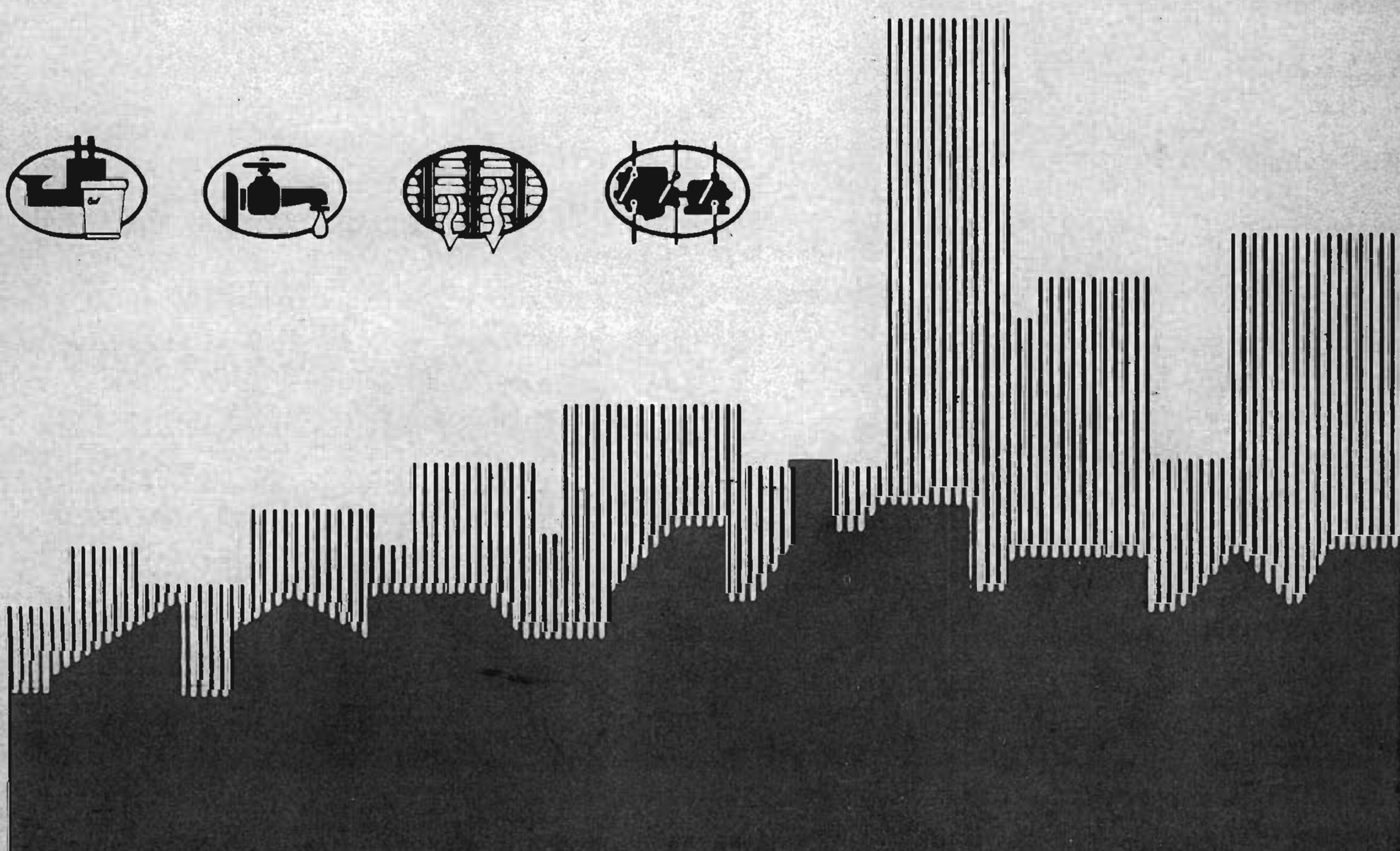
U.S. Department of Housing and Urban Development
Office of Policy Development and Research

Preliminary Design Technical Report MIUS Demonstration Project St. Charles, Maryland

September 1978

HUD/MIUS
Modular Integrated Utility System

Volume 1
Appendices A to E
Book 2 of 2



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HUD Grant No. H-2501-RG
Developer: Interstate Land
Development Co., Inc.
St. Charles, Maryland

NOTE: *This Book Includes APPENDICES A To E / Book 2 Of 2 / For SECTIONS See Book 1 Of 2*

CONTENTS

CONTENTS (Cont)

APPENDIX A - COMMUNITY DEFINITION

The MIUS site consists of a mix of residential, commercial and institutional buildings. Drawings of the buildings and utilities description are presented on the following pages.

A.1 Buildings and Utilities Description

FIGURE A-1. WAKEFIELD TERRACE APARTMENTS

WAKEFIELD TERRACE APARTMENTS/DESCRIPTION

Wakefield Terrace consists of six (6) buildings with a total of two hundred five (204) dwelling units. Each building is conceived as brick buildings of contemporary design with the major wing being four (4) stories and a small wing of three (3) stories. There will be two (2) entrance stairways to a central double loaded corridor for access to each apartment.

Wakefield Terrace provides a total of 238,000 sq. ft. of living space attractively apportioned between one, two and three bedroom apartments as follows:

One Bedroom	-	24 Units
Two Bedroom	-	156 Units
Three Bedroon	-	24 Units

Wakefield Terrace is scheduled for completion by September 1978, with initial occupancy scheduled for May 1978.

(NOTE: Refer to Building Sketch, Figures A-1, A-2, A-3)

Wakefield Terrace Apartments Mechanical and Electrical/Conventional Design

The mechanical rooms for each apartment are vertically aligned and located on exterior walls. Major items of equipment include the following:

Domestic Hot Water - Electric Water Heaters similar to Wakefield Hi-Rise.

Heating and Air Conditioning Equipment - Electric air source heat pump.

Other facilities in each apartment - electric washer/dryer, electric range, and garbage disposal in the kitchen sink.

Wakefield Terrace Apartments Mechanical and Electrical/MIUS System

Domestic Hot Water - Eliminate the electric water heaters and install a central domestic hot water heating system in the basement of each building, similar to Wakefield Hi-Rise.

Heating and Air Conditioning Equipment - Eliminate electric air source heat pumps and provide fan coil units for heating and cooling with hydronic piping.

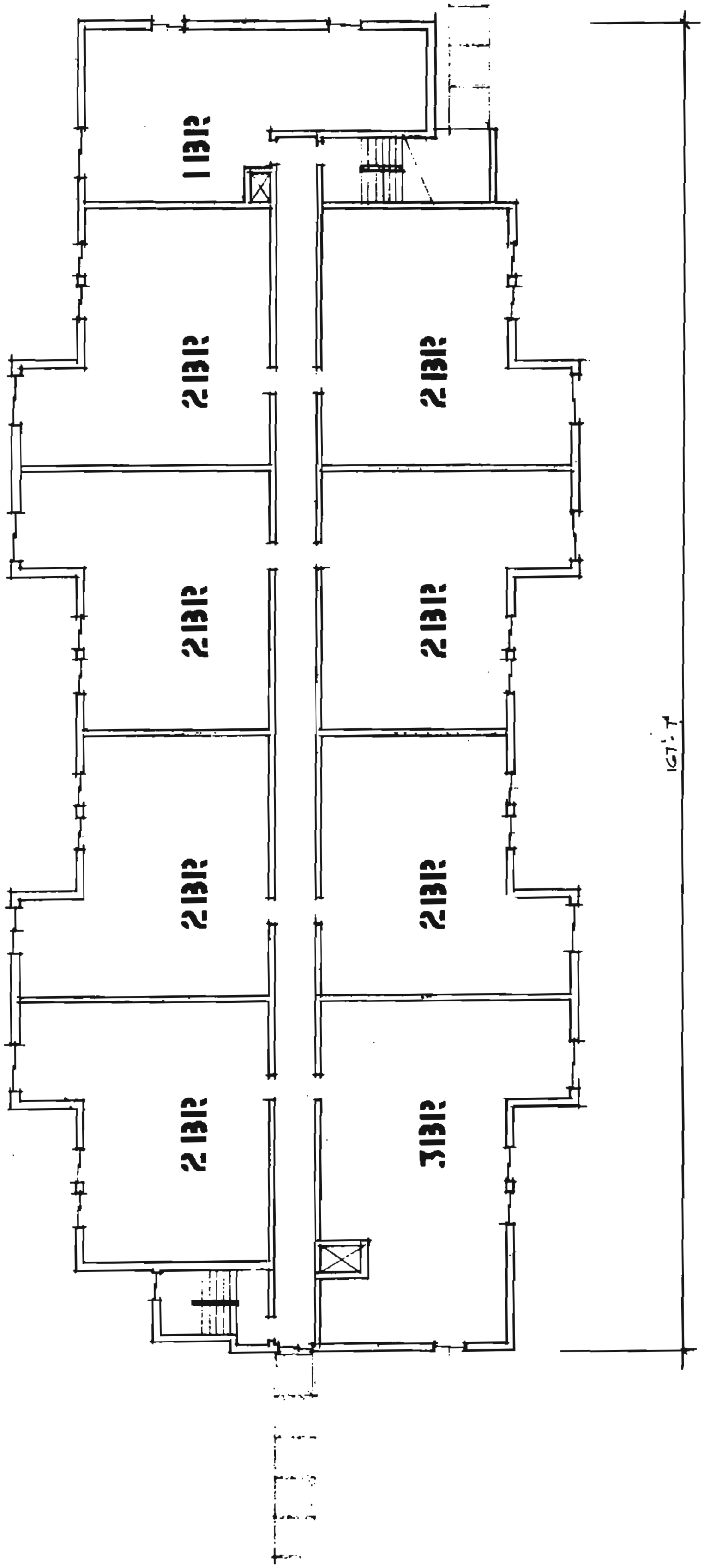


FIGURE A-2. WAKEFIELD TERRACE APARTMENTS

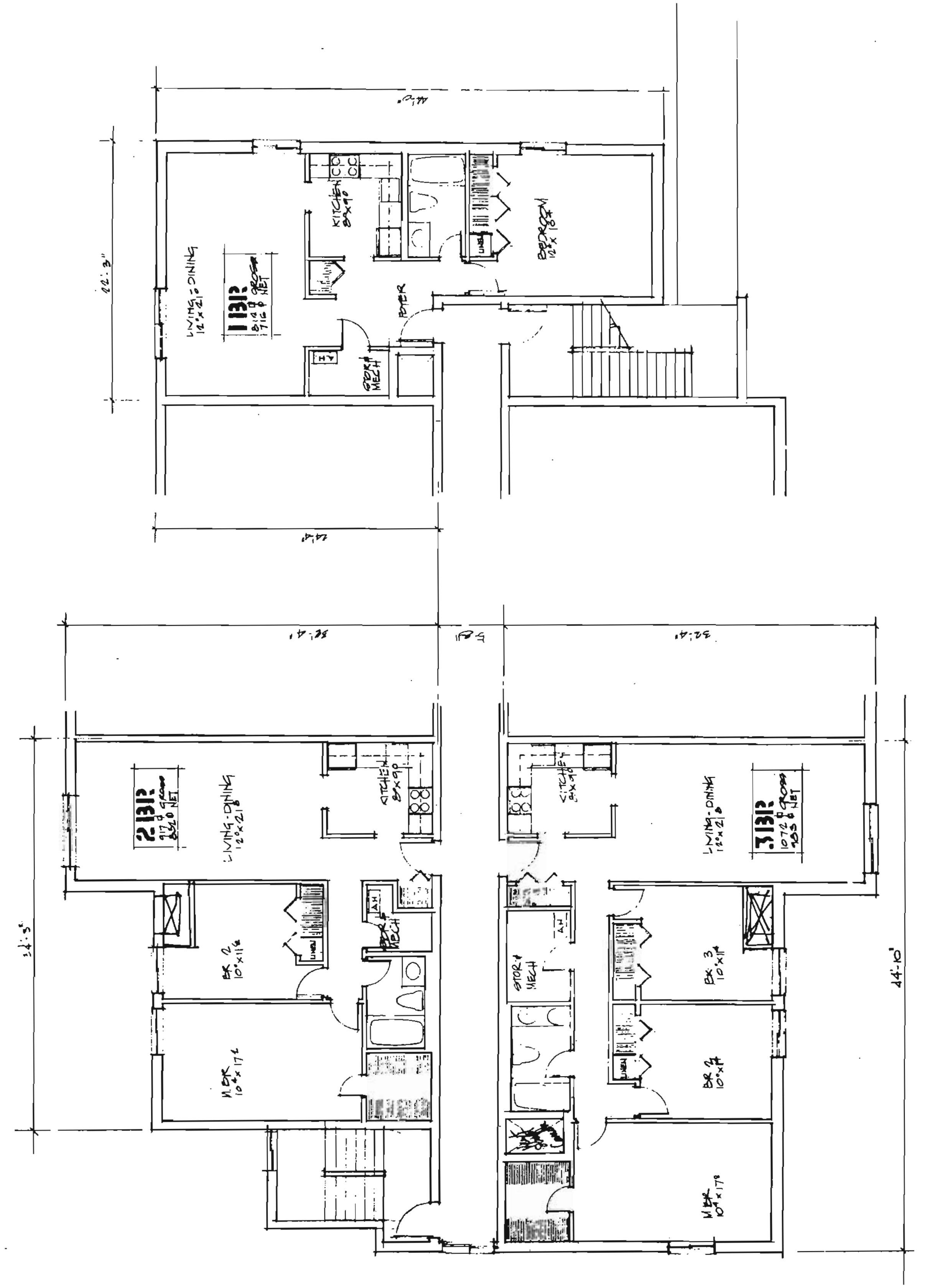


FIGURE A-3. WAKEFIELD TERRACE APARTMENTS

FIGURE A-3. WAKEFIELD TERRACE APARTMENTS

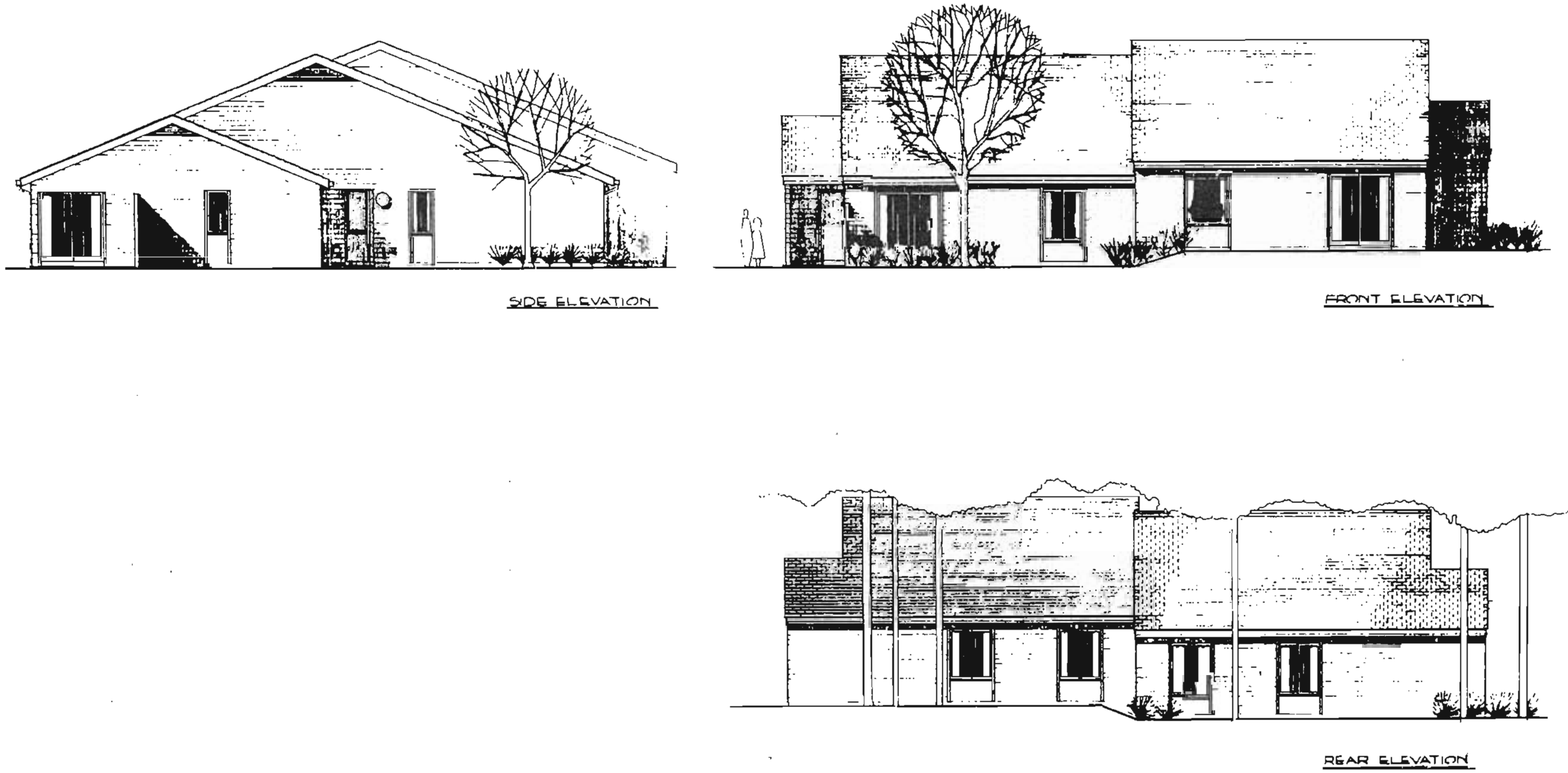


FIGURE A-4. THIRD AGE CENTER HOUSING

THIRD AGE CENTER/DESCRIPTION

These buildings are single story structures with four (4) apartments per building. The site design provides maximum preservation of the natural topography and vegetation.

The exterior walls consists of brick veneer on wood frame. There are interior masonry fire walls separating each apartment. Prefabricated wood trusses are used for roof construction with asphalt shingle roofing. Exterior walls and ceilings are insulated.

Third Age Center total number of buildings and dwelling units are as follows:

Total Number of Buildings	-	26
Total Number of Dwelling Units	-	104
Total Floor Area	-	88,000 Sq.Ft.

Third Age Center is scheduled for completion by November 1978, with initial occupancy scheduled for June 1978.

(NOTE: Refer to Building Sketch, Figures A-4 and A-5)

Third Age Center Mechanical and Electrical/Conventional Design

The typical building plan shows the mechanical rooms located within each apartment. Major items of specified equipment include the following:

Domestic Hot Water - Electric Water Heater, W. L. Jackson, Mfg., Model No. GRE-40-D, 40 Gal. Stor., 20.5 Gph @ 100°F rise; 2 elements of 2500 watts each 240 V, 1-phase.

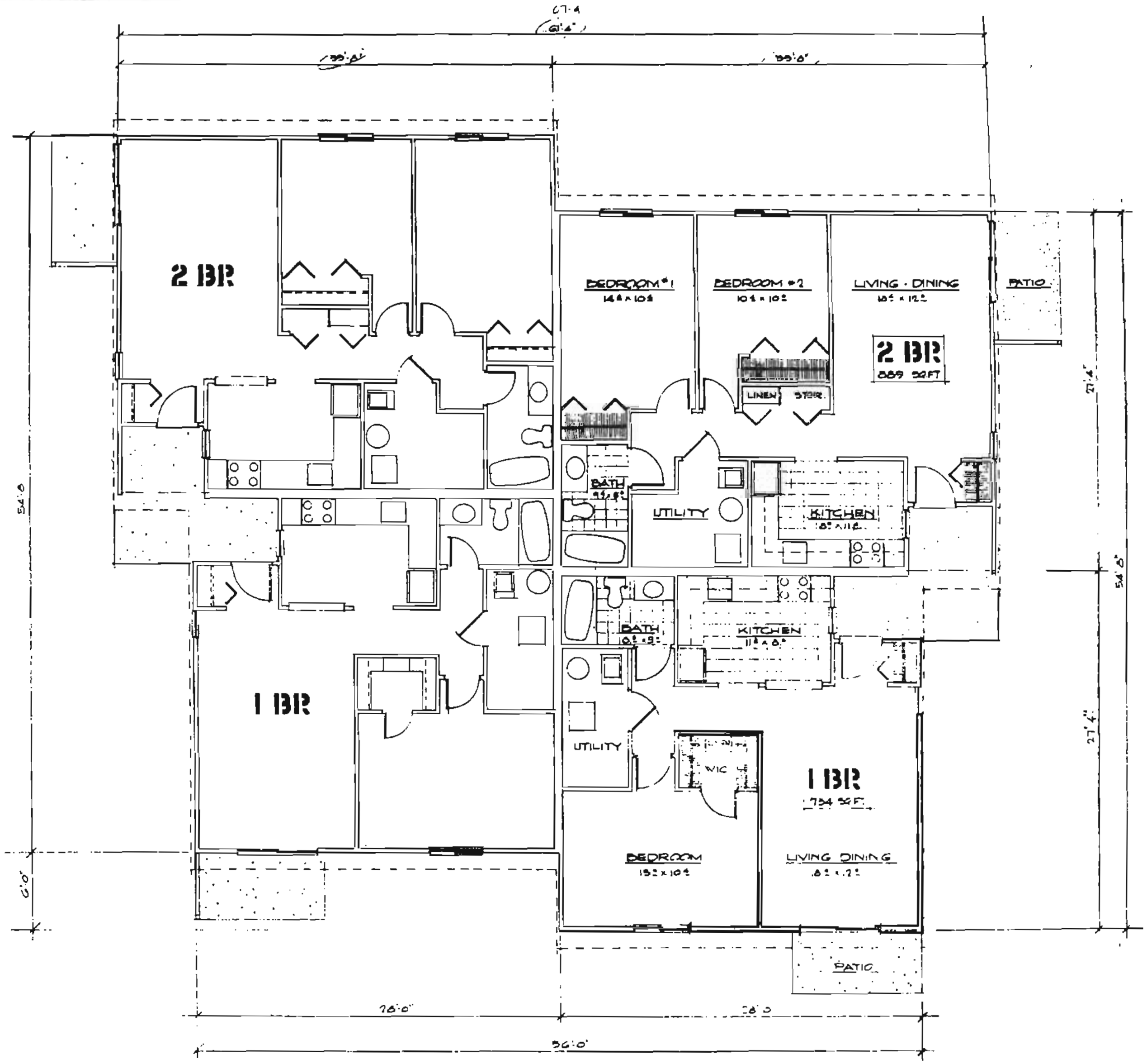
Heating and Air Conditioning Equipment - GE Weathertron Electric Air Source Heat Pumps. Unit "A", Indoor AHU, Model GBWE 518G, cooling capacity 18,000 Btu/Hr w/7.68 Kw heater.

Unit "A" Outdoor Condensing Unit, Model GBWA 918H, cooling capacity 18,000 Btu/Hr.

Unit "B", Indoor AHU, Model BGWE 424G cooling capacity 24,000 Btu/hr w/9.60 Kw heater.

Unit "B", Outdoor Condensing Unit, Model BGWA 924H, cooling capacity 24,000 Btu/Hr.

Other facilities in each apartment includes an electric washer/dryer in the utility room. In the kitchen there is an electric range and a garbage disposal in the kitchen sink.



TYPICAL FLOOR PLANS

FIGURE A-5. THIRD AGE CENTER HOUSING

Third Age Center Mechanical and Electrical/MIUS System

Domestic Hot Water - Install new hydronic hot water tank per each building.

Heating and Air Conditioning Equipment - Run hot water and chilled water piping to and within the buildings from the side hydronic distribution system.

Eliminate the air source heat pumps and replace with fan coil units with hydronic coils for heating and cooling. Units to be International No. 8VE4, or similar.

Eliminate condensing units.

Interface fan coil air handling units with the conventional system air distribution ducts.

SMALLWOOD VILLAGE CENTER/DESCRIPTION

The Village Center has been conceived as a 200,000 sq. ft. shopping complex with interior open pedestrian mall, perimeter vehicular traffic circulation around the Village Center which is connected to parking commons on the east and west side of the Village Center. Rental offices will be on upper levels and some community facilities may also be included (i.e., Village Hall and Library) in this complex.

The exterior architectural treatment consists of brick, precase concrete and diagonal wood siding combined to achieve an interesting contemporary design.

On the MIUS system a hydronic piping distribution system would be included in the Village Center for heating and cooling to coils in air handling units. Distribution piping would be capped at tenant areas for future extension as required.

The Village Center is scheduled for completion of 100,000 sq. ft. by January 1979 and an additional 100,000 sq. ft. completed by January 1981.

(NOTE: Refer to Building Sketch, Figures A-6, A-7)

Smallwood Village Center Mechanical and Electrical/Conventional Design

Major items of equipment specified include the following:

Domestic Hot Water - Electric water heaters to serve tenant spaces as required.

Heating and Air Conditioning Equipment -

Chillers Nos. 1 and 2 @ 275 tons to cool 660 gpm of water from 50° to 45°F, Trane Model No. PCV-2H.

Cooling Tower, 550 tons to cool 1650 gpm water 95°F to 85°F w/ambient temperature 78°F wet bulb. Tower by BAC, Model No. VLT-550A Binks Tower Industries.

Maximum coil wtr. P.D. 10.0 ft. 17.66 gpm and maximum 550 fpm coil face velocity, unit by Carrier, Trane or equal.

Electric wall heaters, capacity 1.2 Kw, 120V, 1 ph, 60 cy, BROAN Model 133 or Penn Model 10FR, Nutone or equal.

Fan, clg. type, 60 cfm 120V, BROAN Model 665 w/640 wall cap.

HVAC For Offices:

AHU (cooling only) 22.7 Btu/Hr cfm total sens. and 30.0 Btu/Hr/cfm total capacity. Fresh air based on 1 cfm/ft^2 of floor area. Maximum coil wtr. P.D. 10.0 ft. and maximum 550 fpm coil face velocity. Coil ARI cert.; Trane, Carrier or equal.

Baseboard Heaters (perimeter heating) 277V, 1-ph, 60 cy; Chromalox, Singer or equal.

Horizontal Split Case Pump:

Chilled water pump, capacity 1320 gpm @ 150 ft. head, 75 hp, 1750 rpm, Thrush Model No. 688SC.

Standby pump (chilled and condenser) same as chilled water pump.

HVAC For Shops:

AHU, capacity 2400 cfm, 200 cfm O.A., 88 mbh total and 61.5 mbh sens. ARI certified coil and 20.0 Kw heating coil w/comb. Filter and Mixing Box, 5 hp fan motor 48V, 3 ph, 60 cy.

Smallwood Village Center Mechanical and Electrical/MIUS System

Domestic Hot Water - Hydronic.

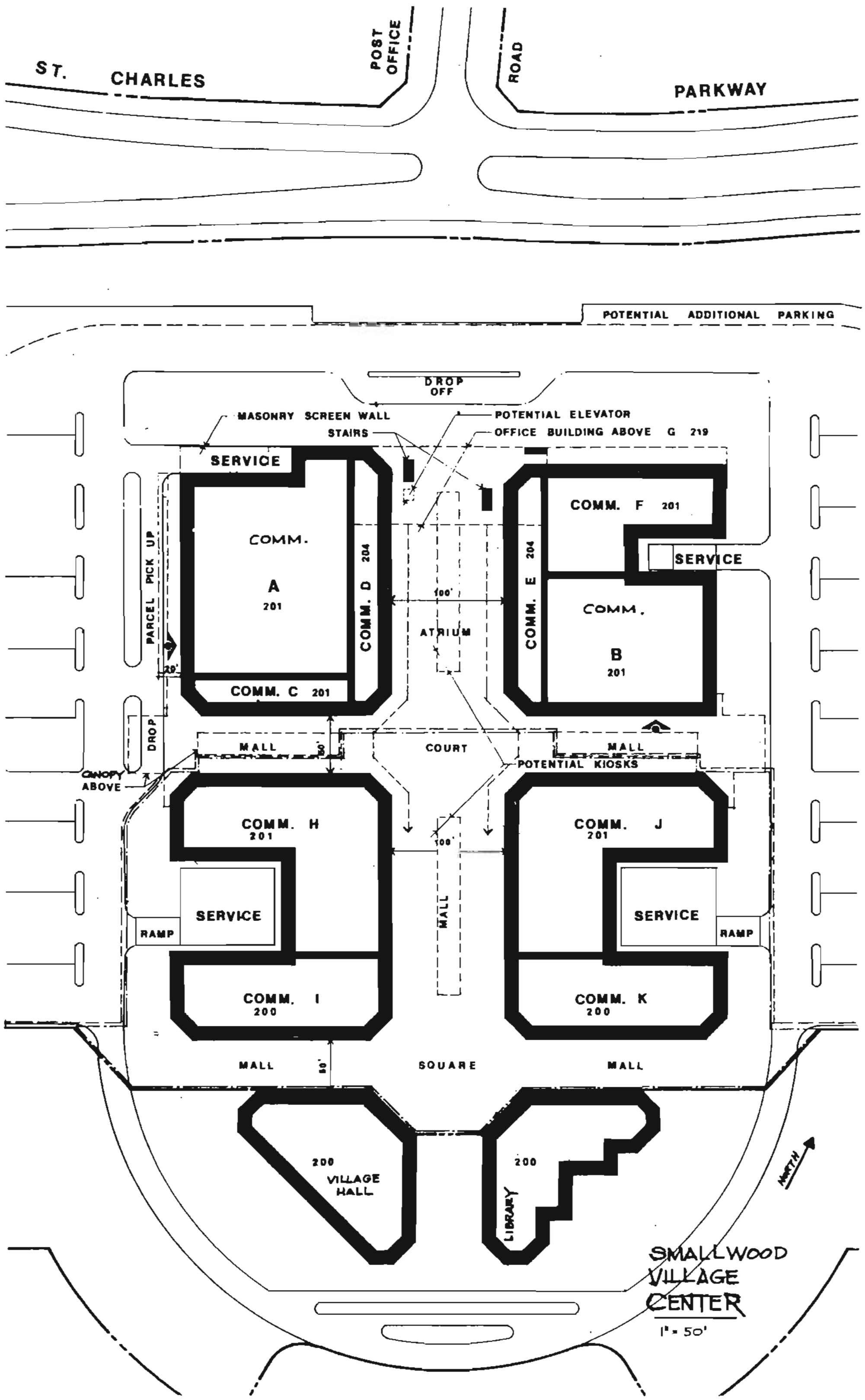
Heating and Air Conditioning Equipment - Eliminate the electric resistance heaters in the air handling units and replace with hot water coils.

Retain the chilled water coils.

Relocate chillers to the MIUS plant.

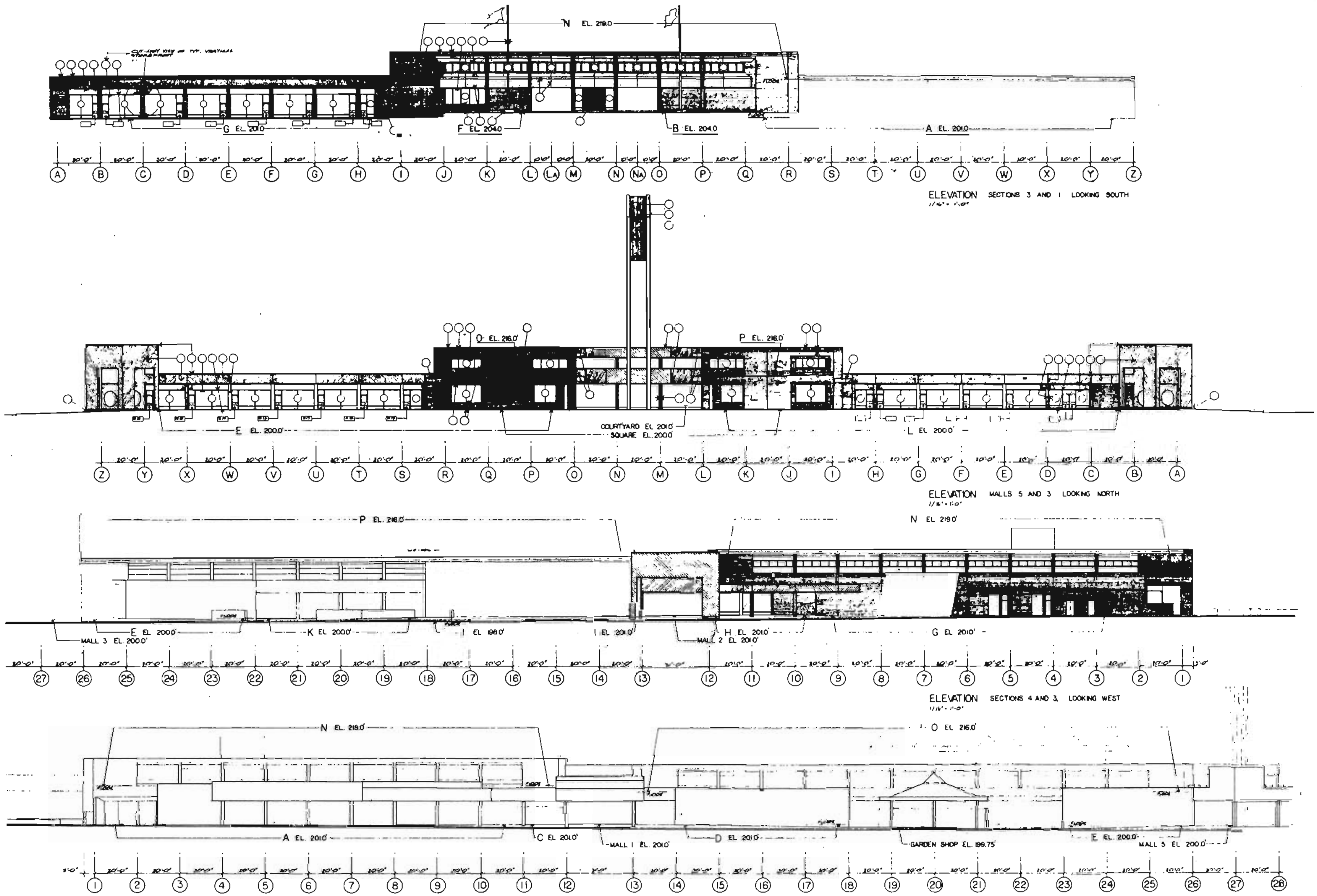
Eliminate cooling tower.

Run new hot water piping from MIUS plant to new coils installed in conventional system air handling units.



ST. CHARLES
PARKWAY
POST OFFICE
ROAD
POTENTIAL ADDITIONAL PARKING
DROP OFF
MASONRY SCREEN WALL
STAIRS
POTENTIAL ELEVATOR
OFFICE BUILDING ABOVE G 219
SERVICE
COMM.
A
201
COMM. D 204
COMM. C 201
PARCEL PICK UP
100'
ATRIUM
COMM. E 204
COMM. F 201
SERVICE
COMM.
B
201
DROP
CANOPY ABOVE
MALL
COURT
MALL
POTENTIAL KIOSKS
COMM. H
201
SERVICE
RAMP
COMM. I
200
MALL
COMM. J
201
SERVICE
RAMP
COMM. K
200
MALL
SQUARE
MALL
50'
200
VILLAGE HALL
200
LIBRARY
NORTH
SMALLWOOD VILLAGE CENTER
1" = 50'

FIGURE A-6



SMALLWOOD VILLAGE CENTER

FIGURE A-7

A9

Run hot water piping parallel to conventional chilled water piping system.

Hydronic distribution piping to be capped at tenant areas for future extension as tenant areas are developed.

Retain electric baseboard heating.

STODDERT MIDDLE SCHOOL/DESCRIPTION

The Benjamin Stoddert Middle School is of contemporary design using face brick with masonry block back up for the exterior walls.

This project was completed for occupancy in September 1976, with a total floor area of 94,500 sq. ft. to accommodate 900 students.

A four pod multi-use space, open plan is a major design feature in this school.

(NOTE: See Building Sketch, Figure A-8)

Stoddert Middle School Mechanical and Electrical/Conventional Design

Major items of equipment specified include the following:

Domestic Hot Water -

Heater, domestic hot water, #2 oil fired, 500 gallon storage 1640 gph recovery @ 140°F rise; 2,400,000 Btu/Hr input; 17.2 gph firing rate, Pressure Vessels, Inc., Model No. 17.2 - NSA-500-0 or equal.

Storage Tank, domestic hot water, 1860 gallon capacity, 72 in. diameter x 10'0" H. vertical; Adamson or equal.

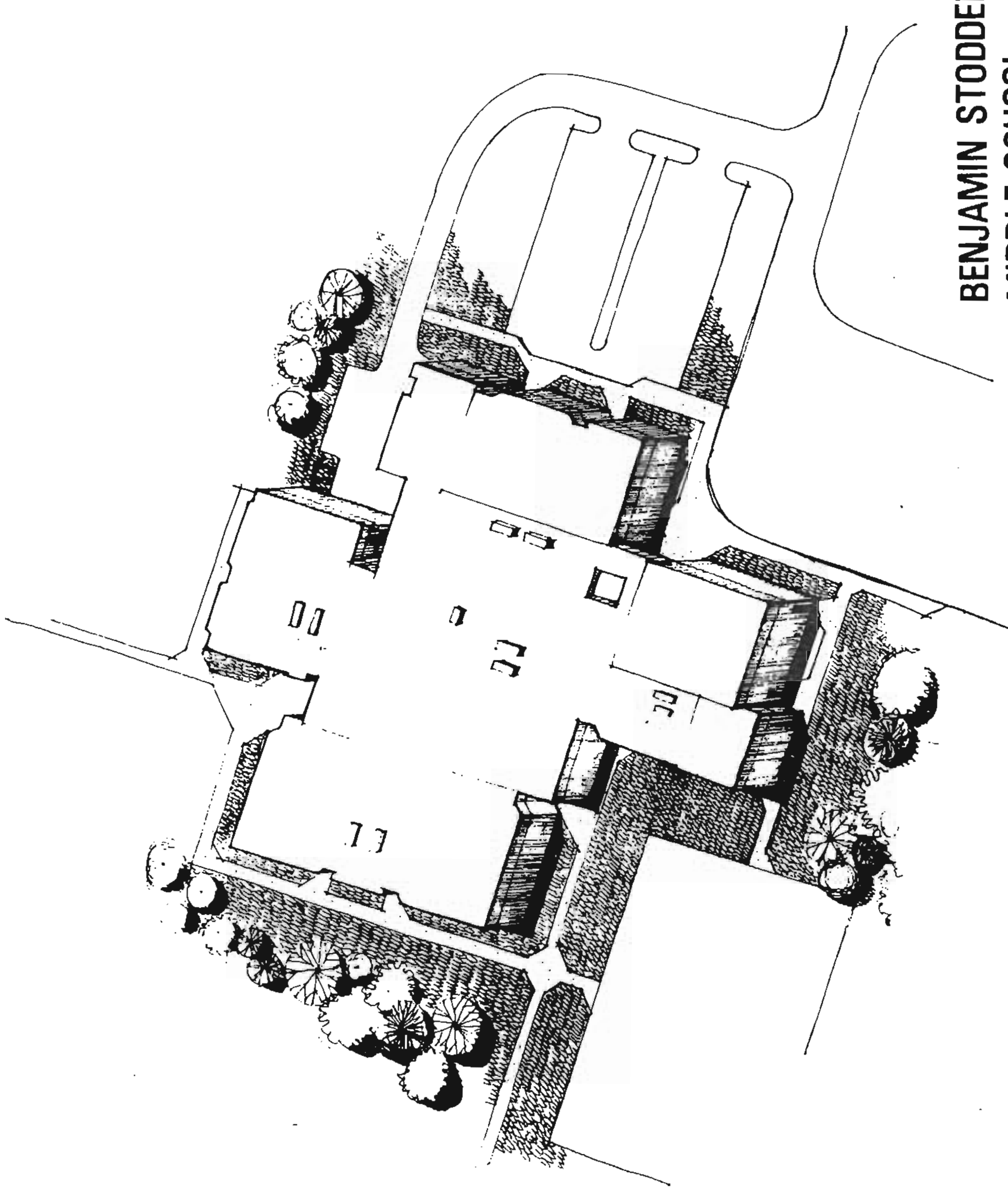
Heating and Air Conditioning Equipment -

Boilers (2), Kewanee type C, Model No. 7L282, steel packaged, 15 psig, steam forced draft, Hi firebox burning #5 oil, 110 bhp, 32 gph oil cons., 560 S.F. heating surface.

Water chiller - centrifugal, 270 tons, Trane No. PCV-3A.

Converter - shell and tube to heat 465 gpm of 30% ethylene glycol sol. from 180° to 200° with 8 psig steam: Taco, B&G or equal.

Boiler feed unit w/3 feed pumps mounted on 150 gallon steel receiver, 20 psig disc. pressure each; 1750 rpm, Federal No. BFV-10020 or equal.



