
e. Refuse Crane	120,000	13,000		1,500	134,500
f. Contaminated Material Conveyor	50,000			1,500	51,500
g. Ash System Addition	15,000	8,000	3,500		26,500
h. Equipment Erection	233,000				233,000
II i. Andco Connections			45,000	57,000	102,000
3. Related Construction					
a. General Construction					
(1) Stack Removal		47,000			47,000
(2) Building Construction		820,000			820,000
b. Mechanical Construction			40,000		40,000
c. Electrical Construction				45,000	45,000
4. Up-Grade Inclinerators	<u>88,000</u>	<u>35,000</u>	<u>35,000</u>	<u>5,000</u>	<u>163,000</u>
Sub-Total	1,515,000	1,026,000	267,000	175,000	2,983,000
Engineering & Contingencies (12%)					358,000
Total, Option II					7,700,800

F. Option III, Hot Water Distribution

	<u>Equipment</u>	<u>General</u>	<u>Construction Mechanical</u>	<u>Electrical</u>	<u>Total</u>
1. Add-On Steam Piping Cost			106,000		106,000
2. Hot Water Heat Exchangers, Tankage and Pumps	104,000	26,000	100,000	20,000	250,000
3. Hot Water Loop			818,000		818,000
4. System Controls	12,000		10,000	26,000	48,000
5. Building System Retrofit			501,000		501,000
Sub-Total	116,000	26,000	1,535,000	46,000	1,723,000
Engineering & Contingencies (12%)					207,000
Total, Option III					1,930,000

MAJOR EQUIPMENT SPECIFICATIONS

Specifications for purchase are indicated for the seventeen (17) Major Equipment Items.

Following the specifications are tabulations and selection of those items for which competitive prices were received.

UNIVERSITY OF MINNESOTA

PHYSICAL PLANT

MINNEAPOLIS, MINNESOTA

5.2.1

SPECIFICATIONS

FOR

TURBINE - GENERATOR

FOR

GRID-CONNECTED INTEGRATED
COMMUNITY ENERGY SYSTEM

HELMICK & LUTZ COMPANY
ENGINEERS

1315 GLENWOOD AVENUE
MINNEAPOLIS, MINNESOTA 55405

JANUARY, 1978

EQUIPMENT ITEM NO. 1

DIVISION 2

TURBINE-GENERATOR

PART 1 - GENERAL

A. Work Under This Section

1. Provide one (1) complete turbine-generator unit.
2. Supervise the installation.
3. Check, adjust, test and start up the unit.
4. Instruct the Owner's personnel for proper operation and maintenance.

B. Related Work By Others

1. Foundation, building enclosure and overhead crane.
2. Erection labor and materials.
3. Steam, water, and electrical connections.

C. General Description

1. One single automatic extraction, non-condensing steam turbine-generator for 450 psig 750° FTT inlet, 20 psig exhaust, 180 psig extraction, Steam flow conditions are as follow:

	<u>Normal</u>	<u>Maximum</u>
Throttle	273,000#/hr.	350,000#/hr.
180# Extraction	200,000	325,000
20# Exhaust	73,000	150,000

2. Direct connected, totally enclosed, air cooled generator rated 15,000 KVA .85 power factor, 3600 rpm, 3 phase, 60 cycle, 13,800 volt; equipped with water to air heat exchangers. Excitation may be either non-rotating, static type or rotating brushless type. Either system shall include a voltage regulator.

D. Performance

1. Submit turbine-generator expected performance curves.
2. Submit extraction and exhaust enthalpy curves over the unit operating range.
3. State limitations or tolerances of turbine throttle steam pressure and temperature.

4. Guarantee generator output at stated normal turbine steam flows.
5. State adjustment range of extraction steam pressure.
6. State generator short-circuit ratio and state guarantee of voltage regulator performance, both steady state and on load change.
7. Provide cooling water flow and pressure requirements.

E. Submittals

1. With proposal
 - a. General arrangement drawing, including dimensions for assembly and maintenance clearances.
 - b. Estimated foundation loads.
 - c. Weights of heaviest piece for assembly, heaviest piece for maintenance.
 - d. Description of control system - governor, inlet and extraction valving.
 - e. Description and detail of accessory equipment.
 - f. Specification of requirements for related equipment not furnished.

2. For approval

Four (4) prints of outline drawings, connection diagrams, etc.

3. Final drawings

Four (4) prints and one (1) reproducible of all applicable drawings.

4. Manuals

Four (4) complete, bound manuals of the operation and maintenance of the equipment, including:

- a. Instructions
- b. Lubrication data and schedules
- c. Adjustment, maintenance and repair instructions
- d. Parts list, recommended spare stock, nearest parts depot and service shop
- e. Assembly drawings and diagrams

Manuals shall be submitted to the Owner 30 days prior to unit shipment.

5. Test reports

Three (3) copies of applicable test reports of all factory and/or field tests.

PART 2 - PRODUCTS

A. Turbine

1. Steam flow through the turbine shall be axial and shall be designed and rated to fully accommodate the steam flow conditions specified.
2. Design shall be sufficiently strong to withstand any strain from sudden application or removal of rated load, and any transient speed to 120% of rated speed.
3. Expansion and contraction due to temperature changes shall not impose harmful distortion or create unit misalignment.
4. Turbine rotor buckets shall be securely anchored but be readily renewable. Welding of buckets to the wheel will not be accepted.
5. The turbine shall be so grounded and insulated to prevent circulating currents from flowing between the rotor and bearings.
6. Shaft packing shall be the spring-backed, labyrinth type and a complete gland evacuation and leak-off systems shall be furnished.
7. Bearings shall be the split sleeve type, designed for pressure lubrication and readily accessible for positive visual inspection. A thrust bearing shall be provided to maintain correct axial relationship of rotor to stator. Normal operation shall imply a maximum vibration amplitude of 1 mil at rated speed.

B. Governors, Valves and Hydraulic System

1. A complete governing system shall be provided to control speed, inlet steam flow, extraction steam flow and pressure and exhaust steam pressure. An emergency governor, quick acting with reset, shall shut off steam flow at approximately 110% rated speed. If the governor is not a proprietary item, a Woodward governor shall be used.
2. The governor system shall permit remote manual adjustment of speed, load, extraction and exhaust pressures.
3. The following valves shall be furnished with the unit.

- a. Turbine stop/throttle valve
 - (1) Provision for ACB trip on closure
 - (2) Solenoid trip
 - (3) Position indicating switches
 - (4) Integral strainer with start-up strainer and replacement normal strainer baskets
 - (5) Valve supports and pipe connections to turbine
- b. Sectional inlet and extraction valves, multi-valve type, automatically operated, cam lifts, and positive closing on loss of hydraulic pressure.
- c. Automatic, air-operated non-return valves for all extraction lines and exhaust steam outlet, complete with tripping device.
- 4. A complete hydraulic and lubrication system for turbine and generator to include:
 - a. Full sized reservoir with level indicators.
 - b. Multiple oil coolers with transfer valve.
 - c. Three full capacity pumps.
 - d. All necessary pressure regulators, alarm and trip switches, temperature and pressure indicators.
 - e. All piping, prewiring, terminal strips in oil tight terminal boxes, etc. to form a complete system.

C. Generator and Exciter

- 1. Generator shall be of the non-salient pole revolving field type built to the standards of ANSI and NEMA.
- 2. Generator shall be equipped with twelve imbedded stator temperature detectors and four temperature detectors in the air cooler units. All shall be prewired to a terminal strip housed in a separate terminal compartment.
- 3. Stator and rotor shall be Class B insulated and temperatures shall not exceed 110°C (stator) or 125°C (rotor) when operating continuously at full load.
- 4. Generator coolers shall be so sized that 80% of rating may be sustained with one cooler out of service.
- 5. Excitation system shall provide stable operation down to 25% load and have the capability of 120% rated ceiling voltage.
- 6. Voltage regulator shall permit parallel operation and include manual control provision.

7. Generator bearings shall be insulated and grounded to prevent circulating shaft currents. A description of the system shall be included.
8. Generator shall include three CT's for differential protection and one CT for neutral resistance ground relaying. All CT's shall be mounted within an enclosure with bus link provision to the generator leads to simplify field connection.

D. Accessories

1. A complete turning gear system with interlocks.
2. Thrust bearing proximity alarm provision and thrust bearing failure trip device.
3. Local control panel for unit start-up to include:
 - a. Throttle valve operation
 - b. Stop valve position and indication
 - c. Inlet steam pressure and temperature gauges
 - d. Extraction steam pressure and temperature gauges
 - e. Exhaust steam pressure and temperature gauges
 - f. Electric speed indicator and tachometer
 - g. Vibration indicator
 - h. Turning gear control elements
 - i. Hydraulic set control elements, lights and alarms
 - j. Generator temperature indicator and selector switch
4. All required special tools to include sledging wrenches for bolts over 1-1/2 inch, eyebolts, casing guide pins, jacking bolts, lifting slings for casing, turbine rotor and generator rotor.
5. All required insulation for high temperature parts for installation by others. Preferred system as follows:
 - a. Plastic insulation for upper and lower turbine shell and valve bodies.
 - b. Preformed segmental pipe insulation.
 - c. Block insulation for stop valve flanges and flange at turbine
 - d. Re-usable blanket insulation at turbine shell joints.
 - e. Preformed metal lagging or prefabricated housing for entire turbine unit.
6. High pressure and low pressure drain valves and piping.
7. Complete set of sole plates for turbine and generator.

PART 3 - EXECUTION

A. Erection

1. Furnish an erection supervisor to oversee the loading, handling and installation of all contract equipment.
2. Supervise grouting of sole plates and verification of elevation and level.
3. Supervise erection including alignment of all rotating elements.

B. Inspection and Check-Out

1. Inspect each component and sub-section for proper installation and operation.
2. Supervise initial start-up of the unit.

C. Instruction

Instruct the plant personnel in all phases of operation and maintenance to the satisfaction of the Plant Superintendent.

D. Acceptance

After start-up, verify performance against submitted curves with the Owner and Engineer based on available load and steam metering.

UNIVERSITY OF MINNESOTA

PHYSICAL PLANT

MINNEAPOLIS, MINNESOTA

5.2.2

SPECIFICATIONS
FOR
BAGHOUSE SYSTEM
FOR
GRID-CONNECTED INTEGRATED
COMMUNITY ENERGY SYSTEM

HELMICK & LUTZ COMPANY
ENGINEERS
1315 GLENWOOD AVENUE
MINNEAPOLIS, MINNESOTA 55405

DECEMBER, 1977

EQUIPMENT ITEM NO. 2

DIVISION 2

BAGHOUSE SYSTEM

GENERAL PROVISIONS

A. General

1. It is the intent of these Specifications to secure a complete dust collection system to be retrofitted to an existing multi-boiler power plant.
2. The dust collector shall be a baghouse type system arranged for air flow through the bags from the inside to the outside. Cleaning shall be by reverse air flow through the baghouse modules.
3. A base bid is requested for a baghouse to service two (2) coal fired boilers, one with pulverizers and one with a stoker. An alternate bid is requested for a baghouse to service the above boilers plus a pyrolysis type solid waste burner with a waste heat boiler.

B. Description of the System

1. The Baghouse System will operate as follows:
 - a. Flue gas from the existing boiler I.D. Fans will be ducted to the baghouse inlet manifold. Provisions will be made to bypass the flue gas directly to the stack.
 - b. Clean gas from the baghouse outlet manifold will be ducted to the baghouse I.D. Fan.
 - c. Baghouse I.D. Fan will control the inlet manifold of the baghouse at approximately 0 inches of water pressure, gauge.
 - d. Outlet gas from the baghouse I.D. Fan will be ducted to the existing stack.
2. During normal operation, any or all boilers may be on the line and boilers may be base loaded or swinging with the load in any combination.
3. Boilers serviced are:
 - a. No. 3 Boiler (Base Bid)
 - (1) Manufacturer - Combustion Engineering
 - (2) Year erected - 1940
 - (3) Capacity - 108,000 #/Hr. at 450 psig, 750°F
 - (4) Firing Equipment - Two pulverizers feeding four burners
 - (5) Stack gas - 60,000 actual cfm at 300°F

b. No. 4 Boiler (Base Bid)

- (1) Manufacturer - Babcock & Wilcox
- (2) Year Erected - 1948
- (3) Capacity - 128,000 #/Hr. at 450 psig, 750°F
- (4) Firing Equipment - Spreader stoker with traveling grate
- (5) Stack gas - 75,000 actual cfm at 300°F

c. Pyrolysis Unit (Alternate Bid)

- (1) Manufacturer - Andco-Torrax
- (2) Year Erected - 1978
- (3) Stack gas - 46,000 actual cfm at 300°F

4. Ambient Temperature Range - (-)25° - (+)100°F

5. Air to Cloth Ratio (AFCM/Sq.Ft.)

a. All modules operating, reverse airflow not included - approximately 2/1

b. One module cleaning, reverse airflow included - approximately 2.5/1

6. Final Stack Emissions - Not to exceed 0.1 pounds of particulate per million BTU input to the boilers.

7. Differential Pressure - Not to exceed 5 inches of water, inlet manifold to outlet manifold, when one cell is being cleaned.

C. Coal

The coal to be fired will have approximately the following analysis:

Proximate Analysis

BTU	8890	8450
Total Moist	24.55	25.11
Ash	8.85	9.09
Sulfur	0.71	0.73

Ultimate Analysis

Carbon	49.40	50.18
Hydrogen	4.44	3.65
Sulfur	0.71	0.73
Oxygen	11.32	10.58
Nitrogen	0.73	0.66
Moisture	24.55	25.11
Ash	8.85	9.09

Ash Mineral Analysis

Phos. Pentoxide	0.49	0.37
Silica	44.73	34.96
Ferric Oxide	4.08	8.30
Alumina	17.58	17.28
Titania	0.80	0.71
Lime	13.03	17.53
Magnesia	5.10	3.25
Sulfur Trioxide	12.23	14.75
Potassium Oxide	0.96	0.68
Sodium Oxide	0.44	1.87
Undetermined	0.66	0.30

Ash Fusion Temperatures

Oxidizing		
Initial Def.	2089	2130
Softening (H=W)	2203	2161
Softening (H=1/2W)	2234	2190
Fluid	2305	2264

D. Site Conditions

1. The baghouse system will be erected on a concrete pad adjacent to the existing heating plant.
2. Provide the structural steel necessary to erect the entire baghouse system including modules, headers, platforms, stairs and ladders.

E. Submittals

1. With Bid
 - a. Equipment Data Sheets
 - b. Detailed description of equipment and operation
 - c. Dimensioned outline drawings of the major pieces of equipment
 - d. Drawings or diagrams showing the weight distribution of the bag-house assembly
2. For Approval Prior to Fabrication
 - a. Certified drawings of all components
 - b. Performance data
 - c. Control Panel arrangement and wiring diagrams
3. Manuals (6 copies)
 - a. Operator's Instructions
 - b. Maintenance Instructions
 - c. Parts Lists

BAGHOUSES

A. Casings

1. Arrangement

- a. Not more than 4 bags deep from a walkway.
- b. Access doors and walkways of adequate width at tube sheet level and at hanger level.

2. Fabrication

- a. Shop fabricated.
- b. All welded construction.
- c. Stiffeners as required to withstand 20 inches of water, pressure or vacuum.

3. Materials

- a. Carbon steel.
- b. Thickness - 3/16" minimum.

4. Thimbles

- a. Length as recommended to prevent rapid wear of lower part of bags.
- b. Not less than 8 inches long.
- c. Thickness - 14 Ga.

5. Access Doors

- a. Hinged.
- b. Minimum size 20" x 60".
- c. Asbestos rope gaskets.
- d. Safety latch to prevent door closing when personnel are inside.