BENJAMIN STODDERT
MIDDLE SCHOOL

FIGURE A–8

Cooling Tower - Vertical discharge, one side inlet, forced draft, to cool 820 gpm from 95° to 85° with 70° WB ambient, Baltimore Aircoil No. VST-300B, or equal.

Fuel oil tank, underground, 10,000 gallons, No. 2 oil.

Stoddert Middle School Mechanical and Electrical/MIUS System

Domestic Hot Water - Install hydronic coil in existing hot water tanks.

Heating and Air Conditioning Equipment - In the school's mechanical room, connect the MIUS hydronic distribution system to the school's hot water and chilled water system.

WAKEFIELD HI-RISE APARTMENTS/DESCRIPTION

Wakefield Hi-Rise is an eight (8) story building (including the basement) located near the lake on the MIUS served site. This apartment building is of contemporary design with a tee-shaped plan and exterior walls of face brick and masonry block backup.

The Wakefield Hi-Rise contains one hundred eight (108) dwelling units as follows:

Bedrooms	-	348
Total Floor Area	-	141,000 sq. ft.

The apartments of each floor level are accessible from central double loaded corridors served by two elevators. A trash chute is accessible on each floor for trash delivery to a compactor located in the basement trash room.

Wakefield Hi-Rise is scheduled for completion by January 1980, with initial occupancy by July 1979.

(NOTE: Refer to building sketch, Figures A-9, A-10, A-11 and A-12).

Wakefield Hi-Rise Mechanical and Electrical/Conventional Design

The mechanicla rooms for each apartment are vertically aligned and located on exterior walls.

Major items of equipment, as specified, include the following:

Domestic Hot Water -

Electric water heaters in each apartment - 5 Kw, 40 gal. storage.

In Basement (Recreational Facility) - Kw, 90 gal. storage.

Heating and Air Conditioning Equipment -

AC unit "A", Fedders Vertipak single package electric heating/ electric cooling, Model CEE018B7A, 16,500 Btu/Hr cooling capacity. 7.5 Kw heater, 25, 575 Btu/Hr capacity.

AC Unit "B", Fedders Vertipak single package electric heating/ electric cooling Model CEE024C3A. 22,000 Btu/Hr cooling capacity. 11.25 Kw heaters, 38,000 Btu/Hr capacity.

AC unit "C", Fedders Vertipak single package electric heating/ electric cooling, Model CEE028C3A. 28,000 Btu/Hr cooling capacity. 11.25 Kw heater, 38,000 Btu/Hr capacity.

AC unit "D", Fedders Vertipak single package electric heating/ cooling, Model CEE033C3A. 33,000 Btu/Hr cooling capacity. 11.25 Kw heater, 38,400 Btu/Hr capacity.

Other facilities in each apartment includes an electric washer/dryer, electric range and garbage disposal in the kitchen sink.

Wakefield Hi-Rise Apartments Mechanical and Electrical/MIUS Design

The mechanical system would be revised to include the following type of equipment:

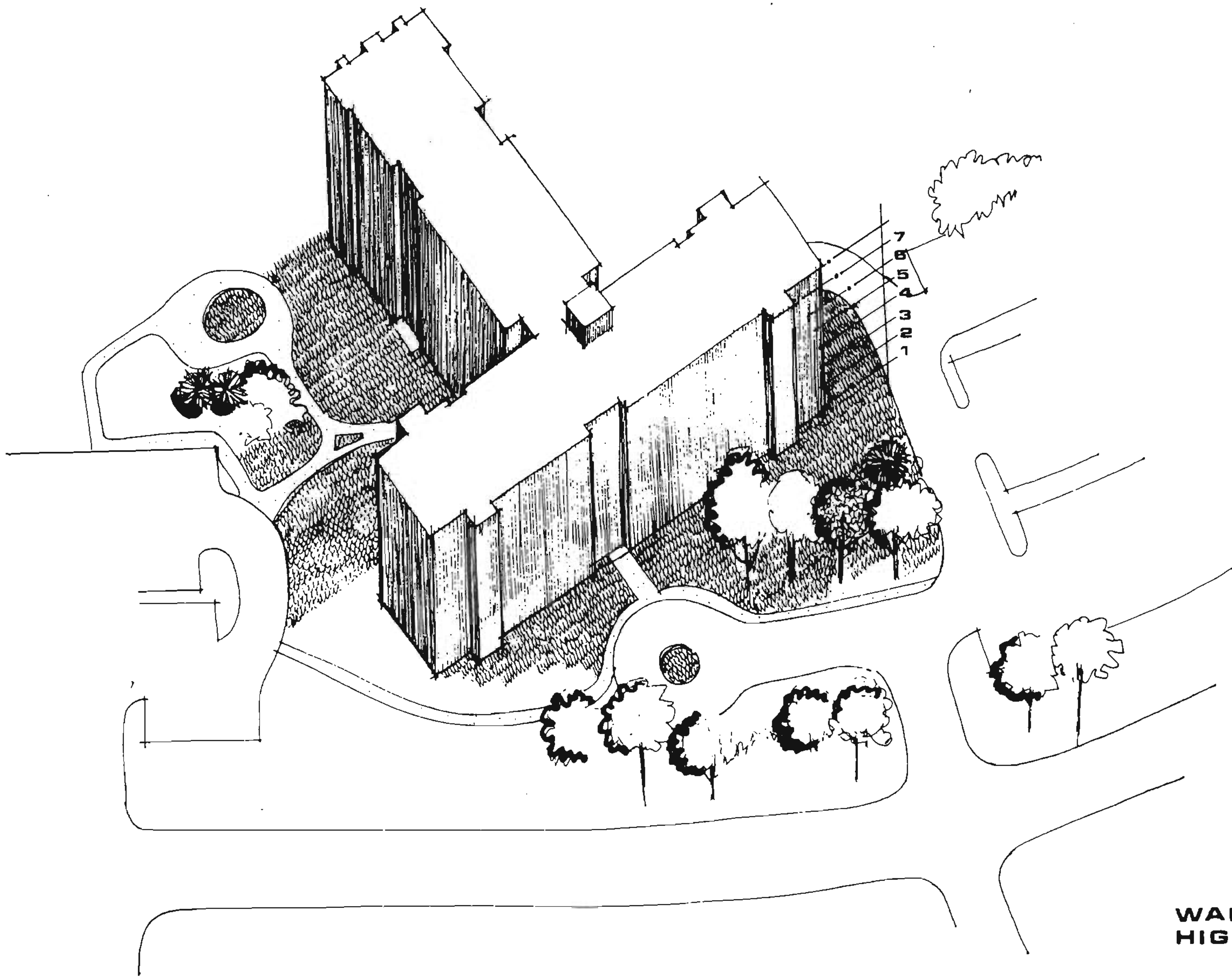
Domestic Hot Water - Eliminate the electric water heaters. Install a central water heating system in the basement mechanical room using a heat exchanger with a 2,000 gallon storage tank. Connect heat exchanger to hydronic system hot water line.

Heating and Air Conditioning Equipment - Run hot water and chilled water piping to and within building from the site hydronic distribution system.

Eliminate the electric furnaces and provide fan coil units with hydronic coils.

Fan coil units (heating and cooling) for 2 bedroom apartments, International Model H-800 (800 cfm), or similar.

Fan coil units (heating and cooling) for 3 bedroom apartments, International Model H-1000 (1000 cfm), or similar.



WAKEFIELD
HIGH-RISE

FIGURE A-9

FIGURE A-9

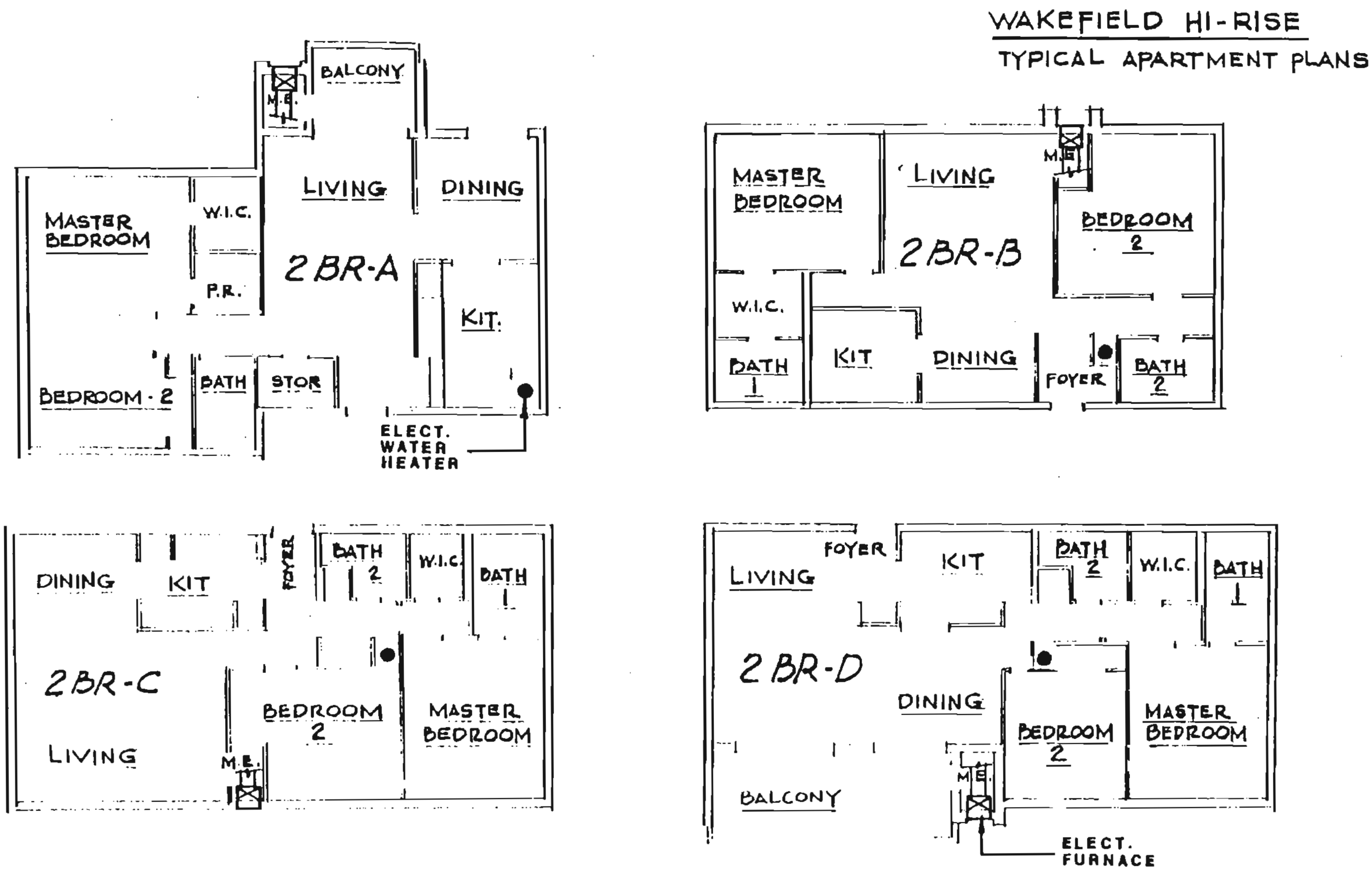


FIGURE A-10. WAKEFIELD HIGH-RISE APARTMENTS

WAKEFIELD HI-RISE
TYPICAL FLOOR
2ND THRU 7TH

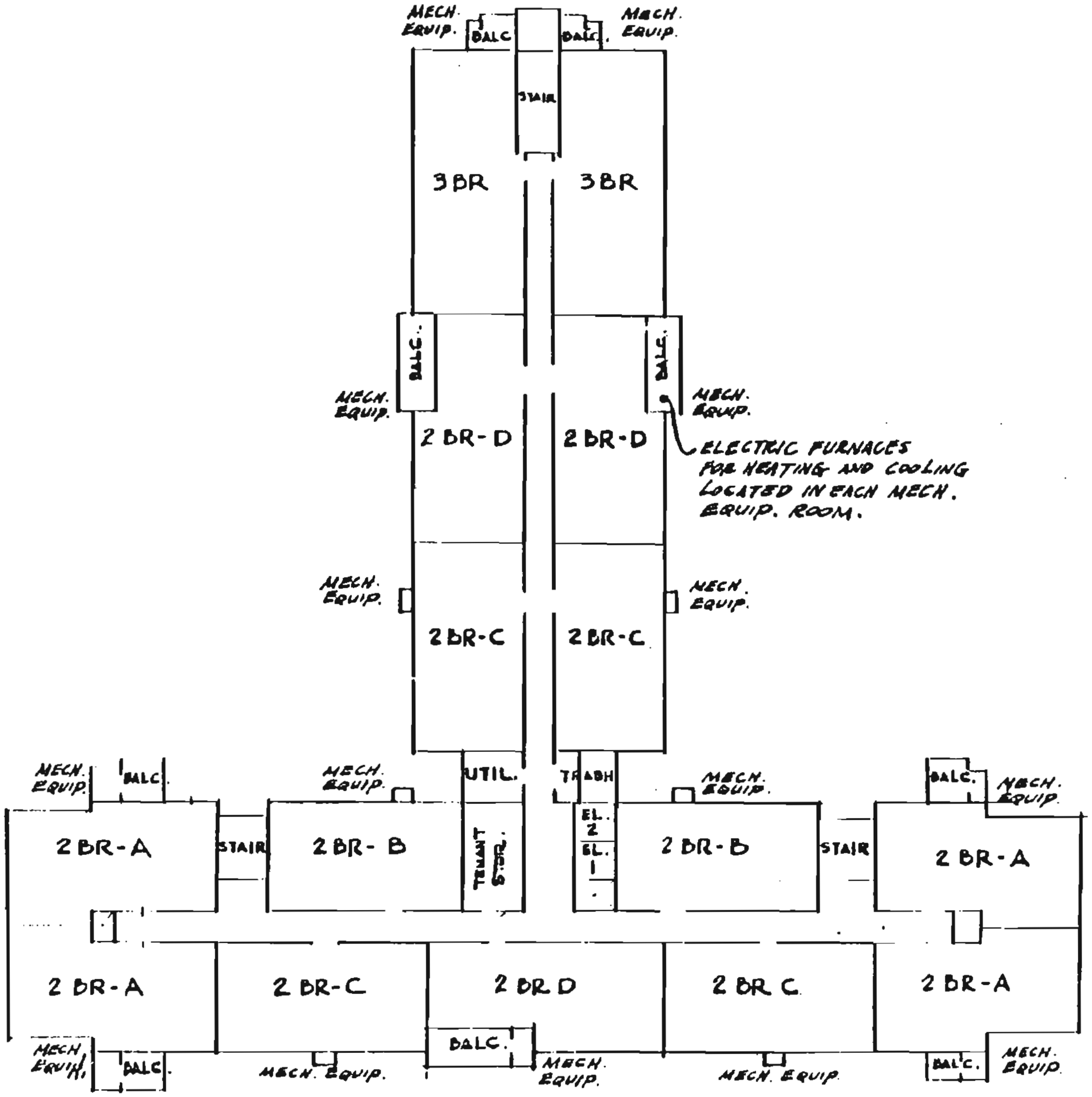


FIGURE A-11. WAKEFIELD HIGH-RISE APARTMENTS

FIGURE A-11. WAKEFIELD HIGH-RISE APARTMENTS

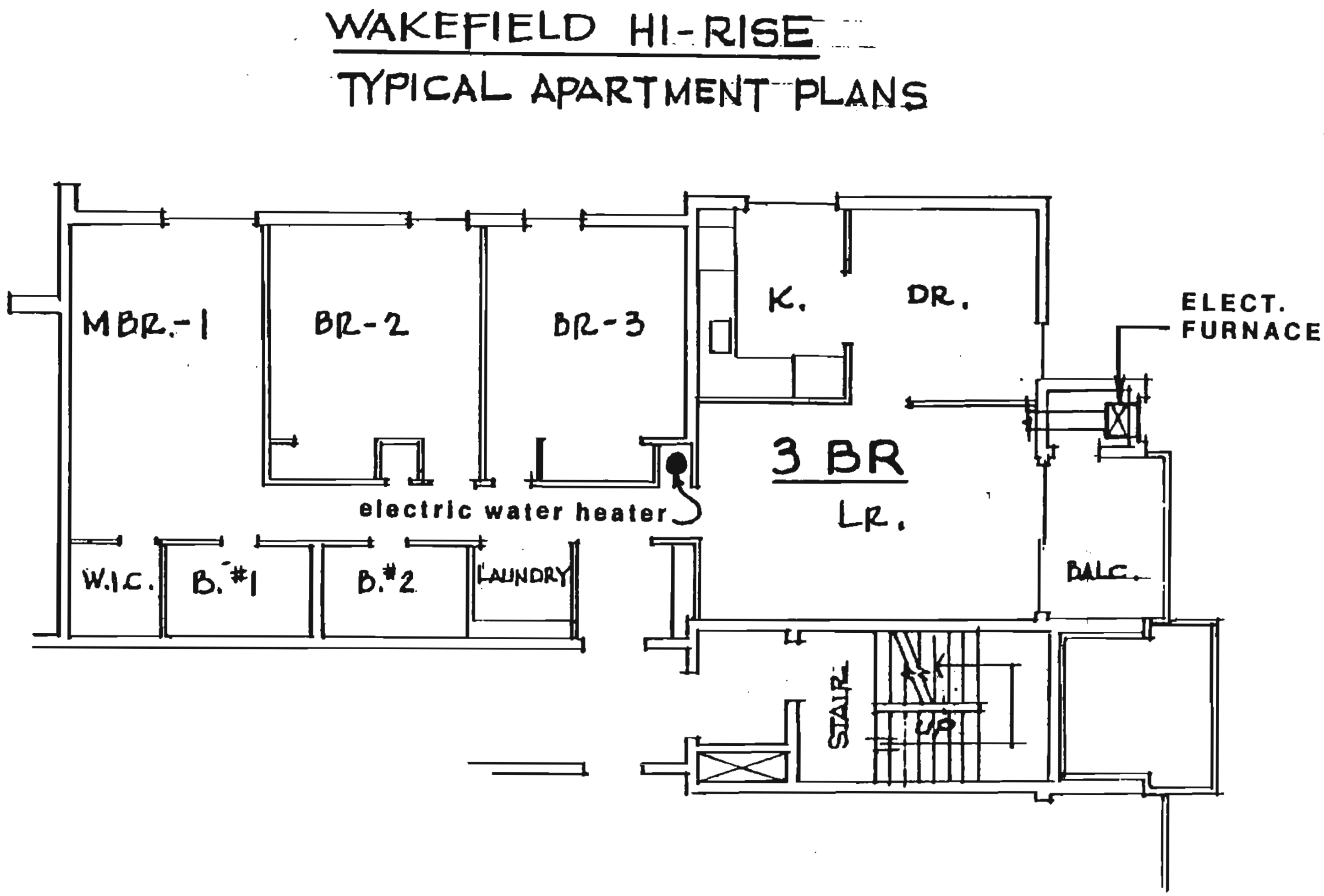


FIGURE A-12. WAKEFIELD HIGH-RISE APARTMENTS

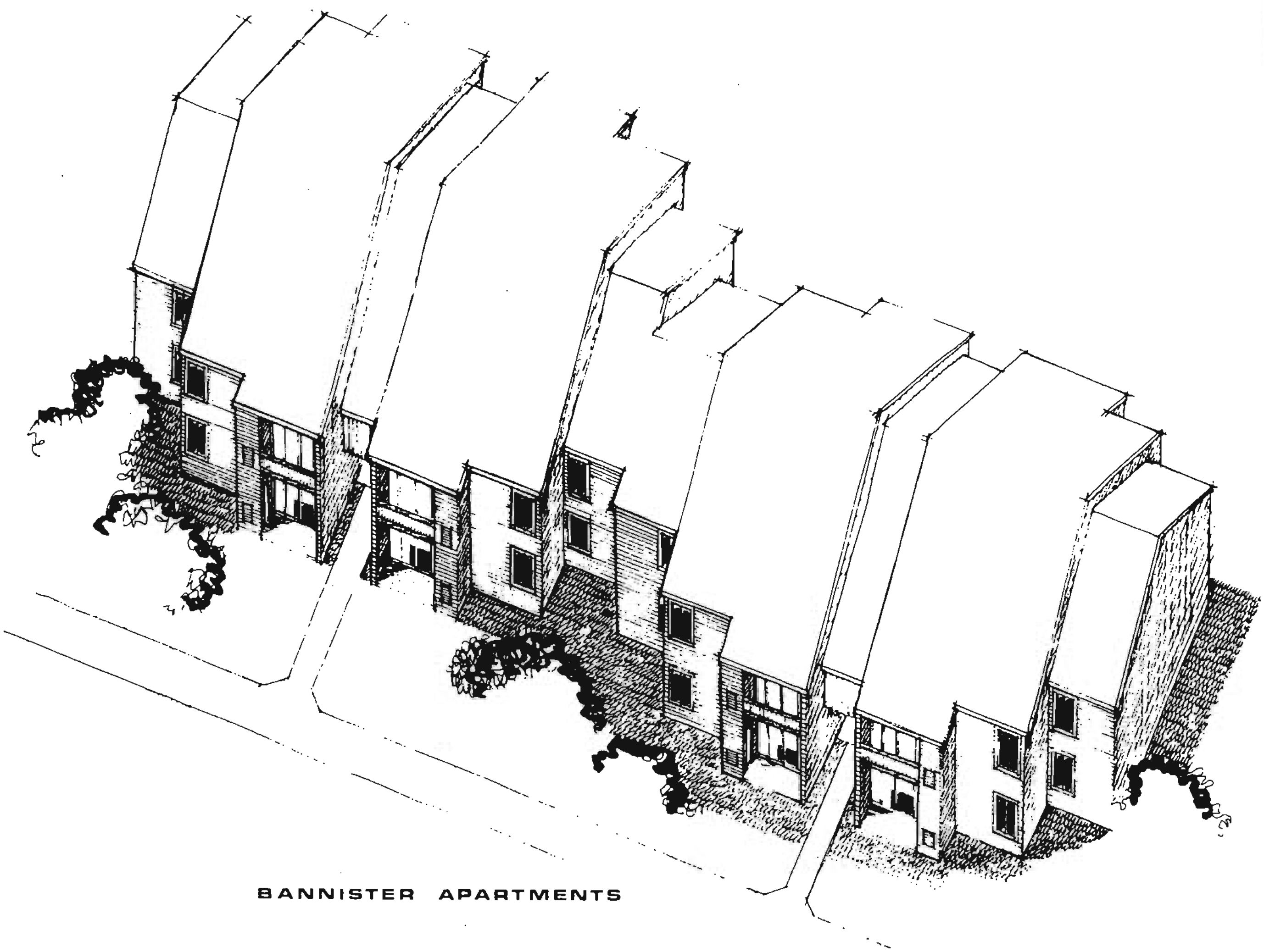
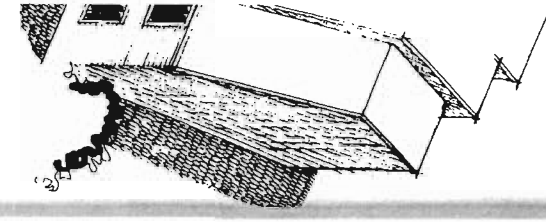


FIGURE A–13. BANNISTER APARTMENTS



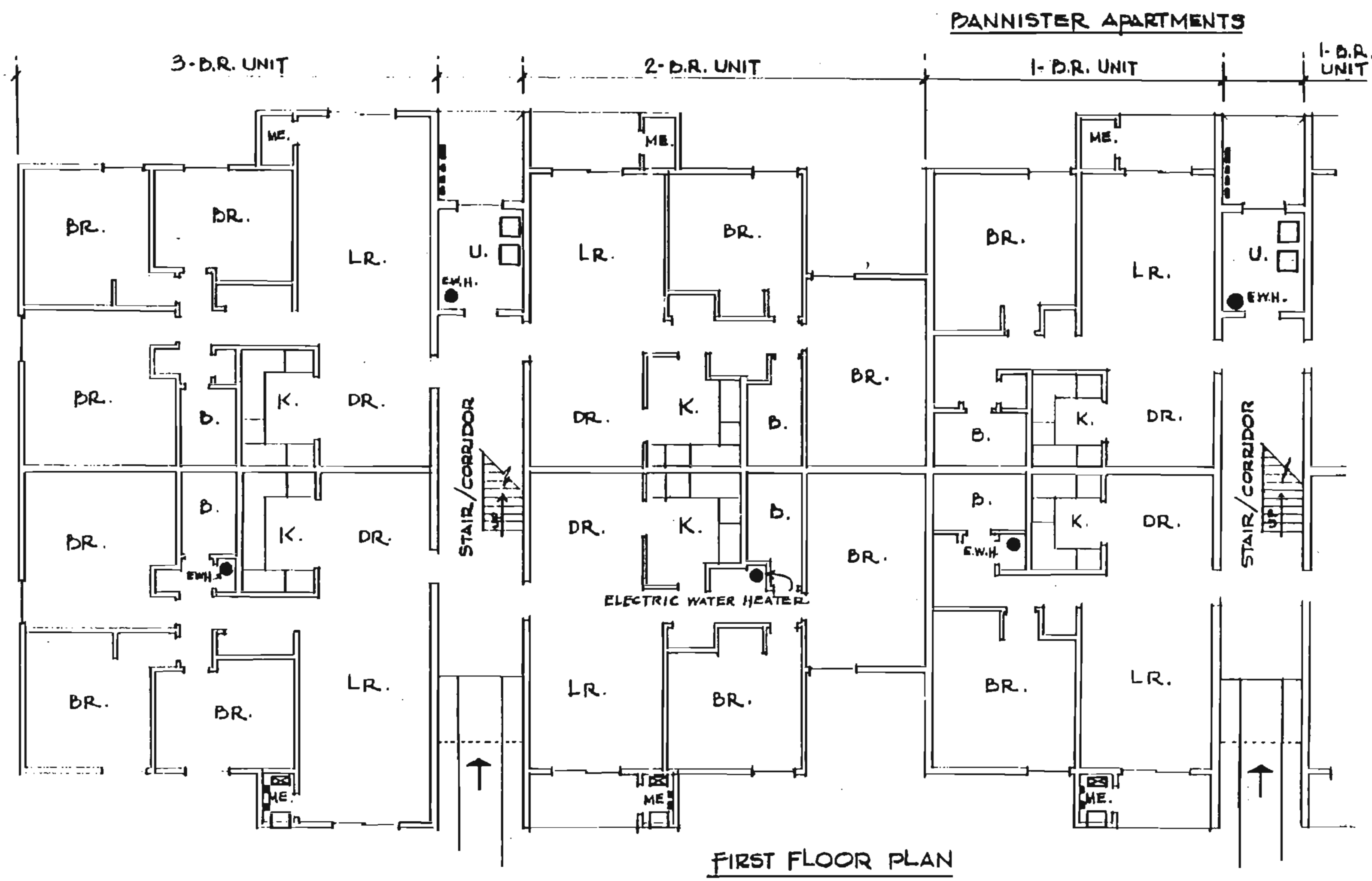


FIGURE A-14. BANNISTER APARTMENTS

BANNISTER APARTMENTS/DESCRIPTION

Bannister Apartments consists of 12 buildings, 2-stories, Town House style of architecture, sited to maintain maximum preservation of the natural surroundings of the area.

There are a total of 208 dwelling units as follows:

One Bedroom Unit	-	20
Two Bedroom Units	-	168
Three Bedroom Units	-	20

The buildings are of wood frame construction with aluminum siding, masonry fire wall between buildings and asphalt shingle roofing.

Perimeter insulation is installed under the first floor concrete slab. The exterior walls and ceilings are insulated with batt insulation.

(NOTE: Refer to Building Sketch Figures A-13, A-14)

Bannister Apartments Mechanical and Electrical/Conventional Design

The floor plan on the following page shows that the location of Mechanical Equipment rooms are on exterior walls for each apartment and adjacent to the first floor terraces and the second floor balconies.

The individual mechanical spaces presently house electric air handling units for heating and cooling with through wall condensing units. Domestic hot water is supplied from 40 gallons electric water heaters in each apartment. (These domestic hot water heaters are located within the interior apartment space).

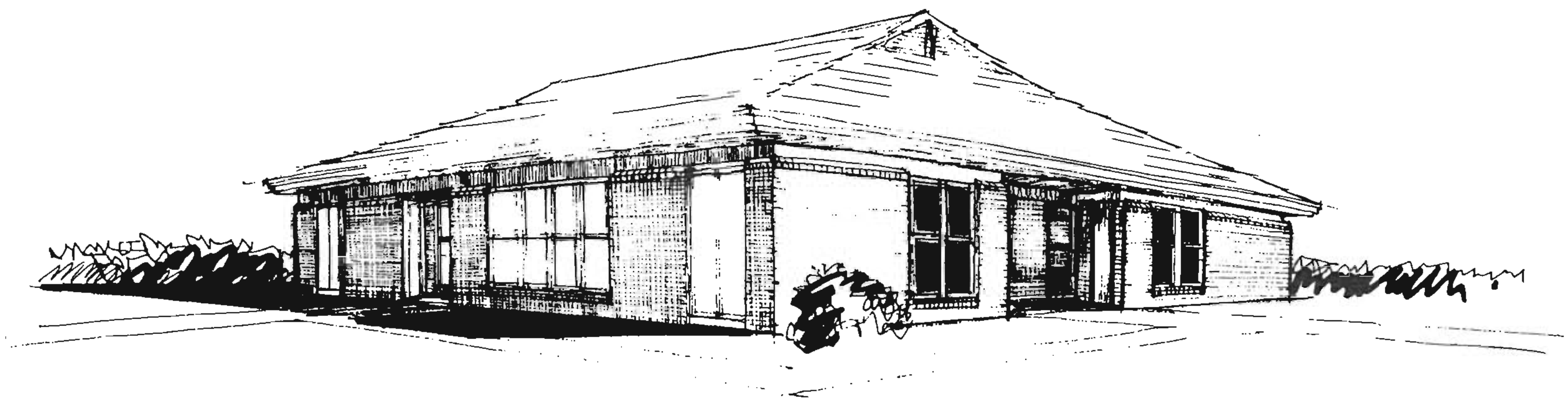
Bannister Apartments Mechanical and Electrical/MIUS System

With the MIUS system the electric air handling units (AHU) to be replaced with hydronic AHU for heating and cooling with connections to the present duct work for air distribution. The electric domestic hot water heater would not be changed with the MIUS system.

The Bannister apartments were completed in November 1976.

CROSSLAND MANOR APARTMENTS/DESCRIPTION

These buildings are single story structures with four (4) apartments per building. The site design provides maximum preservation of the natural topography and vegetation.



CROSSLAND
MANOR

FIGURE A–15. CROSSLAND MANOR

The exterior walls consists of brick veneer on wood frame. There are interior masonry fire walls separating each apartment. Prefabricated wood trusses are used for roof construction with asphalt shingle roofing. Exterior walls and ceilings are insulated.

In Crossland Manor there are a total of twenty-four (24) buildings with a total of ninety-six (96) dwelling units as follows:

One Bedroom Units	-	48
Two Bedroom Units	-	48
Total Floor Area	-	100,000 sq. ft.

Crossland Manor is scheduled for completion by January 1978, with initial occupancy scheduled for September 1977.

(NOTE: Refer to Building Sketch Figures A-15, A-16)

Crossland Manor Apartments Mechanical and Electrical/Conventional Design

The typical building plan shows the mechanical rooms located within each apartment. Major items of specified equipment include the following:

Domestic Hot Water - Electric Water Heater, W. L. Jackson, Mfg. Model No. GRE-40-D, 40 Gal. Stor., 20.5 Gph @ 100°F rise; 2 elements of 2500 watts each 240V, 1-phase.

Heating and Air Conditioning Equipment - GE Weathertron Electric Air Source Heat Pumps. Unit "A", Indoor AHU, Model GBWE 318G, cooling capacity 18,000 Btu/Hr w/7.68 Kw heater.

Unit "A" Outdoor Condensing Unit, Model GBWA 818H, cooling capacity 18,000 Btu/Hr.

Unit "B", Outdoor Condensing Unit, Model BGWA 924H, cooling capacity 24,000 Btu/Hr.

Other facilities in each apartment includes an electric washer/dryer in the utility room. In the kitchen there is an electric range and a garbage disposal in the kitchen sink.

Crossland Manor Apartments Mechanical and Electrical/MIUS System

Domestic Hot Water - Retain conventional.

Heating and Air Conditioning Equipment - Run hot water and chilled water piping to and within the buildings from the site hydronic distribution system.

Eliminate the air source heat pumps and replace with fan coil units with hydronic coils for heating and cooling. Units to be International No. 8VE4, or similar.

Eliminate condensing units.

Interface fan coil air handling units with the conventional system air distribution ducts.

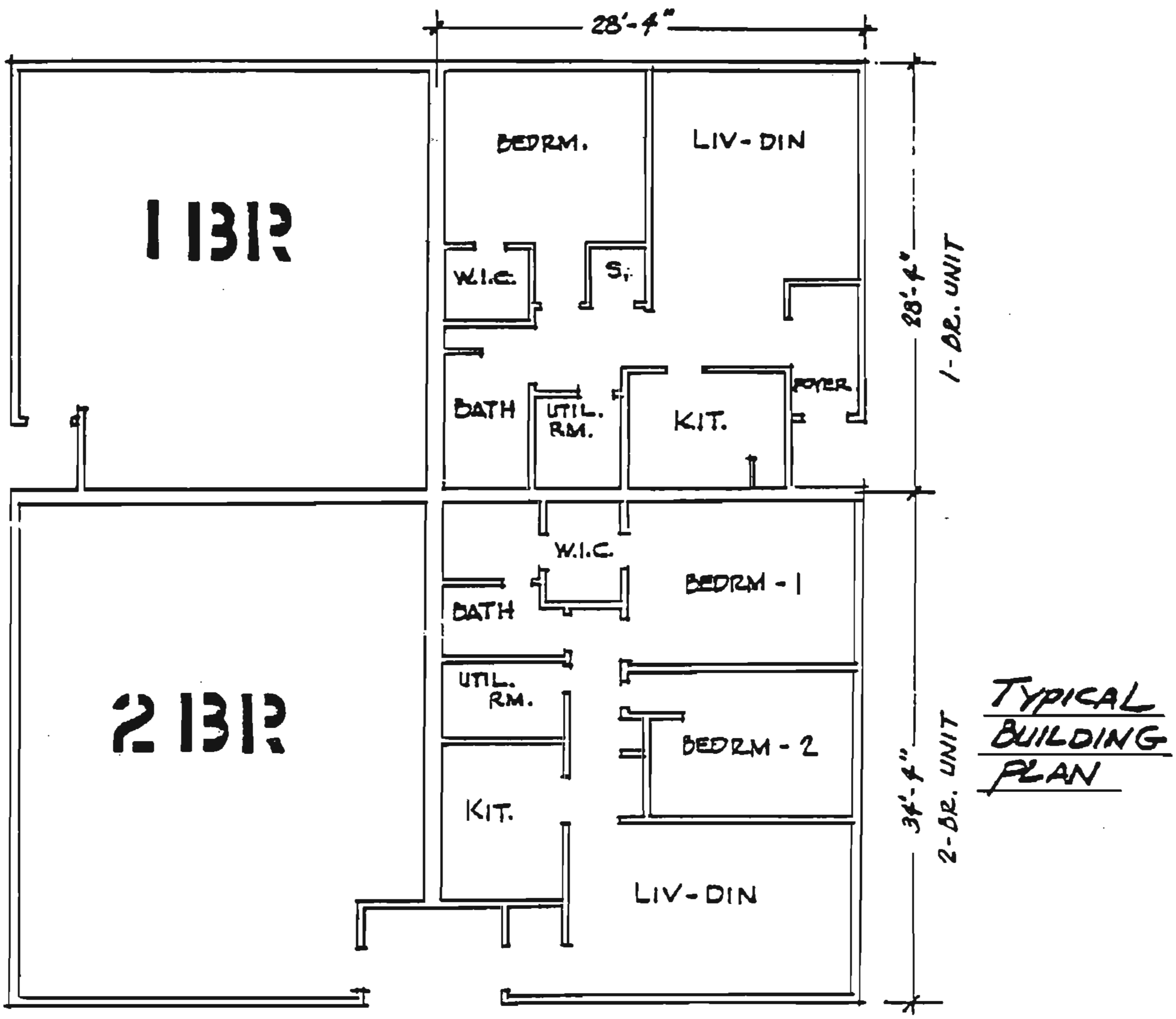
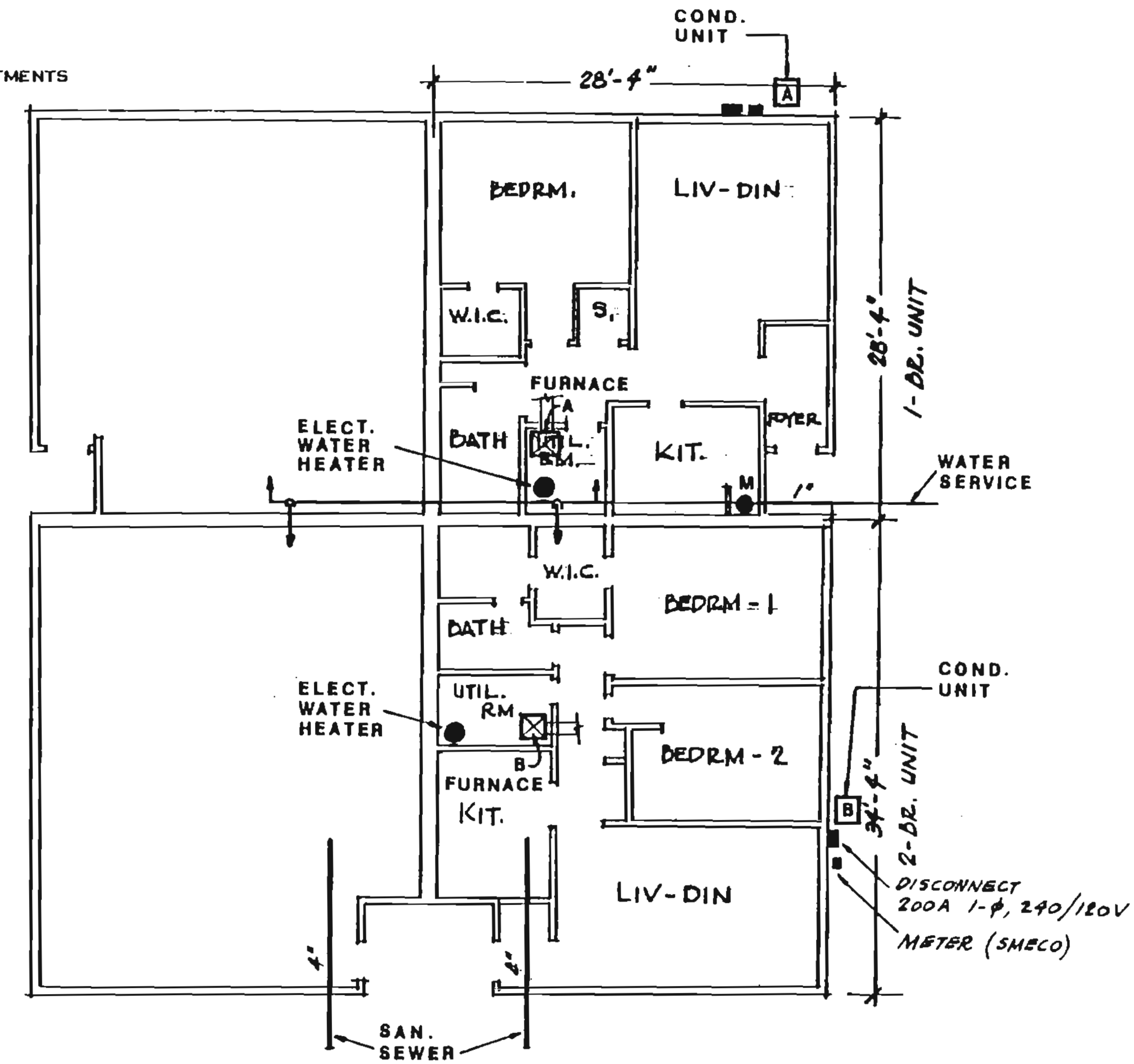