B. Hoppers

1. Sized to hold 100 cubic feet of fly ash minimum.

2. Fabrication

- a. Shop fabricated
- b. All welded construction
- c. May be shop fabricated to casing or may be field connected
- d. Stiffeners as required to withstand 20 inches of water, pressure or vacuum
- e. Side slope not less than 60° from horizontal
- f. Provide a poke hole

3. Material

- a. Carbon steel
- b. Thickness - 3/16" minimum

4. Access Door

- a. Hinged
- b. Minimum size - 18" x 30"
- c. Safety latch to prevent door closing with personnel inside

5. Fly Ash Outlet

- a. Flanged, 12" diameter
- b. Ash removal will be by a manually activated pneumatic ash conveying system, United Conveyor or equal.

C. Bags

1. Size

- a. Diameter - 8"
- b. Length - approximately 22-24 feet

2. Material

- a. Fiberglass, twill weave, 14 oz. per square yard
- b. Finish - Teflon B
- c. Weave - 3 x 1 Twill

3. Temperature - 500°F continuous

4. Rings as recommended by the baghouse manufacturer.

5. Attachment

- a. External worm gear type stainless steel band to thimble at bottom.
- b. External worm gear type stainless steel band to cap at top or factory assembled to disposable top cap.

D. Dampers

1. Poppet type or Butterfly, manual operator - Inlet.

2. Poppet type with pneumatic operator and pilot solenoid valve.

- a. Outlet
- b. Reverse air inlet
- c. Reinflate outlet

E. Ducts

1. Sized for air velocity not to exceed 3,000 feet per minute.
2. Welded construction of 3/16" thick carbon steel.
3. Stiffeners as required to withstand 20 inches of water, pressure or vacuum.
4. Stainless steel expansion joints as required for the thermal expansion with a temperature range of (-)25° to (+)500°F.

F. Exterior Access

1. Platforms to reach all access doors and dampers.
2. Include stairway for primary access and stairways or ladders for secondary access.
3. Platforms constructed with Irving subway grating supported by steel channels and angles.
4. Handrails and kickplates in accordance with the Minnesota Building Code.
5. Stairways with Irving "Visableledge" treads.

G. Painting

1. Shop Coat
 - a. Zinc chromate in areas below 300°F.
 - b. High temperature aluminum in areas 300°F and above.
2. Casings and hoppers painted inside and outside.

H. Reverse Air Fan

1. Carbon steel housing - 3/16" thick, minimum.
2. Wheel statically and dynamically balanced.
3. Sleeve type bearings mounted on structural steel frame or on separate pedestals.
4. Fan and drive mounted on the baghouse assembly or adjacent to it.

5. Motors shall be NEMA Design A or B, dust-ignition-proof or explosion-proof for a Class II, Division 1, Group F hazardous atmosphere, two-bearing squirrel cage induction type with 1.0 service factor when operating continuously in a 40°C ambient. Horsepower rating shall be as required for the design characteristics of the fan. Motors shall be designed for full voltage starting on a 460 volt, 3 phase, 60 hz. system. Windings shall have Class B or Class F nonhygroscopic insulating materials per NEMA MG1-1.27. Bearings shall be shielded, regreaseable, vacuum degassed steel anti-friction type. Terminal box shall have F-1 mounting, shall be sized generously and shall have a gasketed cover. Motors shall be General Electric, Reliance, Westinghouse, or approved equal.

CONTROLS

- A. Provide a complete control system for the baghouse system including panel, panel components, and field components.
- B. Related Work by Others
 1. Erection of the control panel.
 2. Installation of the field components for the baghouse control system.
 3. Motor starters.
 4. Field tubing and wiring.
- C. System Description
 1. The baghouse control system shall be of the manufacturer's recommended design.
 2. In general, this system shall operate as follows:
 - a. Initiate the cleaning cycle when the differential pressure from the inlet header to the outlet header reaches approximately 5 inches of water.
 - b. Clean the first module with the appropriate times of reverse air, null, reinflate, etc.
 - c. Clean each of the other modules in a similar manner.
 - d. Wait until the differential pressure again reaches approximately 5 inches of water.
 - e. Provide for manual start of the cleaning cycle and manual advance to any given module.
 3. Provide a manometer or gauge for each module to indicate differential pressure.

D. Panel Construction

1. NEMA 12 enclosure equal to Hoffman Bul A-12.
2. May be wall mounted or pad mounted.
3. Bottom entry for tube and wire.
4. Laminated nameplate for each control or device, white letters on a black plate, 1" x 3" minimum size, attached with screws.
5. Tube and wire all components to bulkhead connections or terminal strips at the bottom of the panel.
6. Circuit breakers and switches.

SERVICE PERSONNEL

A. Inspection

Inspect each component after erection to verify that it is properly erected, aligned, lubricated, etc. and is clean and ready to operate.

B. Check-Out

1. Run the system as necessary to make final adjustments to the equipment and to verify that the system will meet the specifications. These runs will be required before an acceptance test is scheduled.
2. The owner will provide operating personnel to assist in all of the operations and will operate the boilers as required. However, these runs will have to be scheduled so they do not interfere with the normal operation of the plant.
3. This contractor will be responsible for the safe and proper operation of all of his equipment until it is accepted by the owner.

C. Instruction

1. Instruct the plant personnel in all phases of operation of the equipment so the plant superintendent is satisfied that they are qualified to assume the responsibility of the unit.
2. Coordinate the instruction periods with the Engineer so the proper personnel can be scheduled to attend.

D. Panel Construction

1. NEMA 12 enclosure equal to Hoffman Bul A-12.
2. May be wall mounted or pad mounted.
3. Bottom entry for tube and wire.
4. Laminated nameplate for each control or device, white letters on a black plate, 1" x 3" minimum size, attached with screws.
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SERVICE PERSONNEL

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Inspect each component after erection to verify that it is properly erected, aligned, lubricated, etc. and is clean and ready to operate.

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3. This contractor will be responsible for the safe and proper operation of all of his equipment until it is accepted by the owner.

C. Instruction

1. Instruct the plant personnel in all phases of operation of the equipment so the plant superintendent is satisfied that they are qualified to assume the responsibility of the unit.
2. Coordinate the instruction periods with the Engineer so the proper personnel can be scheduled to attend.

TESTING

A. Acceptance Test

1. Provide the services of an independent testing firm to run an acceptance test on the baghouse system.
2. Before scheduling an acceptance test, check-out the system to verify that it is ready for a test.

B. Testing Firm

1. The testing firm shall be one who regularly conducts tests of this type on utility or large industrial boiler systems.
2. Select a testing firm who is acceptable to the Minnesota Pollution Control Agency and the owner.

C. Witness

The test will be witnessed by the owner and the engineer.

D. Participation

This contractor shall have qualified service personnel on the job at the time of the acceptance test to insure the safe and proper operation of the equipment and to assist as necessary in the test.

EQUIPMENT DATA SHEETS

Submit the attached Equipment Data Sheets, completely filled in, with the proposal.

UNIVERSITY OF MINNESOTA
MINNEAPOLIS CAMPUS
GRID ICES

EQUIPMENT DATA

<u>Baghouse System</u>	<u>Base Bid</u>	<u>Alternate Bid</u>
No. of Modules	_____	_____
Bags - No./Module	_____	_____
Total No.	_____	_____
Effective Area/Bag	_____	_____
Total Effective Area	_____	_____
Reverse Air Flow	_____	_____
Air/Cloth Ratio	_____	_____
All Modules Operating	_____	_____
One Module Cleaning (Including reverse air flow)	_____	_____
Weight	_____	_____
Each Module including hopper	_____	_____
Inlet Manifold	_____	_____
Outlet Manifold	_____	_____
Reverse Air Manifold	_____	_____
Reverse Air Fan & Drive	_____	_____
Total on Foundation (Including structural steel, walkways, stairs & ladders)	_____	_____
Predicted Pressure Drop, Inlet Heads to Outlet Header	_____	_____
All Modules Operating	_____	_____
One Module Cleaning	_____	_____

UNIVERSITY OF MINNESOTA

PHYSICAL PLANT

MINNEAPOLIS, MINNESOTA

5.2.3

SPECIFICATIONS

FOR

BAGHOUSE I.D. FAN

FOR

GRID-CONNECTED INTEGRATED
COMMUNITY ENERGY SYSTEM

HELMICK & LUTZ COMPANY

ENGINEERS

1315 GLENWOOD AVENUE

MINNEAPOLIS, MINNESOTA 55405

DECEMBER, 1977

EQUIPMENT ITEM NO. 3

DIVISION 2

BAGHOUSE I.D. FAN

GENERAL PROVISIONS

A. General

1. It is the intent of these Specifications to secure an induced draft fan complete with drive and control dampers to provide the draft loss through a baghouse system to be retrofitted to an existing multi-boiler power plant.
2. The fan shall be a double inlet, double width mechanical draft centrifugal fan with inlet boxes.
3. A base bid is requested for a fan to service two (2) coal fired boilers. An alternate bid is requested for a fan to service the above boilers plus a pyrolysis solid waste unit.

B. Description of the System

1. The baghouse system will operate as follows:
 - a. Dirty flue gas from the existing boiler I.D. Fans will be ducted to the baghouse system.
 - b. Clean flue gas from the baghouse system will be ducted to the baghouse I.D. Fan.
 - c. The baghouse I.D. Fan will control the inlet manifold of the baghouse system at approximately 0 inches of water pressure, gauge.
 - d. Outlet gas from the baghouse I.D. Fan will be ducted to the existing stack.
2. During normal operation, any or all of the boilers may be on the line and boilers may be base loaded or swinging with the load in any combination.

C. Local Conditions

1. The fan will be installed in a fan room adjacent to the existing heating plant.
2. Concrete pads will be provided by others to support the fan housing, bearings, and motor.

D. Submittals

1. With Bid

- a. Equipment Data Sheets
- b. Dimensioned outline drawings

2. For Approval Prior to Fabrication

- a. Certified drawings of all components

3. Manuals (6 copies)

- a. Operator's Instructions
- b. Maintenance Instructions
- c. Parts Lists

FAN

A. Housing and Inlet Boxes

- 1. Steel plate 3/16" thick minimum
- 2. Steel scroll liners
- 3. Split construction for wheel removal
- 4. Drains in the scroll bottom
- 5. Flanged inlet and outlet
- 6. Nelson NHP studs on 12" centers for attaching insulation

B. Wheels

- 1. Heavy duty design, radial tip with forward curved heel
- 2. Replaceable ribbed blade liners
- 3. Statically and dynamically balanced

C. Bearings

- 1. Sleeve type, split
- 2. Ring oiled with oil sight gauge
- 3. Self-aligning
- 4. Water cooled
- 5. Separate pedestals with machined soleplates

D. Access Doors

- 1. Inlet section and fan wheel section
- 2. Raised bolt-up type
- 3. Inserts to provide a continuous internal scroll surface

E. Operating Data

1. Full load operating conditions are:

<u>Bid</u>	<u>ACFM</u>	<u>Temperature</u>	<u>Inlet Static</u>	<u>Outlet Static</u>
Base	135,000	300°F	(-)8"H ₂ O	0"H ₂ O
Alternate	181,000	300°F	(-)8"H ₂ O	0"H ₂ O

2. For fan design, add the following:

- a. Capacity - 20%
- b. Static - 40%
- c. Temperature - 35%

3. Maximum outlet velocity - 3000 fpm

4. Maximum shaft speed - 1170 rpm

MOTOR

Motor shall be NEMA Design A or B, open dripproof, two-bearing squirrel cage induction type with 1.15 service factor when operating continuously in a 40°C ambient. Horsepower rating shall be as required for the design characteristics of the fan without using the service factor. Motor shall be designed for full voltage starting on a 4160 volt, 3 phase, 60 hz. system. Windings shall have Class B or Class F nonhygroscopic insulating materials per NEMA MG1-1.27. Bearings shall be shielded, regreaseable, vacuum degassed steel anti-friction type. Terminal box shall have F-1 mounting, shall be sized generously and shall have a gasketed cover. Motor shall be General Electric, Reliance, Westinghouse, or approved equal.

DAMPERS

- A. Provide an inlet control damper.
- B. Carbon steel damper blades and frames.
- C. Ball bearings mounted externally from the damper frames.
- D. Blade shafts linded together and arranged for actuation by a pneumatic damper drive. Linkage and arms shall be of carbon steel. After assembly, drill and pin or weld link arms to blade shafts to prevent slipping.

COUPLINGS

- A. Provide a flexible coupling with guard.
- B. Coupling shall be Fast, Falk, or approved equal.

SERVICE PERSONNEL

A. Inspection

Inspect each component after erection to verify that it is properly erected, aligned and lubricated.

B. Balance

Check the dynamic balance of the fan at operating temperature and rebalance if necessary.

C. Additional Service Calls

Quote the service charge for rechecking and rebalancing the fan after the initial service specified above.

EQUIPMENT DATA SHEETS

Submit the attached Equipment Data Sheets, completely filled in, with the proposal.

UNIVERSITY OF MINNESOTA
MINNEAPOLIS CAMPUS
GRID ICES

EQUIPMENT DATA

<u>I.D. Fan</u>	<u>Base Bid</u>	<u>Alternate Bid</u>
<u>Fan</u>		
Model	_____	_____
Size	_____	_____
Wheel Diameter	_____	_____
Brake HP at full load operation	_____	_____
Brake HP at design conditions	_____	_____
<u>Motor</u>		
Manufacturer	_____	_____
Frame	_____	_____
Horsepower	_____	_____
<u>Coupling</u>		
Manufacturer	_____	_____
Size	_____	_____
<u>Weight</u>		
Fan, including inlet boxes	_____	_____
Damper (unless included above)	_____	_____
Motor	_____	_____

UNIVERSITY OF MINNESOTA

PHYSICAL PLANT

MINNEAPOLIS, MINNESOTA

5.2.4

SPECIFICATIONS
FOR
BOILER FEED PUMPS
FOR
GRID-CONNECTED INTEGRATED
COMMUNITY ENERGY SYSTEM

HELMICK & LUTZ COMPANY
ENGINEERS
1315 GLENWOOD AVENUE
MINNEAPOLIS, MINNESOTA 55405

DECEMBER, 1977

EQUIPMENT ITEM NO. 4

DIVISION 2

BOILER FEED PUMPS

GENERAL PROVISIONS

- A. Provide three (3) boiler feed pumps complete with base plate and motor drive to provide the feedwater supply for a multi-boiler power plant.
- B. System Description
 - 1. Pumps will take suction from an elevated deaerating heater and storage tank.
 - 2. Feedwater is approximately 90% condensate and 10% make-up water.
 - 3. Condensate is treated in a condensate polishing system.
 - 4. Make-up water is Minneapolis city water treated in a hot lime - hot zeolite system.
- C. Local Conditions

Pumps will be installed on the operating floor of the existing turbine room.

PUMPS

- A. Pump shall be a multi-stage centrifugal designed for boiler feed service.
- B. If a Kingsbury thrust bearing is recommended, quote this as an add alternate.
- C. Provide a Fast, Falk, or approved equal coupling with guard.
- D. Provide a separate complete lubrication system.
- E. Provide a muffle orifice sized to protect the pump down to zero flow.
- F. Operating Conditions
 - 1. Head - 1300 feet
 - 2. Capacity - 300 gpm each
 - 3. NPSH - 20
 - 4. Temperature - 250°F

MOTORS

Motors shall be NEMA Design A or B, open dripproof, two-bearing squirrel cage induction type with 1.15 service factor. Horsepower rating shall be as required to operate the pump continuously over the complete head/capacity range without exceeding the nameplate rating or using the service factor when operating in a 40°C ambient. Motors shall be designed for full voltage starting on a 460 volt, 3 phase, 60 hz. system. Windings shall have Class B or Class F non-hygroscopic insulating materials per NEMA MG1-1.27. Bearings shall be shielded, regreaseable, vacuum degassed steel anti-friction type. Terminal box shall have F-1 mounting, shall be sized generously, and shall have a gasketed cover. Motors shall be General Electric, Reliance, Westinghouse, or approved equal.

EQUIPMENT DATA SHEETS

Submit the attached Equipment Data Sheets, completely filled in, with the Proposal.

UNIVERSITY OF MINNESOTA
MINNEAPOLIS CAMPUS
GRID ICES

EQUIPMENT DATA

Boiler Feed Pumps

Base Bid

Pump

Model

Size

Stages

Brake HP at Rating

Max HP for the Quoted Impeller

Speed

Motor

Manufacturer

Frame

Horsepower

Coupling

Manufacturer

Size

Weight

Pump w/Base

Motor

UNIVERSITY OF MINNESOTA

PHYSICAL PLANT

MINNEAPOLIS, MINNESOTA

5.2.5

SPECIFICATIONS
FOR
WATER SOFTENING SYSTEM
FOR
GRID-CONNECTED INTEGRATED
COMMUNITY ENERGY SYSTEM

HELMICK & LUTZ COMPANY
ENGINEERS
1315 GLENWOOD AVENUE
MINNEAPOLIS, MINNESOTA 55405

DECEMBER, 1977

EQUIPMENT ITEM NO. 5

DIVISION 2

WATER SOFTENING SYSTEM

GENERAL PROVISIONS

A. General

1. Provide a complete hot lime-zeolite water softening system to supply make-up water to a multi-boiler power plant.
2. Include in the proposal all equipment necessary for a complete system. If pumps are included, quote them as separate add alternates.
3. Clearly list any items necessary for an installed and operating system but not included in the proposal.

B. Description of the Plant Feedwater System

1. Condensate from the Campus heating system is returned to a condensate surge tank. From there it is pumped through a condensate treating system to the deaerating heater. Flow of condensate is controlled by the level in the condensate surge tank.
2. Make-up water is Minneapolis city water treated in a hot lime-zeolite softener and is pumped to the deaerating heater. Flow of make-up water is controlled by the level in the deaerator storage tank.
3. A deaerating heater operating at 10 psig heats the water to 240°F. De-aerated water is stored in an elevated storage tank.
4. Boiler feed pumps take suction from the deaerated water storage tank and supply feedwater to the boilers.
5. Feedwater is approximately 90% condensate and 10% make-up water.

OPERATING DATA

A. Steam pressure to softener - 10 psig

B. Softening capacity required:

1. Continuous - 100 gpm
2. Peak - 150 gpm

EQUIPMENT

A. Hot Process Softener

1. Heat water to near steam temperature
2. Separate and remove non-condensable gasses.

3. Mix treatment chemicals
4. Separate and remove sludge
5. Chemical feed system, automatic proportioning

B. Filters

1. Pressure type
2. Include filtering material
3. Manhole in each vessel
4. Backwash flow controls
5. External valve nests
6. False bottom underdrain system with Johnson strainers, stainless steel
7. Maximum flow rate
 - a. 3 gpm/sq.ft. with all filters in service
 - b. 4.5 gpm/sq.ft. with one filter backwashing

C. Zeolite Softeners

1. Pressure type
2. Include resin
3. Manhole in each vessel
4. Outlet meter on each vessel with alarm contacts, 115 volt
5. External valve nests
6. Semi-automatic (pushbutton initiated) controls
7. False bottom underdrain system with stainless steel strainers
8. Brine system, complete
9. Maximum flow rate
 - a. 8 gpm/sq.ft. with all softeners in service
 - b. 10 gpm/sq.ft. with one softener regenerating

UNIVERSITY OF MINNESOTA

PHYSICAL PLANT

MINNEAPOLIS, MINNESOTA

5.2.6

SPECIFICATIONS
FOR
CONDENSATE TREATING SYSTEM
FOR
GRID-CONNECTED INTEGRATED
COMMUNITY ENERGY SYSTEM

HELMICK & LUTZ COMPANY
ENGINEERS
1315 GLENWOOD AVENUE
MINNEAPOLIS, MINNESOTA 55405

DECEMBER, 1977

EQUIPMENT ITEM NO. 6

DIVISION 2

CONDENSATE TREATING SYSTEM

GENERAL PROVISIONS

- A. Provide a complete ion-exchange type condensate treating system for a multi-boiler power plant.
- B. Include in the proposal all equipment necessary for a complete system.
- C. Clearly list any items necessary for an installed, operating system but not included in the proposal.
- D. Description of the Plant Feedwater System
 - 1. Condensate from the Campus heating system is returned to a condensate surge tank. From there it is pumped through a condensate treating system to the deaerating heater. Flow of condensate is controlled by the level in the condensate surge tank.
 - 2. Make-up water is Minneapolis city water treated in a hot lime-zeolite softener and is pumped to the deaerating heater. Flow of make-up water is controlled by the level in the deaerator storage tank.
 - 3. A deaerating heater operating at 10 psig heats the water to 240°F. De-aerated water is stored in an elevated storage tank.
 - 4. Boiler feed pumps take suction from the deaerated water storage tank and supply feedwater to the boilers.
 - 5. Feedwater is approximately 90% condensate and 10% make-up water.

OPERATING DATA

- A. Condensate temperature range 140-200°F
- B. Flow Rate
 - 1. Continuous - 600 gpm
 - 2. Peak - 800 gpm
- C. Treated Water Quality - 20 parts per million, maximum

EQUIPMENT

- A. Regenerable ion - exchange type
- B. Include resin
- C. Manhole in each vessel
- D. Regeneration within the vessel
- E. External valve nests
- F. Chemical feed systems, complete

UNIVERSITY OF MINNESOTA

PHYSICAL PLANT

MINNEAPOLIS, MINNESOTA

5.2.7

SPECIFICATIONS
FOR
DEAERATING HEATER
FOR
GRID-CONNECTED INTEGRATED
COMMUNITY ENERGY SYSTEM

HELMICK & LUTZ COMPANY
ENGINEERS
1315 GLENWOOD AVENUE
MINNEAPOLIS, MINNESOTA 55405

DECEMBER, 1977

EQUIPMENT ITEM NO. 7

DIVISION 2

DEAERATING HEATER

GENERAL PROVISIONS

- A. Provide a complete deaerating heater with storage tank to supply feedwater to a multi-boiler power plant.
- B. Description of the Plant Feedwater System
 - 1. Condensate from the Campus heating system is returned to a condensate surge tank. From there it is pumped through a condensate treating system to the deaerating heater. Flow of condensate is controlled by the level in the condensate surge tank.
 - 2. Make-up water is Minneapolis city water treated in a hot lime-zeolite softener and is pumped to the deaerating heater. Flow of make-up water is controlled by the level in the deaerator storage tank.
 - 3. A deaerating heater operating at 10 psig heats the water to 240°F. De-aerated water is stored in an elevated storage tank.
 - 4. Boiler feed pumps take suction from the deaerated water storage tank and supply feedwater to the boilers.
 - 5. Feedwater is approximately 90% condensate and 10% makeup water.

OPERATING DATA

- A. Steam pressure to deaerator - 10 psig
- B. Condensate flow to deaerator
 - 1. Continuous flow - 500 gpm
 - 2. Peak flow - 800 gpm
 - 3. Temperature range - 140-200°F
- C. Make-up flow to deaerator
 - 1. Continuous flow - 100 gpm
 - 2. Peak flow - 150 gpm
 - 3. Temperature - 230°F
- D. Deaerating heater capacity
 - 1. Nominal full load - 300,000 #/Hr.
 - 2. Peak flow - 400,000 #/Hr.

- E. Storage Tank capacity - 10,000 gal. minimum
- F. Guaranteed deaerator outlet

- 1. Oxygen - less than 0.005 cc/liter
- 2. Carbon Dioxide - zero

DEAERATING HEATER

- A. Type - tray or spray
- B. Design - ASME Code Construction for 30 psig Operation
- C. Vent condenser
- D. Pressure relief valve
- E. Vacuum breaker
- F. Thermometer
- G. Pressure gauge
- H. Adequate manholes to provide access
- I. Two (2) connections for high pressure trap returns
- J. All connections 2-1/2" and larger flanged
- K. Provide a spare set of trays if tray type deaerator is proposed

STORAGE TANK

- A. Design - ASME Code Construction for 30 psig Operation
- B. Manhole of adequate size
- C. Float operated externally mounted overflow trap
- D. Thermometer
- E. Gauge glass to cover entire liquid level
- F. Connections top and bottom for:
 - 1. Remote level indicator
 - 2. Level control transmitter
- G. Four (4) connections on side for boiler feed pump recirculation
- H. All connections 2-1/2" and larger flanged

UNIVERSITY OF MINNESOTA

PHYSICAL PLANT

MINNEAPOLIS, MINNESOTA

5.2.8

SPECIFICATIONS
FOR
CONTINUOUS BLOWOFF SYSTEM
FOR
GRID-CONNECTED INTEGRATED
COMMUNITY ENERGY SYSTEM

HELMICK & LUTZ COMPANY
ENGINEERS
1315 GLENWOOD AVENUE
MINNEAPOLIS, MINNESOTA 55405

DECEMBER, 1977

EQUIPMENT ITEM NO. 8

DIVISION 2

CONTINUOUS BLOWOFF SYSTEM

GENERAL PROVISIONS

- A. Provide a continuous blowdown heat recovery system for a multi-boiler power plant.
- B. System Description
 - 1. Continuous blowdown from three (3) power boilers and one (1) heat recovery boiler will be piped to the inlet header of the blowdown flash tank.
 - 2. Flash steam will be used in the low pressure (20 psig) system.
 - 3. The remaining water will be cooled in a heat exchanger before being dumped to sewer. Cooling water will be raw Minneapolis city water.
 - 4. An external float type level transmitter on the flash tank will control the blowdown water flow to sewer.

OPERATING DATA

- A. Pressures
 - 1. Boiler drum - 450 psig
 - 2. Flash tank - 20 psig
 - 3. City water - approximately 30 psig
- B. Quantities
 - 1. Boiler output, total - 300,000 #/Hr.
 - 2. Blowdown, maximum - 15,000 #/Hr. (5%)
 - 3. City water usage - 100 gpm
- C. City water temperature - approximately 50°F

FLASH TANK

- A. Centrifugal type, carbon steel
- B. ASME code construction
- C. Wearplates or baffles at points of high erosion
- D. Access manhole
- E. Connections 2-1/2" and larger flanged
- F. Provide connections for external float type level transmitter

G. Accessories

1. Sight glass
2. Pressure gauge
3. Relief valve

HEAT EXCHANGER

- A. U tube type
- B. Size for 20°F terminal difference
- C. Materials

1. Shell - steel
2. Head - cast iron or steel
3. Tube sheet - steel
4. Tubes - copper

UNIVERSITY OF MINNESOTA

PHYSICAL PLANT

MINNEAPOLIS, MINNESOTA

5.2.9

SPECIFICATIONS
FOR
AIR COMPRESSOR
FOR
GRID-CONNECTED INTEGRATED
COMMUNITY ENERGY SYSTEM

HELMICK & LUTZ COMPANY
ENGINEERS
1315 GLENWOOD AVENUE
MINNEAPOLIS, MINNESOTA 55405

DECEMBER, 1977

EQUIPMENT ITEM NO. 9

DIVISION 2

AIR COMPRESSOR

GENERAL PROVISIONS

- A. Provide one (1) non-lubricated air compressor to provide instrument and control air for a power plant.
- B. Include the following:
 - 1. Motor, slide base and belt drive
 - 2. Intake filter
 - 3. Aftercooler
 - 4. Receiver
 - 5. Refrigerated air dryer
- C. Provide check-out and start-up services.

AIR COMPRESSOR

- A. Design
 - 1. Vertical single stage, double acting
 - 2. Heavy duty cross head type
 - 3. Water cooled
 - 4. Double counterweighted crank
 - 5. Teflon piston and wearing rings
 - 6. Light weight piston
 - 7. Channel type or flexible strip type valves
 - 8. Long distance piece and oil wiper rings
 - 9. Size 9 x 7
 - 10. Speed 514 RPM or less
- B. Performance
 - 1. Capacity - 160 scfm, nominal
 - 2. Discharge Pressure - 100 psig
 - 3. Maximum Intake Temperature - 95°F
- C. Lubrication
 - 1. Shaft driven oil pump
 - 2. Force feed lubrication through drilled passages
 - 3. Low oil pressure shut-down switch with contacts suitable for 115 volts AC

D. Capacity Controller

1. Dual control to provide a choice of:
 - a. Continuous operation with intake valve unloaders
 - b. Off-On control to cycle the drive motor
2. Controls factory assembled in a control box for wall mounting.

E. Cooling Water Regulator Valve

1. Self contained reverse acting temperature regulator.
2. Stainless steel trim.
3. Brass capillary tube, armor protected, 15 feet long.
4. Stainless steel well, separate.

F. Air Temperature Cut-Off Switch

1. Semi-automatic type, hand reset
2. Stainless steel well, separate
3. Armor protected capillary tube, 20 feet long
4. Contacts suitable for 115 volts AC

G. Motor

Motor shall be NEMA Design A or B, 460 volt, 3 phase, 60 hz., drip-proof, two-bearing, belted squirrel cage induction type with 1.15 service factor. Horsepower rating shall be as required to operate the compressor at specified output without using any of the service factor. Winding shall have Class B or Class F nonhygroscopic insulating materials per NEMA MG1-1.27. Temperature rise of the winding shall permit the motor to operate continuously in a 40°C ambient at the 1.15 service factor without reducing the normal life of the winding insulation. Bearings shall be shielded, regreaseable, vacuum degassed steel anti-friction type. Terminal box shall have F-1 mounting, shall be oversized and shall have a gasketed cover.

H. Slide Base

Motor shall be furnished complete with slide base.

I. Drive

1. Multiple V-Belt type
2. Service factor at least 2.0
3. Provide a matched set of belts
4. Provide a belt guard

INTAKE FILTER

Dollinger IDR or approved equal.

AFTERCOOLER

A. Design

1. Shell and tube pipe line type
2. Easily removable tube nest
3. Moisture separator and automatic moisture trap
4. ASME stamped

B. Performance

1. Sized to reduce the air temperature to within 15°F of the entering water temperature when 85% clean.
2. Entering water temperature - 70°F
3. Design pressure
 - a. Waterside - 100 psig
 - b. Airside - 125 psig
 - c. Normal water pressure - 30 psig

C. Accessories

1. Air outlet thermometer
2. Cooling water sight flow funnel, cast iron

AIR RECEIVER

A. Design

1. Approximate size - 24" dia. x 72" straight sides
2. ASME stamped
3. Design pressure - 125 psig
4. Steel floor ring stand
5. 11" x 15" manhole

B. Connections

1. Flanged inlet and outlet connections
2. Drain connection, 1" screwed
3. Three (3) additional connections, 1" screwed

C. Safety Valve

1. Capacity equal to compressor rating
2. Set point - 125 psig

AIR DRYER

A. Design

1. "Package" type refrigerated dryer.
2. Designed for continuous 24 hour per day operation at full rating or any load down to zero load.
3. Complete controls to allow automatic operation under any load conditions without freezing.
4. Preheat/precooler heat exchanger.
5. Moisture separator with automatic moisture trap.

B. Performance

1. Capacity - 200 scfm
2. Pressure - 100 psig normal, 125 psig maximum
3. Inlet temperature, maximum - 95°F
4. Outlet dew point - 35°F at 100 psig
5. Electrical supply - 460 volt, 3 phase, 60 hz.