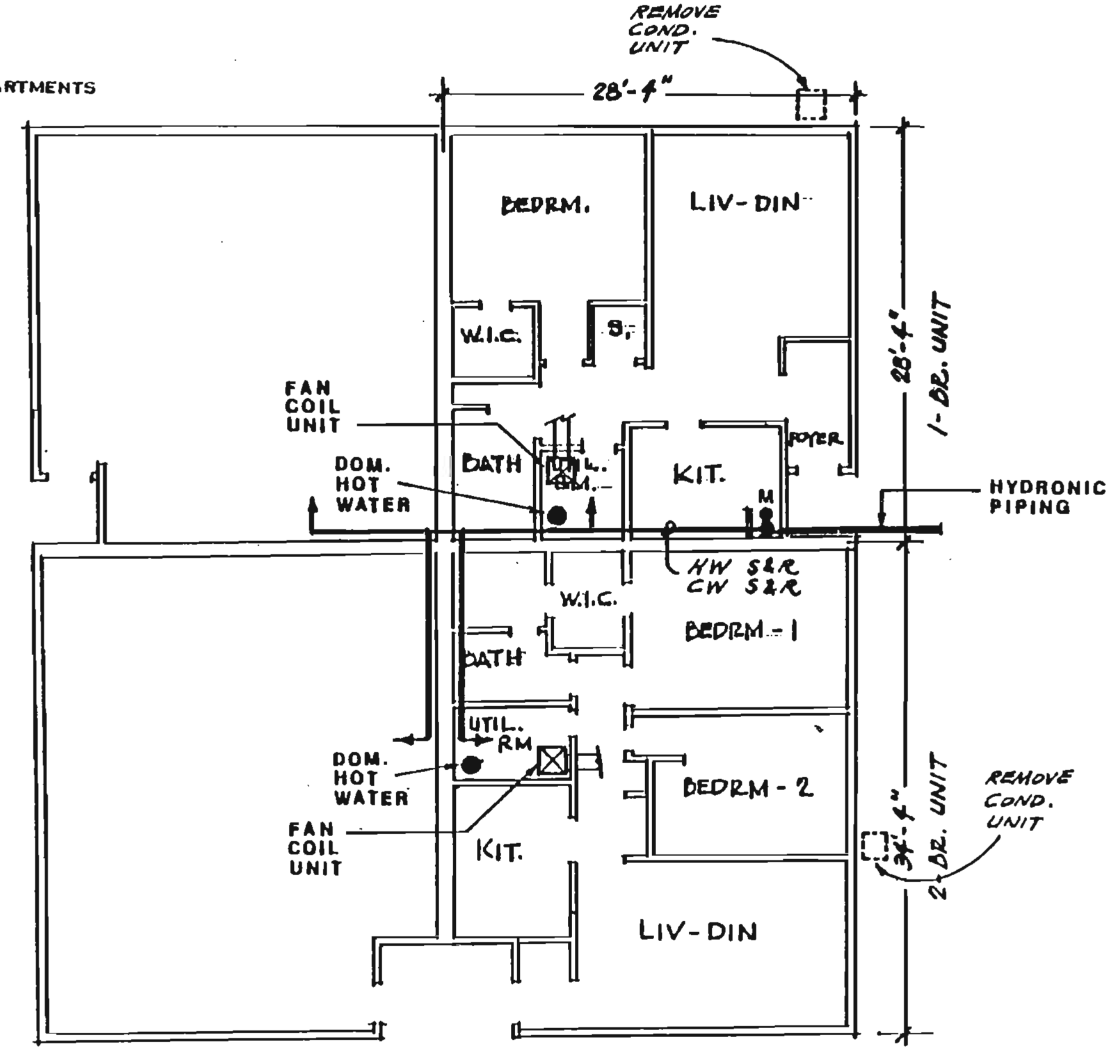
FIGURE A-16. CROSSLAND MANOR APARTMENTS

CROSSLAND MANOR APARTMENTS



CONVENTIONAL DESIGN

FIGURE A-17. TYPICAL BUILDING PLAN



MIUS SYSTEM

FIGURE A-18. TYPICAL BUILDING PLAN

APPENDIX B - MIUS DESCRIPTION

B.1 Plans and Schematics

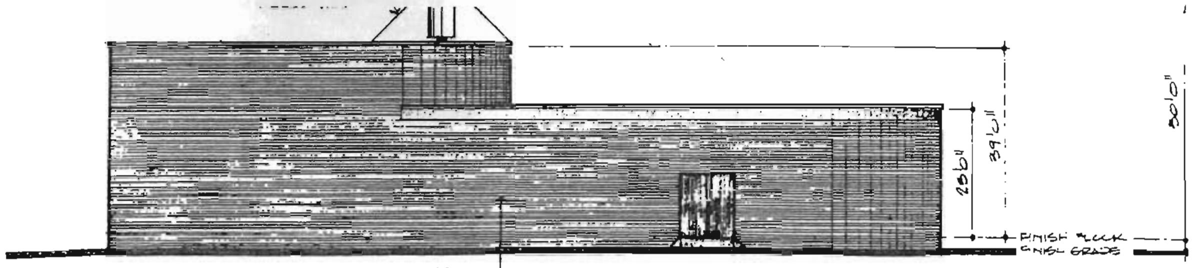
B.1 PLANS AND SCHEMATICS

Preliminary Design Schematic drawings for the MIUS plant presented in this report are listed as follows:

Drawing No.	
M-1	MIUS Plant Architectural Plans & Elevations
M-2	MIUS Plant Mechanical & Electrical Equipment Layout
M-3	Primary Hot Water Flow Diagram
M-4	Oil Cooler Flow; After Cooler Flow and Condenser Water Flow Diagrams
M-5	Diesel Fuel Oil Flow Diagram
M-6	Lubricating Oil Flow Diagram and Compressed Air Flow Diagram
M-7	Chilled Water Flow Diagram
M-8	Solid Waste Subsystem/Schematic
M-9	Equipment Schedule
M-10	Equipment Schedule
E-1	Single Line Riser Diagram with 800 KW Generators at 480 Volts
E-2	Electrical System Control Diagram Metering and Generator Protection
E-3	Motor Control Centers
WMS-4	200,000 GPD Wastewater Management System Schematic Drawing

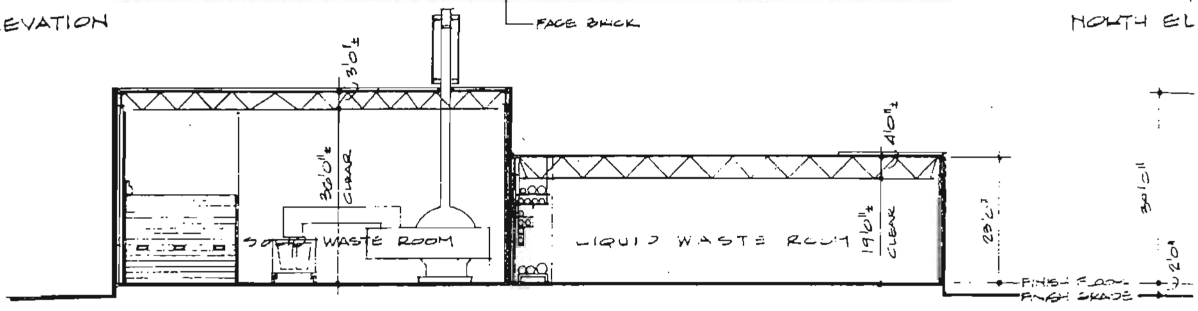
B.1.1 SUBSYSTEM SCHEMATICS

The subsystem schematics, including floor diagrams, are shown on the drawings presented on the following pages.



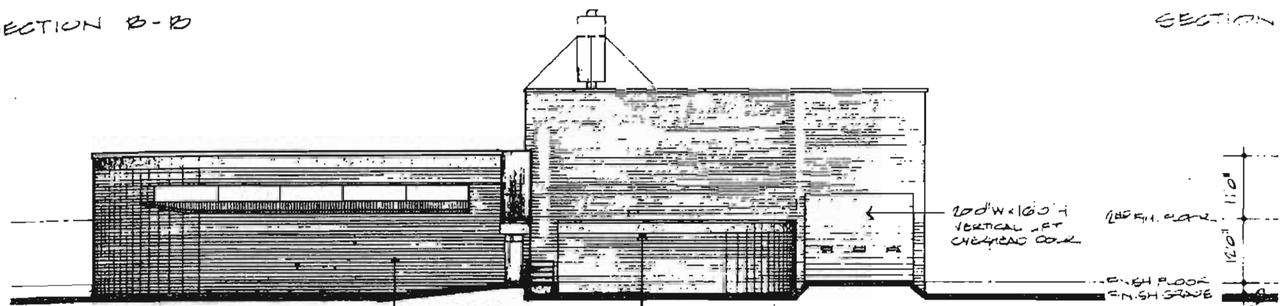
EAST ELEVATION

NORTH EL

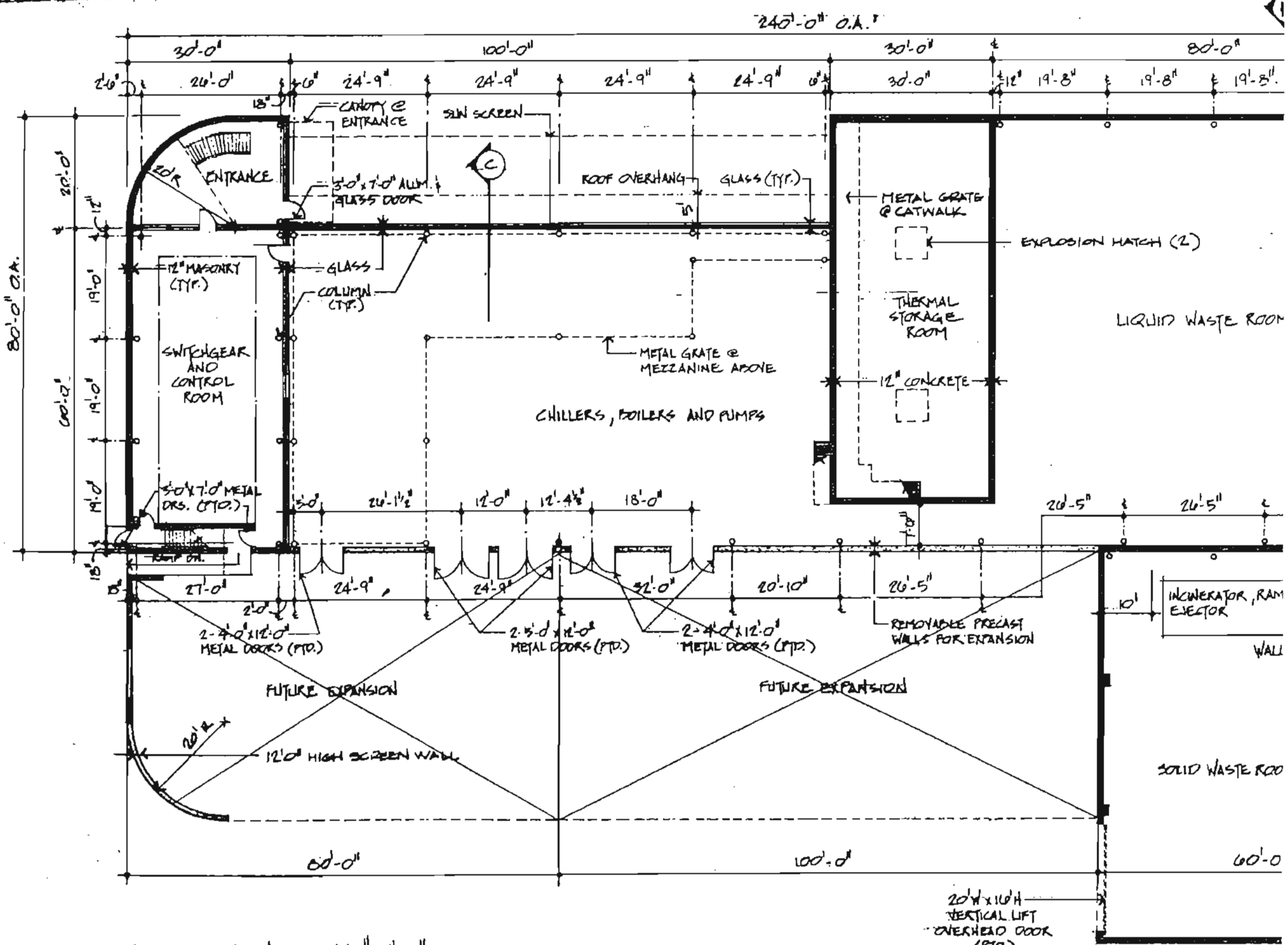


SECTION B-B

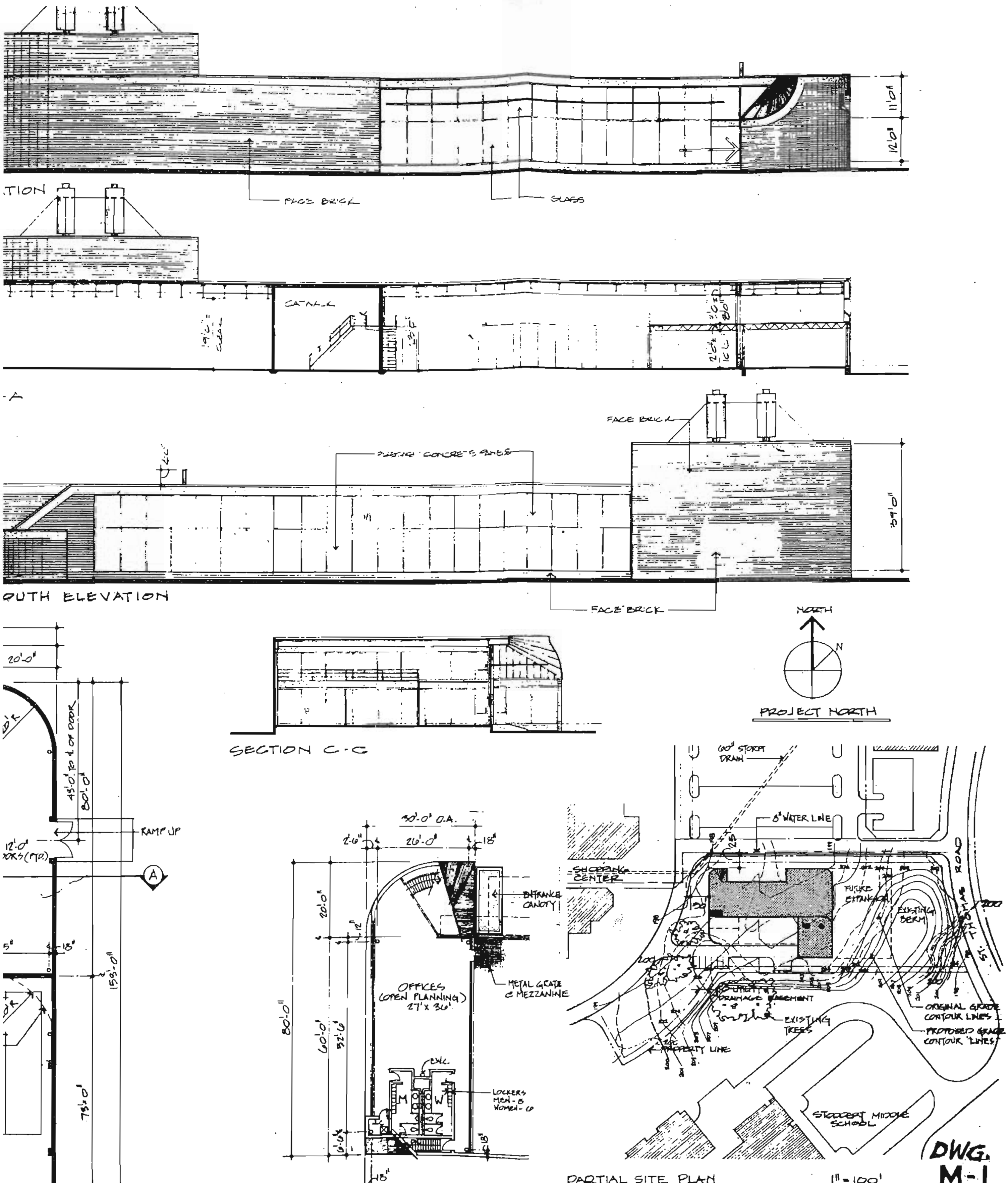
SECTION



WEST ELEVATION



FLOOR PLAN 1/16" = 1'-0"



DWG. M-1

SECOND FLOOR PLAN 1/16" = 1'-0"

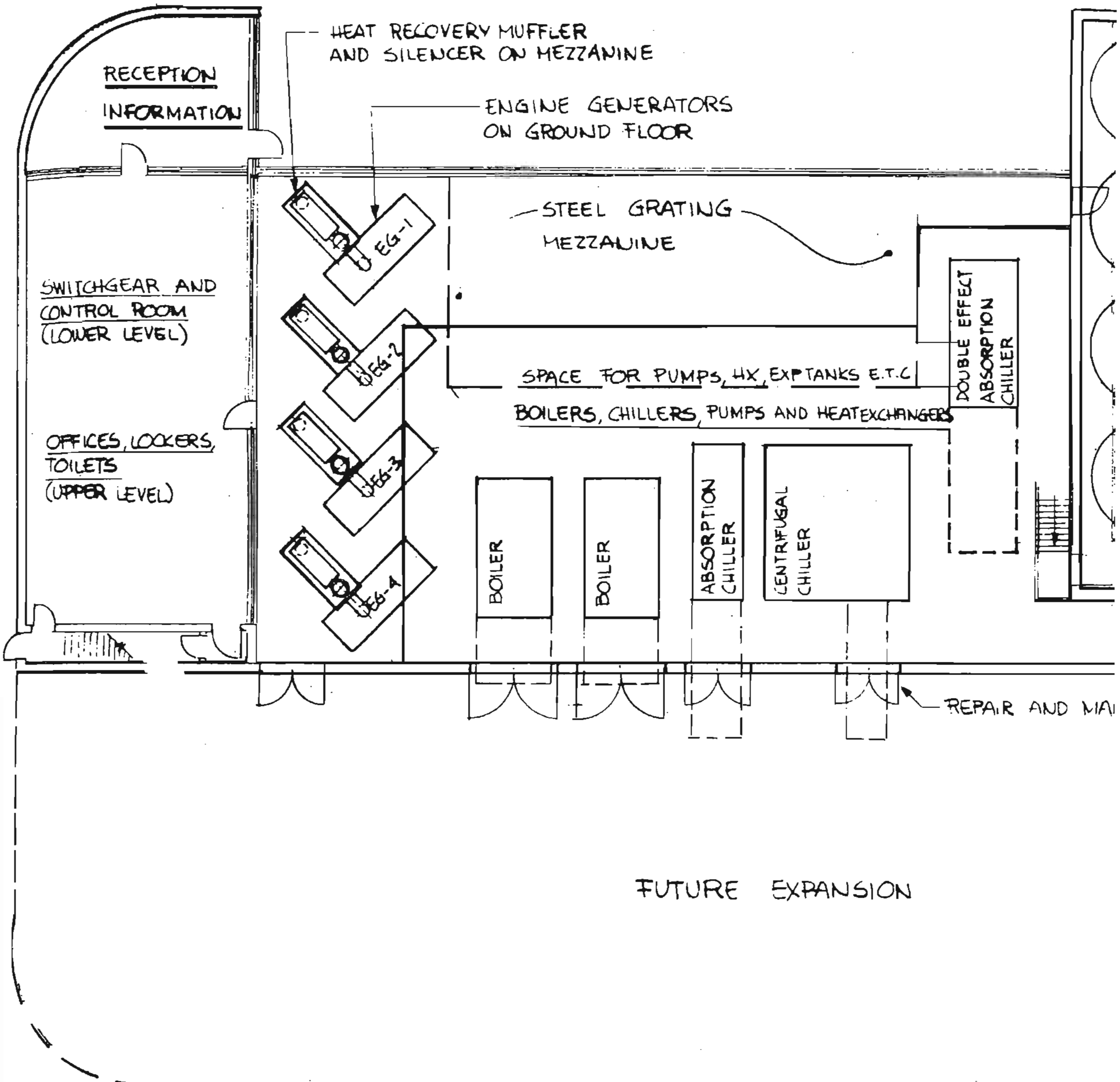
SMALLWOOD VILLAGE SHOPPING CENTER

MIUS

DATE: 18 AUG 1977

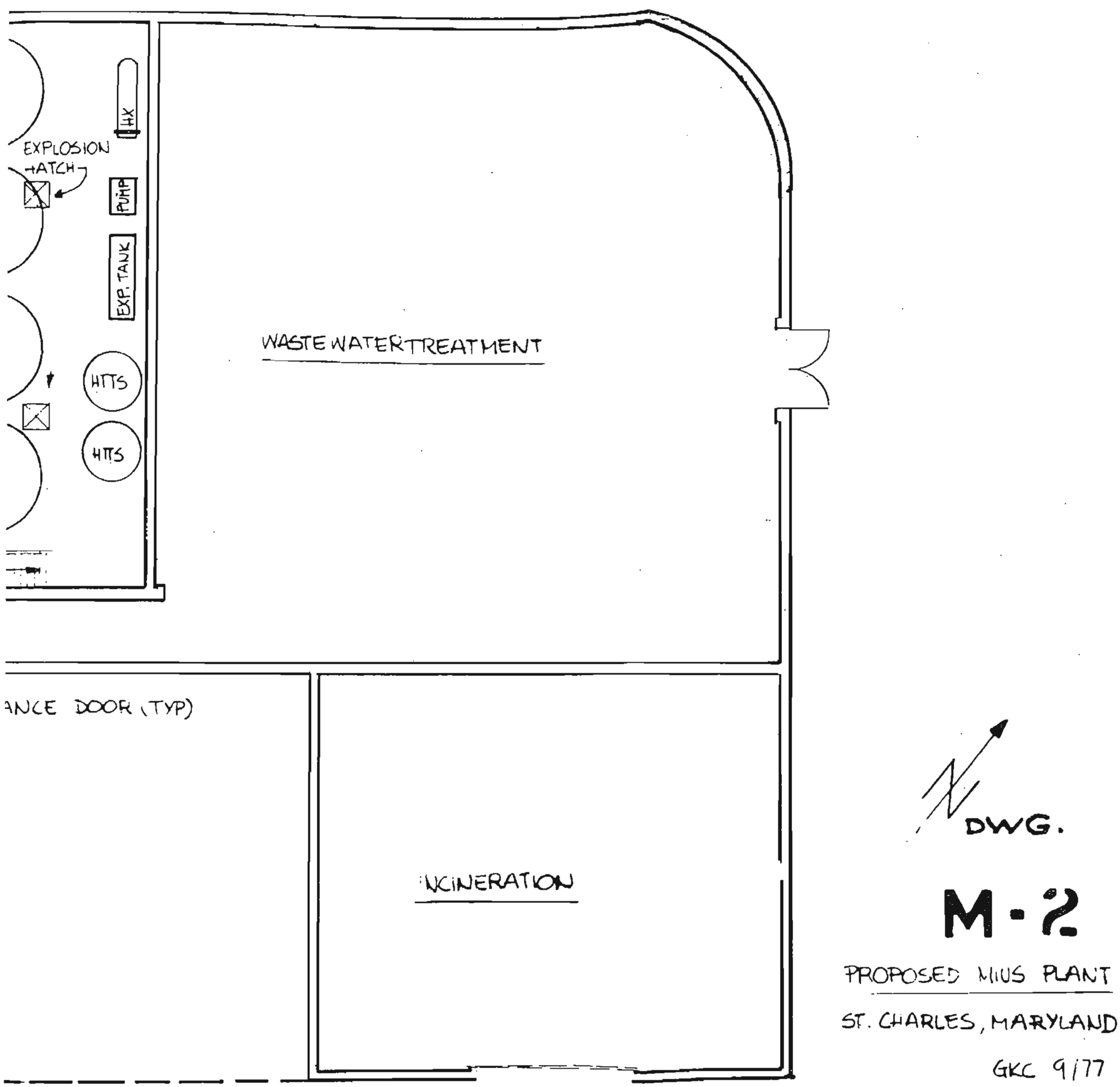
PROJECT NO. 7652

PLANT B-7/B-8

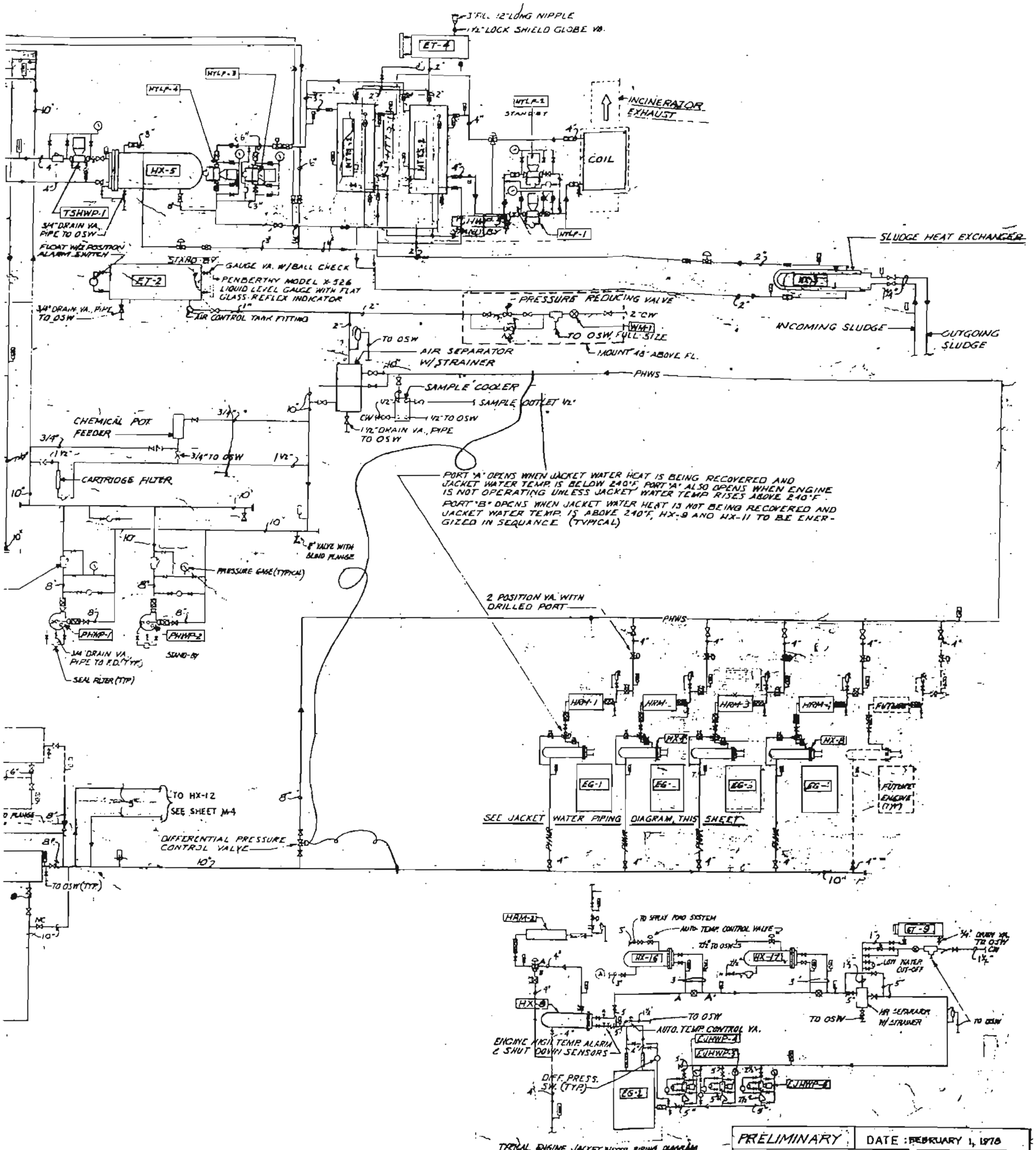


FLOOR PLAN

SCALE : 1/16" = 1'-0"

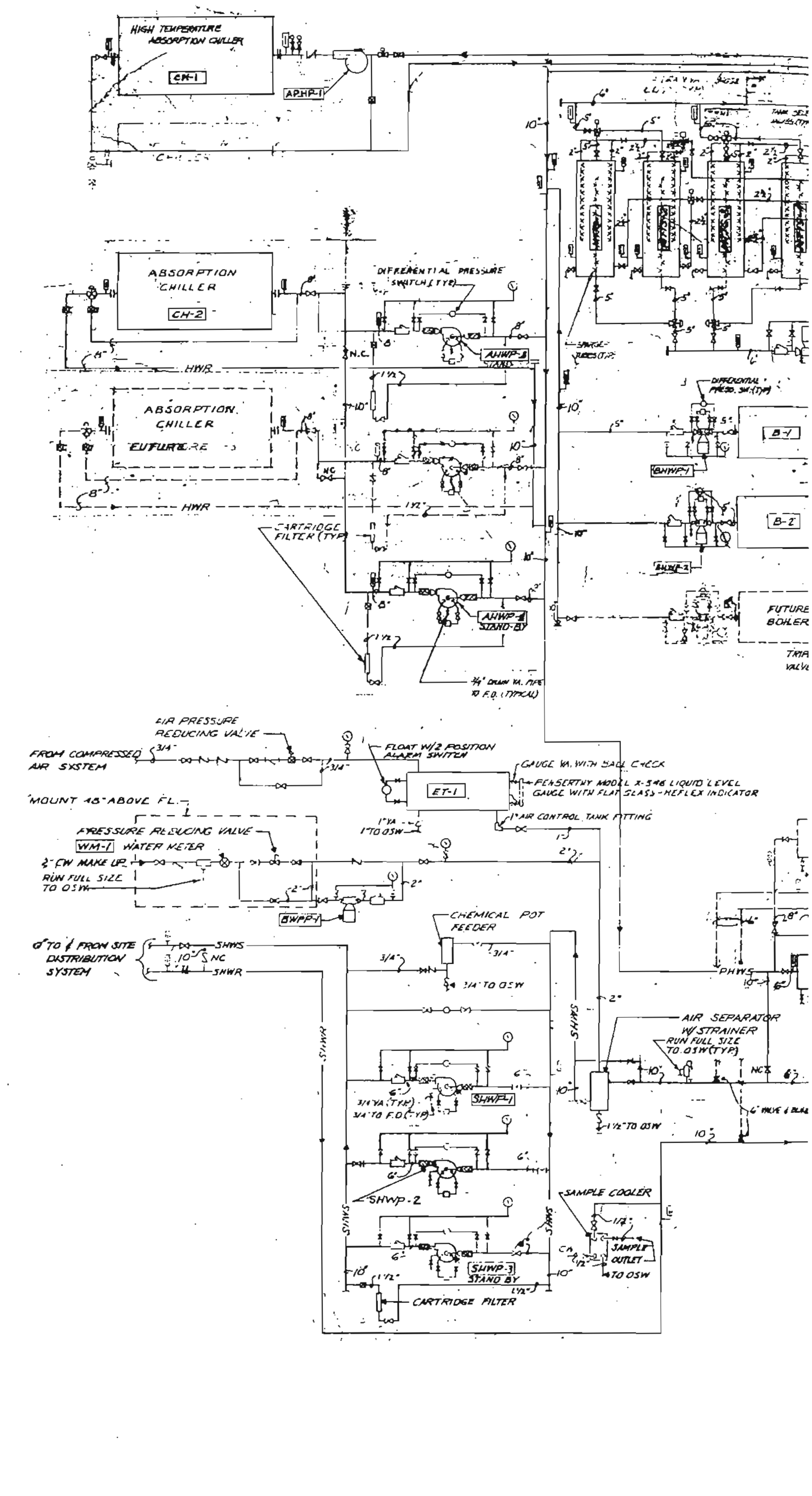


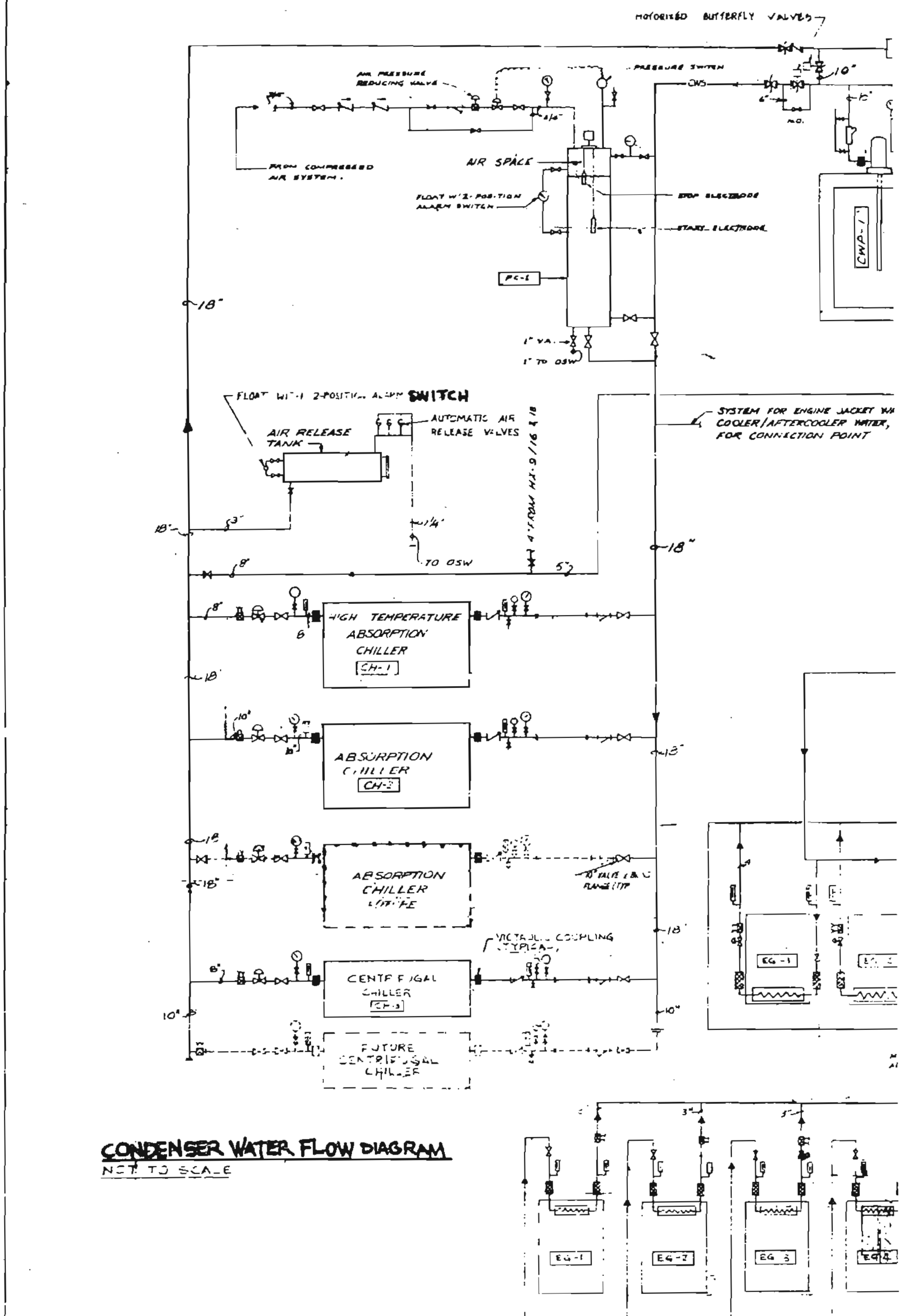
MIUS PLANT / MECHANICAL & ELECTRICAL EQUIPMENT LAYOUT



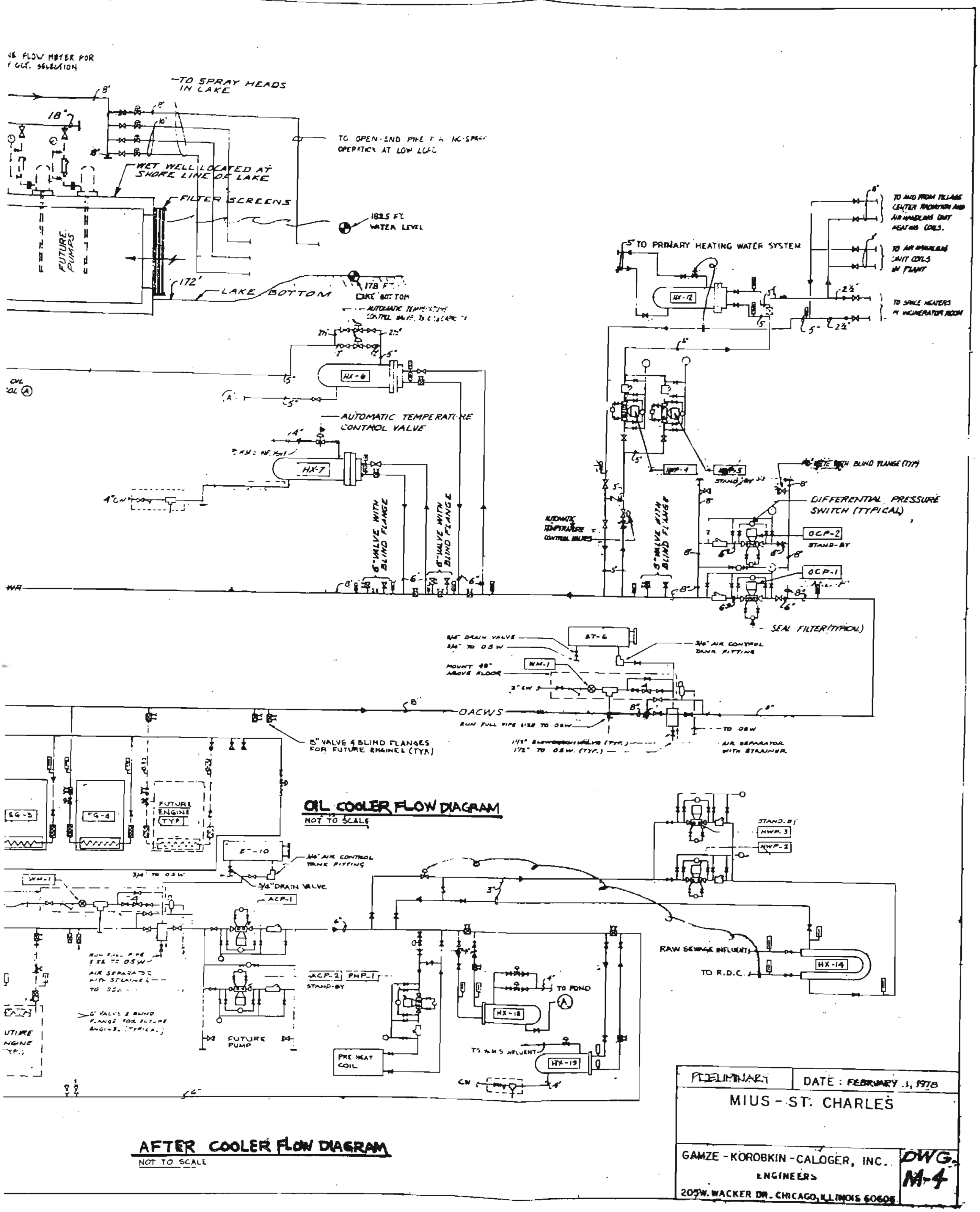
PRIMARY HOT WATER FLOW DIAGRAM

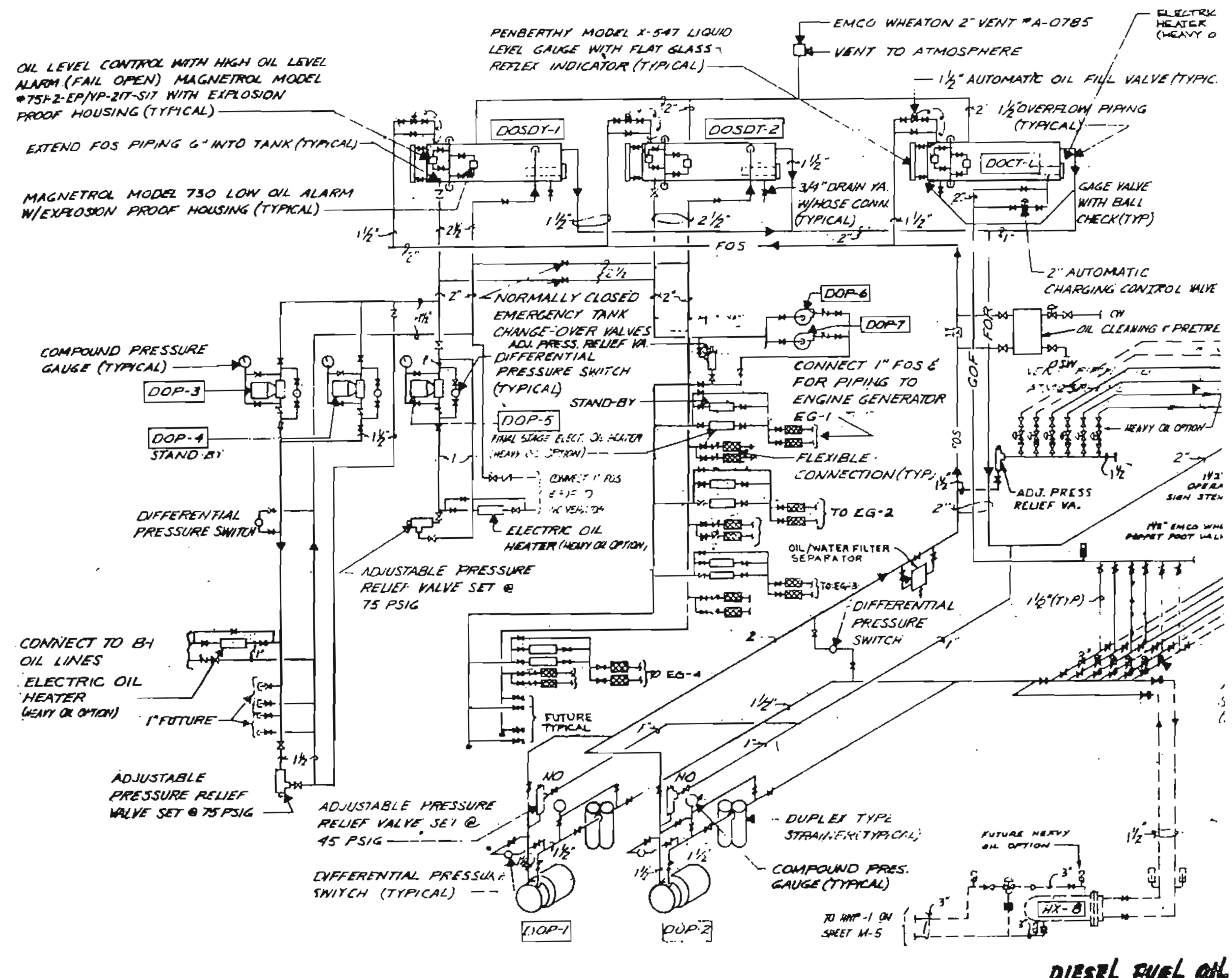
PRELIMINARY	DATE : FEBRUARY 1, 1978
MIUS – ST. CHARLES	
GAMZE - KOROBKIN - CALOGER, INC. ENGINEERS 205 W. WACKER DR. CHICAGO, ILLINOIS 60606	DWG. M-3