SERVICE PERSONNEL

Include the cost of qualified service personnel to:

- A. Inspect installation after erection
- B. Supervise start-up and check-out
- C. Train operating personnel in the proper operation and maintenance

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PHYSICAL PLANT

MINNEAPOLIS, MINNESOTA

5.2.10

SPECIFICATIONS
FOR
PRESSURE REDUCING AND
DESUPERHEATING EQUIPMENT
FOR
GRID-CONNECTED INTEGRATED
COMMUNITY ENERGY SYSTEM

HELMICK & LUTZ COMPANY
ENGINEERS
1315 GLENWOOD AVENUE
MINNEAPOLIS, MINNESOTA 55405

DECEMBER, 1977

EQUIPMENT ITEM NO. 10

DIVISION 2

PRESSURE REDUCING AND DESUPERHEATING EQUIPMENT

GENERAL PROVISIONS

- A. Provide pressure reducing valves and desuperheaters for the various pressure levels as shown on the attached schematic.
- B. Submit separate quotes for each of the pressure reducing and desuperheating stations.
- C. Instrumentation to control this equipment will be provided by others as part of the total plant control system.
- D. The plant contains three power boilers and a single extraction back pressure turbine-generator. Steam is supplied to the Campus at 180 psig and 20 psig. The feedwater system operates on 10 psig steam.

PRESSURE REDUCING VALVES

A. PRV-1

- 1. Turbine bypass service
- 2. Operating conditions
 - a. Inlet steam - 450 psig at 750°F
 - b. Outlet pressure - 180 psig
 - c. Maximum flow - 330,000 #/Hr.
- 3. Materials
 - a. Carbon steel body, 600#, butt weld ends
 - b. Cage type, equal percentage, stellite cage and plug
 - c. Pneumatic diaphragm operator, air-to-open (fail closed)
 - d. Yoke mounted positioner, 6 - 30 psig signal

B. PRV-2

- 1. Turbine bypass service
- 2. Operating conditions
 - a. Inlet steam - 180 psig at 580°F
 - b. Outlet pressure - 20 psig
 - c. Maximum flow - 100,000 #/Hr.

3. Materials

- a. Carbon steel body, 300#, butt weld ends
- b. Cage type, equal percentage, stellite cage and plug
- c. Pneumatic diaphragm operation, air-to-open (fail closed)
- d. Yoke mounted positioner, 6 - 30 signal

C. PRV-3

- 1. Steam supply to water treatment
- 2. Operating conditions
 - a. Inlet steam - 20 psig at 325°F
 - b. Outlet pressure - 10 psig
 - c. Pneumatic diaphragm operator, air-to-open (fail closed)
 - d. Yoke mounted positioner, 6 - 30 psi signal

DESUPERHEATING EQUIPMENT

A. Include atomizing steam and desuperheating water control valves for each system.

B. Desuperheating water is boiler feedwater at 500 - 600 psig, 250°F.

C. DSH-1

- 1. Turbine bypass service
- 2. Operating conditions
 - a. Pressure - 180 psig
 - b. Inlet temperature - 750°F
 - c. Outlet temperature - 580°F
 - d. Maximum flow - 330,000 #/Hr.

D. DSH-2

- 1. Turbine bypass service
- 2. Operating conditions
 - a. Pressure - 20 psig
 - b. Inlet temperature - 580°F
 - c. Outlet temperature - 325°F
 - d. Maximum flow - 100,000 #/Hr.

E. DSH-3

1. Steam supply to Campus
2. Operating conditions
 - a. Pressure - 180 psig
 - b. Inlet temperature - 580°F
 - c. Outlet temperature - 410°F
 - d. Maximum flow - 300,000 #/Hr.

ALTERNATE METHODS

Combination pressure reducing-desuperheating valves may be quoted for PRV-1, DSH-1 and for PRV-2, DSH-2.

KEY:

MAX FLOW / PSIG / °F
BTU/#

EQUIP BIDS				DRAWN <u>JWS</u>
				CHECKED
				APPROVED
REVISIONS	DATE	DWN	APP.	DATE <u>19 DEC 77</u>

MINNEAPOLIS

HELMICK & LUTZ
ENGINEERS

MINNESOTA

UNIV. OF MINN.
GRID ICES

PRESS. RED., DESUPERHEATING,
& RELIEF VALVE DATA

SCALE NONE

NO
MSK

REV.

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PHYSICAL PLANT

MINNEAPOLIS, MINNESOTA

5.2.11

SPECIFICATIONS
FOR
PRESSURE RELIEF VALVES
FOR
GRID-CONNECTED INTEGRATED
COMMUNITY ENERGY SYSTEM

HELMICK & LUTZ COMPANY
ENGINEERS
1315 GLENWOOD AVENUE
MINNEAPOLIS, MINNESOTA 55405

DECEMBER, 1977

EQUIPMENT ITEM NO. 11

DIVISION 2

PRESSURE RELIEF VALVES

GENERAL PROVISIONS

- A. Provide pressure relief valves and drip pan ells for the various pressure levels as shown on the attached schematic.
- B. The plant contains power boilers and a single extraction back pressure turbine-generator. Steam is supplied to the campus at 180 psig and 20 psig.

RELIEF VALVES

A. SV-1

1. Operating Conditions

- a. Steam Pressure - 180 psig
- b. Steam Temperature - 580°F
- c. Relieving Capacity @ 10% Accumulation - 330,000 #/Hr.

2. Materials

- a. Carbon steel body, 300#
- b. Flanged inlet and outlet

B. SV-2

Same as SV-1.

C. SV-3

1. Operating Conditions

- a. Steam Pressure - 20 psig
- b. Steam Temperature - 325°F
- c. Relieving Capacity at 10% Accumulation - 100,000 #/Hr.

2. Materials

- a. Carbon steel body, 150#
- b. Flanged inlet and outlet

D. SV-4

Same as SV-3.

KEY:

MAX FLOW / PSIG / °F
BTU/#

EQUIP BIDS				DRAWN <u>JWS</u>		HELMICK & LUTZ ENGINEERS				MINNEAPOLIS		MINNESOTA	
				CHECKED									
				APPROVED									
REVISIONS	DATE	OWN	APP.	DATE	19 DEC 77								
UNIV. OF MINN. GRID ICES						PRESS RED, DESUPERHEATING, & RELIEF VALVE DATA						SCALE NONE	
												NO	REV.
												MSK	

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PHYSICAL PLANT
MINNEAPOLIS, MINNESOTA

5.2.12

SPECIFICATIONS
FOR
ASH HANDLING SYSTEM
FOR
GRID-CONNECTED INTEGRATED
COMMUNITY ENERGY SYSTEM

HELMICK & LUTZ COMPANY
ENGINEERS
1315 GLENWOOD AVENUE
MINNEAPOLIS, MINNESOTA 55405
DECEMBER, 1977
EQUIPMENT ITEM NO. 12

DIVISION 2

ASH HANDLING SYSTEM

SCOPE OF WORK

- A. Furnish a complete pneumatic ash handling system to remove ashes from two boilers and a baghouse, convey the ashes to the storage silo, and transfer ashes from the silo to trucks. System shall be sized to include a future 200,000 #/Hr. pulverized coal boiler.

WORK BY OTHERS

- A. Complete erection of all materials and equipment
- B. Ash silo with enclosed unloader room and enclosed receiving equipment room
- C. Bottom ash hoppers
- D. Pipe supports for lines supported overhead
- E. Water, steam and compressed air piping
- F. Electrical wiring and motor starters

DESIGN

- A. Boilers
 - 1. Boiler No. 3 is a C.E. pulverized coal unit rated at 108,000#/Hr. at 450 psig, 750°F.
 - 2. Boiler No. 4 is a B & W spreader stoker unit rated at 128,000#/Hr. at 450 psig, 750°F.
 - 3. Future boiler will be a pulverized coal unit rated at 200,000#/Hr.
- B. Coal to be fired is a western coal (Westmoreland) with an ash content of 8.8%, a moisture content of 23%, and a BTU content of 8890 BTU/pound.
- C. Steam for operation of the system is available at 180 psig.
- D. Electrical service
 - 1. Controls - 110 volts, 60 Hz, single phase
 - 2. Power - 460 volts, 60 Hz, three phase
- E. Material shall be equal to United Conveyor Corporation Nuvaloy and Durite.

EQUIPMENT AND MATERIALS

A. Bottom Ash Hopper Accessories

1. Vertical lift doors (22" x 36") with water cooled frame, direct air cylinder operated, and door control accessories.
2. Mild steel door enclosure with access doors.
3. Rotary valve ash intakes, air cylinder operated, with solenoid valve.
4. Heavy duty single roll crusher with replaceable wearplates, complete with chain drive, motor, rotation sensor, automatic stall/reverse control and solenoid for seal air purge.

B. Receiving Equipment and Silo Accessories

1. Primary Receiver - Cylindrical with conical bottom and tangential inlet, constructed throughout of hard metal plates suitable for this type of service. Equip with a counter-weighted gravity dump discharge gate with machined surfaces and seal ring. Gate shall be hinged, self-cleaning, self-aligning and automatic.
2. Secondary Separator - Cylindrical with tangential inlet and wearplates. Equip with a counter-weighted gravity dump discharge gate with machined surfaces and seal ring. Gate shall be hinged, self-cleaning and automatic.
3. Discharge Gate Housing - A rectangular steel plate housing upon which the primary and secondary receivers are mounted and within which the discharge gates are housed. Access doors to the gates shall be provided in the housing. A hopper shall be provided, to receive the discharge from the primary and secondary receivers, with an outlet sized to limit the flow of ashes to the silo to a continuous flow during the dump cycles from the primary and secondary receivers.
4. Exhauster - Steam jet type with removable venturi. Air piping from receivers to exhauster and from exhauster to air washer shall be furnished.
5. Air Washer - multi-stage cyclone type constructed of replaceable hard metal plates with replaceable spray nozzles and access doors. Include vent and exhaust head to extend through enclosure roof.
6. Manhole - Fabricate cover and frame from mild steel plate. Cover shall bolt to frame and be provided with a means of locking with

a padlock (furnished by Owner). Minimum size shall be 30" wide x 37" long.

7. Relief Vent - Cast iron weather-tight assembly that allows for automatic emergency pressure relief of the silo. Provide cross bars in the frame to prevent personnel access through the opening.
8. Filter Vent - Self-cleaning bag filter.

C. Fly Ash Intakes

1. Self-feeding with enclosed swing disk-type valve, air power operated.
2. Provide solenoid air valves, air filters, pressure regulating valves and relief valves.
3. Inlet flange to be 12" I.D., 150# ANSI drilling.

D. Pipe and Fittings

1. All ash pipe shall be made of hard iron alloy suitable for abrasive service. Minimum wall thickness shall be 0.55" for 6" I.D. pipe and 0.65" for 8" I.D. pipe.
2. Elbows shall be of the semi-sweep type with a replaceable wearback not less than 2" thick, and a handhole for cleaning.
3. Tees and laterals shall have replaceable wearbacks not less than 2" thick.
4. Rotary slide gates shall be totally enclosed with two air power chambers to open and close the gate. Include required solenoid air valves.
5. Air intake valves at the end of each branch line shall be spring loaded with adjustable spring compression. Provide rainhood for exterior applications.
6. All couplings, expansion joints, bolts, flanges, gaskets and cement required to complete the installation shall be provided.

E. Unloading Equipment

1. Totally enclosed 30" rotary drum type fly ash unloader, UCC Model #530, or equal.
2. Capacity: 30 tons of ash per hour.

3. Provide the following accessories:

- a. Motor driven rotary vane feeder
- b. Water spray nozzles
- c. Ash bin hopper with aerating nozzles and expansion joint
- d. Air cylinder operated knife gate
- e. Enclosed discharge chute for loading trucks
- f. Drive motors shall be totally-enclosed, fan cooled, 460 volt, 3 phase, 60 Hz.

F. Painting

All metal work shall receive a shop coat of a rust inhibitive zinc-chromate primer.

CONTROLS

A. Ash Conveying System

- 1. Provide a complete control system including panel, panel components, and field components.
- 2. Controls shall be designed for fully automatic operation and sequential operation of the fly ash and bottom ash systems.
- 3. Free standing control panel shall be NEMA 12 enclosure prewired to terminal blocks with identified connection points.
- 4. Local control station shall be NEMA 12.
- 5. Provide for manual indexing.

B. Ash Unloading System

- 1. Provide controls for automatic operation of rotary unloader.
- 2. Unloader local control panel shall be NEMA 12 construction and prewired to a terminal strip.
- 3. A stainless steel NEMA 4 remote control station shall be provided for operation at grade level.
- 4. Provide all components required except external piping and wiring; motor starters for unloader and rotary vane feeder.
- 5. Pushbuttons, selector switches and indicating lights shall be heavy duty, oiltight units. Relays shall be 300 volt machine tool relays. All device and relay contacts shall be rated 10 amp continuous.

6. Motor starters, furnished by Others, will have individual 120 volt control power transformers. Separate 120 volt single phase circuit(s) will be provided by Others for the Ash Removal System controls. Relay contacts shall be provided to interface with the motor starter control circuits.

SERVICE ENGINEER

A qualified factory representative shall inspect the installation, place the equipment into successful operation and instruct the Owner's operators in the care and use of the system. Proposals shall include at least two visits of one week each by the field service engineer.

GUARANTEE

The equipment furnished will be free from all defects in design, materials, and workmanship and will give successful service under the conditions specified. Any part which may prove to be defective within two years after the system is placed in operation shall be replaced at no cost to the Owner.

ALTERNATE

- A. The equipment and materials required to connect the waste heat boiler to the ash system shall be quoted as a separate price.
- B. Expected ash quantity is 3.3 T/day.
- C. Waste heat boiler is operated at a draft of -11" H₂O.

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PHYSICAL PLANT

MINNEAPOLIS, MINNESOTA

5.2.13

SPECIFICATIONS
FOR
WASTE HEAT RECOVERY BOILER
FOR
GRID-CONNECTED INTEGRATED
COMMUNITY ENERGY SYSTEM

HELMICK & LUTZ COMPANY
ENGINEERS
1315 GLENWOOD AVENUE
MINNEAPOLIS, MINNESOTA 55405

DECEMBER, 1977

EQUIPMENT ITEM NO. 13.

DIVISION 2

WASTE HEAT RECOVERY BOILER

PART 1 - GENERAL

A. Work Under This Section

1. Provide one (1) complete steam generating unit with specified auxiliary equipment.
2. Erect the equipment furnished under this contract.
3. Boil out, adjust and test the unit.

B. Related Work by Others

1. Foundation
2. I.D. Fan, Drive and Gas Ducts
3. Dust collector
4. Fuel Supply Systems
5. Ash Removal System
6. Feedwater System
7. Combustion Control System
8. General, Mechanical and Electrical Work to complete the project

C. General Description

1. Boiler shall generate steam at 450 psig, 725°F, with feedwater temperature 250°F.
2. Built in accordance with Section I of the ASME Boiler and Pressure Vessel Code, 1977, and the laws of the State of Minnesota.
3. Boilers will be fired with gas from the secondary combustion chamber of a pyrolysis solid waste conversion system.

D. Performance

1. Guarantee the following items of boiler performance at rated boiler load:
 - a. Capacity
 - b. Pressure
 - c. Steam temperature (See paragraph 2 below)
 - d. Steam purity leaving the drum
 - e. Exit gas temperature from the economizer
 - f. Efficiency
 - g. Gas pressure drops through the system

2. Steam temperature

Steam temperature shall be guaranteed to be controllable at 725°F with operating conditions as specified, throughout the control range, and shall be guaranteed not to deviate more than $\pm 10^\circ\text{F}$ from the 725°F set point for any load change up to 3% per minute.