HIGH TEMPERATURE ABSORPTION CHILLER
CH-1
APHP-1
ABSORPTION CHILLER
CH-2
HWR
ABSORPTION CHILLER
FUTURE
DIFFERENTIAL PRESSURE SWITCH (TYP)
AHWP-1
CARTRIDGE FILTER (TYP)
AHWP-3 STAND-BY
B-1
B-2
BHWP-1
FUTURE BOILER
AIR PRESSURE REDUCING VALVE
FROM COMPRESSED AIR SYSTEM
FLOAT W/2 POSITION ALARM SWITCH
ET-1
MOUNT 48" ABOVE FL.
PRESSURE REDUCING VALVE
WM-1 WATER METER
2" CW MAKE UP
RUN FULL SIZE TO OSW
BWPP-1
CHEMICAL POT FEEDER
SHWS
SHWR
AIR SEPARATOR W/STRAINER
RUN FULL SIZE TO OSW (TYP)
SHWP-1
SHWP-2
SAMPLE COOLER
SAMPLE OUTLET
TO OSW
SHWP-3 STAND BY
CARTRIDGE FILTER



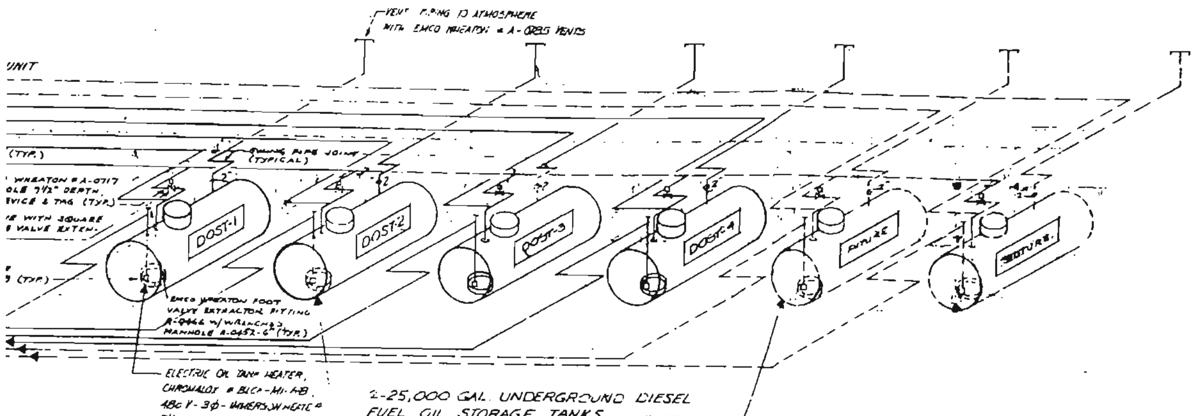
CONDENSER WATER FLOW DIAGRAM
NOT TO SCALE


TO SPRAY HEADS IN LAKE
WET WELL LOCATED AT SHORE LINE OF LAKE
FILTER SCREENS
FUTURE PUMPS
LAKE BOTTOM
183.5 FT. WATER LEVEL
178 FT. LAKE BOTTOM
HX-6
AUTOMATIC TEMPERATURE CONTROL VALVE
HX-7
6" VALVE WITH BLIND FLANGE
TO PRIMARY HEATING WATER SYSTEM
HX-12
TO AIR HANDLING UNIT COILS IN PLANT
TO SPACE HEATERS IN INCINERATOR ROOM
DIFFERENTIAL PRESSURE SWITCH (TYPICAL)
OCP-2
STAND-BY
OCP-1
SEAL FILTER (TYPICAL)
ET-6
WM-1
OACWS
RUN FULL PIPE SIZE TO OSW
TO OSW
AIR SEPARATOR WITH STRAINER
8" VALVE & BLIND FLANGES FOR FUTURE ENGINES (TYP.)
OIL COOLER FLOW DIAGRAM
NOT TO SCALE
FUTURE ENGINE (TYP.)
ET-10
ACP-1
ACP-2
PHP-1
STAND-BY
FUTURE PUMP
HWP-3
HWP-2
RAW SEWAGE INFLUENT
TO R.D.C.
HX-14
HX-18
TO POND
HX-19
PRE HEAT COIL
AFTER COOLER FLOW DIAGRAM
NOT TO SCALE
PRELIMINARY
DATE : FEBRUARY 1, 1978
MIUS - ST. CHARLES
GAMZE - KOROBKIN - CALOGER, INC.
ENGINEERS
205 W. WACKER DR., CHICAGO, ILLINOIS 60606
DWG. M-4



DIESEL FUEL OIL
NOT TO SCALE

ON
N)



C OIL STORAGE TANK
EK CON_ROL VALVE

OSITION:
RMALLY OPEN
RMALLY CLOSED

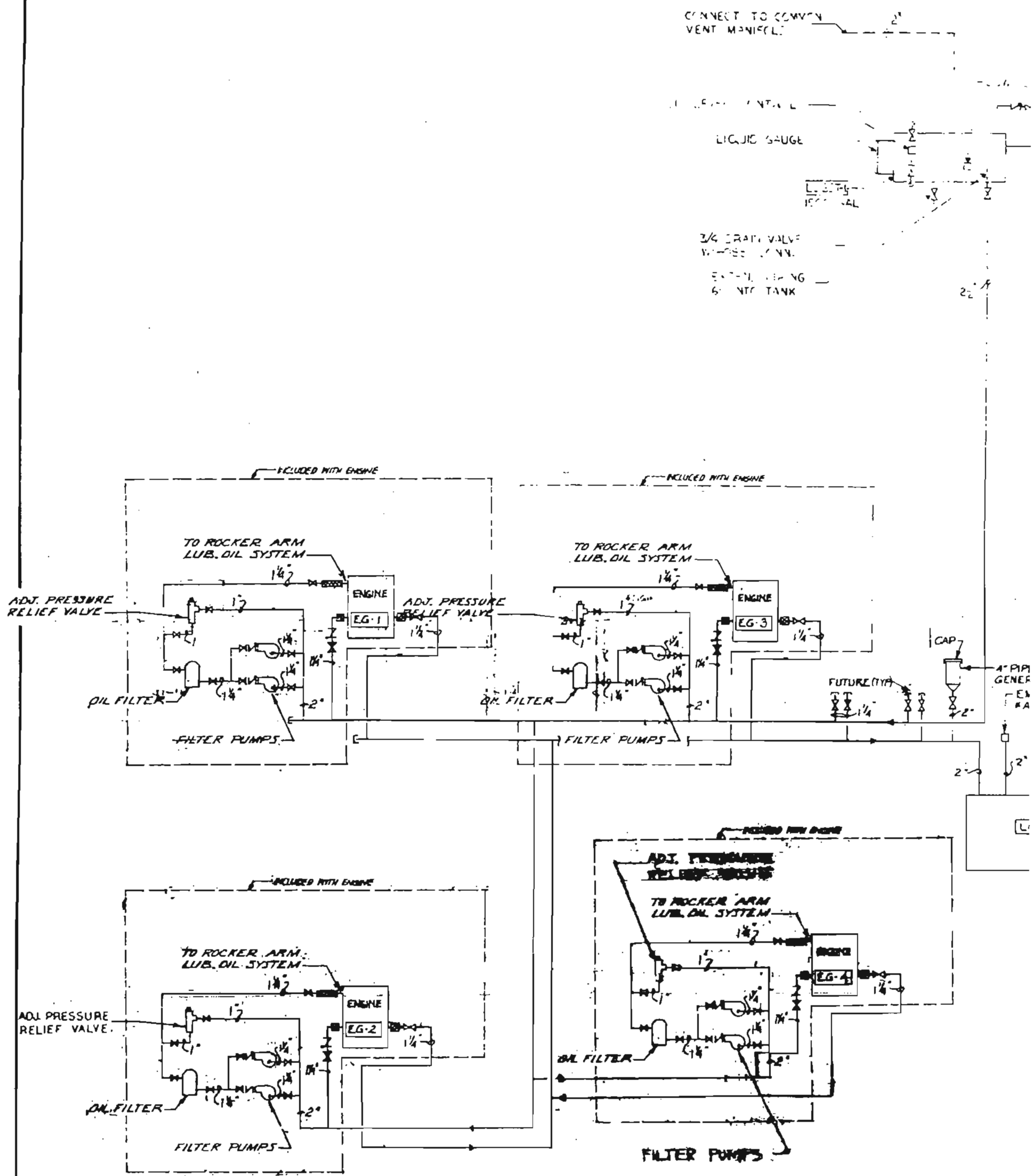
' DIAGRAM

PRELIMINARY | DATE : SEPTEMBER 22, 1977

MIUS - ST. CHARLES

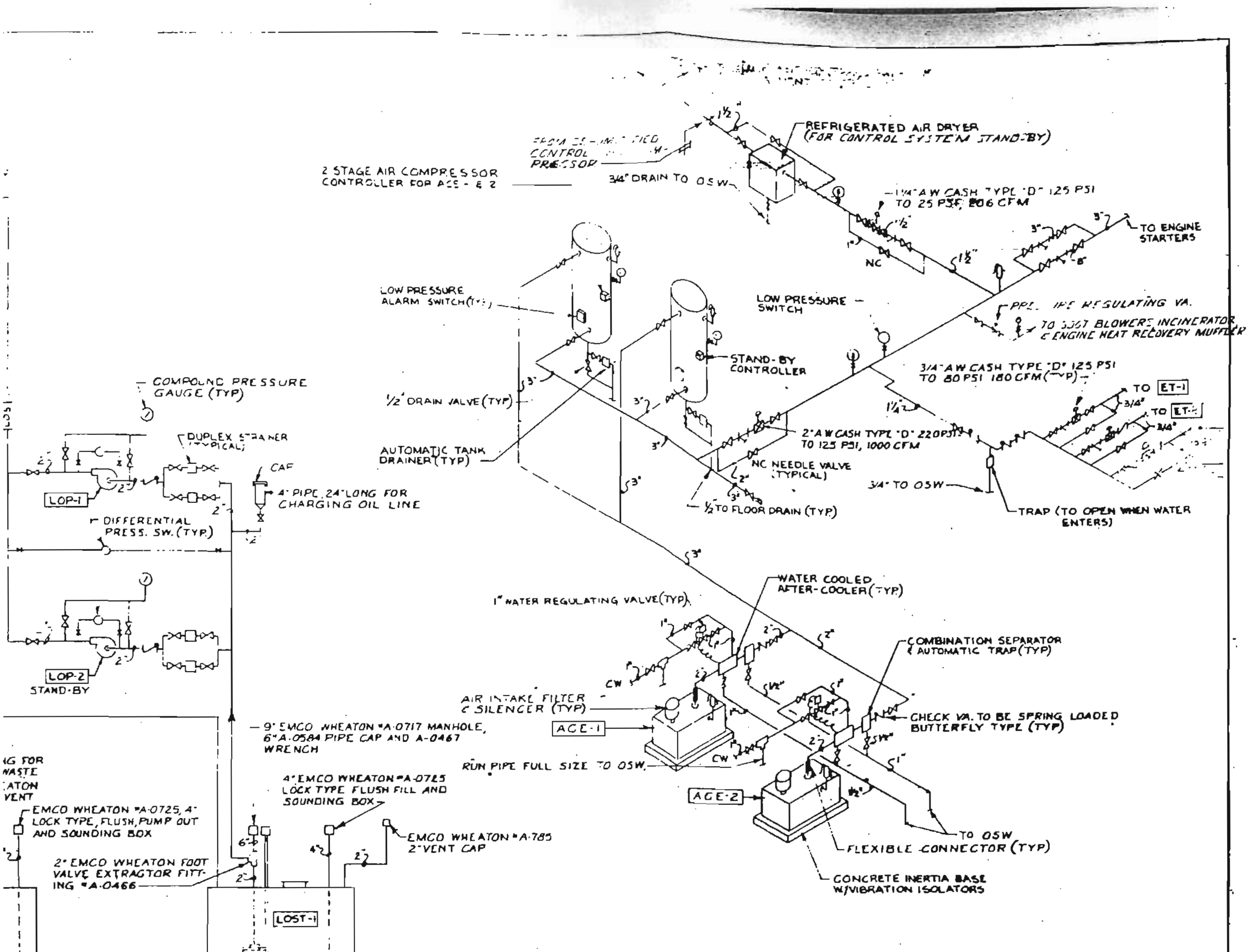
GAMZE - KOROBKIN - CALOGER, INC.
ENGINEERS
205 W. WACKER DR. CHICAGO, ILLINOIS 60606

DWG. M-5



LUBRICATING OIL FLOW DIAGRAM

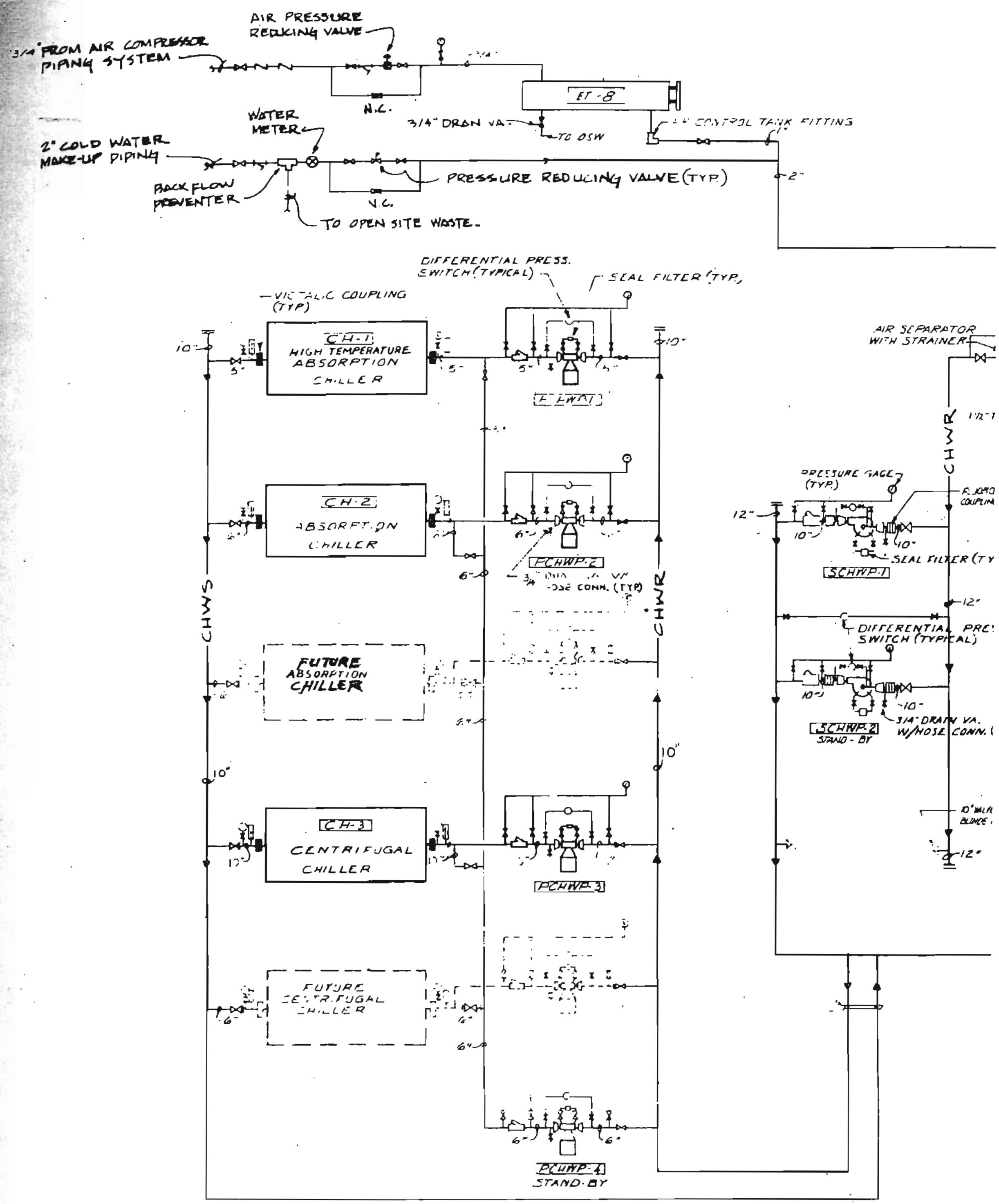
N.T.S.



COMPRESSED AIR FLOW DIAGRAM

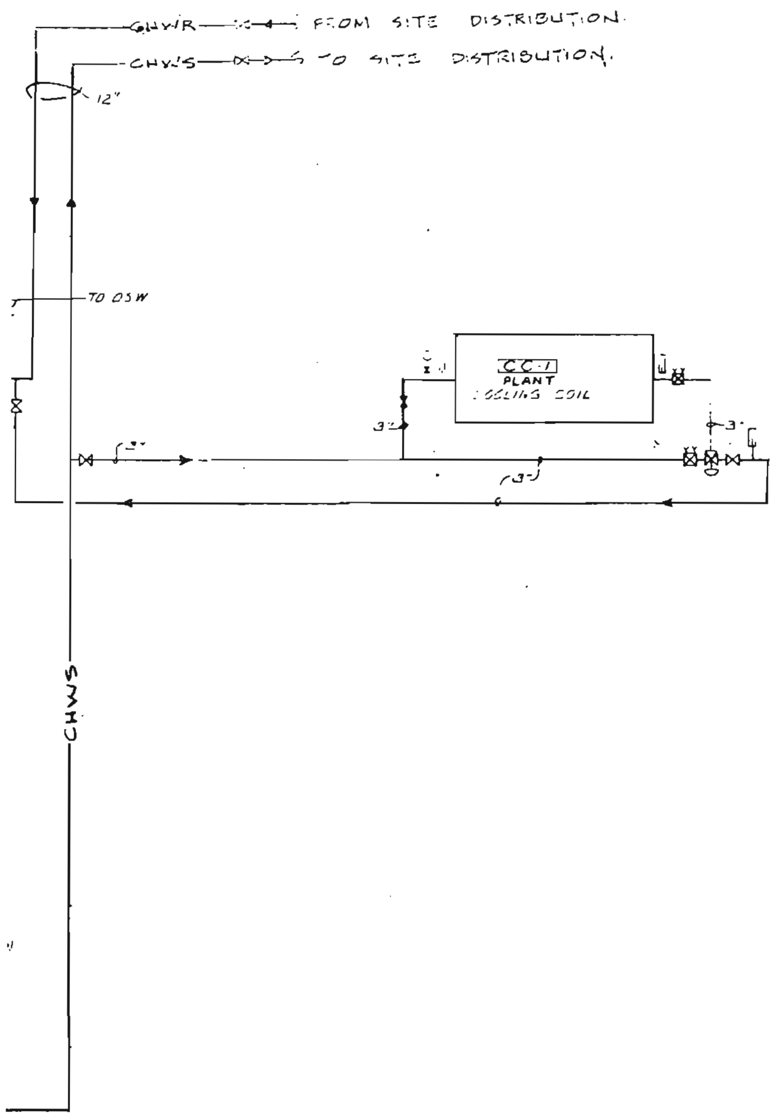
NOT TO SCALE

PRELIMINARY	DATE: SEPTEMBER 22, 1977
MIUS - ST. CHARLES	
GAMZE-KOROBKIN-CALOGER, INC. ENGINEERS 205 W. WACKER DR. CHICAGO, ILLINOIS 60606	DWG. M-6

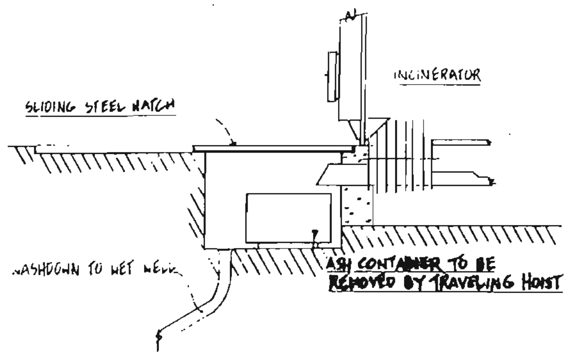


CHILLED WATER FLOW DIAGRAM

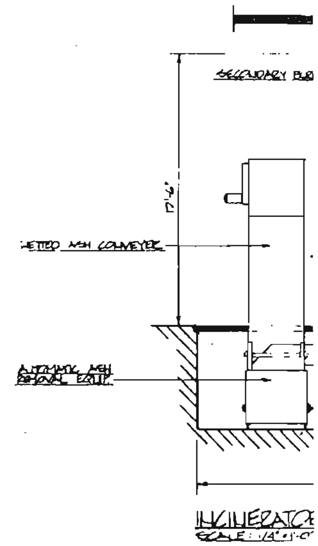
NOT TO SCALE

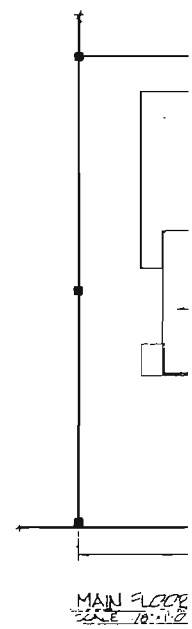


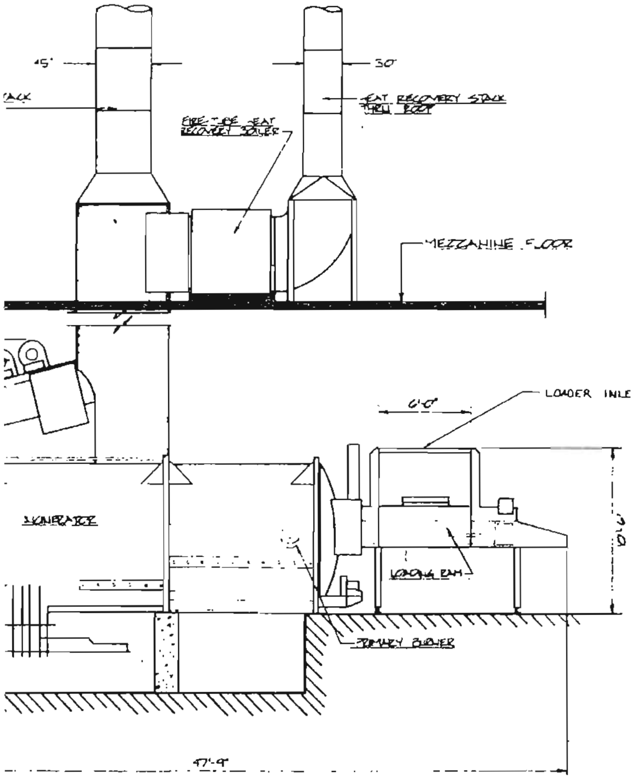
PRELIMINARY	DATE : SEPTEMBER 22, 1977
MIUS - ST. CHARLES	
GAMZE - KOROBKIN - CALOGER, INC. ENGINEERS 205 W. WACKER DR. CHICAGO, ILLINOIS 60606	DWG. M-7



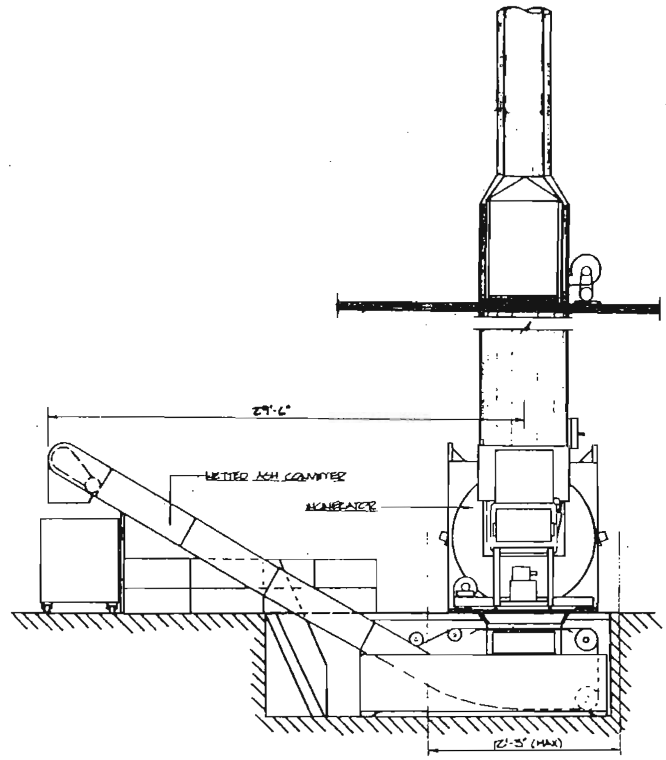
ALTERNATE ASH REMOVAL
SCALE: ¼" = 1'-0"



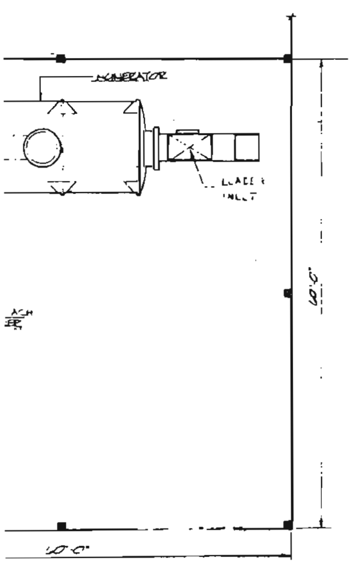




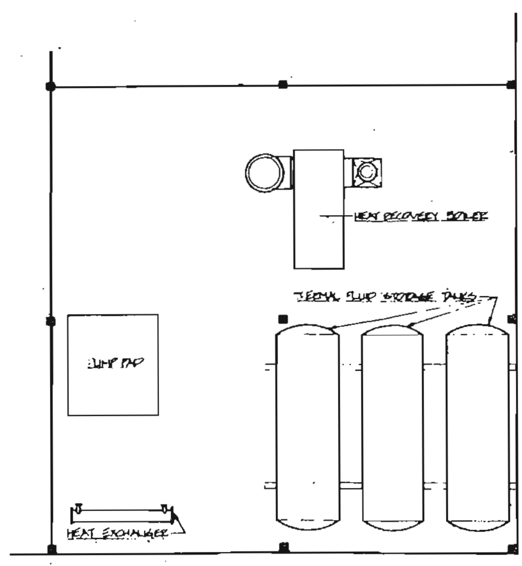
E VIEW



INCINERATOR END VIEW
SCALE: 1/4"=1'-0"



- SOLID WASTE SUBSYSTEM



MEZZANINE FLOOR PLAN - SOLID WASTE SUBSYSTEM
SCALE: 1/8"=1'-0"
NOTE: FOR ZONING SEE PRELIMINARY DESIGN REPORT DWG M-4

PRELIMINARY	DATE: SEPTEMBER 22, 1977
MIUS - ST. CHARLES	
GAMZE - KOROBKIN - CALOGER, INC. ENGINEERS 205 W. WACKER DR. CHICAGO, ILLINOIS 60606	DWG: M-8

SOLID WASTE SUBSYSTEM

EXHAUST FAN SCHEDULE

UNIT	SERVICE and LOCATION	CFM	S.P. W.G.	RPM	MOTOR HP	V.	PHASE	DRIVE	WHEEL DIAM.	WALL or ROOF OPENING	MFGR. & MODEL NO.	REMARKS
GEF-1	GENERAL EXHAUST ROOF	10,300	.25	1100	1½	480	3	BELT	30"	32"	PENN VENTILATOR 30H4528	① ②
GEF-2 TO GEF-7	" "	22,400	.25	780	5	480	3	BELT	42"	44"	PENN VENTILATOR 42H6836	① ②
GEF-8	" "	845	.25	815	⅙	120	1	BELT	—	16½"	PENN VENTILATOR [illegible]-45	② ③
GEF-9	" "	8,000	.25	860	1	480	3	BELT	30"	32"	PENN VENTILATOR 30HG827	① ②
GEF-[illegible]	" "	9,700	.68	340	5	480	3	BELT	48"	50"	PENN VENTILATOR [illegible]	② ③
TEF-1	TOILET EXHAUST ROOF	1,540	.25	400	¼	120	1	BELT	—	20"	PENN VENTILATOR CB-05M	② ③

① TYPE "RB", BUTTERFLY DAMPER, AND DISCONNECT.

② ACOUSTICAL AND THERMAL INSULATE 12" HIGH ROOF CURB.

③ MOTORIZED DAMPERS, DISCONNECT AND BIRDSCREEN

FAN SCHEDULE 480Y-3Ø-60~

Unit Number	Service	Location	Type	CFM	O.V. FPM	S.P. WG.	HP / RPM	Drive	Rot.	Disch.	Arr'g.	REMARKS
S-1 S-2	HEATING AND VENTILATION	MEZZ	HORZ. DRAW THRU	30,000	1816	1.25	10 / 1750	BELT	—	—	—	TRANE TORRIVENT — LP NO. 50
S-3	HEATING AND COOLING	MEZZ	HORZ. DRAW THRU	20,000	1475	2.75	15 / 1750	BELT	—	—	—	TRANE MP NO. 41
SF-1 TO 6	SUMMER VENTILATION	ROOF	PROP	30000	—	.25	7½ / 1750	BELT	—	—	—	PENN VENTILATOR AB 5411 ①

① FILTER EQUIPPED SUPPLY FAN WITH AIR INTAKE HOOD FOR (8) 16×25×2 & (12) 20×25×2 CLEANABLE FILTERS, MOTORIZED DAMPERS, DISCONNECT, BIRD SCREEN, ACOUSTICAL AND THERMAL INSULATED 12" HIGH ROOF CURB

UNIT HEATER SCHEDULE 480Y-3Ø-60~ ENT. WATER 140 °F. LVG. WATER 100 °F.

Unit Number	Location	Type	Htg. Cap. MBH	Total GPM	CHILLED [illegible]	CFM	Final Air Temp.	Water P.D. Ft. HO	Mtr HP.	RPM	REMARKS
MAU-1	ROOF	MAKE-UP AIR UNIT	898.6	461	23	13,000	64	10	2½	850	① WING CO. SIZE 4A

① INTAKE HOOD WITH 2" CLEANABLE FILTERS, 6" INSULATED ROOF CURB, NO. 5 HCF DISCHARGE, PNEUMATIC CONTROL SYSTEM

WATER TO WATER HEAT EXCHANGER SCHEDULE

UNIT NO	SERVICE	SHELL SIDE GPM	SHELL SIDE EWT	SHELL SIDE LWT	SHELL SIDE PSIG	TUBE SIDE GPM	TUBE SIDE EWT	TUBE SIDE LWT	TUBE SIDE PSIG	TUBE SIDE [illegible]	TUBE SIDE PASS	TUBE SIDE F.F.	MANUFACTURER & MODEL	REMARKS
HX-1	SITE HEATING	1500	160	200	4	1700	235	200	3	1822	2	.0005	BELL & GOSSETT QC 2614-212	SPLIT TUBE
HX-3	SLUDGE HEATING	45	650	450	3	12.5	70	425	1.5		4	.001	STEELTUBE QE 69-42	DOWTHERM "A" IN SHELL SIDE
HX-5	[illegible]	117	650	450	2.5	143	230	300	1		2		STEEL TUBE QC106-25	DOWTHERM "A" IN SHELL SIDE
HX-6	[illegible]	[illegible]	80	110	4.3	260	174	148	.5				BELL & GOSSETT QWU 147-22	
HX-7	[illegible] COOLER	140	70	100	3.7	260	134	144	.4				BELL & GOSSETT QWU 146-22	
HX 9,16	JACKET SAFETY COOLER	95	80	125	3.4	118.5	242	206	.5		2		BELL & GOSSETT WU 85 24	
HX 10,15	PRIMARY HEATING	213	200	220	6	356	242	230	1.3		2		BELL & GOSSETT WU 129-26	
HX 11,17	[illegible] COOLER	66	60	125	2	118.5	242	206	.5		2		BELL & GOSSETT WU 86-24	
HX 12	[illegible] HEATING	450	200	160	5.5	450	100	140	1		2		BELL & GOSSETT WU 1810-212	
HX 14	[illegible] HEATING	350	140	120	6.5	250	60	85	1		2		BELL & GOSSETT QC 127-210	
HX 18	AFTER COOLER	147	80	110	4.8	260	147	130	.4				BELL & GOSSETT QWU 146-28	
HX 17	AFTER COOLER	147	70	100	3.4	260	147	130	.4				BELL & GOSSETT QWU 146-28	

	CFM	F.V. FPM	Coil Size	Htg. Cap. BTU/HR	GPM	H_2O P.D. Ft. HD.	Ent. Air °F	Lvg. Air °F	No. Rows	Max. Air Frict.	REMARKS
2	30,000	622	(2) 33-105	1,296,000	65	—	16	56	1	—	TRANE
	20,000	494	(1) 24-100 (1) 30-100	367,200	18	—	37	54	1	—	TRANE
	14,000	679	33-90	544,320	27	—	54	90	1	—	
E	1780	600	18-24	61,517	3	—	54	86	1	—	
	845	563	[illegible]	25,553	1.3	—	54	82	1	—	
3	1540	600	12-30	48,896	2.5	—	54	84	1	—	
	1835	600	18-24	47,563	2.4	—	54	78	1	—	

HOT WATER HEATING COIL SCHEDULE

ENT. WATER 140 °F.
LVG. WATER 100 °F.

CHILLED WATER COOLING COIL SCHEDULE

ENT. WATER 42 °F.
LVG. WATER 56 °F.

	CFM	F.V. FPM	Coil Size	Cooling Cap. BTU/HR	GPM	H_2O P.D. Ft. HD.	Ent. Air DB	Ent. Air WB	Lvg. Air DB	Lvg. Air WB	No. Rows	Max. Air Frict.	REMARKS
	20,000	494	24-108 30-108	630,000	90	—	79	65	57	55	6	—	TRANE

PUMP SCHEDULE

	Location	GPM	Head Ft.	Mtr. HP.	RPM	Liquid Temp.	Type	Manufacturer Model No.	REMARKS
R		1700	25	15	1150			BELL & GOSSETT VSC 8×8×10½	PHWP-2 STAND-BY
R		900	15	5	1150			BELL & GOSSETT VSC 6×6×9¾	
ER		700	15	5	1150			BELL & GOSSETT VSC 6×6×9¾	
R		1000	20	7½	1150			BELL & GOSSETT VSC 8×8×10½	AHWP-2 STAND-BY
R		750	80	20	1750			BELL & GOSSETT VSC 6×6-12	SHWP-3 STAND-BY
TK		HB	25	2	1750	400°F		GOULD PUMP 3736 HPI	
		180	20	2	1750	750°F		GOULD PUMP 3735 HPI	HTLP-2 STAND-BY
		800	25	7½	1750	750°F		GOULD PUMP 3735 HPI	HTLP-4 STAND-BY
EAT		475	20	4	1750	300°F		GOULD PUMP 3736 HPI	
KER		950	25	7½	1150	400°F		GOULD PUMP 3736 HPI	
ER		5000	130	125	1750			BELL & GOSSETT VSC 12×14×15	SCWP-2 STAND-BY VARIABLE SPEED
R		KA0	20	10	1750			BELL & GOSSETT SER. 80 4×4-9½	
ER		200	20	3½	3500			BELL & GOSSETT SER. 80 4×4×9½	
ER		2000	20	15	1150			BELL & GOSSETT VSC 8×10×10½	PCHWP-4 STAND-BY
		8000	150	100	1460			FMC 14 MFH	
		320	60	10	1750			BELL & GOSSETT SER. 80 3×3×9½	OCP-2 STAND-BY
		320	60	10	1750			BELL & GOSSETT SER. 80 3×3×9½	ACP-2 STAND-BY
		[illegible]			[illegible]				
		[illegible]		[illegible]					
		350	15	3	1750			BELL & GOSSETT SER. 80 4×4	HWP-3 STAND-BY
		450	90	15	1750			BELL & GOSSETT SER. 80 4×4×9½	HWP-5 STAND-BY
		66	120	10	1200			TUTHILL 7CF	DOP-2 STAND-BY
		3.3	258	½	600			TUTHILL MODEL 2 CF	SUPPLIED WITH BOILERS
R		7	120	½	1200			TUTHILL OLA	
		20	120	1½	1200			TUTHILL 4CG	LOP-2 STAND-BY
TER		50	220	7½	3500			BELL & GOSSETT SER. 80 1½×1½×7	
		600	120	(2) 20	3500			BELL & GOSSETT 70M 4A30C	
		27	120	3	1200			TUTHILL 5CG	DOP-7 STAND-BY
ET		356	75	15	1750			BELL & GOSSETT SER. 80 4×4×9½	EJHWP-2, 5 STAND-BY
ET		60	10	¾	1750			BELL & GOSSETT SER. 80 1½×1½×7	ENGINE ON STAND-BY

PRELIMINARY	DATE : FEBRUARY 1, 1978
MIUS - ST. CHARLES	
GAMZE - KOROBKIN - CALOGER, INC. ENGINEERS 205 W. WACKER DR., CHICAGO, ILLINOIS 60606	DWG. M-9

MECHANICAL EQUIPMENT SCHEDULE

TAG	DESCRIPTION
CH-1	HIGH TEMPERATURE ABSORPTION CHILLER CAPACITY: 337 TONS CHILLED WATER: 669 GPM FROM 56°F TO 42°F, PD [illegible] FT., [illegible] PASS, FOULING .0005 CONDENSER WATER: 1300 GPM FROM 80°F TO 94°F, PD 35 FT., 4 PASS, FOULING .001 CONDENSE: 552 GPM FROM [illegible]°F TO [illegible]61°F, PD 18 FT., 6 PASS ELECTRICAL: 7½ HP 480V-3Ø-60~ MANUFACTURER: TRANE MODEL
CH-2	ABSORPTION CHILLER CAPACITY: 381 TONS CHILLED WATER: 600 GPM FROM 56°F TO 42°F, PD 12 FT., [illegible] PASS, FOULING .0005 CONDENSER WATER: [illegible]50 GPM FROM 80°F TO 94°F, PD [illegible] FT., [illegible] PASS, FOULING .001 HOT WATER: 345 GPM FROM 220°F TO 207°F, PD [illegible] FT., 1 PASS, FOULING .0005 ELECTRICAL: 7.5 HP 480V-3Ø-60~ MANUFACTURER: TRANE MODEL ABSC-03F.
CH-3	CENTRIFUGAL CHILLER CAPACITY: [illegible] TONS CHILLED WATER: [illegible]00 GPM FROM 56°F TO 42°F, PD 13 FT., 2 PASS, FOULING 0.0005 CONDENSER WATER: 2350 GPM FROM 80°F TO 94°F, PD 10 FT., 2 PASS, FOULING [illegible] ELECTRICAL: 615 KW 480V-3Ø-60~ MANUFACTURER: TRANE MODEL CVHA-035
B1 B2	BOILER (WATER) CAPACITY: BOILER HP 400, INPUT [illegible] MBH, OUTPUT 10,390 MBH, #1 RINGELMANN, BOILER DESIGN 100 PSIG. ASME STAMPED, RELIEF VALVES; 75 PSIG W.P. ASME STAMPED, MAX. WATER TEMP. 245°F, FORCED DRAFT BLOWER INLET SILENCER, DAVITED DOORS, LOW WATER CUTOFF, HIGH LIMIT AND OPERATING AQUASTATS, CONTROL PANEL MOUNTED ON BOILER, DIESEL FUEL OIL BURNER, BURNER SHALL BE FULL MODULATION WITH LOW FIRE START, 20 HP, 480V-3Ø-60~ BLOWER MOTOR, 120V CONTROL CIRCUIT MANUFACTURER: CLEAVER BROOKS. MODEL CB-400
EG-1 EG-2 EG-3 EG-4	ENGINE GENERATOR 1115 BHP AT 1200 RPM, 300 KW OUTPUT JACKET WATER: 356 GPM AT 34 FT. PD HEAT RECOVERY MAXIMUM. 2,952,000. BTU/HR AFTERCOOLER. 80 GPM AT 11.6 FT. PD. OIL COOLER. 80 GPM AT 4.6 FT. PD. SEE SPECIFICATIONS FOR DETAILS MANUFACTURER: CATERPILLAR MODEL D-399TA
PACU-1	PACKAGED AIR CONDITIONING UNIT (FURNISHED AS PART OF DAS) CAPACITY: 35 MBH AT 67°F EWB, 75°F ENTERING WATER TO CONDENSER-95°F LEAVING WATER, WATER REGULATING VALVE, 1200 CFM SUPPLY AIR AT 3/8" SP, 1/2 HP 480V-3Ø-60~ FAN MOTOR, COMPRESSOR MOTOR 480V-3Ø-60~ 3.1 KW. UNIT TO BE COMPLETE WITH DISCHARGE AIR PLENUM, 2" THICK CLEANABLE AIR FILTERS, RETURN AIR GRILL, FULLY CHARGED WITH FREON AND OIL, BUILT-IN THERMOSTAT, STARTER AND SAFETY CONTROLS MANUFACTURER: TRANE MODEL SUW-30

TAG	
HRS-1 HRS-2	
ACE-1 ACE-2	
MTTS-1 MTTS-2 MTTS-3 MTTS-4	
HTTS-1 HTTS-2	
LOST-1	
IHRS-1	
LOSWT-1	
DOST-1 DOST-2	
DOSDT-1 DOSDT-2	
DOSDT-3	
DOCT-1	
WM-1	
GFT-1 GFT-2 GFT-3 (OPTIONAL)	
CT-1	

DESCRIPTION

[illegible] HEAT RECOVERY SYSTEM
[illegible]OVERY : 3.8[illegible] 522 BTU/HR EXHA[illegible] SIDE [illegible]
[illegible] MUFFLER [illegible] 171 GPM AT [illegible] FT PD

PRESSOR (ELECTRIC MOTOR DRIVEN)
Y: 54 CFM AT 250 PSIG, 2 STAGE [illegible] 15 HP 460V·3ϕ·60~ 1750 RPM
UNIT COMPLETE WITH 2-PRESSURE SWITCHES #2298P UNLOADED START,
TAKE FILTER & SILENCER, INTERCOOLER, MOTOR, SLIDE RAILS, BELT GUARD,
OOLED AFTERCOOLER #7734, [illegible]MBINATION SEPARATOR & AUTO. TRAP #5077
GULATING VALVE #7651, RUNNING HOUR METER #7614 ALTERNATOR #7645,
CTURER: QUINCY MODEL C 5105

Y: 51 CU. FT. 36"ϕ × 8'-0" HIGH, 250 PSIG WORKING PRESSURE, ASME
D, 3" INLET, 3" DISCHARGE, 1¼" SAFETY VALVE, ¼" GAUGE, ½" REGULATOR.
TURER: ADAMSON CO. MODEL F-96
C TANK DRAINER, QUINCY # 7639-SPECIAL FOR 250 PSI
RELIEF VALVES - ASME, 1" QUINCY # 5527

TEMPERATURE THERMAL STORAGE
: 20,000 GALLONS, 14'-0" DIA. × 17'-6" HIGH VERTICAL TANK WITH LEG
, MANHOLE, PIPE CONNECTION OPENINGS AS SHOWN, ASME STAMPED
PSIG WP AT 300°F
CTURER: ADAMSON CO.

MPERATURE THERMAL STORAGE
Y: 2,000 GALLONS 7'-0" DIA. × 10'-0" HIGH VERTICAL GALVANIZED
H LEG SUPPORTS, MANHOLE, PIPE CONNECTION OPENINGS AS SHOWN,
TAMPED FOR 100 PSIG WP AT 650°F
CTURER: ADAMSON CO.

ING OIL STORAGE TANK
: 4000 GALLONS, 72"ϕ × 19'-10" LONG COMPLETE WITH 24"ϕ MANHOLE
PIPE CONNECTION OPENINGS AS SHOWN, TANK TO BE SET UNDER-
WITH CONCRETE HOLD DOWN PAD, UNDERWRITERS LABEL
CTURER: OWENS-CORNING FIBERGLAS

OR HEAT RECOVERY SYSTEM
[illegible]OVERY : 7.4 X 10^6 BTU/HR
THRU COIL 176 GPM

TING OIL STORAGE WASTE TANK
Y: 4000 GALLONS, 72"ϕ × 19'-10" LONG COMPLETE WITH 24"ϕ MANHOLE,
PIPE CONNECTIONS AS SHOWN, TANK TO BE SET UNDERGROUND WITH
E HOLD DOWN PAD, UNDERWRITERS LABEL
TURER: OWENS-CORNING FIBERGLAS

OIL STORAGE TANK
: 25,000 GALLONS 126"ϕ × 38'-7" LONG, COMPLETE WITH 24"ϕ MANHOLE,
PIPE CONNECTIONS AS SHOWN, TANK TO BE SET UNDERGROUND
CRETE HOLD DOWN PAD, UNDERWRITERS LABEL
TURER: ADAMSON CO.

OIL STORAGE DAY TANK
Y: 1,500 GALLONS, 64"ϕ × 9'-0" LONG, PROVIDE PIPE CONNECTIONS AS
ENBERTHY X-547 LIQUID LEVEL GAUGE WITH FLAT GLASS-REFLEX
R, GAUGE VALVE WITH BALL CHECK, SADDLES, UNDERWRITERS LABEL
CTURER: ADAMSON CO.

OIL STORAGE DAY TANK
: 1,000 GALLONS, 64"ϕ × 6'-0" LONG, PROVIDE PIPE CONNECTIONS AS
NBERTHY X-547 LIQUID LEVEL GAUGE WITH FLAT GLASS-REFLEX
, GAUGE VALVE WITH BALL CHECK, SADDLES, UNDERWRITERS LABEL
TURER: ADAMSON CO.

OIL CHARGING TANK
THE SAME AS DOSDT-1

METER
WATER METER MODEL SC-ER WITH BADGER FLOW FINDER (REFER
INGS FOR REQUIRED NUMBER OF METERS)

ILL TANK
Y: 24 GALLONS, 13"ϕ × 42" LONG, PROVIDE PIPE CONNECTIONS AS
AUGE GLASS, 125 PSIG WP ASME STAMPED
TURER: BELL & GOSSETT MODEL 24

ION TANK (SECONDARY HEATING SYSTEM)
: 1200 GALLONS, 48"ϕ × 14'-0" LONG, AIR CONTROL TANK FITTING PENBERTHY
UID LEVEL GAUGE, 125 PSIG WP, ASME STAMPED, MECHANICALLY
RIZED TANK
TURER: ADAMSON CO.

SYMBOL LIST

HWS	HOT WATER SUPPLY
HWR	HOT WATER RETURN
PHWS	PRIMARY HOT WATER SUPPLY
PHWR	PRIMARY HOT WATER RETURN
SHWS	SECONDARY HOT WATER SUPPLY
SHWR	SECONDARY HOT WATER RETURN
OACWS	OIL COOLER AFTERCOOLER WATER SUPPLY
OACWR	OIL COOLER AFTERCOOLER WATER RETURN
CHWS	CHILLED WATER SUPPLY
CHWR	CHILLED WATER RETURN
PCHWS	PRIMARY CHILLED WATER SUPPLY
PCHWR	PRIMARY CHILLED WATER RETURN
SCHWS	SECONDARY CHILLED WATER SUPPLY
SCHWR	SECONDARY CHILLED WATER RETURN
A	PNEUMATIC AIR
CW	CITY WATER
CWS	CONDENSER WATER SUPPLY
CWR	CONDENSER WATER RETURN
LOS	LUBE OIL SUPPLY
LOW	LUBE OIL WASTE
FOS	FUEL OIL SUPPLY
FOR	FUEL OIL RETURN
GOF	GRAVITY OIL FILL
ST	OVER HEAD STORM
V	VENT
RD	ROOF DRAIN
FD	FLOOR DRAIN
CI	CAST IRON PIPE
OSW	OPEN SIGHT WASTE
CO	CLEAN OUT
NO	NORMALLY OPEN
NC	NORMALLY CLOSED
NBS	NATIONAL BUREAU OF STANDARDS
— - —	DOMESTIC COLD WATER LINE
— - - —	DOMESTIC HOT WATER LINE
—I—	UNDERGROUND SANITARY SEWER
—II—	UNDERGROUND STORM SEWER
—●—	BELL & GOSSETT CIRCUIT SETTER
—⋈—	GATE VALVE
—⋈—	GLOBE VALVE
—⋈—	LUBRICATED PLUG VALVE WITH GAGE SHUT-OFF VALVES

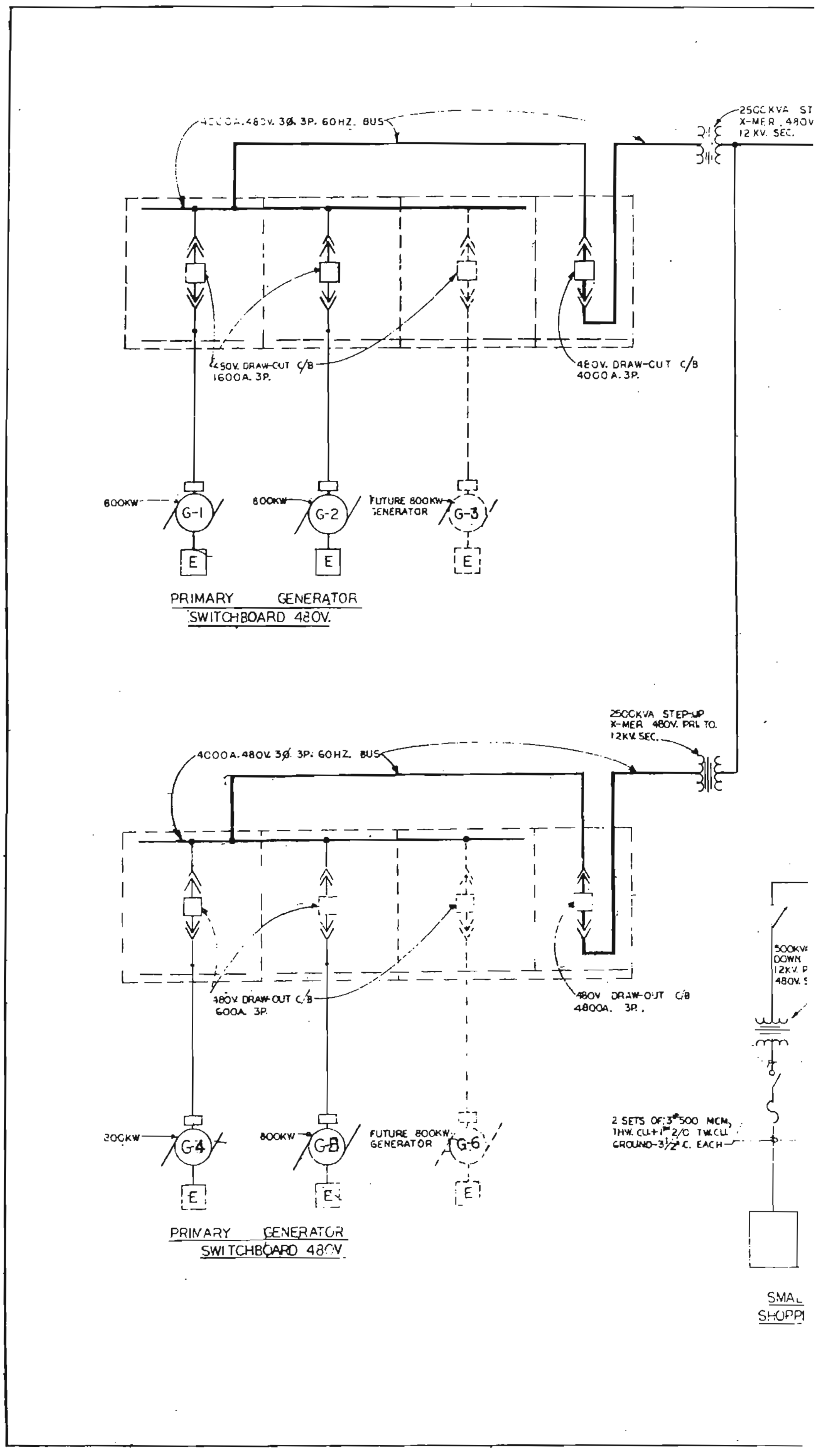
TAG	DESCRIPTION
ET-2 ET-6	EXPANSION TANK [illegible] CAPACITY: 490 GALLONS, 36"ϕ × 10'-0" LONG, AIR CONTROL FITTING, PENBERTHY X-526 LIQUID LEVEL GAUGE, 125 PSIG WP, ASME STAMPED MANUFACTURER: ADAMSON CO.
ET-3 ET-9 ET-11 ET-12	EXPANSION TANK CAPACITY: 270 GALLONS, 30"ϕ × 8'-0" LONG, AIR CONTROL FITTING, LIQUID LEVEL GAUGE, 125 PSIG WP ASME STAMPED MANUFACTURER: BELL & GOSSETT
ET-4 ET-5	EXPANSION TANK CAPACITY: 1600 GALLONS, 60"ϕ × 12'-0" LONG, AIR CONTROL FITTING, LIQUID LEVEL GAUGE, ASME STAMPED FOR 150 PSIG WP AT 500°F MANUFACTURER: ADAMSON CO.
ET-8	EXPANSION TANK CAPACITY: 866 GALLONS, 48"ϕ × 13'-0" LONG, AIR CONTROL FITTING, LIQUID LEVEL GAUGE, ASME STAMPED FOR 125 PSIG WP MANUFACTURER: ADAMSON CO.
ET-10	EXPANSION TANK CAPACITY: 600 GALLONS 36"ϕ × 12'-0" LONG, AIR CONTROL FITTING PENBERTHY X-526 LIQUID LEVEL GAUGE, 125 PSIG WP, ASME STAMPED MANUFACTURER: ADAMSON COMPANY
PC-1	PRESSURE CONTAINER

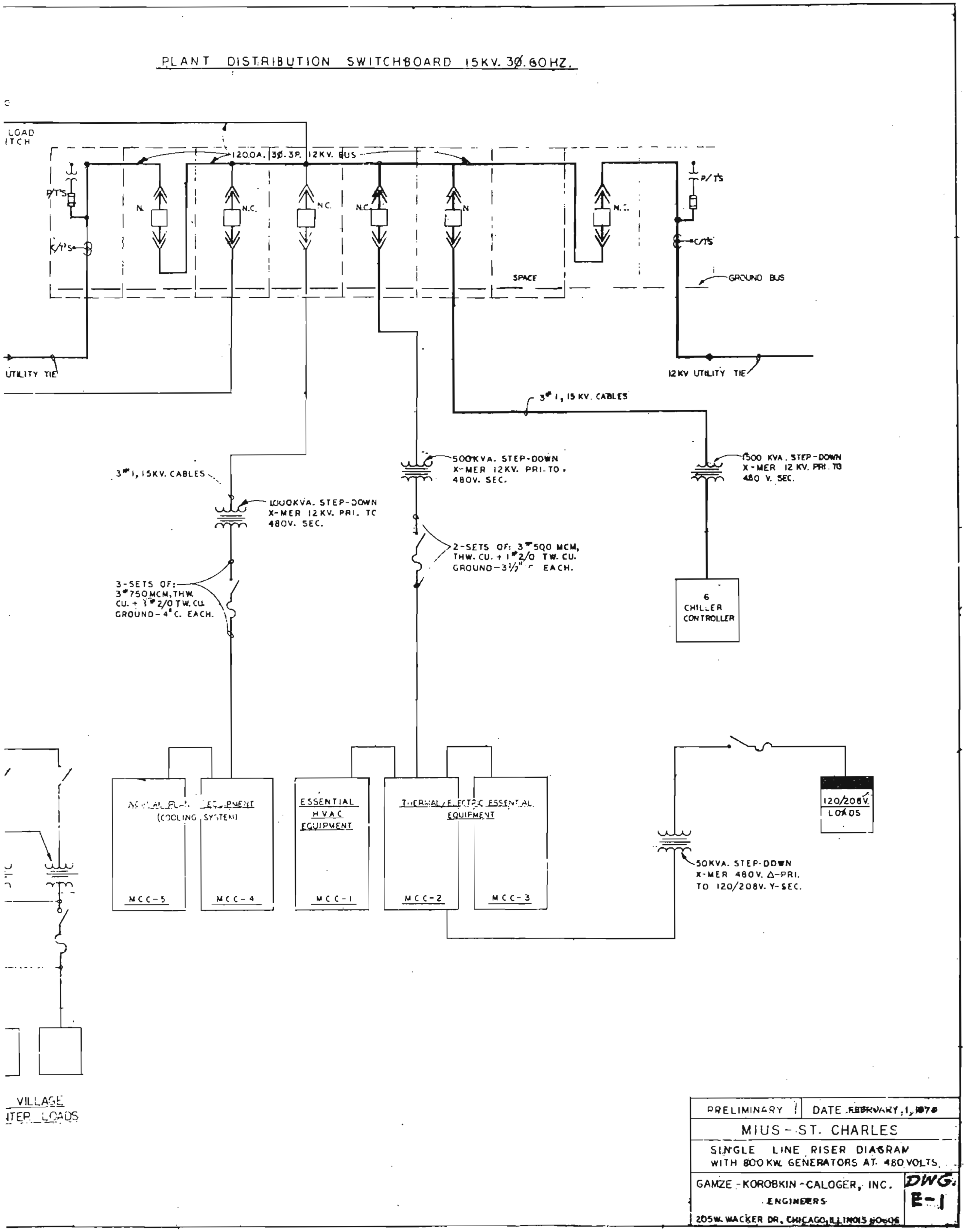
PRELIMINARY | DATE: FEBRUARY 1, 1978

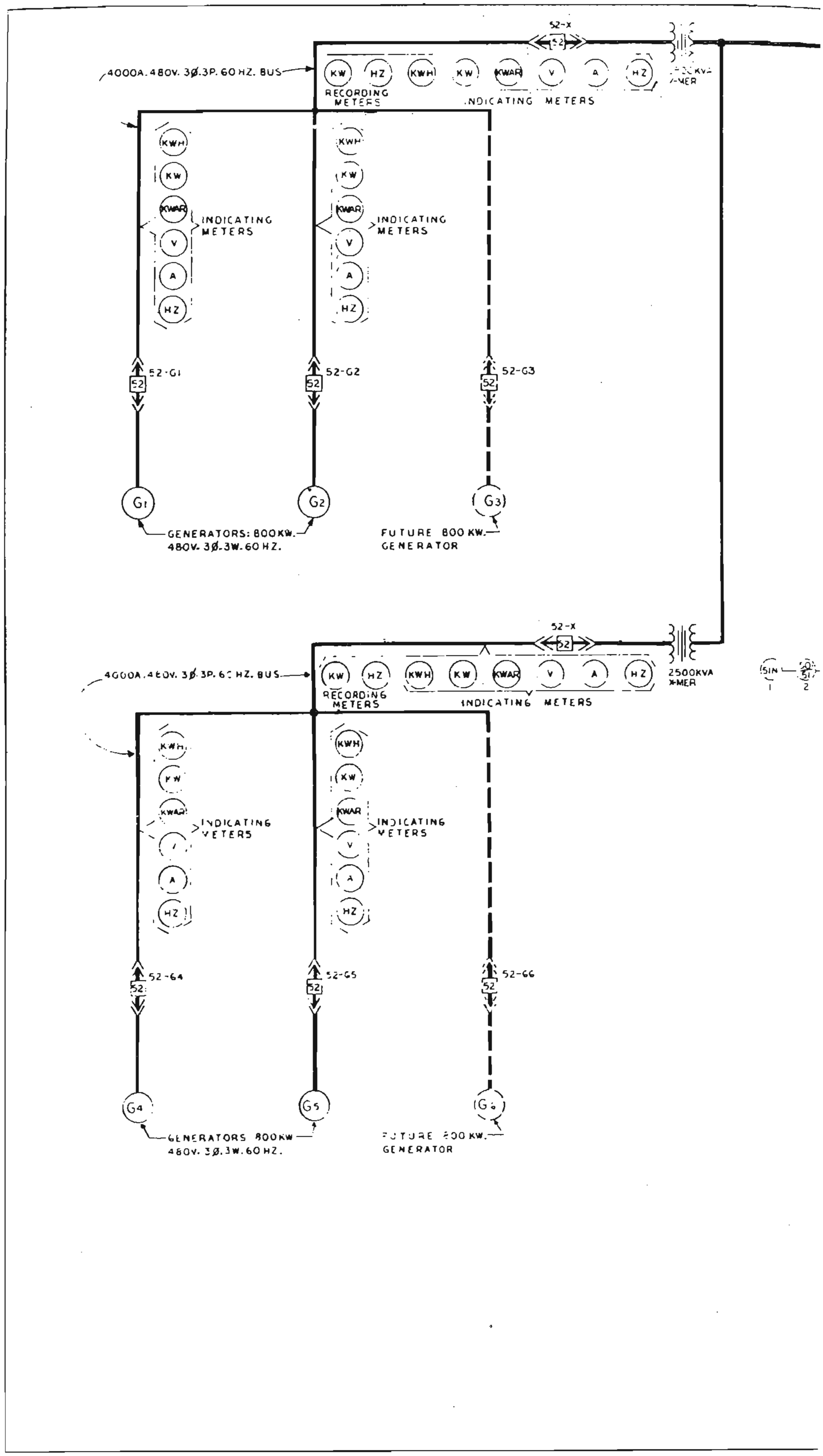
MIUS - ST. CHARLES

GAMZE - KOROBKIN - CALOGER, INC.
ENGINEERS
205 W. WACKER DR. CHICAGO, ILLINOIS 60606

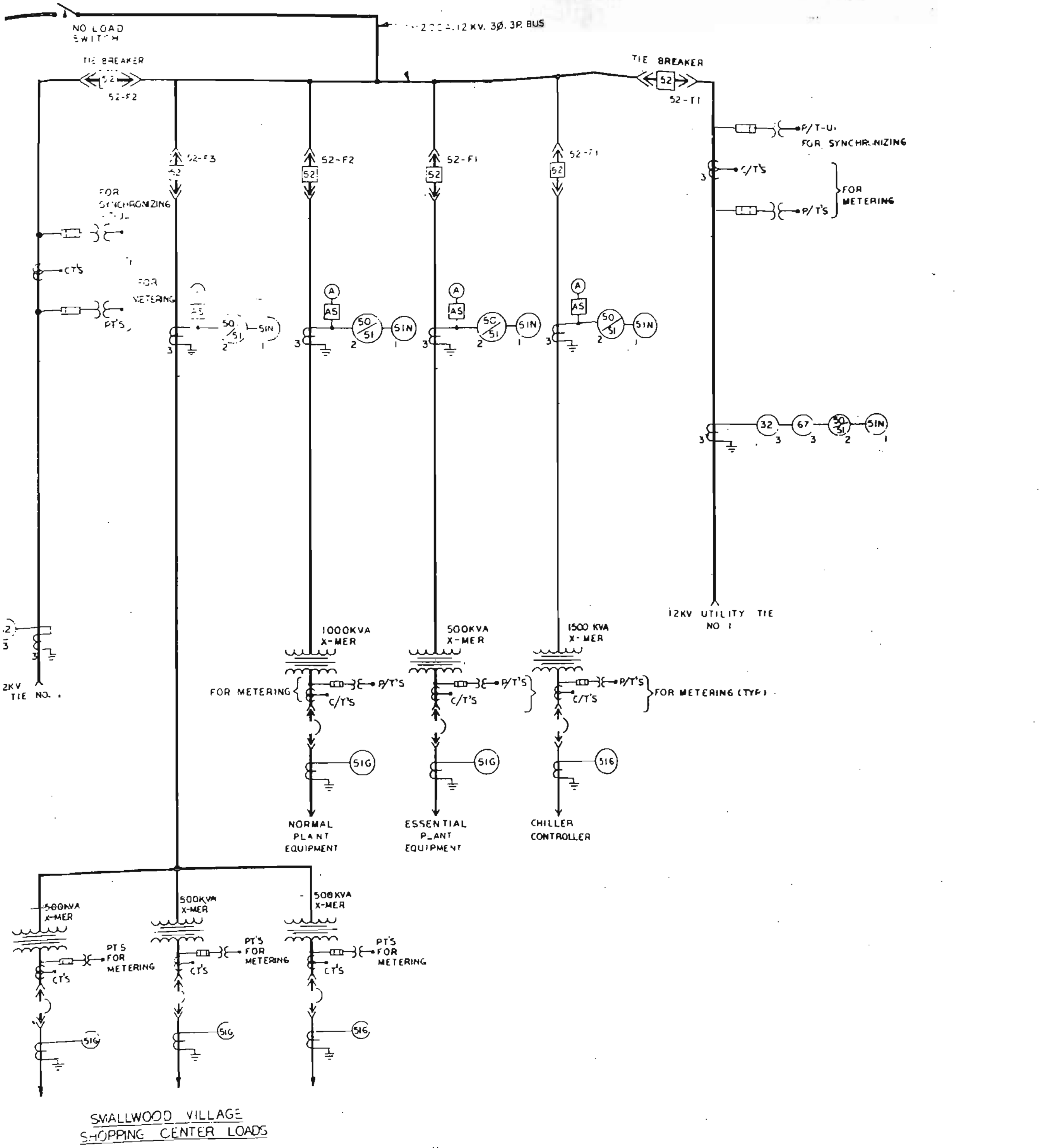
DWG. M-10


4000A.480V. 3Ø. 3P. 60HZ. BUS
2500KVA ST
X-MER 480V
12 KV. SEC.
480V. DRAW-OUT C/B
1600A. 3P.
480V. DRAW-OUT C/B
4000 A. 3P.
800KW
G-1
800KW
G-2
FUTURE 800KW GENERATOR
G-3
E
E
E
PRIMARY GENERATOR
SWITCHBOARD 480V.
2500KVA STEP-UP
X-MER 480V. PRI. TO
12KV. SEC.
4000A. 480V. 3Ø. 3P. 60HZ. BUS
480V. DRAW-OUT C/B
600A. 3P.
480V. DRAW-OUT C/B
4800A. 3P.
500KV
DOWN
12KV. P
480V.
2 SETS OF 3#500 MCM,
THW. CU+1#2/0 TW.CU.
GROUND-3½" C. EACH
800KW
G-4
800KW
G-B
FUTURE 800KW GENERATOR
G-6
E
E
E
PRIMARY GENERATOR
SWITCHBOARD 480V.
SMAL
SHOPPI

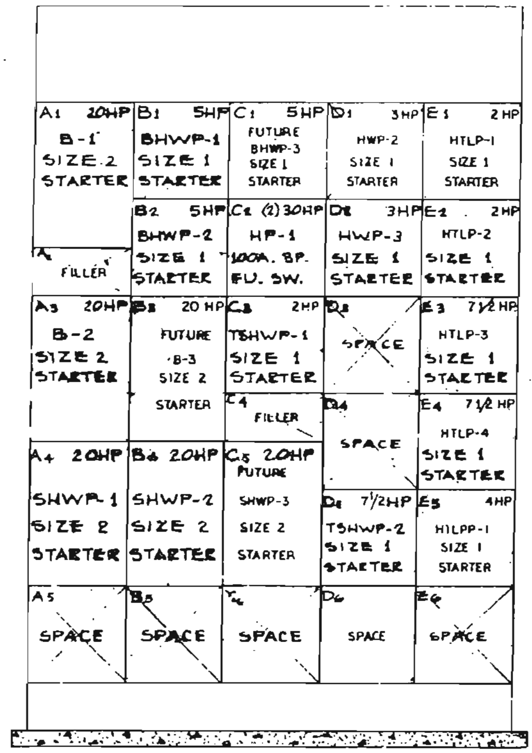

PLANT DISTRIBUTION SWITCHBOARD 15KV. 3Ø. 60HZ.
LOAD
ITCH
1200A. 3Ø. 3P. 12KV. BUS
P/T'S
C/T'S
N.C.
SPACE
GROUND BUS
UTILITY TIE
12KV UTILITY TIE
3#1, 15 KV. CABLES
3#1, 15KV. CABLES
1000KVA. STEP-DOWN X-MER 12KV. PRI. TO 480V. SEC.
500KVA. STEP-DOWN X-MER 12KV. PRI. TO 480V. SEC.
1500 KVA. STEP-DOWN X-MER 12 KV. PRI. TO 480 V. SEC.
3-SETS OF: 3#750MCM, THW. CU. + 1#2/0 TW. CU. GROUND-4"C. EACH.
2-SETS OF: 3#500 MCM, THW. CU. + 1#2/0 TW. CU. GROUND-3½" C. EACH.
6 CHILLER CONTROLLER
(COOLING SYSTEM)
ESSENTIAL HVAC EQUIPMENT
EQUIPMENT
MCC-5
MCC-4
MCC-1
MCC-2
MCC-3
120/208V. LOADS
50KVA. STEP-DOWN X-MER 480V. Δ-PRI. TO 120/208V. Y-SEC.
VILLAGE
PRELIMINARY
DATE FEBRUARY 1, 1974
MIUS - ST. CHARLES
SINGLE LINE RISER DIAGRAM WITH 800 KW. GENERATORS AT 480 VOLTS
GAMZE - KOROBKIN - CALOGER, INC.
ENGINEERS
205 W. WACKER DR., CHICAGO, ILLINOIS 60606
DWG. E-1



52-X
52
4000A. 480V. 3Ø.3P. 60 HZ. BUS
KW
HZ
KWH
KW
KWAR
V
A
HZ
RECORDING METERS
INDICATING METERS
KVA
X-MER
KWH
KW
KWAR
V
A
HZ
INDICATING METERS
52-G1
52-G2
52-G3
G1
G2
G3
GENERATORS: 800KW.
480V. 3Ø.3W.60HZ.
FUTURE 800 KW.
GENERATOR
2500KVA
X-MER
RECORDING METERS
52-G4
52-G5
52-G6
G4
G5
G6
GENERATORS 800KW
480V. 3Ø.3W.60HZ.
GENERATOR

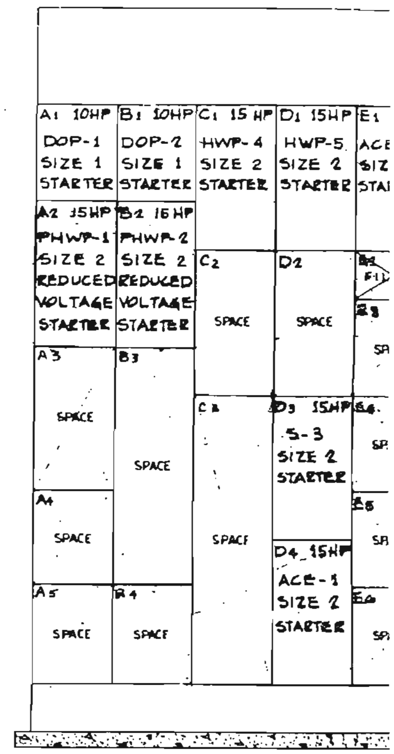


PRELIMINARY	DATE : FEBRUARY 1, 1976
M. JS - ST. CHARLES	
ELECTRICAL SYSTEM CONTROL DIAGRAM METERING & GENERATOR PROTECTION	
GANZE - KOROBKIN - CALOGER, INC. ENGINEERS 205 W. WACKER DR., CHICAGO, ILLINOIS 60606	DWG. E-2



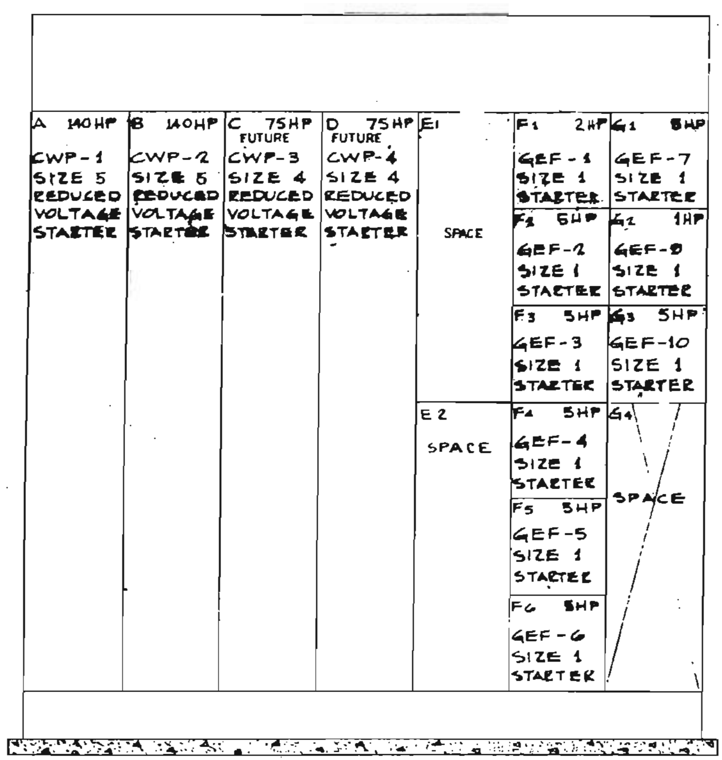
MCC-1
N.T.S.

HVAC ESSENTIAL EQUIPMENT

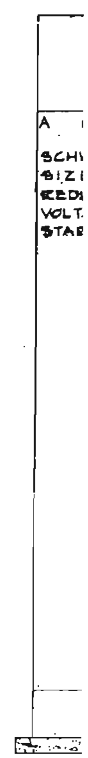


MCC-2
N.T.S.

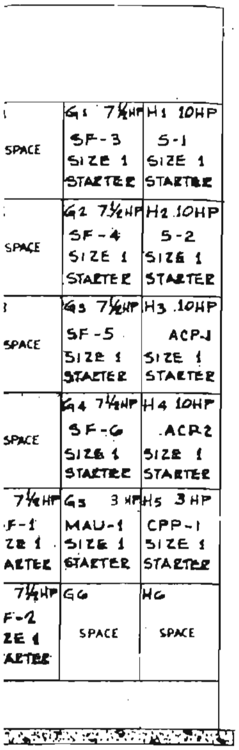
THERMAL/E

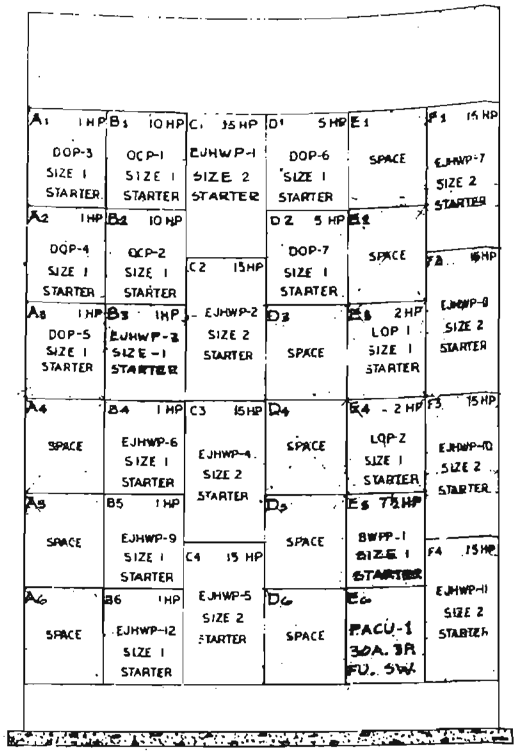


MCC-4
N.T.S.



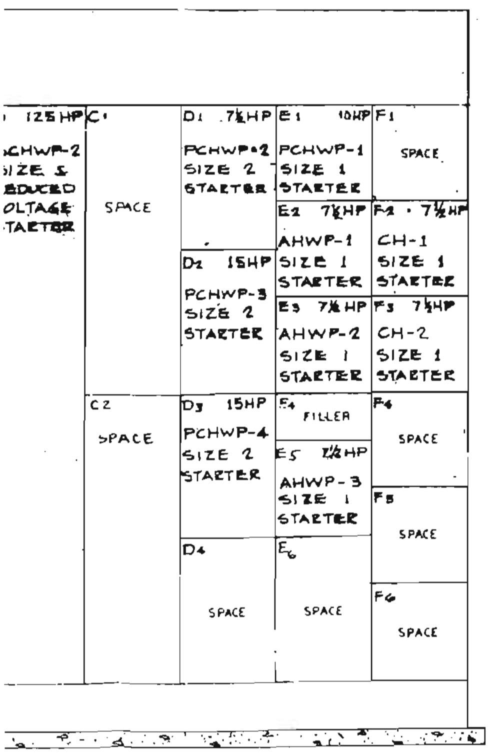
NORMAL EQUIPMENT





MCC-3
N.T.S.

IC ESSENTIAL EQUIPMENT

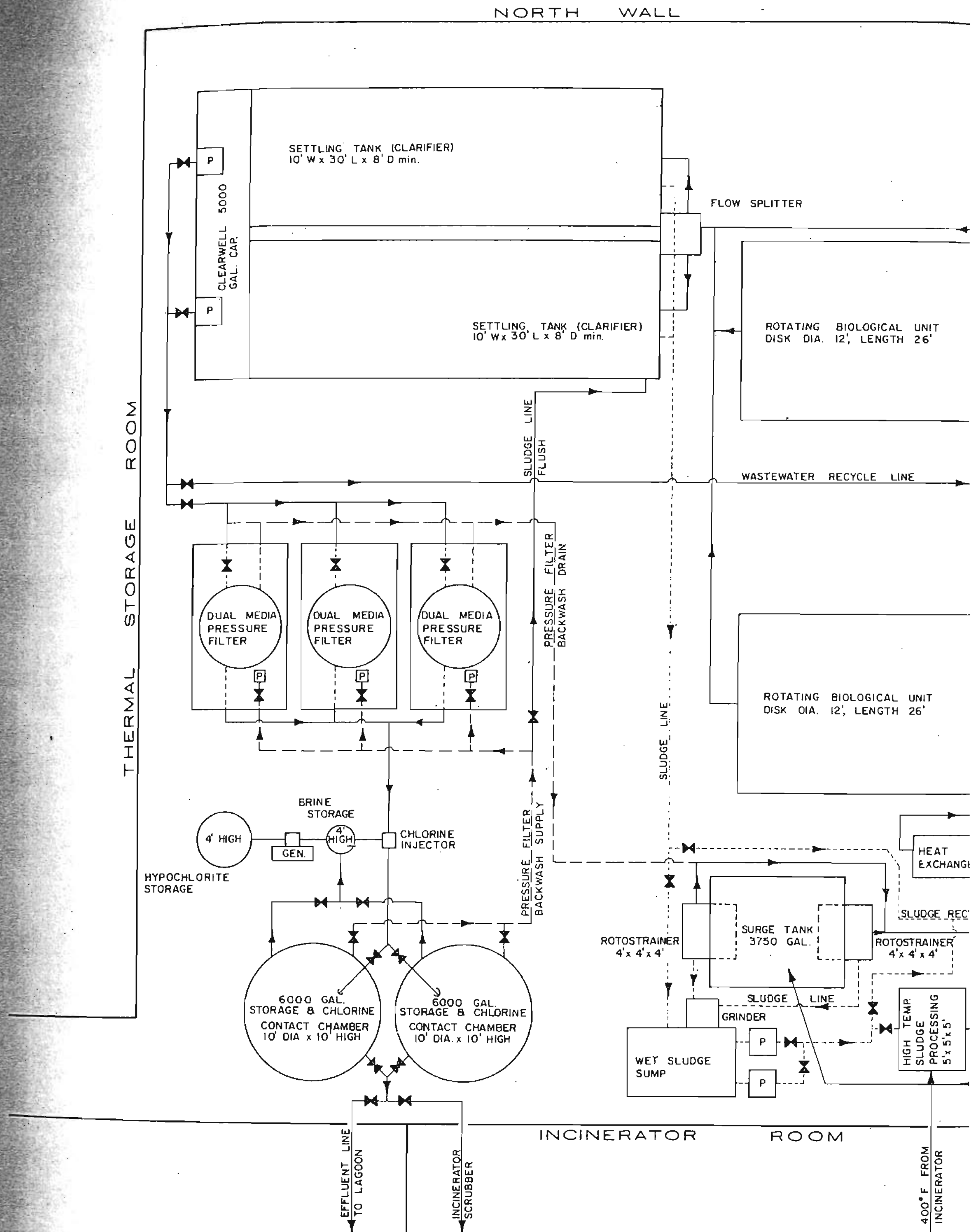


MCC-5
N.T.S.