3. Steam purity from the drum shall contain not more than 1 ppm solids.

E. Submittals

1. With proposal

- a. General arrangement drawing showing overall dimensions of boiler and location of terminal connections.
- b. Estimated weights on the foundations.
- c. List of all motors giving the horsepower rating of each, the power requirements of the driven load at boiler rating, and the maximum power requirements for any operating condition.
- d. Description of accessory equipment.
- e. Performance data per paragraph E. above at rated load, 3/4 rating, 1/2 rating and 1/4 rating.
- f. Additional data as called for in Part 2 of the Specifications.

2. For approval

Four (4) prints of outline and arrangement drawings.

3. Final drawings

Four (4) prints and one (1) reproducible of all drawings.

4. Manuals

Four (4) complete operation and maintenance manuals for the unit and all auxiliaries including:

- a. Operating instructions
- b. Lubrication data and schedules
- c. Maintenance, repair, and adjustment data including manufacturer's instructions.
- d. Parts list, recommended stock, nearest parts depot and service organizations.
- e. Assembly drawings, wiring diagrams and mechanical diagrams.

5. Acceptance Test Report

Three (3) copies of all data.

PART 2 - PRODUCTS

A. Design Data

1. Fuel

Fuel will be waste gas from the secondary combustion chamber of a pyrolysis solid waste conversion system. The system will be designed to gasify hospital waste and general waste at the rate of 130 tons per day $\pm$ 15%.

For purposes of design, the inlet gas conditions will be as follows:

Gas Flow	108,000 pounds per hour
Inlet Gas Temperature	2301°F
Inlet Gas Pressure	-18 lwg

There will be particulate in the gas stream that may have slagging tendencies.

2. Feedwater System

- a. Feedwater will be approximately 75% returned condensate and 25% makeup water.
- b. Condensate will be treated in a condensate polishing system.
- c. Makeup water will be treated in a hot process softener.
- d. Feedwater will be deaerated and heated to 250°F.

B. Steam Generating Unit

1. Boiler

Describe the components in the proposal including such data as:

- a. Drum sizes
- b. Drum manhole sizes
- c. Tube diameter and material
- d. Steam purifier type and performance
- e. Maximum gas temperatures
- f. Gas velocities

2. Superheater

- a. Include superheat curves with the proposal.
- b. Provide complete superheater temperature system as required.
- c. List any limitations or restrictions on steam temperature and load relations.

3. Economizer

The economizer shall be designed to lower the exit gas temperature to 460°F.

4. Soot Blowers

Provide a complete soot blower system with controls.

5. Trim

- a. Water columns, one at each end of drum.
 - (1) Column with high and low water alarm contacts, illuminated glass.
 - (2) Column with illuminated glass and mirror for direct viewing from the operating floor.
 - (3) Include blowdown pipe and valve to approximately 4'-0" above the firing floor.
- b. All required safety valves.
- c. Drum and header blowdown valves and piping to approximately 4'-0" above the firing floor.
- d. Chemical feed distributor, stainless steel.
- e. Connections for Owner's combustion control instrumentation such as:
 - (1) Draft gauges
 - (2) Temperature sensors
 - (3) Drum level transmitter
 - (4) Remote drum level gauge (Yarway)
 - (5) Drum pressure gauge
 - (6) Drum pressure switches

C. Casing Design

The casing shall be designed for a negative pressure of 24 lwg and a positive pressure of 15 lwg.

D. Outlet Gas Control Damper

A control damper shall be provided at the outlet of the unit with extended operating shafts for connection to an automatic control drive. Damper shall be multiple blade construction with lubricated bearings.

E. Insulation, Lagging and Finish

1. Insulate the boiler and economizer so that the skin temperature will not exceed 140°F.
2. Describe in detail the insulation materials and methods to be used.
3. Preferred outside covering would be 4" ribbed aluminum, 0.040" thick, of a manufacturer's standard color.

PART 3 - EXECUTION

A. Erection

1. Furnish all labor and materials to unload, store, handle and erect the equipment furnished under this contract including auxiliaries and trim.
2. Grouting under baseplates and soleplates will be done by others but this Contractor shall furnish supervision for grouting his equipment.
3. Concrete foundations will be provided by others for the boiler. This Contractor shall check all foundations and anchor bolts before concrete is poured and again before erection is started to assure himself that they are correct for his equipment.

B. Inspection and Check-Out

1. After erection is complete, inspect each component and sub-system for proper installation and operation.
2. Boil out the boiler and inspect it for cleanliness in the presence of the Owner's representative. The Owner will provide chemicals for boil out.
3. Pre-test the unit for capacity and performance prior to scheduling the Acceptance Test.

C. Acceptance Test

1. Notify the Engineer when the unit has been checked out, pre-tested and is ready for the Acceptance Test.
2. Test the boiler for compliance with the Guaranteed Performance in cooperation with the Engineer and the Owner. The Test procedure will be mutually agreed upon prior to the test.

3. Submit an ASME test form report together with calculations and laboratory analysis reports in three (3) copies.

D. Operation Prior to Acceptance

1. The Owner will provide fuel, feedwater, chemicals, etc. for operation during check-out, boil-out, pre-testing and Acceptance Test.
2. Operating personnel will be provided to assist the Contractor.
3. The Contractor will retain supervision responsibility for the safe and proper operation of the equipment until it is accepted by the Owner.
4. In the event that the Owner puts the unit into service prior to acceptance, he will assume responsibility.

E. Instruction

Instruct the plant personnel in all phases of operation, adjustment, lubrication and maintenance of the equipment so the Plant Superintendent is satisfied that they are qualified to assume the responsibility of the equipment.

ADDENDUM NO. 1
WASTE HEAT RECOVERY BOILER

PARTICULATE SIZE DISTRIBUTION (DEC. 75)

<u>Size Range (microns)</u>	<u>SCC to Boiler</u>
.25 - .5	0.012
.5 - 1	0.117
1 - 2	0.914
2 - 4	9.82
4 - 8	29.0
8 - 16	32.87
16 - 32	27.6
32 - 64	0.0
Over 64	0.0

Ash Fusion 2100°F

GENERAL DATA BETWEEN SCC AND BOILER

<u>Parameter</u>	<u>Dec. 75</u>
SCFM	8,274
Particulate (pounds/hr.)	76.3
% Carbon of Particulate	
Catch	63.0
SO _x (PPM)	1.2
NO _x (PPM)	192.0
COCl ₂ (PPM)	70.1
Grain Loading (Grains/SCF)	1.01

GASEOUS AND PARTICULATE POLLUTANTS AT THE SCC OUTLET, DEC. 75
(POUNDS/HOUR)

<u>Constituent</u>	<u>Gaseous</u>	<u>Particulate</u>
Va	0.019	0.028
HCl	4.01	5.04
HCN	0.01	0.0
Hg	0.0	0.0
Pb	0.0	0.83
Cd	0.0	0.12
Ni	0.0	0.81
Cu	0.0	0.075
Se	0.0	0.0
Zn	0.01	1.15
HF		0.02
C		45.2
Other		23.03
		<u>76.3</u>

UNIVERSITY OF MINNESOTA

PHYSICAL PLANT

MINNEAPOLIS, MINNESOTA

5.2.14

SPECIFICATIONS
FOR
WASTE HEAT BOILER
INDUCED DRAFT FAN AND DRIVE
FOR
GRID-CONNECTED INTEGRATED
COMMUNITY ENERGY SYSTEM

HELMICK & LUTZ COMPANY
ENGINEERS
1315 GLENWOOD AVENUE
MINNEAPOLIS, MINNESOTA 55405

DECEMBER, 1977

EQUIPMENT ITEM NO. 14

DIVISION 2

INDUCED DRAFT FAN AND DRIVE

GENERAL PROVISIONS

- A. Provide a complete induced draft fan system to transfer gas from the combined gas stream downstream of the waste heat boiler to the inlet of the gas cleaning system. This will include the fan, fluid coupling and motor drive.
- B. Include in the proposal all equipment necessary for a complete system.

OPERATING DATA

The system shall transfer gas at the rate of 55,000 ACFM at temperature of 460°F against a static pressure differential of 28 iwg.

INDUCED DRAFT FAN

Fan shall be heavy duty type designed for mechanical draft service.

Fan housing shall be constructed of 1/4" carbon steel plate, adequately braced. Housing shall be base angle supported and split for wheel removal. Drains shall be provided in the bottom of scroll. Inlet and outlet connections shall be flanged. Raised cleanout doors, bolt-up type, shall be provided in the inlet sections and fan wheel section. Doors shall be raised to accommodate external insulation. Cleanout doors shall have inserts which will provide a continuous internal scroll surface.

Rotating assembly shall be statically and dynamically balanced. Unit shall be designed to operate at overspeed conditions of 15%. Maximum speed shall be 1200 RPM. Shaft shall be extra heavy to keep deflection to a minimum. Shaft shall be double extended with flexible coupling on one end and coupling guard.

Wheels shall have blades formed from carbon steel plate, radial tip and a forward curved heel. Hub shall be heavy high grade cast iron or steel. To prevent erosion, blade liners, cut-away center plate, and side plate liners shall be used.

Independent bearing pedestals with a machined surface top and bottom shall be used. Machined sole leveling plates shall be provided. Bearing shall be sleeve oil-bath type, split, water cooled with all metal flexible connectors for supply and return water. Oil sight gauge with filler cup shall be provided.

Inlet dampers shall be of the heavy structural steel channel frame design with welded louvers supported by cold roll steel shafting. Louvers shall be balanced in the direction of opening. Inlet dampers for use with inlet boxes shall be arranged to spin the air in the direction of rotation of the fan. Bearings shall be prelubricated anti-friction or oil tight type mounted on steel plates attached to the exterior flange of the damper frame. Louver shafts shall be interconnected with heavy duty levers and linkages external to the duct.

All exterior surfaces shall be surfaced with Nelson NHP upset weld studs with speed clips at 9" horizontal and 12" vertical centers. Stud lengths shall be such that studs will not protrude from the insulation surface.

VARIABLE SPEED COUPLING

A variable speed type coupling shall be installed between the motor and the induced draft fan. The coupling shall be a fluid drive designed to transmit the power requirements at test block conditions. Unit shall be center supported and designed so as to give minimum vertical displacement between cold and hot conditions. Motor, variable speed coupling and bearing pedestals shall be supported on a common structural steel bed plate designed to maintain alignment. All control components required for adjusting fan speed in accordance with requirements of the control shall be furnished and installed. Sufficient space shall be provided on the output shaft of the coupling for a tachometer drive to indicate output shaft speed.

Coupling shall be American Blower, Nelson or approved equal.

MOTOR DRIVE

Motor shall be dripproof construction, induction type with Class B moisture and contamination resistant insulation. Electrical power supply is 3 phase, 60 cycle, 2300 volts. Acceptable manufacturers are Allis Chalmers, Electric Machinery, General Electric, Westinghouse or approved equal. Starters shall not be included. Drives shall have capacity to satisfy maximum fan requirements.

Fan Motors shall be furnished with 1" machined sole plates.

COUPLINGS

Flexible couplings complete with guards, between motors, variable speed drive and fan shall be Dodge Para-flex of the proper size to transmit load from the drive.

UNIVERSITY OF MINNESOTA

PHYSICAL PLANT

MINNEAPOLIS, MINNESOTA

5.2.15

SPECIFICATIONS

FOR

UNIT SUBSTATIONS

FOR

GRID-CONNECTED INTEGRATED
COMMUNITY ENERGY SYSTEM

HELMICK & LUTZ COMPANY
ENGINEERS

1315 CLEENWOOD AVENUE
MINNEAPOLIS, MINNESOTA 55405

JANUARY, 1978

EQUIPMENT ITEM NO. 15

DIVISION 2

UNIT SUBSTATIONS

SCOPE OF WORK

- A. Furnish two (2) unit substations as described below.
- B. Substations will be installed by Others.

2500 KVA UNIT SUBSTATIONS

A. Incoming Line Section

1. Incoming line section shall consist of two free-standing, metal-enclosed, stationary, 3-pole, 2-position load-break air interrupter NEMA Class A switches rated 600 amp. continuous, 3 phase, 60 hz., 15 KV; one set of primary fuses; and a transition section.
2. Switches shall be designed for operation on a 13.8 KV, 3 phase, 60 hz., grounded system. Switches shall have an interrupting capacity of 600 amp. at 13.8 KV, and shall close and latch against a 40,000 amp. RMS symmetrical fault current. BIL rating shall be a minimum of 95 KV. Visible air clearance between live parts when the switch is open shall be not less than six inches. Switches shall have an operations counter (Contractor shall set to zero before energizing the switch) visible from the front of the bay without the opening of any doors. Switches shall be hinged on the load side.
3. Fuses shall be hook stick disconnecting type and of minimum size which will withstand the transformer magnetizing inrush current, which will carry the transformer full load current continuously, and which will coordinate with the substation secondary breakers. Minimum fuse interrupting rating shall be 500 MVA, 30,000 amps asymmetrical at 13.8 KV. Fuses shall be S & C SM-5B or Westinghouse RBA-400, and shall be sized for minimum current rating based upon transformer inrush and coordination with the secondary breakers. Fuse mounting assemblies shall have individual insulating and isolating barriers between each assembly and between the assembly and the side of the compartment. Mounting assembly shall be hinged on the load side. Fuse mounting and arrangement shall permit fuse removal with a fuse handling tool.
4. One set of fuses, complete with fuse links, shall be mounted in the switchgear. One set of refills shall be furnished as spares.
5. Each switch shall be furnished with a single phase voltmeter and stationary mounted potential transformer with two primary fuses connected to the source side of the switch to indicate whether or not the feeder is energized.

B. Transforming Section

1. Transformer shall be rated 2500/3125/3500 KVA, 3 phase, 60 hz., 13.8 KV delta primary, 4160 volt wye secondary, self-cooled/forced-air-cooled (Class OA/FA), 55/65°C rise above an average of 30°C over a 24-hour period or 40°C maximum ambient temperature. Insulating liquid shall be oil.
2. Primary winding shall have 110 KV BIL and 14,400; 14,100; 13,800; 13,500; 13,200 volt taps. Secondary winding shall have 75 KV BIL, and the neutral shall be brought out to a bushing for connection to a grounding resistor.
3. Forced-air-cooling equipment, including liquid-temperature indicator-relay, hand-auto switch, control cabinet, fans and control wiring shall be furnished for connecting to Owner's 120 volt, single phase power supply.
4. Transformer primary and secondary shall have flanges for bolting to the incoming line and outgoing line sections respectively.
5. Standard features and accessories shall be furnished which shall include the following:
 - a. Base designed to permit rolling or skidding in any direction, including pulling eyes and provisions for jacking.
 - b. Ground pads.
 - c. Liquid-temperature indicator-relay with separate contacts for controlling the cooling fans and for an alarm.
 - d. Magnetic liquid-level gauge with alarm contacts.
 - e. Pressure-vacuum gauge.
 - f. Upper filter connection including 1" screw-end globe valve.
 - g. Drain valve - 2" screw-end globe valve.
 - h. Sampling valve - 3/8" device at liquid level.
 - i. Pressure test and gas sampling valve.
 - j. Manually operated tap changer (de-energized operation) with external handle which has provision for pad-locking.
 - k. Dial type thermometer.

6. The following transformer test and data sheets shall be furnished in quintuplicate:

- a. Standard factory tests.
- b. Nameplate rating.
- c. Impedance.
- d. Regulation at 0.8 and 1.0 power factor.
- e. Temperature rise.
- f. No-load and full-load losses.
- g. Magnetizing current inrush.
- h. Efficiency at 4/4, 3/4, 2/4, 1/4 load.
- i. Basic impulse levels or primary and secondary windings.

C. Alternate Transformer Liquid

Quote the price addition for providing a transformer insulated with a high fire point, self-extinguishing liquid such as silicone or RTE Corp. "RTE mp".

D. Outgoing Line Section

1. Outgoing line section shall consist of a group of factory-assembled, 4160 volt motor starters furnished and connected to the transformer by Others.
2. Transformer secondary shall have secondary terminals brought out the side and shall have flanges for connection to the above motor starters.

E. Neutral Grounding Resistor

Furnish a neutral grounding for separate mounting by Others. Resistor shall have a 400 amp., 10 second rating and shall be complete with safety screen enclosure.

1000 KVA UNIT SUBSTATION

A. Incoming Line Section

1. Incoming line section shall consist of two free-standing, metal-enclosed, stationary, 3-pole, 2-position load-break-air interrupter NEMA Class A switches rated 600 amp. continuous, 3 phase, 60 hz., 15 KV; one set of primary fuses; and a transition section.
2. Switches shall be designed for operation on a 13.8 KV, 3 phase, 60 hz., grounded system. Switches shall have an interrupting capacity of 600 amp. at 13.8 KV, and shall close and latch against a 40,000 amp. RMS symmetrical fault current. BIL rating shall be a minimum of 95 KV. Visible air clearance between live parts when the switch

is open shall be not less than six inches. Switches shall have an operations counter (Contractor shall set to zero before energizing the switch) visible from the front of the bay without the opening of any doors. Switches shall be hinged on the load side.

3. Fuses shall be hook stick disconnecting type and of minimum size which will withstand the transformer magnetizing inrush current, which will carry the transformer full load current continuously, and which will coordinate with the substation secondary breakers. Minimum fuse interrupting rating shall be 500 MVA, 30,000 amps asymmetrical at 13.8 KV. Fuses shall be S & C SM-5B or Westinghouse RBA-400, and shall be sized for minimum current rating based upon transformer inrush and coordination with the secondary breakers. Fuse mounting assemblies shall have individual insulating and isolating barriers between each assembly and between the assembly and the side of the compartment. Mounting assembly shall be hinged on the load side. Fuse mounting and arrangement shall permit fuse removal with a fuse handling tool.
4. One set of fuses, complete with fuse links, shall be mounted in the switchgear. One set of refills shall be furnished as spares.
5. Each switch shall be furnished with a single phase voltmeter and stationary mounted potential transformer with two primary fuses connected to the source side of the switch to indicate whether or not the feeder is energized.

B. Transforming Section

1. Transformer shall be rated 1000/1120/1288 KVA, 3 phase, 60 hz., 13.8 KV delta primary and 480Y/277 volt secondary with neutral bushing for resistance grounding; shall be oil-immersed, self-cooled/forced-air-cooled (Class OA/FA) rated with a winding temperature rise of 55/65°C by resistance above an average of 30°C over a 24-hour period or 40°C maximum ambient temperature; and shall be designed, constructed and tested in accordance with the latest applicable NEMA and ANSI Standards.
2. Forced-air-cooling equipment, including liquid-temperature indicator-relay, hand-auto switch, control cabinet, fans and control wiring shall be furnished for connecting to Owner's 120 volt, single phase power supply.
3. Primary winding shall have four approximately 2-1/2% rated KVA taps; two above and two below rated voltage.

4. Transformer shall be complete with standard accessories including the following:
 - a. Externally operated tap changer for de-energized operation.
 - b. Pressure relief device with visual mechanical alarm.
 - c. Filling and top filter press connection.
 - d. Pressure vacuum gauge.
 - e. Liquid level gauge with alarm contacts.
 - f. Dial-type liquid thermometer with separate control and alarm contacts.
 - g. Combination drain and lower filter press valve.
 - h. Pressure test valve.
 - i. Gas sampling valve.
 - j. Low voltage neutral bushing.
 - k. Diagrammatic nameplate.
 - l. Provisions for lifting.
 - m. Provisions for jacking.
 - n. Ground pad.
5. Transformer base shall be of fabricated steel construction suitable for use with rollers or for skidding in any direction. Flanges shall be provided for bolting to the incoming and outgoing line sections.

C. Alternate Transformer Liquid

Quote the price addition for providing a transformer insulated with a high fire point, self-extinguishing liquid such as silicone or RTE Corp. "RTE mp".

D. Outgoing Line Section

1. Outgoing line section shall consist of a line-up of low voltage, metal-enclosed, drawout air circuit breaker switchgear bolted directly to the secondary flange of the transforming section. A 1600 amp. main secondary and a total of six (6) feeder breakers of the manually operated drawout type, 600 amp. frame with 400 amp. current rating, long time and instantaneous trips, and 25,000 amp. RMS symmetrical interrupting rating when operating on a 460 volt, 3 phase, 60 hz. system shall be furnished.
2. All bussing shall have 600 volt insulation or shall be isolated with insulating barriers. Breaker load lugs shall be the only exposed, current-carrying part; and they shall be readily accessible from the rear of the switchgear.
3. A 10:5 amp. CT and meter relay with alarm contacts which close at approximately 5 amp. shall be furnished. The CT shall be a bar type with an accuracy class of 0.3 at a B-2 burden, and shall be

installed in the transformer neutral grounding connection. Meter shall be mounted in the meter section.

4. The top compartment of each breaker section shall be left blank for Owner's metering.
5. Main secondary metering only shall be furnished as follows:
 - a. AC ammeter and transfer switch.
 - b. Watthour meter with 30 minute demand register.
 - c. AC voltmeter and transfer switch.
 - d. All necessary PT's and/or CT's required on above metering.
6. Each feeder shall have ground detector CT(s) and relays as required for a feeder ground indicating light.
7. Each feeder breaker shall have lugs arranged for terminating 500 MCM cable entering from the top or bottom.
8. A breaker lifting device which traverses the full length of the switch-gear shall be furnished.

E. Neutral Grounding Resistor

A neutral grounding resistor shall be furnished for grounding the transformer secondary. Resistor shall be rated 10 amp. continuous and shall be mounted in the transition section.

F. Capacitors

Six 50 KVAR, 1 phase, 60 hz., 480 volt indoor, dustproof capacitor bank complete with individual terminal mounted indicating type fuses, internal discharge resistor, non-PCB insulating fluid, external grounding terminal and terminal compartment. Capacitors shall be connected in 100 KVAR per phase arrangement. Unit shall be free-standing wall or ceiling mounted; General Electric Type DPS, Westinghouse Type MDP, or approved equal. Capacitor bank will be connected to the secondary of the substation through the feeder breaker specified above.

GUARANTEES

All equipment and materials shall be guaranteed to be free from any and all defects in materials and workmanship, and to meet the performance specified for a minimum of one year from the date the equipment is placed in service, or 18 months from date of delivery, whichever occurs first.

UNIVERSITY OF MINNESOTA

PHYSICAL PLANT

MINNEAPOLIS, MINNESOTA

5.2.16

SPECIFICATIONS
FOR
METAL-CLAD SWITCHGEAR
FOR
GRID-CONNECTED INTEGRATED
COMMUNITY ENERGY SYSTEM

HELMICK & LUTZ COMPANY
ENGINEERS
1315 GLENWOOD AVENUE
MINNEAPOLIS, MINNESOTA 55405
JANUARY, 1978
EQUIPMENT ITEM NO. 16

DIVISION 2

METAL-CLAD SWITCHGEAR

SCOPE OF WORK

A lineup of 13.8 KV metal-clad switchgear shall be provided for installation by Others.

METAL-CLAD SWITCHGEAR

- A. Switchgear shall be indoor, metal-clad, drawout air circuit breaker equipment for operation on a 13.8 KV, 3 phase, 60 hz. system. Breakers shall have 500 MVA, 18,000 amp. RMS symmetrical interrupting capability. Breakers shall be DC close and DC trip using a stored energy operating mechanism. Main bus shall be rated 1200 amp. continuous with a bracing for above fault currents. Lineup shall consist of a generator breaker, two incoming line breakers, a bus tie breaker, two feeder breakers, a bus transition section, auxiliary sections as required, and a synchronizing panel.
- B. Generator breaker and auxiliary section shall include the following:
 - 1. 1200 ampere bus
 - 2. 1200 ampere air circuit breaker
 - 3. 3 relays, time overcurrent with voltage restraint
 - 4. 1 relay, ground backup
 - 5. 3 relays, generator differential
 - 6. 3 CT's, 800/5, phase
 - 7. 3 CT's, 2000/5, bus differential
 - 8. 3 CT's, 200/5, generator differential
 - 9. 1 CT, voltage regulator
 - 10. 2 PT, relay metering
 - 11. 1 PT, synchronizing
 - 12. 1 PT, voltage regulator sensing
 - 13. 1 PT, 1-1/2 KVA, voltage regulator supply
 - 14. 1 set surge capacitors, 3 phase
 - 15. 1 set station lightning arresters, 3 phase
 - 16. Circuit breaker control switch with two indicating lights
 - 17. 1 set of lugs for 2-500 MCM cables per phase
 - 18. AC ammeter and switch
 - 19. AC wattmeter
 - 20. AC varmeter
 - 21. AC KWH meter with 15 minute demand register, primary reading
 - 22. DC ammeter
 - 23. DC voltmeter
 - 24. Synchronizing switch

25. Breaker control switch and indicating lights

26. Space and drilling for:

- a. voltage regulator
- b. voltage regulator switch
- c. voltage regulator adjusting device
- d. field switch

C. Incoming line and auxiliary sections shall include the following

1. 1200 ampere bus
2. 1200 ampere air circuit breaker
3. 3 CT's, 600/5; phase relaying and metering
4. 3 CT's, 2000/5; bus differential
5. 1 window CT, 50:5 for 6 - 500 MCM, 15 KV cable
6. 1 PT, synchronizing
7. 1 set surge capacitors, 3 phase
8. 1 set station lightning arresters, 3 phase
9. Circuit breaker control switch with two indicating lights
10. Synchronizing switch
11. 1 set of lugs for 2 - 500 MCM cables per phase
12. 3 phase overcurrent relays with instantaneous trip (50/51)
13. 1 ground sensor relay (51G)
14. 3 directional overcurrent relays (67)
15. 1 directional ground relay (67G)
16. Undervoltage/overvoltage protection to detect phase-to-ground faults (27G/59G)
17. Underfrequency relay (81)
18. Provisions for interlocking with Power Co. breaker
19. AC ammeter and switch
20. Provisions for mounting following Power Co. metering equipment
 - a. 2 Pt's
 - b. 3 CT's
 - c. watthour meter
 - d. varhour meter

D. Bus tie breaker section shall include the following:

1. 1200 ampere bus
2. 1200 ampere air circuit breaker
3. 3 CT's, 600/5
4. Circuit breaker control switch with two indicating lights
5. AC ammeter and switch
6. Interlocking with two incoming line breakers

E. Bus transition section shall include the following:

1. 1200 ampere bus
2. 3 bus differential relays (87B)

3... Provisions only for mounting following Power Co. meters:

- a. totalizing watthour meter
- b. totalizing varhour meter
- c. recording demand meter

F. Feeder breaker sections shall include the following:

1. 1200 ampere bus
2. 1200 ampere air circuit breaker
3. 3 CT's, 300/5
4. 3 CT's, 2000/5, bus differential
5. 1 window CT, 50:5 for 3 - 500 MCM, 15 KV cables
6. 3 phase overcurrent relays with instantaneous trip (50/51)
7. 1 ground sensor relay (51G)
8. Circuit breaker control switch with two indicating lights
9. AC ammeter and switch
10. Watthour demand meter with 15 min. interval, primary reading
11. 1 set of lugs for 1 - 250 MCM cable per phase

G. Synchronizing panel shall include the following:

1. Swinging bracket
2. Synchroscope
3. 2 voltmeters
4. 2 synchronizing lights

GENERATOR GROUNDING RESISTOR

A. A 400 ampere, 10 second rated, cast grid resistor shall be furnished for installation by Others to ground the generator neutral.

B. Resistor shall include the following:

1. 1 CT, 100/5
2. Screened enclosure for indoor installation

SERVICE ENGINEER

A. Proposal shall include the services of an engineer who shall make a minimum of two trips to the switchgear installation.

B. The first trip shall be made to inspect the switchgear after it has been installed but before the field connections are insulated. Service engineer shall check to be sure the equipment is installed correctly, all equipment is aligned properly and that all bolted connections are of proper tightness.

- C. After the service engineer is satisfied that the switchgear is installed correctly, he shall check and adjust each air circuit breaker. Each breaker shall be checked and adjusted, if necessary, for proper alignment in the connected position.
- D. All relays shall be set according to the settings provided by the Owner, and the relays tested for proper operation.
- E. All meters shall be checked and adjusted, if necessary, to obtain proper operation.
- F. The intent is to have the service engineer make all checks and adjustments required to assure proper operation of the complete switchgear installation.

GUARANTEE

All equipment and materials shall be guaranteed to be free from any and all defects in materials and workmanship, and to meet the performance specified for a minimum of one year from the date the equipment is placed in service.

UNIVERSITY OF MINNESOTA

PHYSICAL PLANT

MINNEAPOLIS, MINNESOTA

5.2.17

SPECIFICATIONS

FOR

COAL HANDLING SYSTEMS

FOR

GRID-CONNECTED INTEGRATED
COMMUNITY ENERGY SYSTEM

HELMICK & LUTZ COMPANY
ENGINEERS

1315 GLENWOOD AVENUE
MINNEAPOLIS, MINNESOTA 55405

JANUARY, 1978

EQUIPMENT ITEM NO. 17

DIVISION 2

COAL HANDLING SYSTEMS

PART 1 - GENERAL

DESCRIPTION OF SYSTEMS

A. R.R. Car Unloading to Storage

Railroad cars will be emptied into a track hopper and the coal conveyed to a diverter spout, from which it will be conveyed to storage at either the Minneapolis Campus Heating Plant, or the S.E. Steam Plant. At the S.E. Steam Plant, fixed trippers will divert the coal to the outdoor storage bunker.

B. Reclaim from Outdoor Storage to Boiler Bunker

Coal will be reclaimed with vibrating draw down hoppers to feeders which deposit the coal on a belt conveyor. The belt conveyor will feed a vibrating feeder with grizzly. Oversized coal will pass thru a crusher to the bucket elevator. The minus 1-1/2" coal will bypass the crusher. The bucket elevator will discharge to either the belt conveyor over the top of the bunkers or to the belt conveyor which will discharge to a silo outside the building.

WORK BY OTHERS

A. General Construction

1. Concrete construction
2. Gallery from S.E. Steam Plant to Minneapolis Campus Heating Plant
3. S.E. Steam Building modifications
4. Truck load-out silo

B. Mechanical Construction

External water and air piping

C. Electrical Construction

1. Motor starters
2. External wiring

QUALITY ASSURANCE

Manufacturer shall be regularly engaged in the manufacture of coal conveying equipment and shall, upon request, submit a list of five successful project installations of comparable extent.

DESIGN CRITERIA

- A. R.R. car unloading to storage: 40, 100 ton bottom hopper cars in 10 hours.
- B. Reclaim to boiler bunkers: 100 ton per hour.
- C. Coal weight: 45 to 55 pounds per cubic foot.
- D. Equipment shall be designed and sized to start up under full load without damage to any component.
- E. Guards shall be provided as per OSHA requirements.

SUBMITTALS

A. With Proposal

- 1. General Arrangement drawings
- 2. Outline drawings of major equipment
- 3. Description of equipment and operation

B. For Approval Prior to Fabrication

- 1. Shop drawings showing complete details of construction and installation
- 2. Control Panel arrangement and wiring diagram

C. Manuals (6 copies)

- 1. Operations and maintenance instructions
- 2. Parts list

GUARANTEE

If, within one year after the date of Substantial Completion, any work is found to be defective or not in accordance with the Contract Documents, the Contractor shall correct or replace it immediately and bear all costs of same.