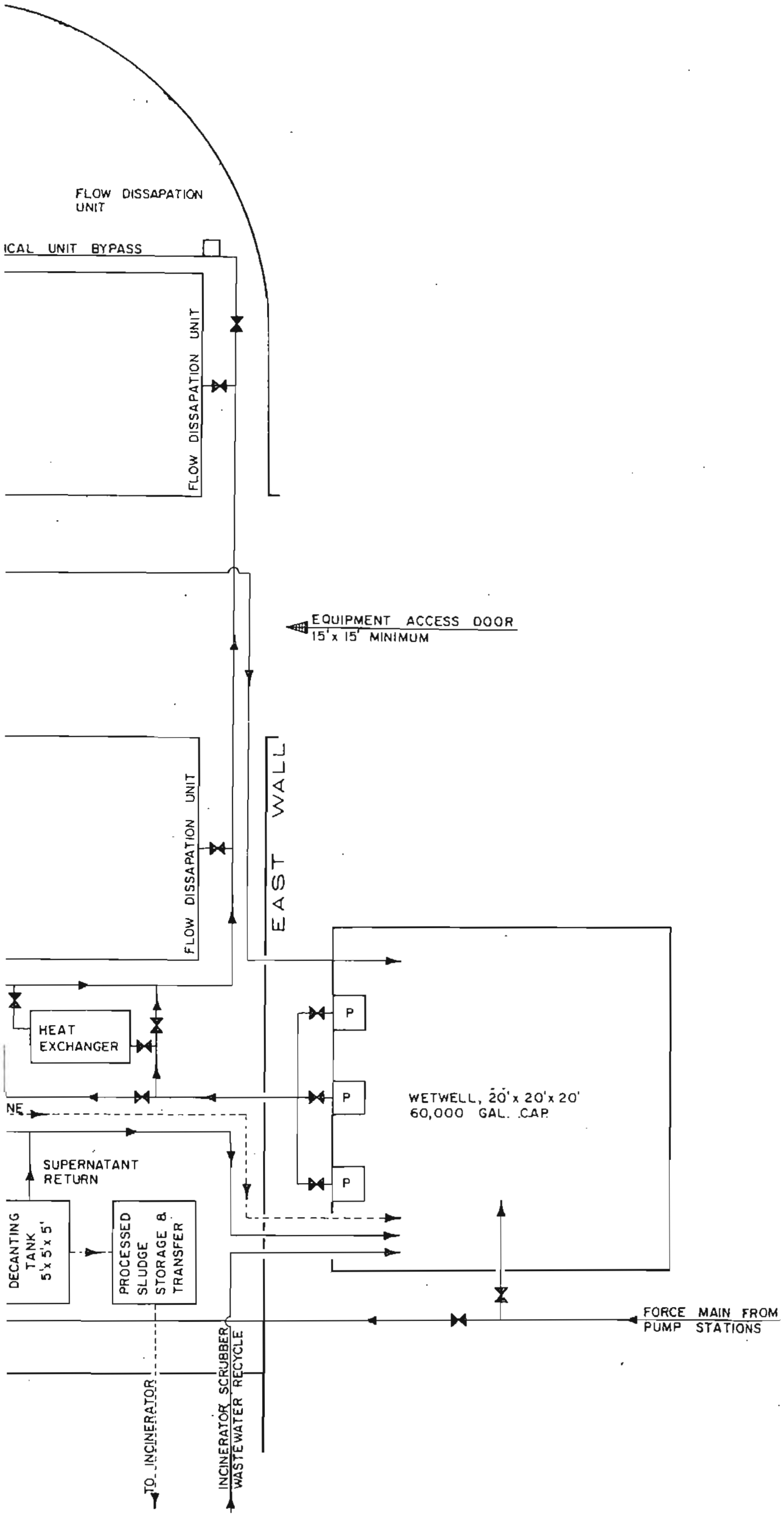
SYMBOLS

∅	MOTOR OUTLET
▭	MOTOR CONTROL CENTER
◄□►	DRAW-OUT AIR CIRCUIT BREAKER (600V. & 15KV)
Ⓖ	ENGINE GENERATOR
	TRANSFORMER
	PANELBOARD
GFP	GROUND FAULT PROTECTION
KW	KILOWATT METER
HZ	FREQUENCY METER
V	VOLTMETER
A	AMPMETER
HRM	ENGINE HOUR RUNNING METER
SW	SELECTOR SWITCH
MCC	MOTOR CONTROL CENTER

PRELIMINARY	DATE FEBRUARY 1, 1978
MIUS ST. CHARLES	
MOTOR CONTROL CENTERS	
GAMZE-KOROBKIN-CALOGER, INC. ENGINEERS 205 W. WACKER DR. CHICAGO, ILLINOIS 60606	DWG E-3



NORTH WALL
SETTLING TANK (CLARIFIER)
10' W x 30' L x 8' D min.
CLEARWELL 5000 GAL. CAP.
P
FLOW SPLITTER
SETTLING TANK (CLARIFIER)
10' W x 30' L x 8' D min.
ROTATING BIOLOGICAL UNIT
DISK DIA. 12', LENGTH 26'
THERMAL STORAGE ROOM
SLUDGE LINE
FLUSH
WASTEWATER RECYCLE LINE
PRESSURE FILTER
BACKWASH DRAIN
DUAL MEDIA PRESSURE FILTER
DUAL MEDIA PRESSURE FILTER
DUAL MEDIA PRESSURE FILTER
ROTATING BIOLOGICAL UNIT
DISK DIA. 12', LENGTH 26'
SLUDGE LINE
BRINE STORAGE
4' HIGH
GEN.
4' HIGH
CHLORINE INJECTOR
HYPOCHLORITE STORAGE
PRESSURE FILTER
BACKWASH SUPPLY
HEAT EXCHANG
SLUDGE REC
ROTOSTRAINER
4' x 4' x 4'
SURGE TANK
3750 GAL.
ROTOSTRAINER
4' x 4' x 4'
6000 GAL.
STORAGE & CHLORINE
CONTACT CHAMBER
10' DIA x 10' HIGH
6000 GAL.
STORAGE & CHLORINE
CONTACT CHAMBER
10' DIA. x 10' HIGH
SLUDGE LINE
GRINDER
HIGH TEMP. SLUDGE PROCESSING
5' x 5' x 5'
WET SLUDGE SUMP
INCINERATOR ROOM
EFFLUENT LINE TO LAGOON
INCINERATOR SCRUBBER
400° F FROM INCINERATOR



MAIN PROCESS LINE

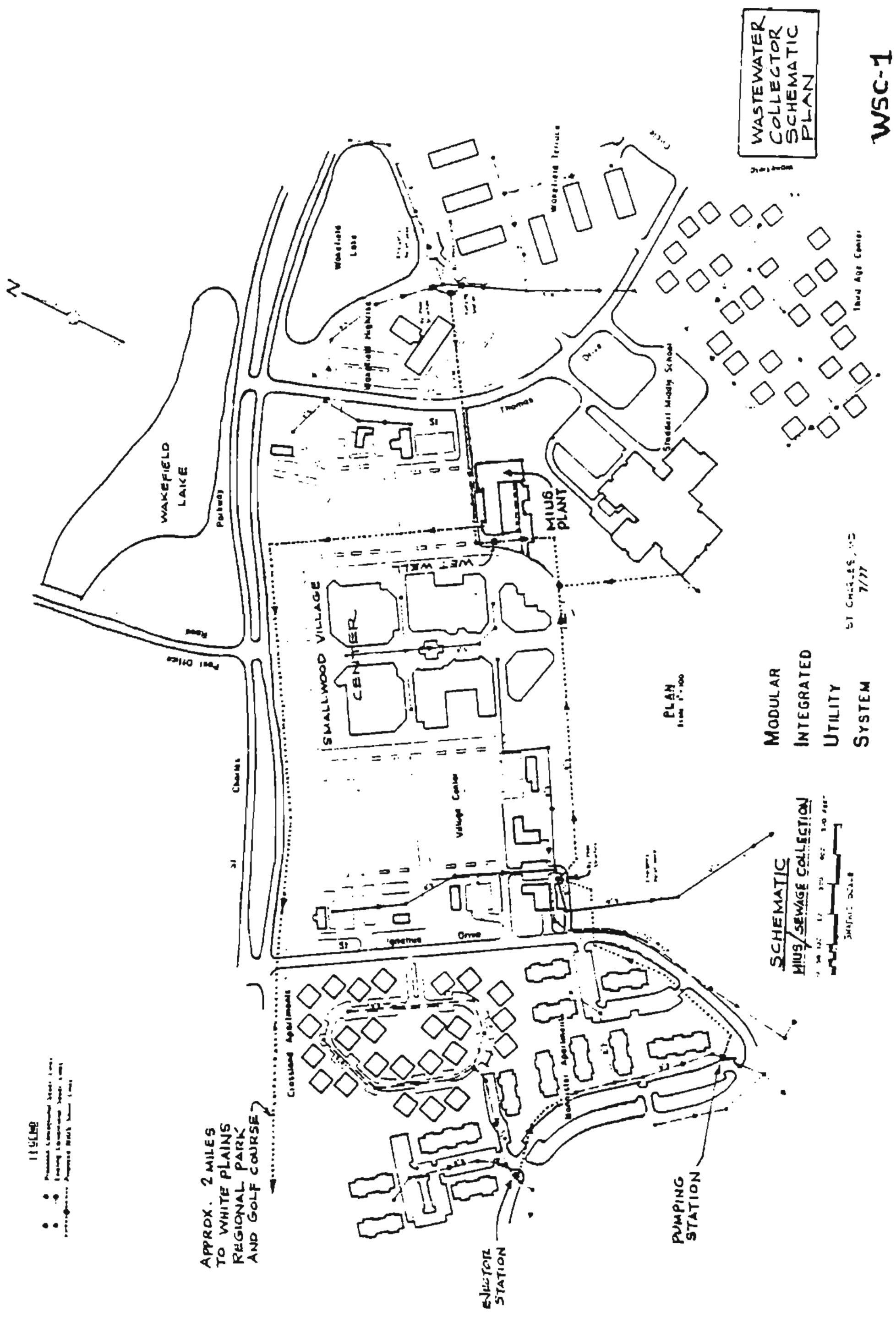
— — — — BACKWASH LINE

---------- SLUDGE LINE

DWG. WMS 4

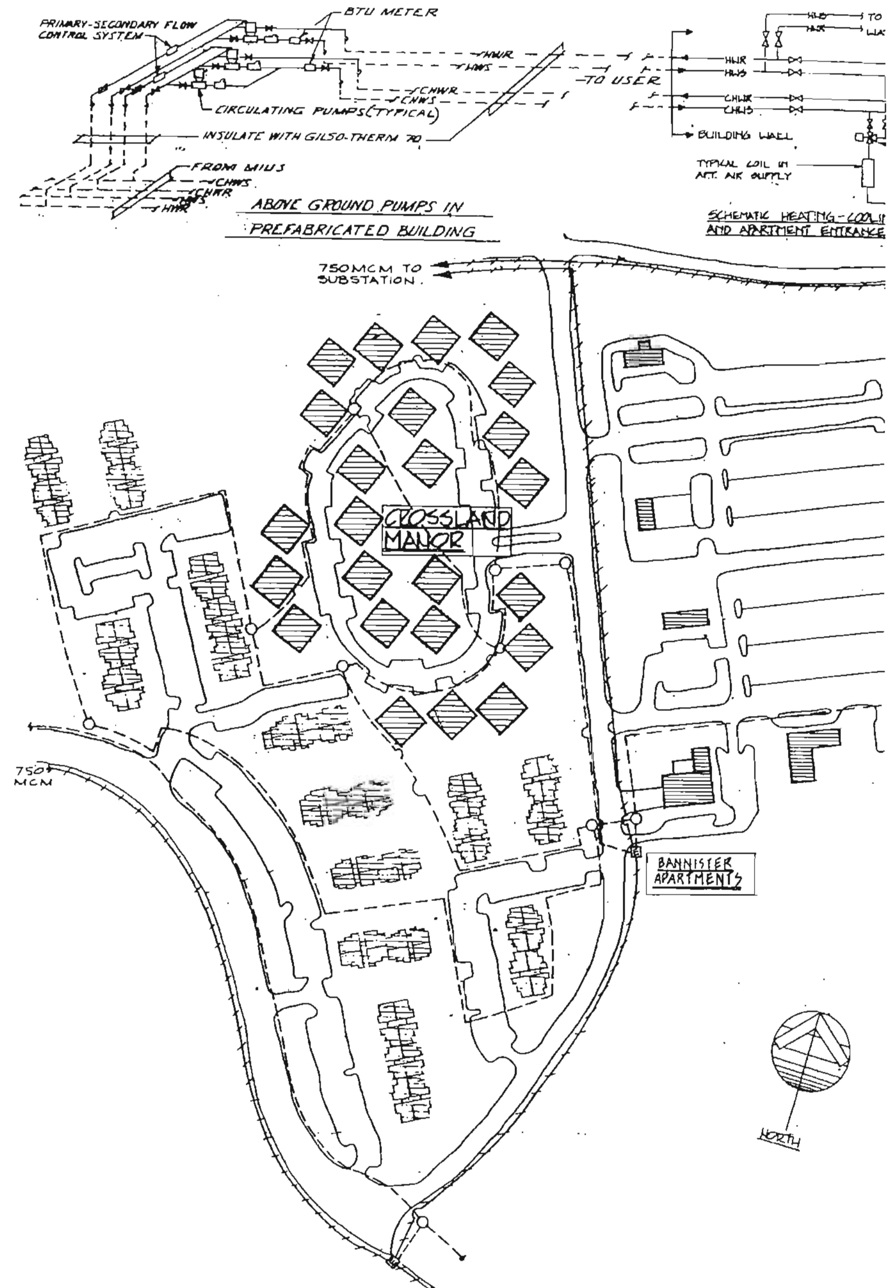
200,000 GPD WMS MIUS DEMO PLANT ST. CHARLES, MD.	
DAVID VOLKERT & ASSOCIATES CONSULTING ENGINEERS BETHESDA, MD.	DATE: JUNE 1978 SCALE: N.T.S.
	FILE NO. WMS 4 SHEET NO. 1 OF 1

B.1.2 Wastewater Collector Schematic Plan (WSC-1)



WASTEWATER
COLLECTOR
SCHEMATIC
PLAN
WSC-1
WAKEFIELD
LAKE
Parkway
Post Office
Road
SMALLWOOD VILLAGE
CENTER
WET WELL
MIUS
PLANT
Thomas
Village Center
Drive
Charles
St
Smallwood Middle School
Third Age Center
PLAN
MODULAR
INTEGRATED
UTILITY
SYSTEM
SCHEMATIC
MIUS/SEWAGE COLLECTION
APPROX. 2 MILES
TO WHITE PLAINS
REGIONAL PARK
AND GOLF COURSE
LEGEND
EJECTOR
STATION
PUMPING
STATION

B.1.3 Site Hydronic and Electrical Distribution Schematic Plan



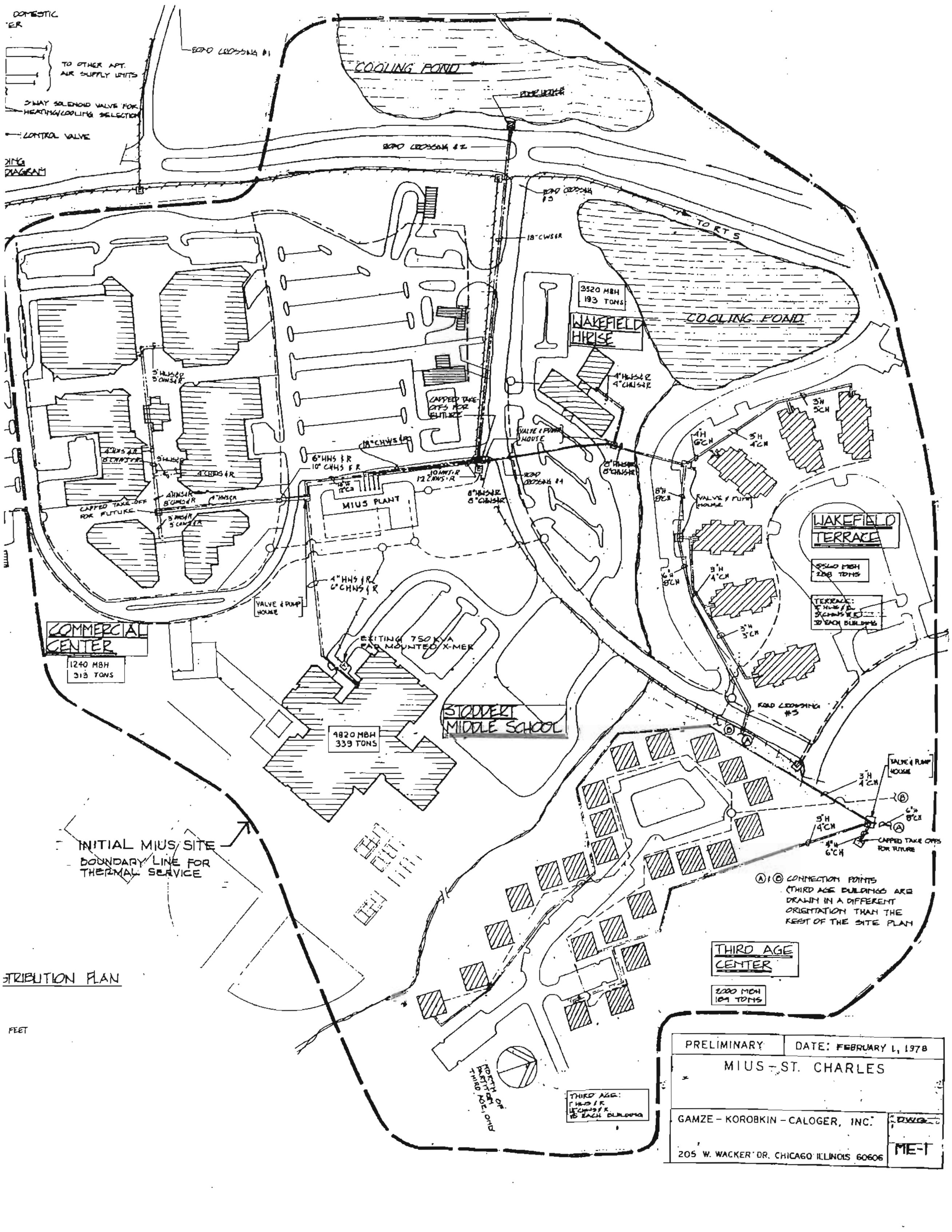
MIUS, ST. CHARLES

SITE PLAN - ELECTRICAL AND HYDRON

SCALE: 1" = 100'

GRAPHIC SCALE 0 100 200 400

SYMBOLS & ABREVIATIONS	
HWS	HOT WATER SUPPLY
HWR	HOT WATER RETURN
CHWS	CHILLED WATER SUPPLY
CHWR	CHILLED WATER RETURN
CWS	CONDENSER WATER SUPPLY
CWR	CONDENSER WATER RETURN
----	1/0 200A. CAPACITY
-/-/-	750 MCM. 600A. CAPACITY
O	200A. SWITCH VAULT
▣	600A. SWITCH VAULT


COOLING POND
ROAD CROSSING #1
ROAD CROSSING #2
ROAD CROSSING #3
TO RT 5
18" CWS&R
3520 MBH
193 TONS
WAKEFIELD
HI-RISE
COOLING POND
CAPPED TAKE-OFFS FOR FUTURE
VALVE & PUMP HOUSE
MIUS PLANT
ROAD CROSSING #4
WAKEFIELD
TERRACE
CAPPED TAKE-OFF FOR FUTURE
VALVE & PUMP HOUSE
EXISTING 750 KVA PAD MOUNTED X-MER
COMMERCIAL
CENTER
1240 MBH
313 TONS
4820 MBH
339 TONS
STODDERT
MIDDLE SCHOOL
ROAD CROSSING #5
VALVE & PUMP HOUSE
CAPPED TAKE OFFS FOR FUTURE
INITIAL MIUS SITE
BOUNDARY LINE FOR THERMAL SERVICE
Ⓐ & Ⓑ CONNECTION POINTS (THIRD AGE BUILDINGS ARE DRAWN IN A DIFFERENT ORIENTATION THAN THE REST OF THE SITE PLAN
THIRD AGE
CENTER
2000 MBH
189 TONS
STRIBUTION PLAN
FEET
NORTH OF THIRD AGE ONLY
PRELIMINARY
DATE: FEBRUARY 1, 1978
MIUS - ST. CHARLES
GAMZE - KOROBKIN - CALOGER, INC.
DWG.
ME-1
205 W. WACKER DR. CHICAGO ILLINOIS 60606

B.2 Plant Machinery

B.2.1 Specifications

ENGINE/GENERATOR

EG-1
EG-2
EG-3
EG-4

Capacity	800 KW, 1115 BHP, 1200 RPM at 85°F ambient, 1500 ft A.S.L. elevation, and maximum allowable air backpressure of 20" W.C. Four-stroke diesel-cycle 'V' cylinder arrangement. Dual turbochargers and aftercoolers.
Fuel:	#2 Diesel oil.
Generator:	800 KW, 480 volt, 60 Hz, PF = 0.8. Air cooled.
Including:	Engine-driven rotary-gear. Fuel-oil pump at 6.4 GPM and 12 ft W.C. suction lift. Precombustion chamber.
Manufacturers:	*Caterpillar Model D 399TA. Others as approved.

NOTE: *See Generator Set Data/Section B.2.2

BOILER (Hot Water)

B-1
B-2

Capacity:	400 Boiler HP
Input:	16,740 MBH
Output:	13,390 MBH
Design:	100 psig ASME stamped. Smoke - #1 Ringelman. Davited doors, low water cutoff, hi-limit and operating aquastats.
Relief Valves:	75 psig W.P. ASME stamped.
Max. Water Temp.	245°F
Burner:	Diesel Fuel-Oil, full modulating with low fire start.
Blower Motor:	20 HP, 480V - 3Ø - 60 Hz forced draft with inlet silencer.
Controls:	120V, Panel mounted on boiler. Cleaver-Brooks Model CB-400 North American (as approved). Trane (as approved).

HIGH TEMPERATURE ABSORPTION CHILLER CH-I

Capacity:	391 Tons
Chilled Water:	669 GPM from 56° F to 42°F 17 ft. W.C. pressure drop 4 Pass, fouling factor = 0.005
Condenser Water:	1390 GPM from 80°F to 94°F 33 ft. W.C. pressure drop 4 Pass, fouling factor = 0.001
Concentrator: (Dowtherm A)	552 GPM from 400°F to 361°F 18 ft. W.C. pressure drop 4 Pass, fouling factor = 0.0005
Electrical:	7 1/2 HP, 480V - 3Ø - 60 Hz
Manufacturers:	Trane Model - ABTD - 03J

ABSORPTION CHILLER CH-2

Capacity:	351 Tons
Chilled Water:	600 GPM from 56°F to 42°F 12 ft. W.C. pressure drop 3 Pass, fouling factor - 0.0005
Condenser Water:	1250 GPM from 80°F to 94°F 20 ft. W.C. pressure drop 4 Pass, fouling factor = 0.001
Hot Water:	945 GPM from 220°F to 207°F 15.5 ft. W.C. pressure drop 1 Pass, fouling factor = 0.0005
Electrical	7.5 HP, 480V, - 3Ø - 60 Hz
Manufacturers:	Trane Model ABSC - 03F Carrier (as approved) York (as approved)

CENTRIFUGAL CHILLER		CH-3
Capacity:	1111 Tons	
Chilled Water:	1900 GPM from 56°F to 42°F 17 ft. W.C. pressure drop 2 Pass, fouling factor = 0.0005	
Condenser Water:	2350 GPM from 56° to 42°F 10 ft. W.C. pressure drop 2 Pass, fouling factor = 0.001	
Electrical	813 KW, 480 V - 3Ø - 60 Hz	
Manufacturers:	Trane Model CVHB - 125 Carrier (as approved) York (as approved)	

FUEL-OIL STORAGE TANK		DOST-1 DOST-2 DOST-3 DOST-4
Capacity:	25,000 Gallons each	
Dimensions:	126" Diameter, 38' - 7" long Provide pipe connections as shown tank to be set underground with concrete hold-down pad 24" diameter manhole, Underwriter Laboratory label.	
Manufacturers:	Adamson Company	

HIGH-TEMPERATURE THERMAL STORAGE		HTTS-1 HTTS-2
Capacity:	2,000 Gallons	
Dimensions:	7'-0" high Leg supports, manhold, phenolic lining, galvanized ASME stamped for 100 psig WP at 650°F Pipe connections as shown	
Manufacturers:	Adamson Company	

MEDIUM-TEMPERATURE THERMAL STORAGE

MTTS-1
MTTS-2
MTTS-3
MTTS-4

Capacity:	20, 000 Gallons
Dimensions:	14'-0" Diameter, 17'-6" high Manhole, galvanized, phenolic lining ASME stamped for 150 psig WP at 300°F Pipe connections as shown
Manufacturers:	Adamson Company Others as approved

GENERATOR CONTROL AND MAIN BREAKER SWITCHGEAR

1. Complete automatic engine generator control and synchronizing switchgear complete with all indicating, recording and protective instruments called for on the drawings.

2. Main circuit breaker for each generator output, 480V, 3Ø, 1600 amp, drawout type, ITE, GE or Westinghouse.

3. Entire assembly shall be of the indoor type 600 volt construction and be finished in ANSI #61. Assembly shall include one master module and two engine/generator modules. Master shall be expanded for up to six engine/generator units with automatic starting and stopping of engine to meet load requirements.

4. Equipment shall be Westinghouse, Russelectric, Electrical Machinery or Custom Controls Corporation specifically designed to meet the requirements of the detailed specifications.

STEP UP TRANSFORMER

1. Indoor ventilated dry type transformer to step up 480V, 3Ø, to 13,800V, 3Ø, 2500 KVA.

2. Transformer shall be self-cooled, 150°C, Class H insulation and shall have 4 - 2 1/2% taps.

3. Standard impedance of 5.75%.

SOLID WASTE MANAGEMENT EQUIPMENT

- Pick-Up and Delivery Equipment

  Dempster Dumpster type vehicle with capacity sufficient to lift containers up to 15 cu. yds. in size.

SOLID WASTE MANAGEMENT EQUIPMENT (Continued)

- Incinerator

Type:	Controlled air.
Capacity:	To burn 2500 lbs/hr with a Btu content of 4500 Btu/lb 8 to 10 hours/day.
General:	Automatic; collection-hopper-to-charge-ram conveying system, ram loader, and wet type ash removal. Factory manufactured, pre-engineered package type unit, factory tested. Factory fabricated refractory lined sectional stack with 1/4" thick steel jacket.
Controls:	Full control system for automatically regulating combustion air to chambers, fuel to burners, and waste charging rate.
Emissions:	To operate at full capacity free from smoke, fly-ash, soot or odor and must meet all local emission regulations without the use of scrubbers or electrostatic precipitators.
Auxiliary Fuel:	#2 fuel-oil (Diesel #2). Average consumption not to exceed 695 Btu per lb waste.
Electrical:	240/480, 60, 3 - 100 amperes and 120, 60 1 - 30 amperes.
Manufacturers:	Consumat Model C-1200 Comtro (as approved) Kelley-Hoskinson (as approved)

WASTEWATER SUBSYSTEM EQUIPMENT DESCRIPTION

Component:	Sewage Pumps (3)
Characteristics:	Vertical Pumps with Extended Shafts; 6" Suction, 4" Discharge Enclosed Impeller; Non-Clog, Dry Basin Type. Level-Controlled; 1150 RPM Type VOS 6410 W/8" Impeller. Flow = 70 GPM, Power = 1 1/2 HP Head = 30 ft. W.C.
Manufacturer:	Chicago Pump or Approved Equal
Alternates:	Submersible Pumps, FLYGT, Weil or Approved Equal

WASTEWATER SUBSYSTEM EQUIPMENT DESCRIPTION (Continued)

Component: Rotary Strainers (2)

Characteristics: Rotating Cylinder of Stainless Steel with Wedge Wire Screen 12" Long; Opening to be 0.010"; Stainless Steel Chassis with Bottom Discharge; Doctor of Stainless Steel with Adjustable Pressure

Rated Flow = 250 GPM, Power = 1/2 HP

Manufacturer: Hydrocyclonics RSA-2524 or Approved Equal

Component: Rotating Disc Contractors (2)

Characteristics: Plastic Extended Surface Media Fixed to Central Shaft; Chain Driven with Speed Reducer; Installed in Concrete Tanks;

Rated Flow = 133,300 GPD, Power of motor = 7 1/2 HP

Manufacturer: Autotrol #25-4 or Envirodisc F-89 Approximately effluent bod. Normal operation is 10 to 12 mg/l.

Component: Sedimentation Basin (2)

Characteristics: Longitudinal Sedimentation Basins with Chain Drive Sludge Collector and Surface Skimmer; 10 ft. Width, 25 ft. Length, 10 ft. Water Depth; Concrete Tank Construction

Flight drive = 1/4 HP, Sludge Life = 1/2 HP

Manufacturer: Leopold-Clarivac or Link Belt "Straightline" Type L or Approved Equal.

Alternates: Circular Clarifier in Concrete Tank; Lamella Inclined Plate Setting

WASTEWATER SUBSYSTEM EQUIPMENT DESCRIPTION (Continued)

Component:	Filter Feed Pumps (2)
Characteristics:	Vertical Wet Pit Turbine Pumps; 75 psig Discharge Pressure; 10 HP, 1800 RPM Motor 230/460V. Flow = 140 GPM
Manufacturer:	Allis-Chalmes or Approved Equal

Component:	Pressure Filters (3)
Characteristics:	Mixed Media Filters; 75 psi Operating Pressure; 7 ft. Diameter; 3 ft. Straight Height; Double Disk Underdrain Design; Automatic Multiport Valve. Flow = 84 GPM, 240 GPM Backwash for 10 minutes.
Manufacturer:	Permutit Type "G" or Approved Equal

Component:	Chlorine Generator (1)
Characteristics:	On-Site Chlorine Generator Making Sodium Hypochlorite from Sodium Chloride Solution. Capacity to be 30 lbs per day of Chlorine Equivalent.
Manufacturer:	Diamond Shamrock "sanilec" or Approved Equal
Alternates:	Bottled Chlorine Gas

Component:	Communitor and Bar Screen (1)
Characteristics:	Drum Type with Non-Clog Design and Bypass Bar Screen; Bottom Discharge. 1/4 HP Motor Chicago Pump #7C
Manufacturer:	Chicago Pump or Approved Equal
Alternates:	Grinder Pumps in the Collection System; Hydromatic; Environment One.

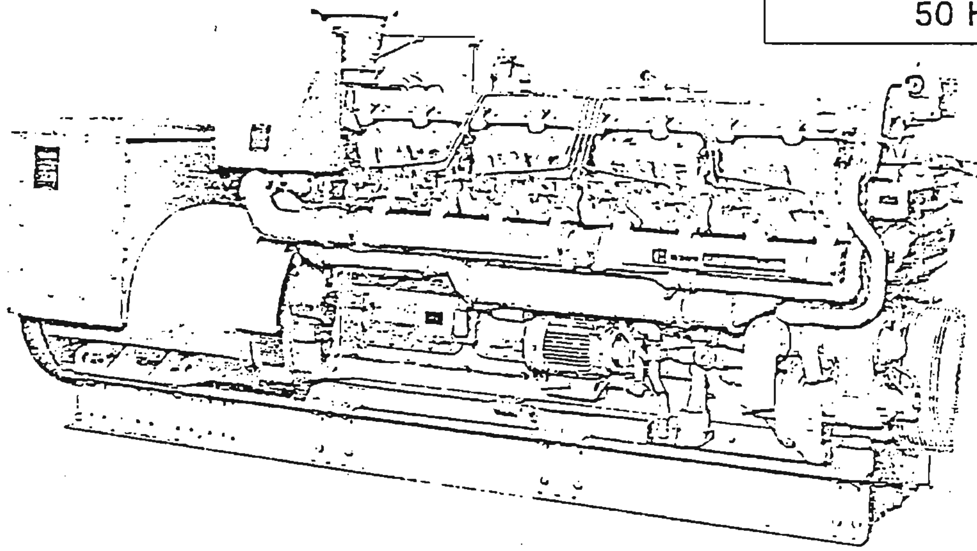
B.2.2 Performance Information

CATERPILLAR

D399 GENERATOR SETS

900 KW 60 Hz
750 KW 50 Hz

• *DIESEL ENGINE GENERATOR SET*



RATINGS

	60 Hz @ 1200 RPM		50 Hz @ 1000 RPM	
	Standby	Prime	Standby	Prime
kW @ 0.8 P.F. w/o Fan	900	800	750	660
kVA	1125	1000	937	825
kW @ 0.8 P.F. w/Fan	870	770	733	643
kVA	1087	962	916	803
Horsepower w/o Fan @ Rated RPM	1260	1115	1035	915

GENERAL SPECIFICATIONS

ENGINE
Type
Watercooled Diesel
Aspiration
Turbocharged-Aftercooled
Cycle
Four Stroke
No. of Cylinders
V-16
Bore
6.25 in (159 mm)
Stroke
8.00 in (203 mm)
Piston Displacement
3928 cu in (64.5 lit)

GENERATOR
Type
Revolving Field—Solid State Exciter
Construction
Single Bearing—Close Coupled
Regulation
Volts per Hertz
Insulation
Class F
(Epoxy Impregnated)
Phase
3
Wire
10
Connection
Wye

VOLTAGES AVAILABLE
60 Hz—125/216, 230-460
50 Hz—200-400, 230-460

DESIGN AND PERFORMANCE
CATERPILLAR D399 ENGINE AND SRCR GENERATOR

- Caterpillar designed and manufactured fuel system. Adjustment-free individual injection pumps and large diameter, single orifice injection valves.
- Precombustion chamber design. Enables engine to operate on a wide variety of fuels including No. 2 burner oil (ASTM D396).
- Generator built to NEMA MG-1 standards and equipped with reactive droop compensation for parallel operation.
- Telephone Influence Factor (TIF) less than 100—well within NEMA standards.
- Voltage Regulation—steady state, within ±2% from no load to full load.
- Voltage Level—adjustable from rated voltage a minimum of ±5%.
- Voltage Gain—adjustable to compensate for use with speed droop governor.
- Voltage Droop—adjustable for proper division of active and reactive power when operating in parallel with other generators.
- Wave Form Deviation—no more than 10%, well within NEMA limits.

D399 GENERATOR SETS

STANDARD EQUIPMENT

Caterpillar D399 Diesel Engine
- Air Cleaner, Single Stage, Dry, with Service Indicators
- Cooler, Lubricating Oil
- Filters, Fuel and Lubricating Oil
- Gauges—Fuel Pressure, Oil Pressure, Water Temperature
- Governor, Woodward UG8 (Isochronous)
- Lines, Flexible Fuel
- Manifolds, Exhaust, Watershielded
- Pumps: Fuel—Priming and Transfer
  - Water—Engine Coolant Gear Driven
  - Lubricating Oil—Prelube
- Rails, Mounting (Floor Type)
- Safety Shutoffs (Mechanical)—
  - Low Oil Pressure
  - Overspeed
- Service Meter
- Tachometer Drive, Dual (SAE Standard)
- Thermostats and Housing

Caterpillar SRCR Generator
- Multi-Plate Flexible Coupling
- Voltage Regulator

OPTIONAL EQUIPMENT*

- ☐ Alarm Switches
- ☐ Alternator, Charging
- ☐ Automatic Start-Stop
- ☐ Batteries, Caterpillar
- ☐ Battery Charger
- ☐ Cranking Panel
- ☐ Flexible Exhaust Fittings
- ☐ Governor, Woodward Electric EG3P/2301 (Isochronous)
- ☐ Heat Exchanger/Expansion Tank
- ☐ Heater, Jacket Water
- ☐ Muffler
- ☐ Pump, Auxiliary Water
- ☐ Radiator
- ☐ Safety Shutoff, Water Temperature
- ☐ Starting, Air
- ☐ Starting, Electric
- ☐ Starting Aids, Glow Plugs

*Additional Optional Equipment and Mounting Locations Available. Consult your Caterpillar Dealer

RATINGS:

Standby Power — For continuous electrical service during interruption of normal power.

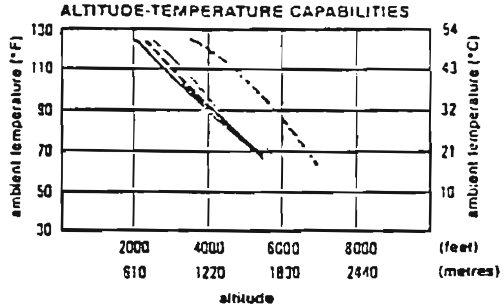
Prime Power — For continuous electrical service.

STANDARDS:

Ratings are at 29.38 in (746 mm) Hg and 85°F (30°C).

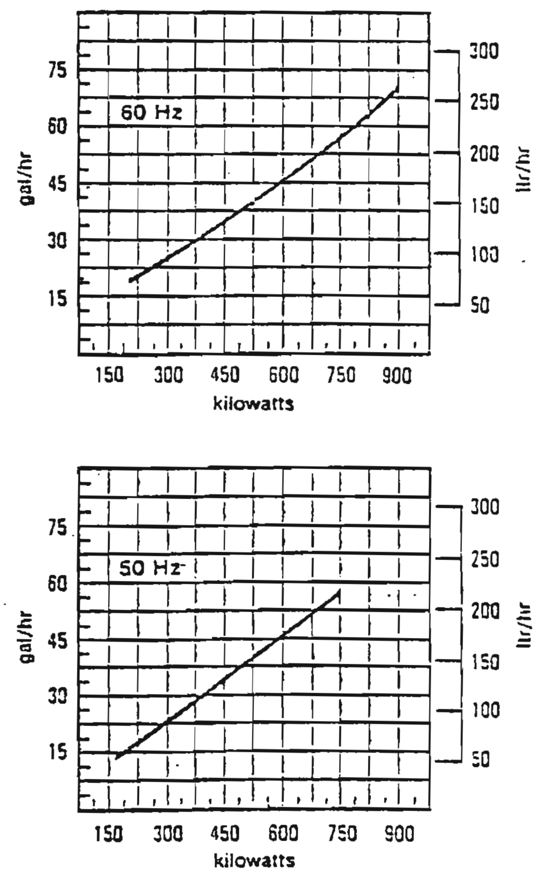
60 Hz Standby —— 50 Hz Standby ——
60 Hz Prime — — — 50 Hz Prime — · —

ALTITUDE-TEMPERATURE CAPABILITIES



NOTE: If ambient conditions are to the right of the appropriate line, consult your Caterpillar dealer for necessary deration. These deration curves apply to the engine-generator only and include considerations for humidity.

FUEL RATE CURVES



Fuel consumption applies to standard generator set without fan, based on fuel oil having a gross heat value of 19 500 BTU per pound (10 830 K-cal/Kg) and weighing 7.12 pounds per U.S. gallon (855 gm/ltr).