REQUESTED ALTERNATES

Provide automatic telescoping chutes in place of dust towers at S.E. Steam Plant storage bunker.

PART 2 - PRODUCTS

HOPPERS, CHUTES, DUST TOWERS, ETC.

- A. 1/4" minimum thickness, copper bearing steel (0.20%).
- B. Corners and seams to be continuously welded inside and ground smooth.
- C. Provide access doors or panels as required to service equipment.
- D. Provide abrasion resistant replaceable liners in chutes.

DRIVES

A. Motors

1. Totally-enclosed, fan-cooled (TEFC) or totally-enclosed, non-ventilated (TENV) explosion-proof for Class II, Division I, Group F location.
2. Two thermal protectors per motor to open motor starter control circuit for surface temperature limitation per U.L. and N.E.C. Motor nameplate shall be stamped with surface temperature identification number.
3. Squirrel cage induction type, NEMA Design B or Design C as required by equipment starting requirements.
4. 1.0 service factor, 40°C ambient.
5. Class B or Class F nonhygroscopic insulation system.
6. 460 volt, 3 phase, 60 hz., full voltage starting.
7. Two-bearing, direct coupled with grease-lubricated, shielded, regreaseable, vacuum degassed steel anti-friction bearings.
8. Oversized terminal box with gasketed cover.
9. General Electric, Reliance, U.S. Electrical Motors, Westinghouse, or approved equal.

B. Reducers

1. Shaft mounted, Falk Type J or Dodge Torque Arm
2. Load classification
 - a. Belt conveyors: Class II
 - b. Bucket elevator: Class III

C. V-Belts and Sheaves

1. Properly sized to match motor and reducer.
2. Sheaves shall be cast from gray iron.
3. Groove design and spacing to conform to ASA, MPTA and RMA Standards.

FEEDERS

- A. Vibrating type - Carman Adjust-A-Flow, S-A Vibraline II, or approved equal.

- B. Totally enclosed and dust tight with flanged connections to hoppers and conveyors.
- C. Unit feeding crusher and bucket elevator to have grizzly section at discharge end. Maximum size passed to be 1-1/4".
- D. Provide manufacturer's standard control arrangement for multi-feeder application with individual trim for each feeder. See paragraph 2.09 Controls for description of controls for total system.

BELT CONVEYORS

- A. Totally enclosed, dust tight with gasketing, rubber skirts, bottom clean-out panels, removeable top covers.
- B. Channel framework and support legs to floor beams.
- C. Idlers: 5" diameter rolls, CEMA III service, regreaseable tapered roller bearings, 20° trough.
- D. Belt: Fire resistant, USBM and MESA approved; B.F. Goodrich Flexseal with Coalseal covers, or approved equal.

BUCKET ELEVATOR

- A. Free standing with dust tight casing
- B. Split upper head section with abrasion-resistant liner
- C. Positive, screw-type foot-end take-up
- D. Discharge fitted with motorized flop gate

CRUSHER

- A. Ring type: Pennsylvania Type TK, Williams Type CACB, or approved equal
- B. Reduced size of coal to be 1-1/4" x 1/4"
- C. Approximate capacity: 50 TPH

DRAW DOWN HOPPERS

- A. Carman Industries, Inc. "Drawdown Hopper", Vibra Screw, Inc. "Storage Pile Activator", or approved equal
- B. Size: 10'-0" diameter
- C. Materials in contact with coal to be 3.16 S.S.

DUST CONTROL

- A. R.R. Car Unloading to Storage
 - 1. Chemical wetting agent system, Johnson-March Chem-Jet, or approved equal.

2. Spray jets required at track hopper and conveyor transfer points.
3. Spray jets at transfer points controlled by actuators that automatically detect the presence of materials.
4. System to include automatic proportioners and header controllers.
5. Distribution piping shall be mounted on conveyor frame where possible.

B. Reclaim to Boiler Bunker and Truck Load Out

1. Exhaust system with dust exhausted at all transfer points and a negative pressure maintained in the bunker during coal conveying.
2. Dust filter shall be a Carter-Day "RJ", or approved equal.
3. Air to cloth ratio: 5 cfm/sq. ft.
4. Collected dust to be discharged to No. 3 Boiler coal bunker.

CONTROL SYSTEMS

A. Provide complete control system for the two conveyor systems including panels, panel components and field components.

B. Description of Operation

1. R.R. Car Unloading to Storage

- a. System will be controlled from a graphic panel located at the Unloading Building.
- b. System shall be semi-automatic with sequential starting and stopping of conveyors to allow for all the coal to be purged from the system.
- c. Selector switches shall be used to allow the coal to flow to either the Minneapolis Campus Heating Plant or any one of the four fixed trippers at the S.E. Plant.
- d. Level control switches shall be mounted on the dust towers to automatically change the point of discharge or stop the conveyor system.

2. Reclaim to Boiler Bunker and Truck Load Out

- a. System will be controlled from a graphic panel located in the Boiler Control Room.

- b. System shall be semi-automatic with sequential starting and stopping of conveyors to allow for all the coal to be purged from the system.
- c. Selector switches shall be used to allow coal to flow from any one or a combination of draw down hoppers to any one fixed tripper over the boiler bunkers or to the truck load out silo.
- d. Level control switches shall be provided for placement in the bunker and silo to automatically change the point of discharge or stop the conveyor system.

2. Reclaim to Boiler Bunker and Truck Load Out

- a. System will be controlled from a graphic panel located in the Boiler Control Room.
- b. System shall be semi-automatic with sequential starting and stopping of conveyors to allow for all the coal to be purged from the system.
- c. Selector switches shall be used to allow coal to flow from any one or a combination of draw down hoppers to any one fixed tripper over the boiler bunkers or to the truck load out silo.
- d. Level control switches shall be provided for placement in the bunker and silo to automatically change the point of discharge or stop the conveyor system when bunker is full.

C. Components

1. Graphic Control Panels

- a. NEMA 1 enclosure with gasketed rear door(s).
- b. Free-standing with internal light and switch.
- c. Light gray textured polyurethane exterior and white interior.
- d. White enamel graphics.
- e. Deluxe molded indicator lights with bayonet base, 120 volt incandescent lamp, phenolic housing, polished chrome finish, 1/2" diameter lens, screw lugs and front mounting. Lens color as required to indicate equipment status.
- f. Heavy duty, oil tight, 600 VAC, 10 amp. continuous, momentary contact pushbuttons. Black start operators. Red stop

operators or illuminated pushbutton with red lens. 120/6 volt transformer type indicating lights with appropriate colored lens. Allen-Bradley, General Electric, Westinghouse, or approved equal.

- g. Enclosed plug-in relays with 10 amp. contacts and octal base with screw terminals for interlocking and control functions; Deltrol Series 105, Potter and Brumfield KRP Series, Struthers and Dunn A314 Frame, or approved equal. A single auxiliary contact will be provided on each motor starter for control interlocking.
 - h. Timers and timing relays as required; Agastat pneumatic, Potter and Brumfield solid state, or approved equal.
 - i. Switchboard ammeters with taut band suspension, 1% accuracy, 250 degree scale and 4-1/2" square case; General Electric Type AB-40 or Westinghouse Type KA-241.
 - j. Engraved laminated plastic nameplates, attached with screws, to identify all control devices such as pushbuttons, ammeters, relays and timers.
 - k. Annunciator with "first out" indication to alarm a stopped conveyor, tripper problem, bunker levels, etc.; Panalarm Series 10, Model 11 with AS sequence and Magna-Plac nameplates, or approved equal.
 - l. Wiring in plastic wiring duct, Panduit "Panduct", or approved equal.
 - m. Sleeve type wire markers at each end of every wire which corresponds to wire number on control schematic.
 - n. Terminal strips with 15% spare terminals for terminating all field wiring.
- 2. Motion switches with NEMA Type 7 & 9 enclosure for Class II, Group F hazardous location; Allen-Bradley Bulletin 808 or approved equal, connected to the tail pulley of each conveyor and elevator for interlocking and alarm.
 - 3. Rotating level control switches with explosion-proof enclosure for Class II, Group F hazardous location, Bindicator "Roto-Bin-Dicator", or approved equal, for level control and alarm.

PAINTING

All equipment except factory finished items, shall receive one coat of a rust inhibitive primer, Mobil Chemical Co., Zinc Chromate Primer 13-R-52, or approved equal.

PART 3 - EXECUTION

INSTALLATION

- A. Erect all equipment in accordance with the manufacturer's approved shop drawings.
- B. Lubricate all equipment requiring lubrication. Owner will furnish lubricants.

SERVICE ENGINEER

- A. Inspect each component after erection to verify that it is properly erected, aligned, lubricated, etc., and is ready to run.
- B. Run the system to make final adjustments and verify that the system meets the specifications.
- C. Instruct the plant personnel in all phases of operation.

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UNIVERSITY OF MINNESOTA

PHYSICAL PLANT

MINNEAPOLIS, MINNESOTA

5.2.18

SPECIFICATIONS
FOR
OVERHEAD TRAVELING CRANE
FOR
GRID-CONNECTED INTEGRATED
COMMUNITY ENERGY SYSTEM

HELMICK & LUTZ COMPANY
ENGINEERS
1315 GLENWOOD AVENUE
MINNEAPOLIS, MINNESOTA 55405
JANUARY, 1978
EQUIPMENT ITEM NO. 18

DIVISION 2

OVERHEAD TRAVELING CRANE

1. GENERAL

Bidders shall be manufacturers who repetitively build cranes and who maintain a service department and spare parts inventory.

2. SCOPE

This specification covers furnishing one service crane, complete with bridge, trolleys, hoists, controls, bridge conductors and incinerator grapple.

2. INTENT

The crane quoted shall be a top running, manufacturer's standard "low profile" design with bridge mounted electric controls, access walkways, rear service platform and remote radio controls. All bridge mounted conductors shall be enclosed "Insul-8" type or equal. Runway conductors will be similar type furnished and installed by Others.

All hoists shall be two-speed design with the lowest standard lift speeds for each sized hoist. Low speed hoist rating shall be 10 fpm and respective high speed rating shall be 30 fpm.

Trolley and bridge speeds should not exceed 75 fpm for trolleys and 125 fpm for bridges.

Electric power service will be 3 phase 60 hertz 460 volts. All electric brakes shall be rectified DC type. In addition to electric braking, each hoist shall have a Weston type mechanical load brake.

4. CONTROLS

Crane shall be controlled by remote radio from a control room located at the center of the runway.

5. CRANE RUNWAY

Crane rail and support beams will be furnished and installed by Others.

Crane span is plus or minus one foot depending on ultimate column design and clearance requirements of the crane. All clearance requirements shall be shown in the proposal.

6. SCHEDULE OF CRANES

No. 1 Crane

Capacity - 10 T
Trolleys - 2 @ 10 T
Span - 32 Ft.
Lift - 75 Ft.
Runway - 80 Ft.

CMAA Class D Service

Incinerator Grapple Capacity - 6 Yds.

5.2.19

MAJOR EQUIPMENT
SELECTIONS
AND

PROPOSAL TABULATIONS

EQUIPMENT SELECTIONS

Equipment Item No. 2 - Baghouse System

The Equipment bid by ICA is being used at this time for the following reasons:

- A. The University and Helmick & Lutz have firsthand knowledge of the ICA equipment and are satisfied that the equipment offered is of the quality desired.
- B. The price quoted includes insulation and ICA has quoted an erection cost. These additional cost figures are more accurate than the Engineer's estimate.

The University and Helmick & Lutz plan to further review the other two Vendor's equipment to evaluate their design features and quality before equipment purchase. Price adjustments will be made to bring the various quotes to a common base.

Equipment Item No. 3 - Baghouse I.D. Fan

The equipment bid by Westinghouse is recommended. Although their bid was not low, the higher efficiency provides a reasonable payback time on the higher initial cost.

Equipment Item No. 4 - Boiler Feed Pumps

The equipment bid by Ingersoll-Rand is being used at this time. The low bidder proposes a different basic design which is unfamiliar to the University and Helmick & Lutz. A further review of this design will be made prior to equipment purchase to determine the acceptability of the low bid.

Equipment Item No. 5 - Water Softening System

The equipment bid by Cochrane is being used at this time. The low bid is being reviewed by the Vendor because it appears to be in error.

Equipment Item No. 6 - Condensate Treating System

The equipment bid by Cochrane is recommended because of firsthand knowledge of this Vendor's equipment.

Equipment Item No. 7 - Deaerating Heater

The equipment bid by Chicago Heater is recommended because it meets the Specifications and is the lowest price.

Equipment Item No. 8 - Continuous Blowoff System

The equipment bid by Environmental Dynamics is recommended because it meets the Specifications and is the lowest price.

Equipment Item No. 9 - Air Compressor

The equipment bid by Ingersoll-Rand is recommended because it is the lowest price which meets the Specifications.

Equipment Item No. 10 - Pressure Reducing and Desuperheating Stations

The pressure reducing valves bid by Masoneilan are recommended. The desuperheating systems bid by Bailey are recommended. These are the lowest price items.

Equipment Item No. 11 - Pressure Relief Valves

The equipment bid by Consolidated is recommended because it is the lowest price.

Equipment Item No. 14 - Waste Heat Boiler I.D. Fan

The equipment bid by Westinghouse is recommended. Although their bid was not low, the higher efficiency provides a reasonable payback time on the higher initial cost.