Project: MIUS - ST. CHARLES   Structure:

For: Figure 2.2-1 : Diesel Engine Energy Balance

Heat rejection figures from Engine Data Sheet 59.0

by Caterpillar Tractor Co. : D399, 1200 RPM

		68% 724 HP (540 KW)	90% 965 HP (720 KW)
① Oil cooler	(BTU/MIN)	6154	8203
② After cooler	(BTU/MIN)	500	2750
③ Jacket Water	(BTU/MIN)	26,500	33,500
④ Exhaust total	(BTU/MIN)	28,000	39,000
⑤ Exhaust recoverable:	(BTU/MIN)	14,000	19,500
⑥ Exhaust non recoverable:	(BTU/MIN)	14,000	19,500
⑦ Radiation	(BTU/MIN)	5000	5,200
⑧ Work	(BTU/MIN)	31,000	40,800
⑨ Total (1+2+3+4+7+8)	(BTU/MIN)	97,154	129,453

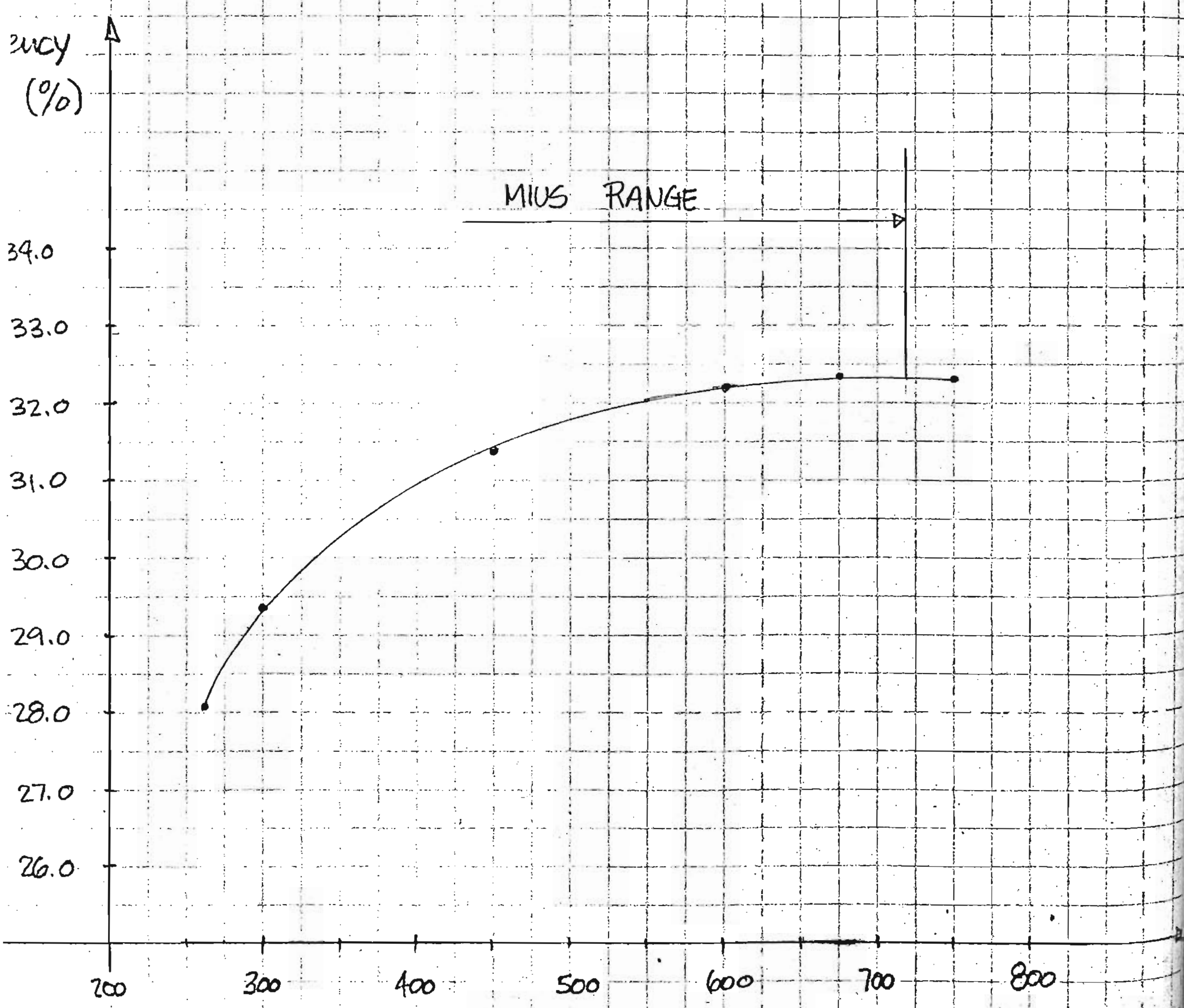
Low grade heat: 1+2	(BTU/MIN)	6654 (7%)	10,953 (8
High grade heat: 3+5	(BTU/MIN)	40,500 (41%)	53,000 (4
Non recoverable: 6+7	(BTU/MIN)	19,000 (20%)	24,700 (19
Work: 8	(BTU/MIN)	31,000 (32%)	40,800 (3

Project MIUS - ST. CHARLES Structure

For ENERGY ANALYSIS

CATERPILLAR D399 : Over all efficiency vs. Power Output (W/ Generator Efficiency, Caterpillar Set)

Source : Catalog D399 Generator Set 60 Hz



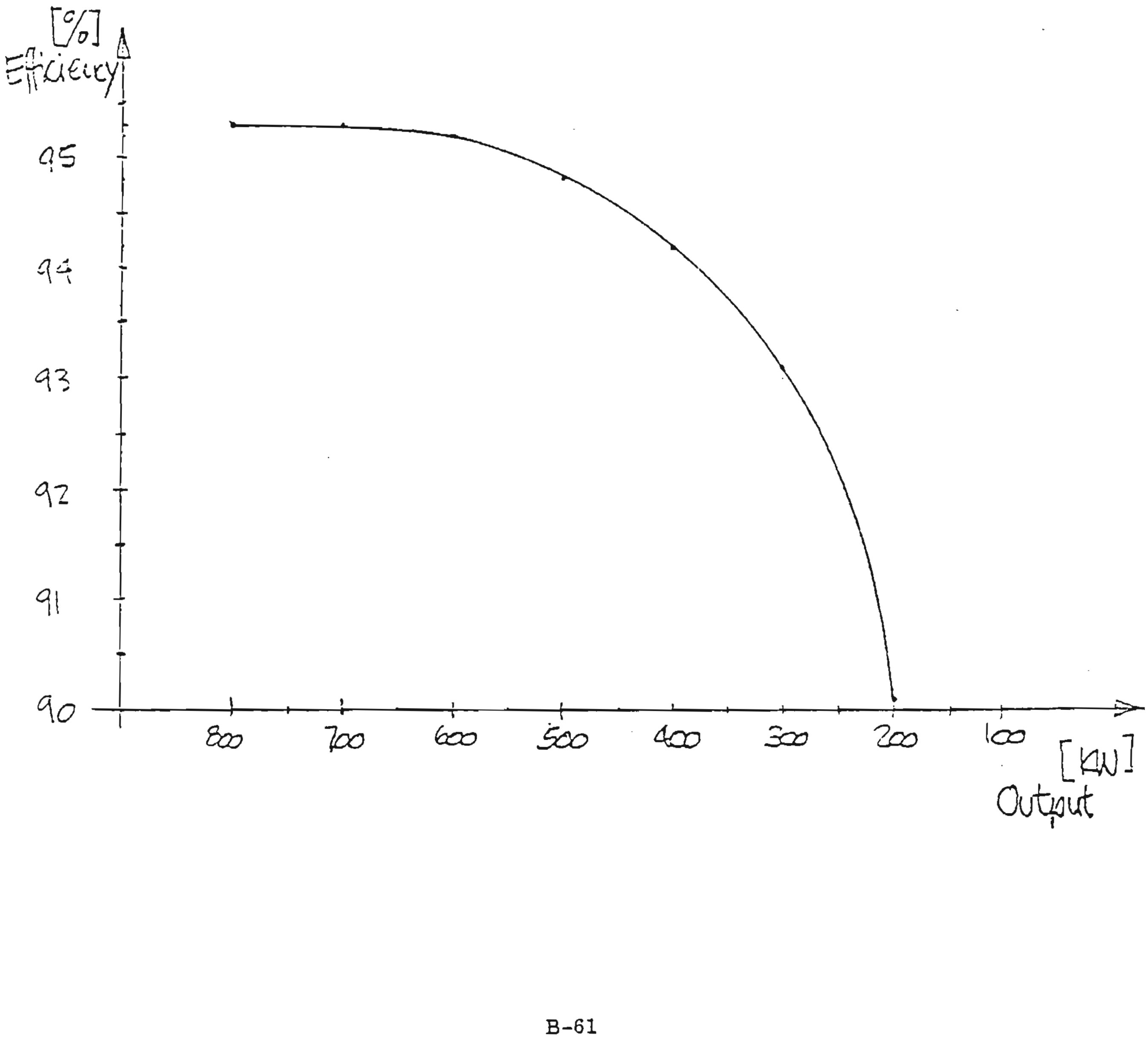
Project MIUS- ST. CHARLES Structure

For

Generator Efficiency

Manufacterer : Caterpillar

Nominal Rating : 800 KW (480V, 60 Hz)



August 1, 1977

Ganze-Korobkin-Caloger, Inc.
205 West Wacker Drive
Chicago, Illinois 60606

Attention: Mr. Martin Wettstein

Subject: St. Charles, Maryland
D399 Caterpillar Generator Set

Gentlemen:

Attached please find a copy of Engine Data Sheet 59.0 which contains the information you requested in your letter of July 29, 1977.

If we can be of further assistance to you, please feel free to contact us at any time.

Sincerely,

Roy Parmley
Sales Engineer

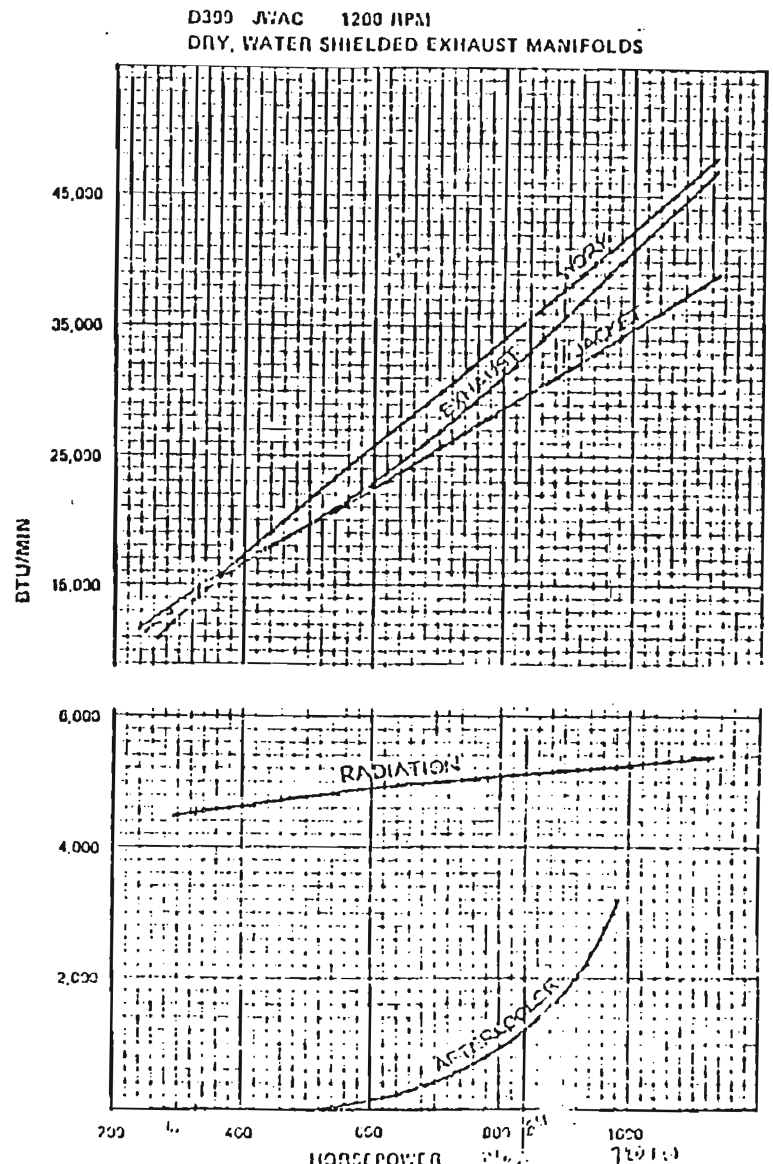
RP/mw
Attachment

The following heat rejection data on diesel engines should be added to the previous mailing on gas engine heat rejection data (59.0):

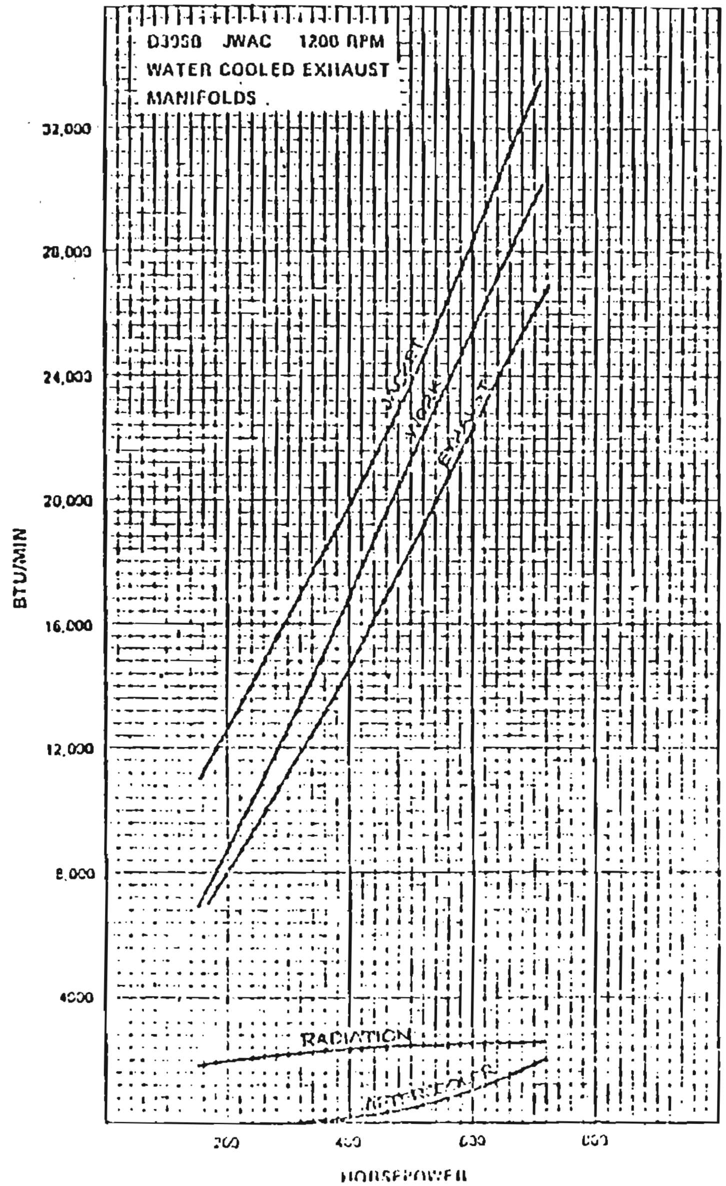
Oil cooler heat rejection on diesel engines can be calculated by the following formula (also listed on page 10).

Approximately 8.5 BTU/MIN/HP

ENGINE DATA SHEET



OIL COOLER : 8.5 BTU/MIN HP



January 24, 1978

Gamze, Korobkin, & Caloger Inc.
205 West Wacker Drive
Suite 2201
Chicago, Illinois 60606

Attention: Mr. Martin Wettstein

Subject: Caterpillar D399 Engine Generator Data

Gentlemen:

In reply to your letter of January 4, 1978, the maximum jacket water temperature leaving the D399 engine when developing 720 KW is 210° F.

With reference to your questions on the Caterpillar generator efficiencies, please extrapolate from the following:

At 800 KW	.953
At 700 KW	.953
At 600 KW	.952
At 500 KW	.948
At 400 KW	.943
At 300 KW	.931
At 200 KW	.909

We trust the above information will satisfy the technical requirements as outlined in your letter of January 4th.

Sincerely,

Roy Parmley
Sales Engineer

RP/mw

November 24, 1976

Mr. Lou Wichmann
Gamze Korobkin Caloger Inc.
205 W Wacker Drive
Room 2201
Chicago, IL 60606

Dear Lou:

Enclosed please find the letter dated on November 19, from Caterpillar Tractor Co., covering data on D399 TA Generator Set Heat Rejection St. Charles Project.

We will be lookingforward to talking to you some tine next week.

Sincerely yours,

POWERTRON INC.

Roy Parmley
Salesman

November 19, 1976

Mr. Roy Parmley
Powertron, Inc.
615 West Lake Street
Elmhurst, Illinois 60126

Dear Roy:

Subject: D399 TA Generator Set Heat Rejection
St. Charles Project

The following heat rejection data applies to the D399 TA Generator Set, ebulliently cooled, rated 630 kW, 60 Hz, 1200 rpm:

Load kW	Jacket Water Btu/min.	Exhaust (Total) Btu/min.	Oil & Aftercooler Btu/min.
630	25,400	31,900	12,300
473	18,900	24,380	10,000
315	12,300	17,040	8,400

The following data is extrapolated information. We do not have data for an ebulliently cooled arrangement of the D399 TA rated 800 kW. A load of 800 kW could only be applied if the engine was being operated as a solid jacket water system with forced flow and controlled to a maximum jacket water outlet temperature of 210°F.

Load kW	Jacket Water Btu/min.	Exhaust (Total) Btu/min.	Oil & Aftercooler Btu/min.
800	32,255 1,935 MBH	47,480 2,849 MBH	15,620 937 MBH
600	24,000	33,420	12,700
400	15,620	22,550	10,670

CATERPILLAR TRACTOR CO.

As we discussed, we will not ship an ebullient arrangement of the D399 TA Generator Set at any rating other than 630 kW. Any other rating must be approved by our Engineering Department.

If we can be of further assistance, please contact us.

Very truly yours,

November 11, 1976

Gamze Korobkin Caloger Inc.
Room 2201
205 W. Wacker Drive
Chicago, Illinois 60606

Attn: Lou Wichmann

Subject: St. Charles Project - 8-D399s
Our File BS/SE 84

Dear Mr. Wichmann,

In reference to the subject matter St. Charles Project - 8-D339's, this is to confirm the verbal information I passed on to you earlier.

Very truly yours,

Roy Parmley
Sales Engineer

RP:rl

Enclosure

October 25, 1976

Mr. Roy Parmley
Powertron, Inc.
615 West Lake Street
Elmhurst, Illinois 60126

Dear Roy,

Subject: St. Charles Project - 8-D399s
Our File BS/SE 84

This will confirm our phone conversation of October 19, 1976 and October 22, 1976. All information is relative to a D399 TA Generator Set, ebulliently cooled, rated 630 kW, 1200 rpm.

Oil Cooler/Aftercooler Heat Rejection

kW	HP	Btu/min
630	887	12300
473	669	10000
315	453	8400

Note: oil cooler heat rejection is approximately 10 Btu/bhp.

	Oil Cooler	Aftercooler
Minimum water flow	80 gpm	80 gpm
Maximum water inlet temperature	160°F	130°F
Approximate pressure drop at minimum water flow	2 psi	5 psi

Roy, if we can be of further assistance, please contact us.

Very truly yours,

Dealer Sales Development
Marketing Department

July 11, 1977

Mr. Roy Parmley
Powertron, Inc.
615 West Lake Street
Elmhurst, IL 60126

Dear Roy:

St. Charles Project

Much of the performance data requested in your June 6 letter has been itemized below. Because some of the values are the result of calculation rather than actual test, the tolerances imposed on these figures must necessarily be liberal. Note that all data is for a normally cooled engine. If ebullient cooling is utilized, the engine must be derated.

The remainder of the information requested is not readily available at this time. Hopefully, the following data will be sufficient to satisfy your customer's needs.

D399 - 800 kW at 1200 RPM

	Full	3/4	1/2
Air Flow (lb/hr)	10,900	8,850	6,820
Specific Heat (C_p) Exh. (BTU/lb° F)	.260	.258	.254
Density (lb/ft^3)	.029	.031	.033
Thermal Efficiency of Engine	34.2%	34.0%	32.5%

Very truly yours,

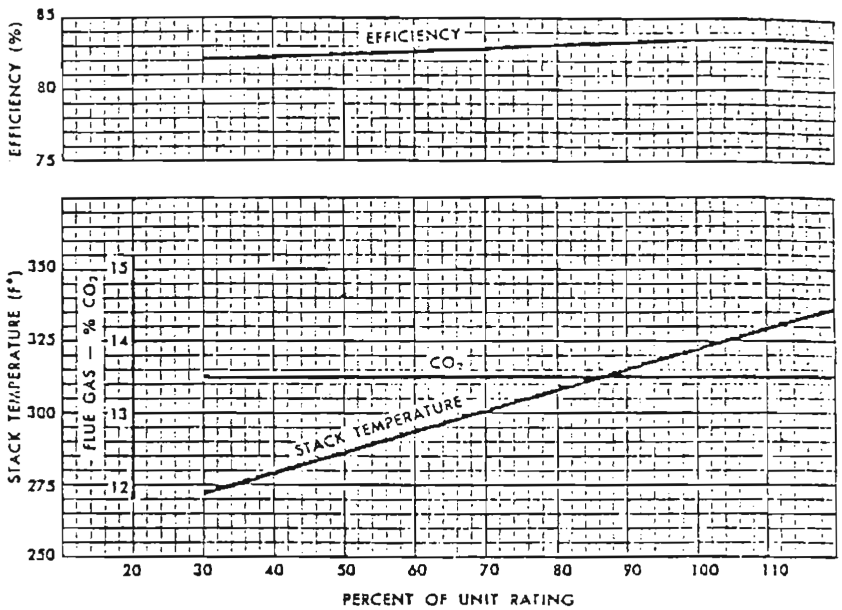
Dealer Sales Development
Marketing Department

GDMinor
Telephone: (309) 578-6727
ko

• BOILER

Every CB *Boiler is guaranteed to operate at* 80% Efficiency

The outstanding feature of the Cleaver-Brooks steam boiler is its proven high efficiency. Economy of operation is assured first by establishing an efficient flame and then absorbing all usable heat in the four passes, before the combustion gases leave the boiler.

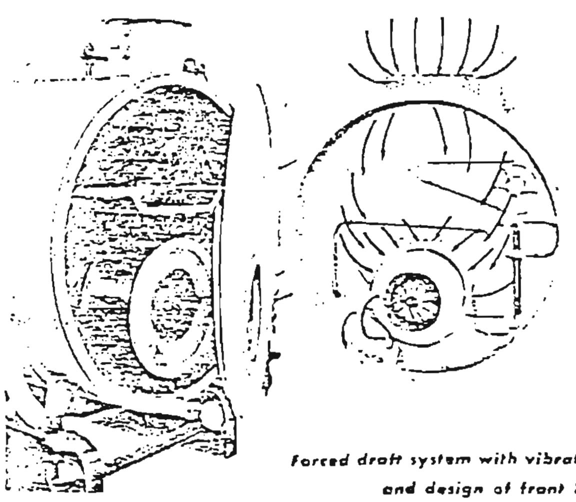


TYPICAL PERFORMANCE CURVE OF A LOW PRESSURE CB BOILER FIRED WITH NO. 6

WARRANTY

The CB boiler is guaranteed to operate at a fuel-to-steam efficiency of not less than 80% at a rating of 30 to 100% and at the designated working pressure. This efficiency will be indicated by a stack temperature approximately 150° F. above saturated steam temperature at the operating pressure and a stack gas analysis showing approximately 13.5% CO_2 when firing with oil, and 90% of the ultimate CO_2 obtainable with the particular gas being burned when firing with gas.

UNIQUE CASELESS FAN *keeps operation quiet!*



An outstanding feature of the CB boiler is its unusually quiet operation. Fan noise is often a problem with mechanical equipment — not so with Cleaver-Brooks. The exclusive CB caseless fan design draws combustion air into the large plenum chamber of the front head, which confines and deadens fan and air noises. At peak loads, the CB more than meets the low sound levels required for schools, hospitals and institutions.

Forced draft system with vibrationless impeller and design of front head keeps CB boiler operation "hospital quiet."

• DOUBLE EFFECT ABSORPTION CHILLER

JOHN H. HOFFMAN
MANAGER

June 23, 1977

Mr. Martin Wettstein
Gamze, Korobkin-Caloger, Inc.
205 W. Wacker Drive
Chicago, Ill. 60606

Subject: St. Charles
Two Stage Absorption Machine   ABTD - 03J

Below is the selection data for the double effect absorber using Dow Therm A which you requested.

Capacity: 391 tons

Evaporator: 669 GPM from 56°F to 42°F, 4 pass - 16.5 ft. pressure drop, .0001 ff.

Abs/Condenser: 1390 GPM of "pond" water from 80°F to 94°F, .001 ff, 33 ft. drop.
4 pass absorber
1 pass condenser

Concentrator: (4 pass) 552 GPM of Dow Therm A, from ~~40°F~~ 400°F to 361°F, pressure drop 18.3 ft.

Alternate Concentrator Selection: (use if lower flow rates are anticipated)(3-pass) 500 GPM of Dow Therm A from 400°F to 357°F, 33.7 ft. pressure drop

Very truly yours,

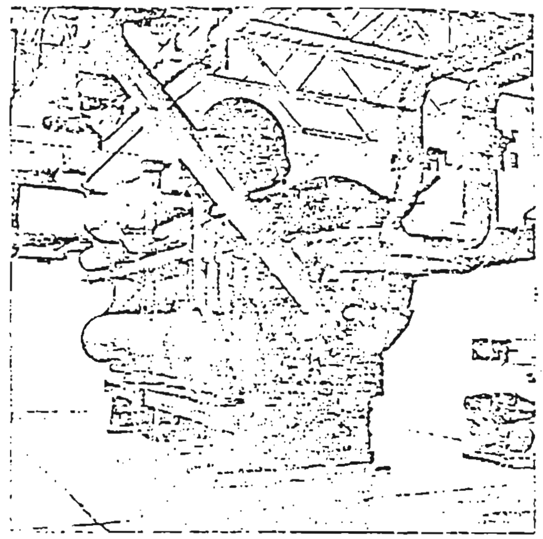
Jay N. Nelson
Sales Manager

JNN/bab
cc: Mr. M. Gamze

for operating economy

the standard of comparison

Absorption Cold Generators use steam or hot water to produce chilled water for comfort and process applications. To improve the thermodynamic efficiency of the absorption process — a timely concept with today's urgent need for energy conservation — Trane's exclusive, Two-Stage Absorption Cold Generator adapts multiple effect concentrators to the proven, lithium bromide and water absorption refrigeration cycle. The result is a great reduction in the amount of energy used per ton of refrigeration.



Compared to single-stage units at full load, Trane two-stage chillers provide energy savings of at least 30%. Often, they save up to 40% when compared on a typical profile of variations in load and outside ambient conditions.

Further, Trane two-stage units reject 20% less heat to the cooling tower; thus, a smaller tower can be selected for any given machine cooling capacity.

	Trane Two-stage Absorption (ABTD-03E)	Typical Single-stage Absorption (ABSC-03E)
Full load steam consumption	12.2 lbs./ton-hr. (123 psi steam, 233 F condensate)	18.7 lbs./ton-hr. (12 psig steam, 240 F condensate)
Full load energy input	12,100 BTU/ton-hr.	17,800 BTU/ton-hr.
Full load coefficient of performance	0.99	0.67
Typical annualized energy input	10,600 BTU/ton-hr.	16,600 BTU/ton-hr.

True, Trane two-stage chillers cost significantly more than single-stage alternatives. But the cost of fuel for a single-stage machine often exceeds the cost of the unit itself within four years. So, with the accumulated savings in operating costs, Trane Two-Stage Absorption Cold Generators frequently recover the first-cost difference in a short period.

From then on, they save money... cold, hard cash!

2-stage operation

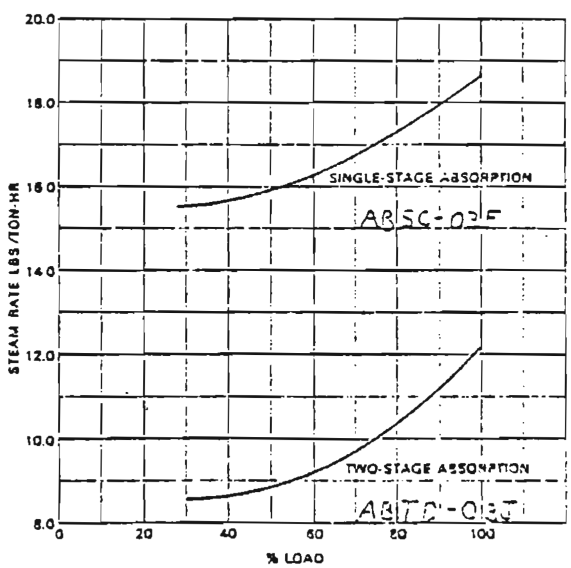
what it provides

Full and part load savings — Basic, full load heat input to the machine is 12,100 BTU's per ton hour. This is the heat input required for each machine at nominal conditions regardless of unit size, hot water or steam heat, and whether or not a condensate heat exchanger is supplied. Heat input, as measured in pounds of steam consumed per ton-hour, is 12.2 This is based upon supplying a two-stage machine with saturated steam at either 123 or 144 psig, and upon discharging condensate at approximately 230 F.

As Chart 5-1 shows, at part load conditions, or if cooling tower water temperature is below 85 F, the steam rate for absorption chillers decreases. To determine annual steam consumption for single-stage or two-stage absorption requires a detailed study of full and part load performance, building load profile, ambient conditions and cooling tower performance. Many of these studies have been performed, in a variety of situations, using Trane's sophisticated "TRACE" computer program. They show, overall, that the two-stage absorption machine requires a steam input of 10 to 11 pounds per ton-hour. They also show that, compared with single-stage, two-stage chillers save 6 to 7 pounds per ton-hour. For preliminary estimates, a steam savings of 6.5 pounds per ton-hour should be assumed.

If hot water is under consideration as the heat source, a BTU savings corresponding to 6.5 pounds of steam per ton-hour should be used.

CHART 4-1 — Comparison of Part Load Performance



Steam and operating cost savings — In comparison with conventional, single-stage chillers, Trane's exclusive, two-stage units reduce steam consumption and lower operating costs. A preliminary estimate of the steam savings can be made if the "equivalent full load hours" of operation are known. The efficiency of a modern boiler, operating on gas, is approximately 76%. With this information, and if the cost of fuel is known, operating cost savings can also be easily estimated.

Typically, a detailed analysis, as mentioned in "Full and part load savings," will show slightly larger savings for both steam consumption and operating costs than in the preliminary estimate.

Comparative annual savings for steam consumption and operating costs are directly dependent upon the estimate of equivalent full load hours of operation. In the following example, 1200 hours are assumed. Modern, compact buildings with high internal heat loads may require air conditioning equipment to operate as much as 3000 equivalent full load hours per year. In such a situation, annual savings with Trane Two-Stage Absorption Cold Generators would be correspondingly higher than in the example.

Example:

If a 750 ton chiller is applied on a project with 1200 equivalent full load hours per year, and the cost of gas is $.85 per thousand cubic feet (or $.085 per Therm), savings may be estimated as follows:

Steam savings per year (thousands of pounds):

$$\frac{\text{Savings lbs./ton-hour} \times \text{EFLH} \times \text{tonnage of the chiller}}{1000} =$$

$$\frac{6.5 \times 1200 \times 750}{1000} =$$

5850 thousands of pounds per year steam savings.

CHART 5-1 — Two-Stage Part Load Performance

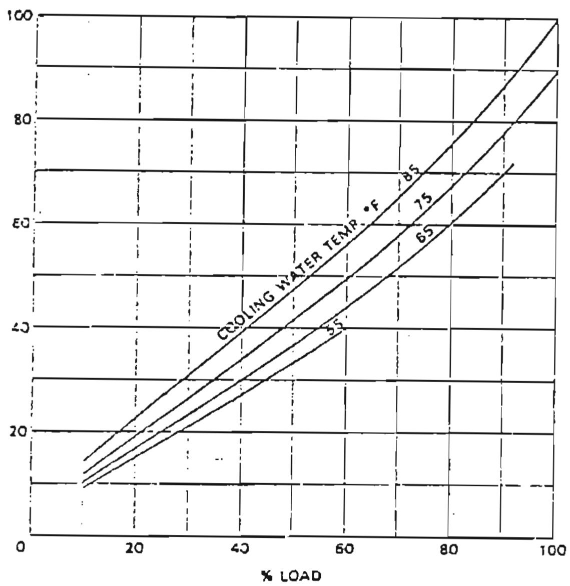
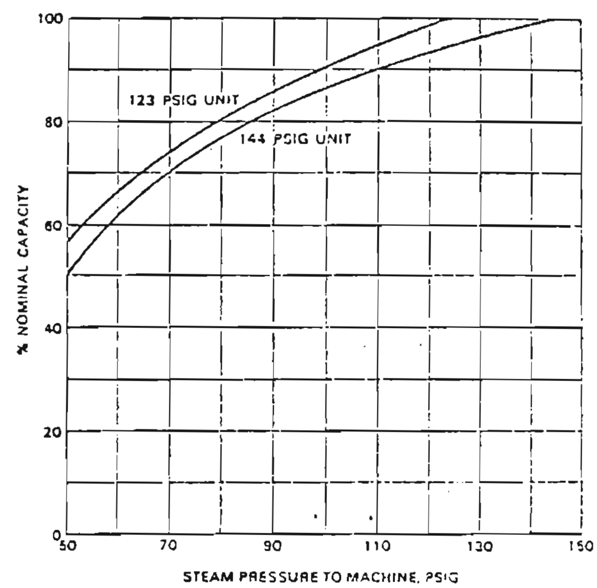


CHART 5-2 — Capacity at Reduced Steam Pressure



Fuel cost of steam (dollars per thousand pounds):

$$\frac{\text{Cost of fuel per Therm} \times 10^*}{\text{Boiler efficiency}} =$$

$$\frac{.085 \times 10}{.76} =$$

$1.118 per thousand pounds of steam.

Annual savings in operating costs:

Steam saved (thousands of pounds) x cost per thousand pounds =

5850 x $1.118 =

$6,540.30 per year

*There are approximately 10 Therms of heat per thousand pounds of low pressure (12 psi) steam.

Condensate Heat Exchanger

For units that will use steam as the heat source, and when it is desireable to reduce the temperature of the leaving condensate, an optional, condensate heat exchanger is available. Its purpose is to reduce flashing losses in an open condensate return system. Only when serving this function will it improve the overall efficiency of the closed system.

In order to maximize the amount of heat extracted from each pound of steam, the condensate heat exchanger should always be used on machines applied in district steam applications.

For further discussion, see the application section of data catalog D-ABS2.

TABLE 1ABTD-03J - Available Capacity

ENTERING COOLING WATER TEMP F	144 PSIG STEAM PRESSURE UNIT	123 PSIG STEAM PRESSURE UNIT	LEAVING CHILLED WATER TEMP 40	42	44	45	46	48	50
80	144	123	335	403	427	439	450	474	485
	120	105	358	381	404	416	427	450	474
	100	90	331	354	377	389	404	427	447
	75	70	293	312	335	347	358	381	404
	50	45	273	243	266	277	289	308	331
85	144	123	339	362	385	397	408	435	458
	120	105	312	335	358	373	385	403	431
	100	90	289	312	335	347	358	381	400
	75	70	239	262	285	295	304	331	354
	50	45	154	173	193	204	216	235	254
90	144	123	285	308	331	343	354	381	404
	120	105	262	285	312	323	335	358	381
	100	90	227	250	277	239	296	320	353
	75	70	196	216	235	246	254	227	296
	50	45	112	150	163	177	139	208	223

NOTE: CAPACITIES GIVEN ARE BASED ON 1390 GPM COOLING WATER. 4 PASS EVAPORATOR AND .0005 FOULING FACTOR

CHART 2ABTD-03J - Chilled Water

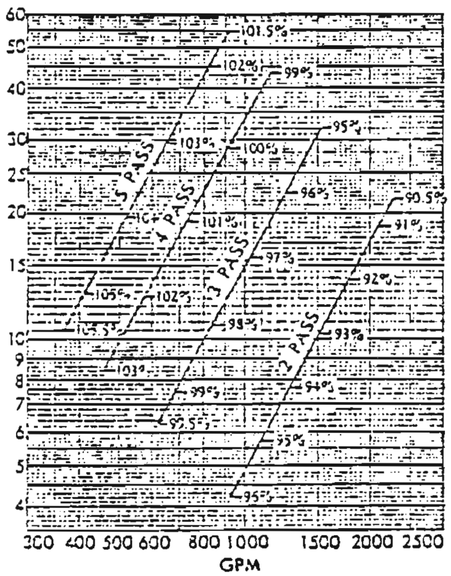
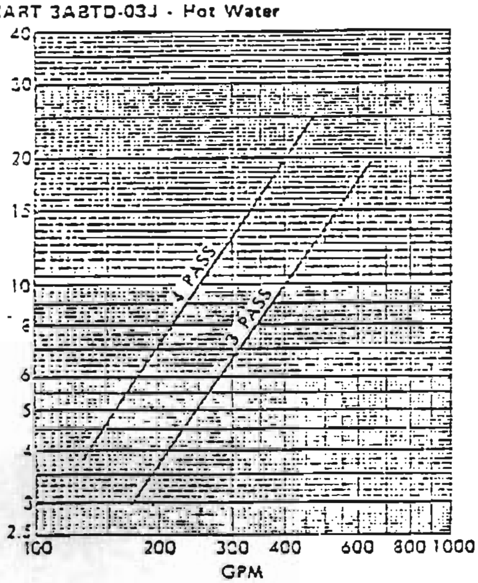


CHART 3ABTD-03J - Hot Water



MODEL ABTD - 03J

A. Nominal Capacity: 385 tons

B. Nominal Steam Rate: 12.2 lbs/hr-ton

C. Cooling Tower Water:

Nominal GPM	Passes Absorber	Condenser
1390	4	1

D. Unit Pumps:
Nameplate Motor Rating 15 hp
Power Input 9.3 kw
For additional electrical data see Table 2, Page 27.

E. Purge Pump:
Nameplate Motor Rating 1/4 hp

F. Connection Sizes:

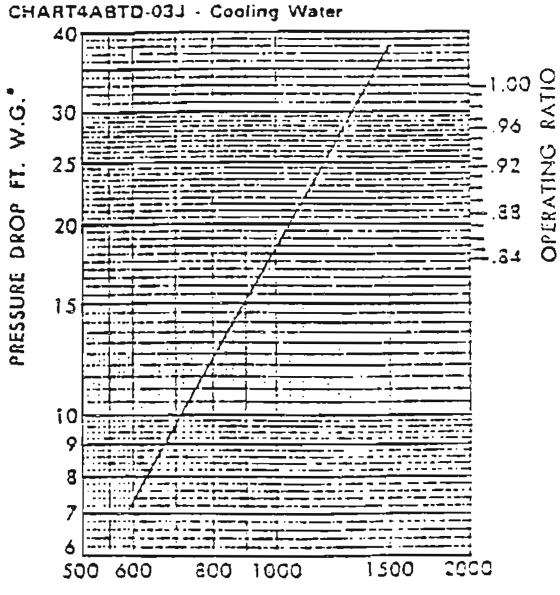
Absorber	Condenser
8 in.	8 in.

Concentrator
Steam: Same as Steam Valve
Evaporator (Passes—In.)
2—8 in. 4—6 in.
3—8 in. 5—6 in.

G. Machine Dimensions:
Overall Length 212 in.
Overall Width 105 in.
Overall Height 140 in.
Shipping Weight 28,500
Steam Operating Weight 41,850
Floor Loading (Steam) PSI 50
Hot Water Operating Weight 42,330
Floor Loading (Hot Water) PSI 51

H. Maximum Allowable Design Tons: 423 Tons

CHART4ABTD-03J - Cooling Water



*SEE PRESSURE DROP NOTE ON PAGE 30

• SINGLE EFFECT ABSORPTION CHILLER

MODEL ABSC-03F

A. Nominal Capacity: 354 tons
B. Nominal Steam Rate: 18.7 lbm/hr-ton
C. Cooling Tower Water:

Nominal GPM	Passes Absorber	Passes Condenser
1275	2	1

D. Unit Pumps:
Nameplate Motor Rating 7½ hp
Power Input 7.5 kw
For additional electrical data see Table 3, page 46.

E. Purge Pump:
Nameplate Motor Rating ¼ hp

F. Traps:
Type F & T. See Table 4, page 52.

G. Connection Sizes:

Absorber	Condenser
6 in.	6 in.

Concentrator
Steam: Same as Steam Valve
Hot Water: See Page 55

Evaporator (Passes—In.)
2—8 in. 5—5 in.
3—6 in. 6—5 in.
4—5 in.