UNIVERSITY OF MINNESOTA
GRID ICES

BAGHOUSE SYSTEM
EQUIPMENT ITEM NO. 2

Vendor Bid	Zurn		ICA		Mikropul	
	Base	Alt.	Base	Alt.	Base	Att.
No. of Modules	8	11	10	13	10	14
Bags/Module	168	168	128	128	143	143
Total Bags	1344	1848	1280	1664	1430	2002
Effective Area/Bag, ft. ²	50	50	50	50	46	
Total Effective Area, ft. ²	67,200	92,400	64,000	83,200	65,900	92,252
Reverse Air Flow, ACFM	12,600	12,600	9,600	9,600	14,000	14,000
A/C Ratio-Normal	2.0/1	1.96/1	2.11/1	2.18/1	2.05/1	1.96/1
A/C Ratio-Cleaning	2.5/1	2.5/1	2.5/1	2.48/1	2.27/1	2.11/1
Weight/Module, #	25,900	25,900			19,500	19,500
Weight-Inlet Manifold, #	26,320	38,540			8,000	11,200
Weight-Out Manifold, #	3,360	4,920			13,000	18,200
Weight-Rev Manifold, #	3,360	4,920			Inc. Above	Inc. Above
Weight-Fan, #	1,300	1,300			2,200	2,200
Weight-Total, #	250,000	340,500	420,000	546,000	246,000	344,400
▲ P-Normal, in	2-4	2-4	4.5/6.0	4.5/6.0	8	8
▲ P-Cleaning, in	6.0	6.0			8	8
Price	\$409,889	\$547,688	\$560,000	\$725,000	\$336,549	\$448,261
Erection			\$190,000	\$235,000		
Remarks			Includes Insulation Includes Add'l Controls Testing Not Included			

HELMICK & LUTZ COMPANY
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January 24, 1978

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BAGHOUSE I.D. FAN
EQUIPMENT ITEM NO. 3

Vendor	Zurn		Buffalo		Westinghouse	
Bid	Base	Alt.	Base	Alt.	Base	Alt.
Model	3150	3150	H-36	H-26	9000	9000
Size	16RT	17RT	1085	1460	9066	9081
Wheel Dia.	64.505	68.273	57.75	73.5	67.65	82.75
RPM	884	885	1180	880	880	705
BHP - Full Load	287	418	377	484	277	361
BHP - Design	392	569	434	561	381	498
Motor Mfg.	Reliance	Reliance	GE	GE	West.	West.
Frame					5808L	5810L
HP	400	600	450	600	400	500
Coupling Mfg.	Falk	Falk	Falk	Falk	Fast	Fast
Coupling Size	T-10-100T	T-10-110T	100T10	120T10	4-1/2FS	5FS
Weight, Fan, #	13085	17260	13285	22439	25204	35550
Weight, Damper, #	1623	1623	---	---	---	---
Weight, Motor, #	4500	5780	3250	5900	4100	5100
Price	\$44,983	\$53,566	\$50,016	\$67,563	\$58,222	\$84,177

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BOILER FEED PUMPS
EQUIPMENT ITEM NO. 4

Vendor	Worthington	I-R	Byron Jackson
Model	WDR32-6	2CNTA-6	2x4x13
Type	---	4x2-1/2	GSJH
Stages	6	6	2
HP @ Rate	130	136	171
Max HP	178	146	210
Speed, RPM	3550	3550	3550
Min Flow, gpm	22	35	100
Motor Mfg.	GE or Equal	---	Louis Allis
Frame	444TS	405TS	444TS
HP	200	150	200
Coupling Mfg.	Falk	Waldron	Fast
Coupling Size		1-1/2W	BS
Weight - Pump & Base, #	1919	2950	2560
Weight - Motor, #	1079	926	1190
Price for 3 Pumps	\$25,512	\$45,840	\$51,018

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WATER SOFTENING SYSTEM
EQUIPMENT ITEM NO. 5

Vendor	Environmental Dynamics	Cochrane
Softener Size	108" Dia. x 38 Ft.	114" Dia. x 38 Ft.
Softener Weight, #	20,000	19,000
Filters	3	3
Zeolites	3	3
Accessories	Make-Up Valve Level Controller Float Trap Lime System Sludge Pump	Sludge Pump Make-Up Valve & Controls Overflow Valve & Controls Lime System Booster Pump
Price	\$ 36,230	\$101,975

CONDENSATE TREATING SYSTEM
EQUIPMENT ITEM NO. 6

Vendor	Environmental Dynamics	Cochrane
No. Units	3	3
Resin/Unit, ft. ³	38	48
Weight, #	18,000	15,000
Price	\$34,290	\$39,005

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DEAERATING HEATER
EQUIPMENT ITEM NO. 7

Vendor	Chicago Heater	Environmental Dynamics	Cochrane
Type	Spray	Tray	Spray/Tray
Vent Condenser	Internal		Internal
Stg. Tk. Dia., in.		102	120
Stg. Tk. Length, ft.		24	22-1/4
Dry Weight, #	13,700	20,200	28,580
Opr. Weight, #	92,000		
Flooded Weight, #	110,800		130,280
Price	\$25,775	\$41,842	\$30,784

CONTINUOUS BLOWOFF SYSTEM
EQUIPMENT ITEM NO. 8

Vendor	Environmental Dynamics	Madden	Cochrane
Model	36" D x 48" H	HC-160-150	36" D x 62" H
Heat Exchanger	Bell & Gossett	Internal	Model 8180-2
Accessories Included	Pressure Gauge	Pressure Gauge	Pressure Gauge
	Thermometer	Gauge Glass	Gauge Glass
	Gauge Glass	Relief Valve	Relief Valve
	Relief Valve	Drain Valve	
	Drain Valve	Level Controller	
	Level Controller	Gauge Panel	
		Float Switch	
		Hi Level Alarm	
Price	\$4,525	\$8,143	\$5,311

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AIR COMPRESSOR
EQUIPMENT ITEM NO. 9

Vendor	Kellogg (Clayhill)	Ingersoll- Rand (Air Power)	Worthington (Federal Air)	Chicago Pneumatic (Clayhill)	Worthington (Van Bergen & Markson)
Model	BW4D	ESV	VBB	T80-82	VBB
Size		9 x 7	9 x 7	10 x 9	9 x 7
RPM	460	514	472		
Motor HP/RPM	40/1800	40/1800	40/1800	50/1800	50
Intake Filter		IR	Doll. or Air Maze		
Aftercooler		IR			Adams
Air Dryer	Arrow	Air Tek	Hank.	Arrow	Pneuma
Receiver Size			200 gal.		120 gal./16 ft. ³
Comp Wt, #	2,000			3,400	2,560
Motor Wt, #	425			450	525
Acc Wt, #	300			300	250
Separator, #					400
Air Receiver, #	350			350	285
Dryer, #	450			450	500
Price	\$13,505	\$15,863	\$16,122	\$16,833	\$18,988
Remarks	Numerous Exceptions			Horizontal Cylinders	Service Not Included

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PRESSURE REDUCING AND
 DESUPERHEATING STATIONS
 EQUIPMENT ITEM NO. 10

PRV-1/DSH-1

PRV Vendor	Masoneilan	Fisher	Masoneilan	Fisher	Yarway
Price	\$11,095	\$13,835	\$11,095	\$13,835	Combination
DSH Vendor	Bailey	Bailey	Yarway	Yarway	PRV/DSH
Price	\$ 3,116	\$ 3,116	\$ 6,353	\$ 6,353	\$47,558
Station Price	\$14,211	\$16,951	\$17,448	\$20,188	\$47,558

PRV-2/DSH-2

PRV Vendor	Masoneilan	Fisher	Masoneilan	Fisher	Yarway
Price	\$11,095	\$13,464	\$11,095	\$13,464	Combination
DSH Vendor	Bailey	Bailey	Yarway	Yarway	PRV/DSH
Price	\$ 3,098	\$ 3,098	\$ 6,353	\$ 6,353	\$33,169
Station Price	\$14,193	\$16,562	\$17,448	\$19,817	\$33,169

PRV-3

Vendor	Masoneilan	Fisher	Fisher
Price	\$ 2,749	\$ 3,136	\$ 4,280

DSH-3

Vendor	Bailey	Yarway
Price	\$ 6,232	\$ 6,353

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PRESSURE RELIEF VALVES
EQUIPMENT ITEM NO. 11

Vendor	Atwood & Morrill	Consolidated (Grinnell)	Consolidated (Simone)
SV-1			
No. of Valves	3	6	(Quoted Same As
Size, in.	10 x 12	6 x 10	Grinnell At Approx.
Weight, Ea., #	975	550	The Same Price)
Price, Ea.	\$ 6,740	\$ 4,642	
Station Total	\$20,220	\$ 9,284	
SV-2			
Same As SV-1	\$20,220	\$ 9,284	
SV-3			
No. of Valves	1	2	
Size, in.	18	8 x 10	
Weight, Ea., #	1500	620	
Price, Ea.	\$10,934	\$ 5,371	
Station Total	\$10,934	\$10,742	
SV-4			
Same As SV-3	\$10,934	\$10,742	

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WASTE HEAT BOILER I.D. FAN
EQUIPMENT ITEM NO. 14

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Vendor	Buffalo	Westinghouse	Zurn
Model	H-12	TVRT-3	1250
Size	1615	81	178xLR
Wheel Dia.	84.75	---	---
RPM	1128	1130	1178
BHP - Full Load	352	311	446
BHP - Design	---	---	500
Motor Mfg.	GE	West.	AC
Frame		5008L	587US
HP	400	350	500
Voltage	2300	2300	4160
Clutch Mfg.	Nelson	Nelson	Nelson
Model	PM4-590-AA1	PM4-590-AA1	PM4-685-AA1
Full Load Slip, %		5.8	2.4
Coupling Mfg.	Dodge	Fast	Falk
Size	Paraflex		T-10-90T
Fan, Wt., #	8900		25,888
Motor Wt., #	3250		5,500
Clutch Wt., #	3600		4,800
Price	\$52,705	\$66,205	\$92,868

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January 24, 1978

CAPITAL BUDGETOPTION I ADD-ON TUNNEL

The following material represents the 1978 capital budget for tunnel construction for adding on St. Mary's, Fairview and Augsburg to the University's West Bank steam distribution system.

CAPITAL BUDGET1. Contract Costs

a. Concrete lined tunnel in sandstone 7.5 W x 7.75 H - 1,265 L.F. at \$450/L.F.	\$569,250
b. Expansion Chambers - 4 at \$20,000	80,000
c. Shaft at St. Mary's Hospital - 60" I.D., 93 ft at \$870/L.F.	80,910
d. Meter chamber at top of shaft	35,000
e. Tunnel lighting and power - 12,65 L.F. at \$25/L.F.	31,625
f. Drill hole	12,000
g. Contingencies @ 5%	<u>40,440</u>
Total Contract Costs	\$849,225

2. Non-Contract Cost

a. Design	\$ 11,323
b. Construction Management	16,175
c. Site Restoration	<u>10,000</u>
Total Non-Contract Costs	<u>\$ 37,498</u>
Total Construction Costs	<u><u>\$886,723</u></u>

These costs reflect an escalation factor (7%) for the time of construction into 1979.

CAPITAL BUDGETBUILDING RETROFIT TO HOT WATER DISTRIBUTION

The following Table 1 presents the capital budget required to retrofit existing University buildings from an existing steam distribution system to a hot water distribution system. The buildings outlined are presently heated with hot water systems internally utilizing steam-to-hot water converters on the existing system.

TABLE 1.

HOT WATER DISTRIBUTION - BUILDING CONVERSION CAPITAL BUDGET COSTS - 1978

<u>Equipment</u>	<u>Conversion Costs</u>		<u>Total</u>
	<u>Material</u>	<u>Labor</u>	
<u>Building #208 Sanford Hall</u>			
- Btu Meters, Flow Meters, Totalizer	\$ 4,600	\$ 1,000	
4 - New Converters	8,000	10,000	
3 - New H.W. Heaters	15,000		
7 - New Pumps	4,500		
Controls	15,400		
Pipe, Bkts. Ftgs.	500		
Insulation	400		
Total	<u>\$48,400</u>	<u>\$11,000</u>	\$59,400
<u>Building #201 Business Administration Building</u>			
- Btu Meters, Flow Meters, Totalizer	\$ 4,600	\$ 1,000	
5 - New Converters	10,000	8,000	
5 - New Pumps	3,000		
Controls	11,000		
Pipe, Bkts. Ftgs.	1,200		
Insulation	900		
Total	<u>\$30,700</u>	<u>\$ 9,000</u>	\$39,700
<u>Building #202 Social Science</u>			
- Btu Meters, Flow Meters, Totalizer	\$ 4,600	\$ 1,000	
4 - New Converters	8,000	7,000	
4 - New Pumps	2,400		
Controls	8,800		
Pipe, Bkts. Ftgs.	1,600		
Insulation	900		
Total	<u>\$26,300</u>	<u>\$ 8,000</u>	\$34,300
<u>Building #203 Blegen Hall</u>			
- Btu Meters, Flow Meters, Totalizer	\$ 4,600	\$ 1,000	
2 - New Converters	4,000	4,000	
2 - New Pumps	1,200		
Controls	4,400		
Pipe, Bkts. Ftgs.	600		
Insulation	500		
Total	<u>\$15,300</u>	<u>\$ 5,000</u>	\$20,300
<u>Building #204 Wilson Library</u>			
- Btu Meters, Flow Meters, Totalizer	\$ 4,600	\$ 1,000	
1 - New Converter	2,000	4,500	
1 - New H.W. Heater	5,500		
2 - New Pumps	1,200		
Absorber Alterations	30,000	15,000	
Controls	4,400		
Pipe, Bkts. Ftgs.	1,000		
Insulation	600		
Total	<u>\$49,300</u>	<u>\$20,500</u>	\$69,800

Equipment	Conversion Costs		Total
	Material	Labor	
<u>Building #205 Anderson Hall</u>			
- Btu Meters, Flow Meters, Totalizer	\$ 4,600	\$ 1,000	
4 - New Converters	8,000	5,500	
4 - New Pumps	2,400		
Controls	8,800		
Pipe, Bkts. Ftgs.	850		
Insulation	650		
Total	<u>\$25,300</u>	<u>\$ 6,500</u>	\$31,800
<u>Building #207 Willey Hall</u>			
- Btu Meters, Flow Meters, Totalizer	\$ 4,600	\$ 1,000	
1 - New H.W. Heater	5,500	2,500	
1 - New Pump	600		
Absorber Alterations	10,000	4,000	
Controls	2,200		
Pipe, Bkts. Ftgs.	900		
Insulation	700		
Total	<u>\$24,500</u>	<u>\$ 7,500</u>	\$32,000
<u>Building #208 Middlebrook Hall</u>			
- Btu Meters, Flow Meters, Totalizer	\$ 4,600	\$ 1,000	
1 - New Converter	11,000		
5 - New H.W. Heaters	28,500	11,000	
12 - New Pumps	7,200		
Absorber Alterations	10,000	4,000	
Controls	26,400		
Pipe, Bkts. Ftgs.	1,050		
Insulation	800		
Total	<u>\$89,550</u>	<u>\$16,000</u>	\$105,550
<u>Building #209 Rarig Center</u>			
- Btu Meters, Flow Meters, Totalizer	\$ 4,600	\$ 1,000	
3 - New Converters	6,000	6,000	
1 - New H.W. Heater	5,500		
4 - Pumps	2,400		
Absorber Alterations	10,000	4,000	
Controls	8,800		
Pipe, Bkts. Ftgs.	350		
Insulation	700		
Total	<u>\$38,350</u>	<u>\$11,000</u>	\$49,350
<u>Building #211 Law Building</u>			
- Btu Meters, Flow Meters, Totalizer	\$ 4,600	\$ 1,000	
1 - New Converter	2,000	4,500	
1 - New H.W. Heater	5,500		
2 - New Pumps	1,200		
Absorber Alteration	20,000	8,000	
Controls	4,400		
Pipe, Bkts. Ftgs.	950		
Insulation	900		
Total	<u>\$39,550</u>	<u>\$13,500</u>	\$53,050

<u>Equipment</u>	<u>Conversion Costs</u>		<u>Total</u>
	<u>Material</u>	<u>Labor</u>	
<u>Building #122 - Kolthoff Hall</u>			
- Btu Meters, Flow Meters, Totalizer	\$ 4,600	\$ 1,000	\$ 5,600
Total	\$391,858	\$109,000	\$500,850
Engr. and Cont. @ 12%			60,100
Total Construction (Option III) - 1978			\$560,950

TWIN CITY **TRANE** SERVICE CO.

8030 CEDAR AVENUE SOUTH • BLOOMINGTON, MINNESOTA 55420

PHONE: (612) 853-1732

April 12, 1978

University of Minnesota
Physical Plant
Room 200 Shops Building
Minneapolis, Minnesota 55455

Attn: Mr. Stan Borys

Subject: Conversion of Trane Steam Absorption Machines
for Hot Water Energy Source:

Gentlemen:

At your request to Mr. Robert O'Brien we are pleased to submit this proposal to convert Trane Absorption Chillers for Hot Water Energy Source Operation.

The following will be provided by us:

- A. Change concentrator steam boxes to hot water boxes.
- B. Install rupture disk pressure relief safety device.
- C. Furnish and install necessary controls and calibrate same.
- D. Restart and check operation of unit.

Not included:

- A. Hot water control valves.
- B. Steam, condensate, hot water piping modifications.
- C. Hot water pump, controls, interlock wiring, pneumatic temperature control changes external to Trane panel.

* Model A machines requiring only one water box.....
total cost \$11,250 per machine

* Model A machines requiring two water boxes.....
total cost \$19,400 per machine

4-12-78

* Model B machines.....total cost \$8,250 per machine

We look forward to being of service to you on the modification of your units.

Very truly yours,

TWIN CITY TRANE SERVICE COMPANY

Joseph G. Skach
Service Manager

JGS:bk