H. Machine Dimensions:
Overall Length 19'-3"
Overall Width 5'-9"
Overall Height 8'-2"
Shipping Weight 17,000 lb.
Steam Operating Weight 24,700 lb.
Floor Loading 50 psi

I. Maximum Allowable Design Tons: 395 Tons

CHART 8C3F—Hot Water

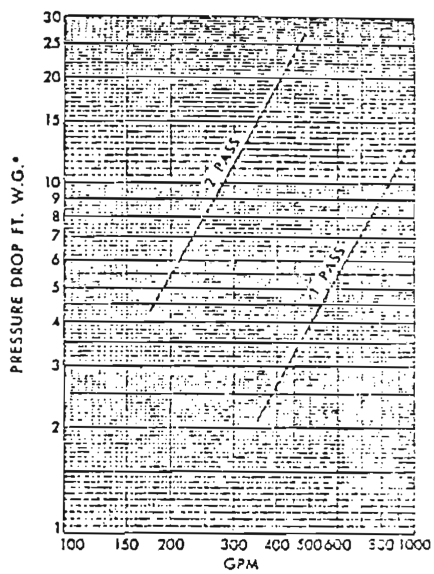


TABLE 2C3F—Available Capacity

ENTERING COOLING WATER TEMP. °F.	STEAM PRESSURE PSIG	LEAVING CHILLED WATER TEMPERATURE 40	42	44	45	46	48	50
80	12	358	385	402	411	418	442	449
	10	351	368	385	392	405	425	446
	8	329	351	371	380	390	411	431
	6	302	323	343	352	363	385	407
	4	279	297	317	327	339	362	387
	2	252	272	293	304	315	337	364
85	14	—	—	—	372	382	397	413
	12	318	336	354	362	372	388	403
	10	301	318	338	348	360	381	400
	8	280	298	318	329	339	363	390
	6	258	276	297	307	318	340	366
	4	234	251	272	283	293	316	343
	2	203	226	246	258	269	290	315
90	14	286	304	322	333	343	360	373
	12	272	290	306	315	324	340	357
	10	255	269	283	293	301	323	347
	8	235	251	268	277	287	308	329
	6	214	230	248	256	265	287	305
	4	192	208	226	235	244	265	287
	2	170	187	205	213	223	241	262

NOTE: CAPACITIES GIVEN ARE BASED ON 1275 GPM COOLING WATER, 3 PASS EVAPORATOR AND .0005 FOULING FACTOR.

CHART 7C3F—Chilled Water

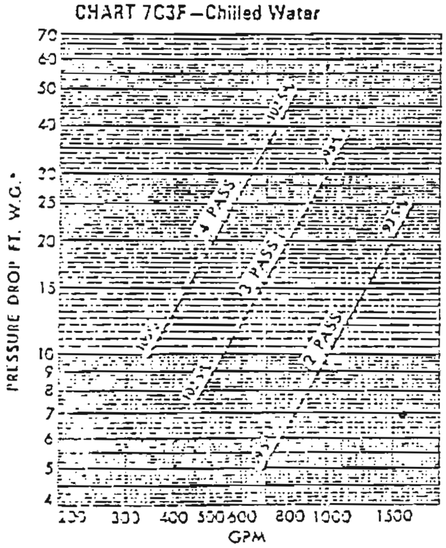
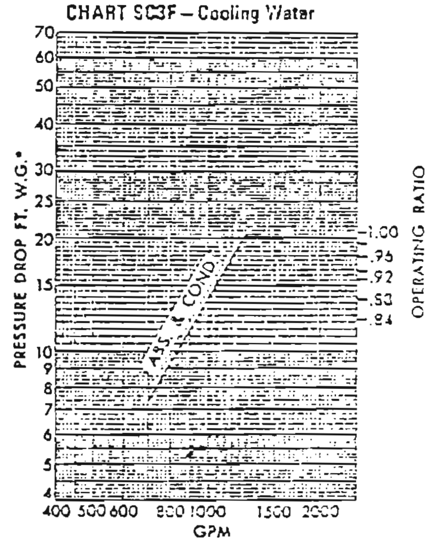


CHART 9C3F—Cooling Water



*SEE PRESSURE DROP NOTE ON PAGE 53

TABLE 1 – Index of Absorption Cold Generator Data

MACHINE DESIGNATION	NOMINAL* CAPACITY—TONS	PAGE	MACHINE DESIGNATION	NOMINAL* CAPACITY—TONS	PAGE	MACHINE DESIGNATION	NOMINAL* CAPACITY—TONS	PAGE
ABSC-01A	101	17	ABSC-02J	294	25	ABSC-07C	750	33
ABSC-01B	112	18	ABSC-03E	354	26	ABSC-08C	852	34
ABSC-01C	129	19	ABSC-03J	385	27	ABSC-09D	955	35
ABSC-01E	148	20	ABSC-04B	420	28	ABSC-11A	1125	36
ABSC-01H	174	21	ABSC-04F	465	29	ABSC-12A	1250	37
ABSC-02A	200	22	ABSC-05C	520	30	ABSC-14C	1465	38
ABSC-02C	228	23	ABSC-05J	550	31	ABSC-16C	1660	39
ABSC-02F	256	24	ABSC-06C	665	32			

*NOMINAL CAPACITY IS DEFINED AS FULL LOAD CAPACITY AT 12 PSIG STEAM AT THE CONCENTRATOR FLANGE, 85 F ENTERING CONDENSER WATER, 44 F LEAVING CHILLED WATER AND .0005 FOULING FACTOR.

CHART 2 – Steam Consumption Rate and Cooling Water Temperature Rise.

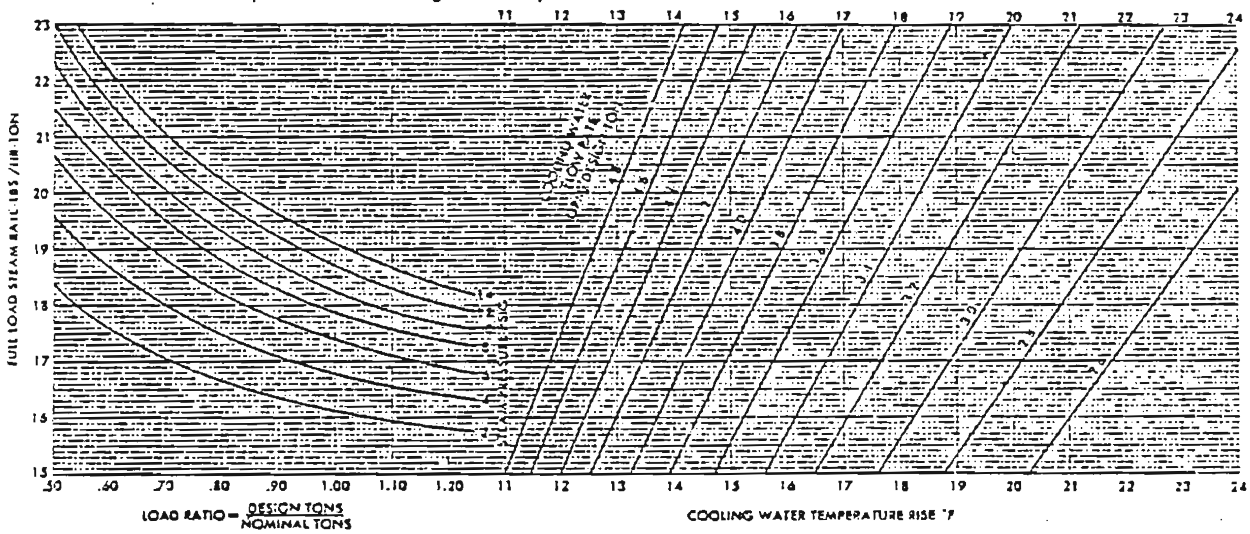
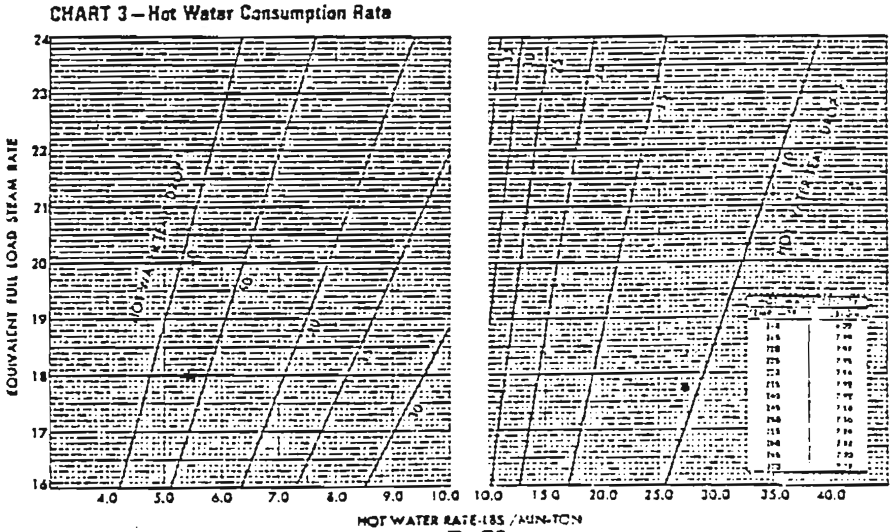


CHART 3 – Hot Water Consumption Rate



7E

CHART 4 – Part Load Performance Without Economizer – All Units

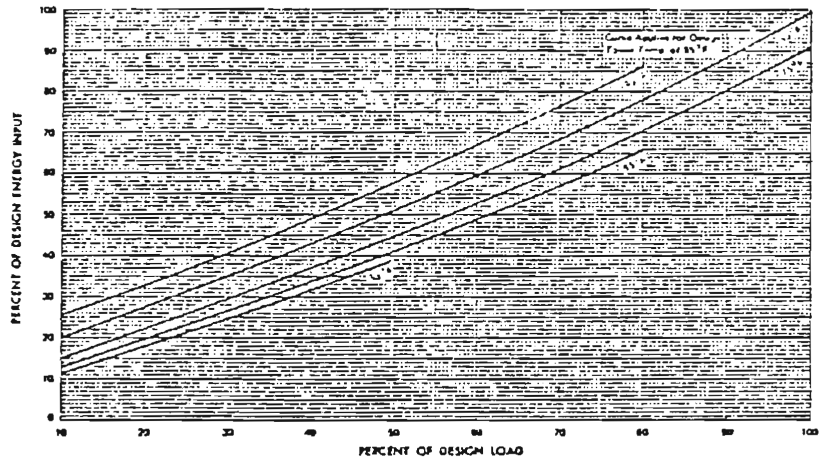


CHART 5 – Part Load Performance with Economizer – Units ABSC-01A thru ABSC-12A

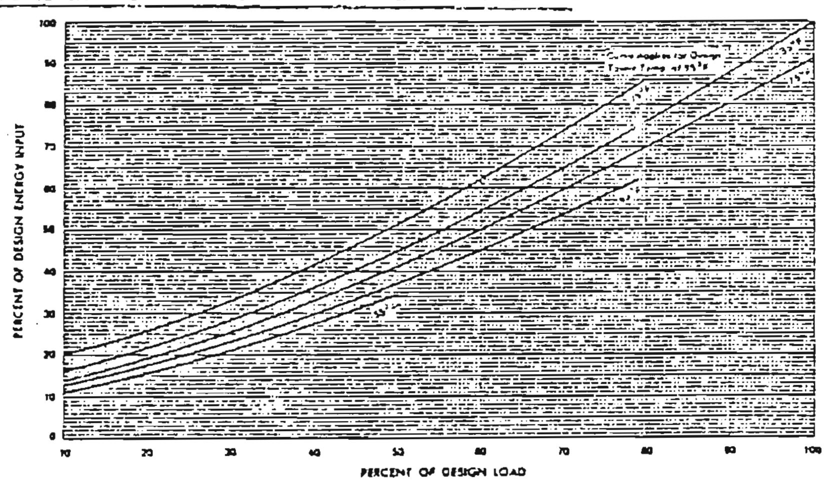
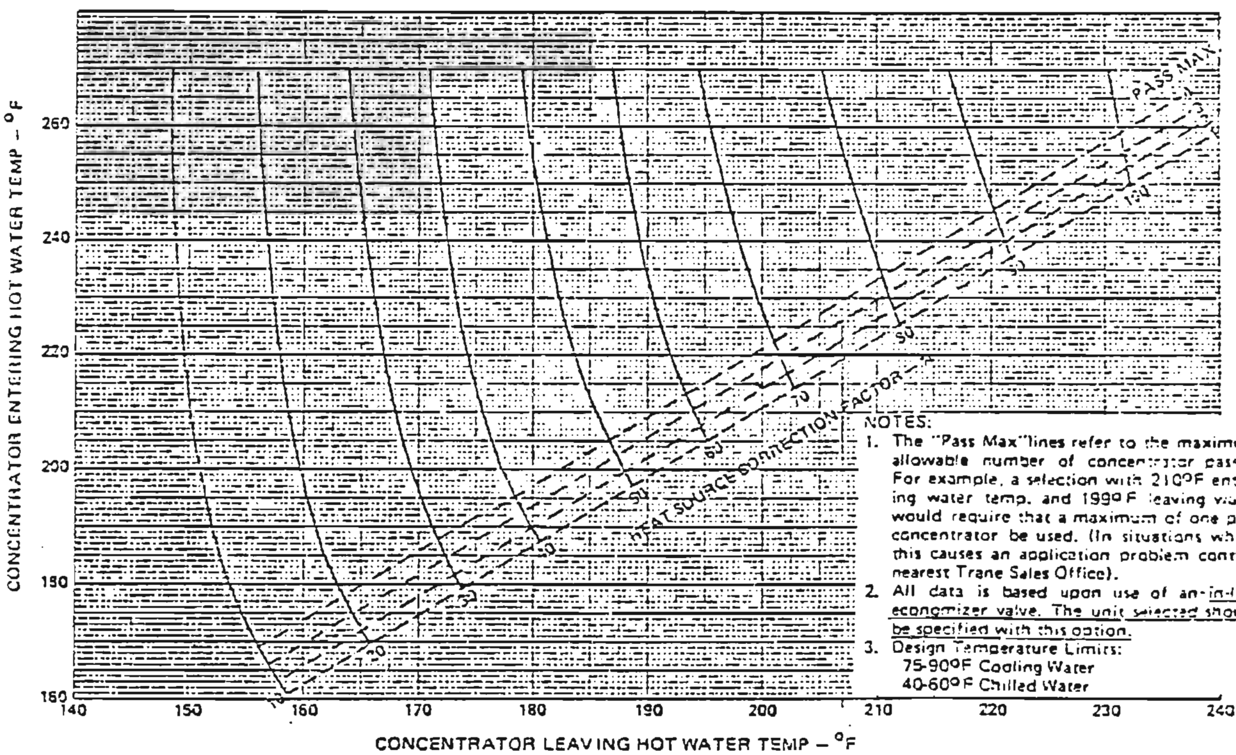


CHART 1
HEAT SOURCE CORRECTION FACTOR



NOTES:

1. The "Pass Max" lines refer to the maximum allowable number of concentrator passes. For example, a selection with 210°F entering water temp. and 199°F leaving water would require that a maximum of one pass concentrator be used. (In situations where this causes an application problem contact nearest Trane Sales Office).
2. All data is based upon use of an in-line economizer valve. The unit selected should be specified with this option.
3. Design Temperature Limits:
   75-90°F Cooling Water
   40-60°F Chilled Water

CHART 2
DESIGN CONDITION CORRECTION FACTOR

ENTERING COOLING WATER (TOWER) TEMPERATURE (°F)	LEAVING CHILLED WATER TEMPERATURE °F 40	42	44	45	46	48	50	52	54	55	56	58	60
65	1.28	1.32	1.37	1.40	1.42	1.46	1.50	–	–	–	–	–	–
75	1.13	1.19	1.26	1.29	1.32	1.39	1.44	1.47	1.50	1.52	1.53	1.54	1.59
80	1.03	1.09	1.13	1.15	1.18	.23	1.27	1.32	1.37	1.39	1.40	1.43	1.45
85	0.90	0.95	1.00	1.02	1.05	1.10	1.14	1.19	1.23	1.25	1.26	1.30	1.33
90	0.77	0.82	0.87	0.89	0.92	0.96	1.01	1.06	1.11	1.13	1.15	1.15	1.21
95	0.60	0.61	0.71	0.74	0.76	0.81	0.86	0.90	0.94	0.95	0.98	1.01	1.04

PERFORMANCE EXAMPLE NO. 13

EVAPORATOR — N1
CONDENSER — N1S

• CENTRIFUGAL CHILLER

MODEL CVHB 125 T N1 N1S

TABLE 37-1 Performance

COMP 125 EVAP N1 COND N1S		ADJUSTED LEAVING CONDENSER - F			
		90	95	100	
ADJUSTED LEAVING EVAPORATOR - °F	40	1130	1074	1000	TONS
		813	813	813	KW
		09	10	12	IMPELLER
	42	1161	1111	1029	TONS
		813	813	813	KW
		08	09	11	IMPELLER
	44	1195	1148	1086	TONS
		805	813	813	KW
		07	08	10	IMPELLER
	46	1220	1182	1119	TONS
		789	813	813	KW
		06	08	09	IMPELLER
	48	1246	1220	1154	TONS
		773	813	813	KW
		05	07	08	IMPELLER
	50	1272	1261	1191	TONS
		757	813	813	KW
		05	06	07	IMPELLER

Refrigerant (lbs R-11)	2,100
Oil Charge (Gallons)	10
Auxiliary Water Required (GPM)	4
Evaporator Insulation Area (Square Feet)	326
Shipping Weight (lbs)	43,050
Operating Weight (lbs)	47,600
Maximum Rigging Weight (lbs)	22,400
Shell & Water Box Volume (Gallons)	
Evaporator	190
Condenser	260

NOTE: All dimensional and physical information applies only to the component combination identified on this page.

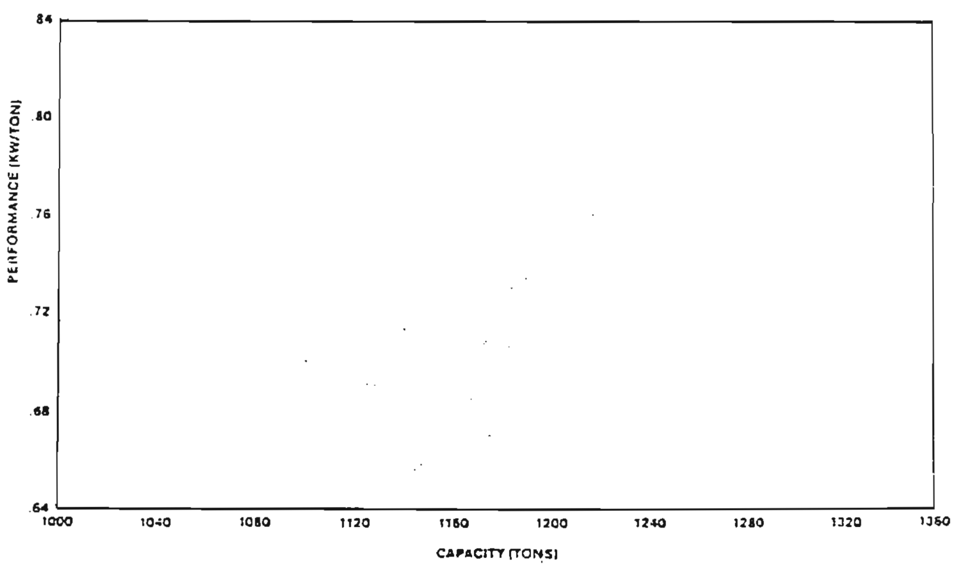
NOTE: Capacities are tabulated for a two-pass evaporator and condenser. All capacities are net tons for the size listed.

Adjusted leaving evaporator water temperature is obtained by using correction factors in Table 37-2 or fouling factor correction as explained on page 9.

Adjusted leaving condenser water temperatures are obtained by using fouling factor corrections as required, shown on page 9.

Do not select one-pass evaporator unit in shaded areas.

CHART 37-1
Performance Field



NOTE: Performance field indicates the range of performance available using the compressor listed above with various combinations of evaporators and condensers. Data is based on a .0005 fouling factor, 44F leaving chilled water temperature, and 95F leaving condenser water temperature. Use Trane's computer program to obtain specific component selections.

TABLE 37-2 Evaporator Correction Factors

ΔT (F)	4	6	5	10	12	14	16	15	20	22	24	26	28	30	32	34	36
ONE PASS	-2.0	-3.0	-4.0	-4.5	-5.5												
TWO PASS			0	0	0	0	0	0	-.5	-.5	-.5	-.5	-.5	-.5			
THREE PASS					1.5	1.5	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0	2.0	2.5	2.5

NOTE. Apply pass and temperature difference correction factors to design leaving chilled water temperature to obtain the adjusted leaving chilled water temperature.

ΔT refers to the chilled water temperature drop through the evaporator.

Corrected temperatures are used for selection purposes only. Design leaving chilled water temperatures remain the same

TABLE 9-1 Component Combination Availability

COMPRESSOR	EVAPORATOR			STANDARD CONDENSER			EXTENDED CONDENSER			MOTORS (KW RATING)		
	MIN	STD	MAX	MIN	STD	MAX	MIN	STD	MAX	MIN	STD	MAX
CVHA 008		A1			A1S		—	—	—		83	105
CVHA 011		B1	C1		B1S	C1S	—	—	—	80	105	131
CVHA 015	B1	C1	D1	B1S	C1S	D1S	—	—	—	80	105 131	157
CVHA 018	C1	D1		C1S	D1S		—	—	—	80	105 131	157
CVHA 025	E3	E2	E1	E3S	E2S	E1S	E3L	E2L	E1L		134	214
CVHA 032		F2	F1		F2S	F1S		F2L	F1L	224	244	292
CVHA 038		G2	G1		G2S	G1S		G2L	G1L		298	321
CVHA 044	H1	J2	J1	H1S	J2S	J1S	H1L	J2L	J1L	359	419	461
CVHA 055		J2	J1		J2S	J1S		J2L	J1L	359	419	461
CVHB 061	K1	L1	M2	K1S	L1S	M2S	K1L	L1L	M2L	464	531, 609	654
CVHB 080	K1	L1	M2	K1S	L1S	M2S	K1L	L1L	M2L	464	531, 609	654
CVHB 095	M1	N1	P1	M1S	N1S	P1S	M1L	N1L	P1L		703	857
CVHB 125	M1	N1	P1	M1S	N1S	P1S	M1L	N1L	P1L	703	857, 931	1015
CVHB 155	P1	R1	S1	P1S	—	—	P1L	R1L	S1L	931	1015	[illegible]

NOTE: THE FIRST LETTER IN THE EVAPORATOR AND CONDENSER IDENTIFIERS MUST BE IDENTICAL FOR A VALID COMBINATION.
EXAMPLE: E1 EVAPORATOR WITH AN E3L CONDENSER IS ACCEPTABLE.
H1 EVAPORATOR WITH A J1S CONDENSER WILL BE REJECTED.

Performance Field

The performance field charts on each performance spread indicate the general range of capacity and associated power consumption (KW/ton) available with the compressor listed, and utilize various evaporator-condenser and motor combinations. The charts are based on two-pass evaporators and condensers with standard (.0005) fouling factors and leaving water temperatures of 44 F from the evaporators and 95 F from the condensers.

The performance field charts present general performance data and are not intended for final machine selection. The charts are useful to determine the approximate range of capacity available with a specific compressor and energy consumption rates obtainable. The performance field charts are also useful for guidance in entering data for the Trane CenTraVac computer selection program. To obtain maximum benefit from the wide range of selections available, designers are encouraged to develop performance specifications and to use the computer selection program to select the compressor-evaporator-condenser combination that exactly meets the specifications.

The upper portions of the shaded areas on the performance field charts represent performance typically available with smaller and less costly evaporator-condenser combinations. Progressively larger evaporators and condensers are used to obtain the lower KW/ton figures at a given tonnage.

It should be noted that changing the number of evaporator or condenser water passes or water flow rates will also significantly alter the performance of a particular compressor. All final selections should be made by using the computer selection program.

Evaporator Correction Factors

Evaporator correction factors are tabulated on each data spread for the number of evaporator water passes and for the chilled water temperature drop through the evaporator (design entering liquid temperature minus leaving liquid temperature, degrees F). Machine capacity and performance for the specific combination of compressor, evaporator and condenser listed may be determined for pass combinations and water temperature differences other than nominal by entering the capacity table at an adjusted leaving chilled water temperature.

Where a correction factor is not shown it normally indicates that evaporator tube water velocity limits would be exceeded at that particular temperature difference and full load tonnage.

Rectangle Dimensions

The dimensional drawings illustrate the overall measurements of the combination of compressor, evaporator and condenser listed. Detailed dimensional drawings are available for other component combinations from the local Trane sales office.

Minimum Space Envelope

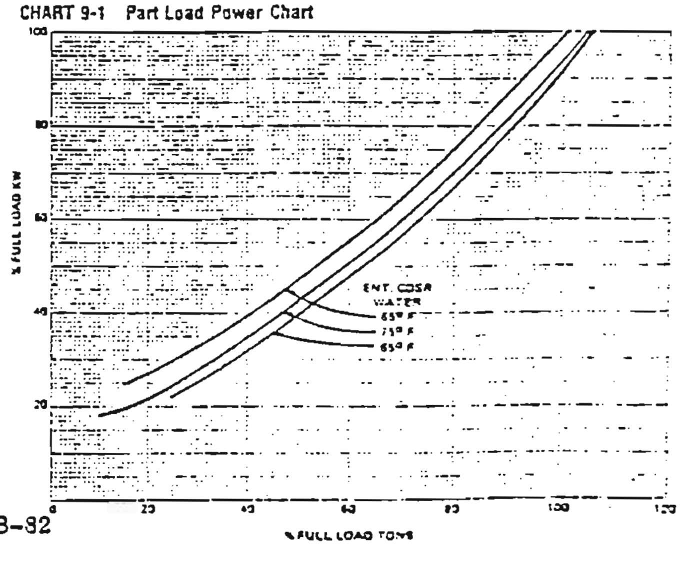
The recommended minimum space envelope indicates overall clearance required to easily service the CenTraVac. A view of the unit is superimposed on this drawing with all four unit support feet shown.

All catalog dimensional drawings are subject to change. Current submittal drawings should be referred to for detailed dimensional information.

Unit Performance With Nonstandard Fouling Factors

The effect of a .001 condenser fouling factor on unit performance may be approximated by the addition of a 2.5 F correction factor to the leaving condenser water temperature. Similarly, the effect of a .001 fouling factor in the evaporator may be approximated by a reduction in leaving chilled water temperature of 2 F. These corrections are in addition to any which might be necessary based on the evaporator correction factor table. These corrections are required for determination of machine capacity and power consumption only. They do not affect actual design leaving water temperatures.

CHART 9-1 Part Load Power Chart



B.2.3 Lead Time and Tests

June 9, 1977

Mr. William Reeves
St. Charles Associates
336 Post Office Road
St. Charles, Maryland 20601

Re: MIUS Plant Equipment

Dear Bill:

In reply to your request for current lead time for delivery of the major equipment for the MIUS plant, we obtained the following informatio from suppliers:

1.	Caterpillar (D-399) engine/generators	4 to 5 months
2.	Absorption chiller (High temperature type)	6 months
3.	Absorption chiller (conventional)	4 months
4.	Electric chiller	4 months
5.	Boilers (Cleaver Brooks)	3 to 4 months
6.	Pumps	3 months
7.	Heat Exchangers	2 to 3 months
8.	Incinerator	3 to 4 months
9.	Transformers and switchgear	4 to 5 months

I am also enclosing an energy analysis for the very latest site configuration which shows the fuel requirements for the engines and incinerator on the basis of generating capacity being available to match the thermal needs of the site. Since a D-399 Cat running continuously will generate about 500,000 KWH per month, two machines must be available at least 5 months of the year. For this reason and to allow for scheduled and unscheduled maintenance, a third machine is strongly recommended for reliability and also to permit you to charge SMECO a meaningful monthly demand.

Sincerely yours,
GAMZE-KOROBKIN-CALOGER, INC.

Ion Caloger

Encl.
IC:cjb

PRELIMINARY LIST OF EQUIPMENT TESTS

Final design specifications will include standard and special tests for all major pieces of equipment to be conducted by the manufacturer to show compliance with the specification. All readings and measurements will be submitted by the manufacturer to the owner before authorizing shipment.

Acceptance tests for the equipment will be conducted on the MIUS site by the supplier for a specified period to show adequate performance under actual conditions with all results to be submitted to the engineer before approval of final payment.

Major equipment to be factory tested:

a. Engine/generator

b. Switchgear

c. Chillers

d. Boilers

e. Incinerator

f. Rotating-disc contactor

Procurement specifications for the above equipment shall include detailed procedures for factory testing.

B.3 Specifications

- Thermal Distribution Specifications

Johns-Manville

Transite® Ring-Tite® Pressure Pipe Class 100 - 150 - 200 psi

TRX-1

Manufacture & Properties

Johns-Manville TRANSITE Pipe is an asbestos-cement product. It is composed of an intimate mixture of Portland cement, silica and asbestos fiber. The material is completely free from organic or metallic substances. The pipe is formed under pressure on a steel mandrel creating a dense wall with a smooth interior surface. Final curing of the product is done in an autoclave employing high pressure steam for dimensional and chemical stability.

TRANSITE pipe is an asbestos-fiber-reinforced product. The asbestos fibers have a tensile strength as high as 400,000 psi and the fibers are oriented in the material in such a way as to utilize their high tensile properties for maximum reinforcement and stress resistance. The high strength of TRANSITE pipe may be demonstrated by examining the hydrostatic and crush strengths of each size and strength of pipe. (See below.) Continuous plant testing assures the maintenance of these high values.

Flow Characteristics

TRANSITE pipe comes in 10' and 13' lengths. The long length, its smooth interior and factory-made close-tolerance joint make possible a coefficient of C=140. This high carrying capacity can result in the use of smaller diameter pipes and lower pumping costs.

Hydrostatic Strength

Each standard, random and short length of Transite water pipe is designed to have sufficient strength to withstand an internal hydrostatic pressure listed in the table below.

ROUTINE HYDROSTATIC PRESSURE, PSI (5 second dwell)	CLASS	100	150	200
	TEST PRESSURE	350	525	700

SAMPLING* HYDROSTATIC TEST PRESSURE, PSI (5 second dwell)	CLASS	100	150	200
	TEST PRESSURE	400	600	800

* One standard length in every 300 is tested to pressures shown and then retested to routine pressure.

Flexural Strength

Each standard length of Transite water pipe in sizes 4, 6 and 8 inches has sufficient strength to withstand, without failure, total loads listed in table below, when applied at the third points of a clear span at a minimum rate at least 500 lbs. per second maintained for five seconds. The supports shall be 9' apart except that, at the manufacturer's option, lengths greater than 12.5' may be tested on supports 12' apart.

NOMINAL PIPE SIZE, INCHES	TOTAL APPLIED LOAD, POUNDS		
	CLASS	9' SPAN	12' SPAN
4	100	1200	–
	150	1470	–
	200	1870	–
6	100	2800	2100
	150	3700	2800
	200	4900	3700
8	100	5330	4000
	150	7600	5700
	200	10130	7600

Design Approach

The strength of asbestos-cement water pipe must be sufficient to withstand the combined forces of internal hydrostatic pressure and external loads. Furthermore, the conditions under which the pipe is installed have a direct relationship to its ability to resist these forces. Therefore, satisfactory pipe performance in field service requires that the bedding conditions, as well as the internal and external forces acting on the pipe, be taken into consideration in selecting a class of pipe for any given installation. Sound engineering practice requires that adequate safety factors be applied to strength requirements to insure performance under less than ideal conditions.

Research tests and the application of statistical analysis have shown that asbestos-cement pipe strength may be graphically illustrated by combined loading parabolic curves. The combined-loading theory developed by the late W. J. Schlick is presented in detail in the AWWA H2 Handbook "Standard Practice for the Selection of Asbestos Cement Water Pipe".) (AWWA C401)

This handbook has been prepared so that design engineers may quickly determine the correct class of asbestos-cement pipe to use under various combinations of internal pressure and external loading. Curves are included in this handbook to expedite the selection of the correct pipe class. Detailed analyses of the various structural factors affecting pipe design and selection are treated under separate headings.

Crushing Strength

Transite water pipe has the crushing strength indicated in the table to the right when tested in accordance with the ASTM 3-Edge Bearing Method.

NOMINAL PIPE SIZE, INCHES	CRUSHING STRENGTH PER LINEAR FT, LB		
	CLASS 100	CLASS 150	CLASS 200
4	4,100	5,400	8,700
6	4,000	5,400	9,000
8	4,000	5,500	9,300
10	4,400	7,000	11,000
12	5,200	7,600	11,800
14	5,200	8,600	13,500
16	5,800	9,200	15,400

Physical Characteristics

STANDARD LENGTHS (NOMINAL)

PIPE SIZES	STANDARD LENGTHS
4"	10'
6"	10' & 13'
8" thru 16"	13'

Weights

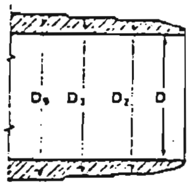
PIPE SIZE INCHES	CLASS 100		CLASS 150		CLASS 200	
	PIPE WGT LBS PER FT*	CPLG WGT EACH	PIPE WGT LBS PER FT*	CPLG WGT EACH	PIPE WGT LBS PER FT*	CPLG WGT EACH
4	6.1	6.6	7.2	7.4	8.8	7.4
6	11.1	10.6	12.3	11.3	14.5	12.4
8	15.5	13.5	18.7	17.5	22.2	18.9
10	22.7	17.1	29.9	25.8	34.5	28.9
12	32.1	26.4	41.0	41.5	48.2	46.8
14	39.2	37.1	55.0	64.2	64.7	72.7
16	50.0	45.6	68.3	81.0	83.7	91.8

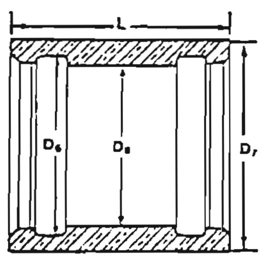
* Includes pipe, coupling and rings.

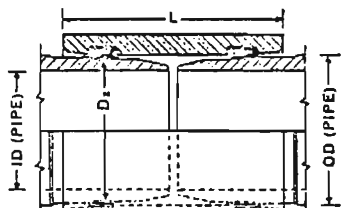
PIPE & COUPLING DIMENSIONS (INCHES)

SIZE Pipe inches	D	D_2	D_3	D_4	D_7*	D_5	D_9* min.	D_9* max.	L
CLASS 100									
4	4.00	4.64	4.80	5.38	6.38	4.76	4.79	5.14	7.00
6	6.00	6.91	7.07	7.65	8.85	7.03	7.05	7.40	7.00
8	8.00	9.11	9.27	9.85	11.05	9.23	9.22	9.57	7.00
10	10.00	11.24	11.40	11.99	13.25	11.36	11.42	11.77	7.00
12	12.00	13.44	13.60	14.18	15.70	13.56	13.69	14.04	8.00
14	13.59	15.07	15.23	15.95	17.39	15.20	15.40	15.80	9.00
16	15.50	17.15	17.31	18.03	19.86	17.28	17.54	17.94	9.00
CLASS 150									
4	4.00	4.81	4.97	5.55	6.67	4.93	4.97	5.27	7.00
6	5.85	6.91	7.07	7.65	8.96	7.03	7.07	7.37	7.00
8	7.85	9.11	9.27	9.85	11.52	9.23	9.27	9.57	7.00
10	10.00	11.65	11.82	12.40	14.51	11.78	11.82	12.12	7.00
12	12.00	13.92	14.08	14.66	17.15	14.04	14.08	14.38	8.00
14	14.00	16.22	16.38	17.10	20.00	16.35	16.39	16.73	9.00
16	16.00	18.46	18.62	19.34	22.64	18.59	18.62	18.97	9.00
CLASS 200									
4	4.00	4.81	4.97	5.55	6.67	4.93	5.22	5.57	7.00
6	5.70	6.91	7.07	7.65	9.10	7.03	7.26	7.56	7.00
8	7.60	9.11	9.27	9.85	11.66	9.23	9.39	9.74	7.00
10	9.63	11.66	11.82	12.40	14.69	11.78	11.77	12.12	7.00
12	11.56	13.92	14.03	14.66	17.48	14.04	14.03	14.38	8.00
14	13.59	16.22	16.38	17.10	20.42	16.35	16.48	16.88	9.00
16	15.50	18.46	18.62	19.34	23.11	18.59	18.79	19.19	9.00

* Subject to manufacturing tolerances.







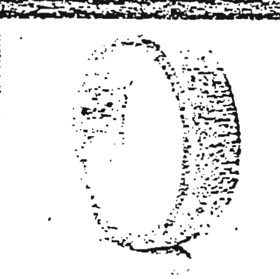
Corrosion Resistance

Pictured below are pipe samples taken from in-service lines—many years old—where aggressive waters and soils have been the best indices of Transite pipe's resistance to corrosion inside, outside, and all-the-way-through. Transite pipe is immune to rust, electrolysis, galvanic and electrochemical types of corrosion. Numerous installations for mine drainage, in cinder fills and for salt water disposal lines are further evidence of Transite pipe's high stability, maintained hydraulic efficiency and long, economical performance. They document why Transite pipe is considered the most corrosion-resistant water pipe in general use by the water works industry.

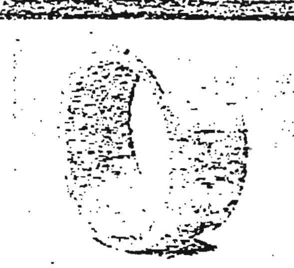
UNRETOUCHED PHOTOS OF PIPE SECTIONS REMOVED FROM OLD, IN-SERVICE TRANSITE WATER LINES

TE OF INSTALLATION ..Late 30's
ICE Arkansas
TURE OF SOIL Acid
TE REMOVED 1962
IGTH OF SERVICE 27 years

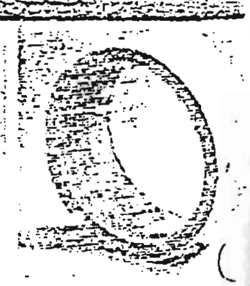
DATE OF INSTALLATION ..1938
PLACE Washington
NATURE OF WATER . Aggressive
DATE REMOVED 1962
LENGTH OF SERVICE ...24 years



DATE OF INSTALLATION .1937
PLACE North Carolina
DATE REMOVED 1962
LENGTH OF SERVICE .25 years



DATE OF INSTALLATION ..1942
PLACE Oregon
NATURE OF WATER .. Aggressive
DATE REMOVED 1962
LENGTH OF SERVICE .. 20 years



DATE OF INSTALLATION ...
PLACE Oregon
NATURE OF WATER Aggr
DATE REMOVED 1962
LENGTH OF SERVICE ..12 y

Technical Data

Johns-Manville

Temp-Tite® Pressure Pipe

for conveying chilled water and low temperature hot water (35-210°F) Sizes 3"-30"

CH-8

- INSTALLS FASTER THAN MANY OTHER INSULATED PIPE SYSTEMS
- COSTS LESS INSTALLED
- OUTPERFORMS OTHER INSULATED PIPE SYSTEMS NOW AVAILABLE.

This factory-insulated pipe is designed especially for central heating/cooling systems in multi-building projects.

Description

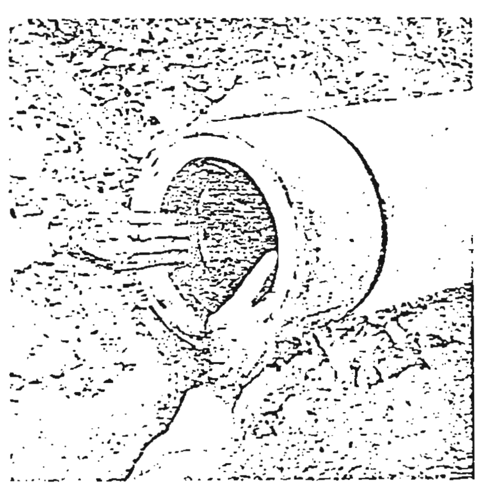
Factory insulated underground pipe — one unit that is completely non-metallic.

TRANSITE® CASING. Light and rugged autoclave cured asbestos-cement resists corrosion from aggressive soils and water. Withstands normal field handling associated with pipeline construction. Meets broadest range of earth loading conditions.

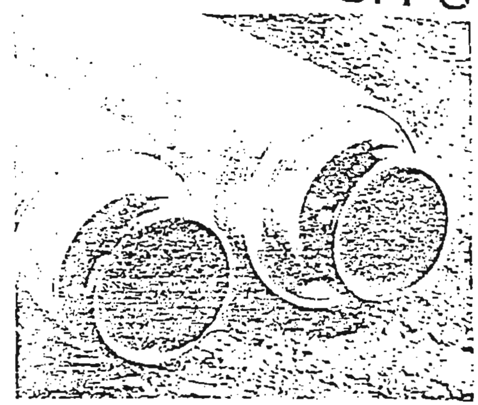
POLYURETHANE FOAM INSULATION is bonded between a lined casing and core, and capped at both ends with water and heat resistant end seals to ensure complete encasement ... to maintain high thermal efficiency.

TRANSITE EPOXY-LINED PIPE CORE. Provides maximum flow rates (C = 150) and eliminates internal corrosion.

RING-TITE® COUPLING with rubber rings provides proven, water-tight seal ... permits quick easy assembly, even in a wet trench ... allows expansion and contraction in the joint ... eliminates need for loops, conventional expansion joints and other costly accessories.



Ring in Coupling Groove



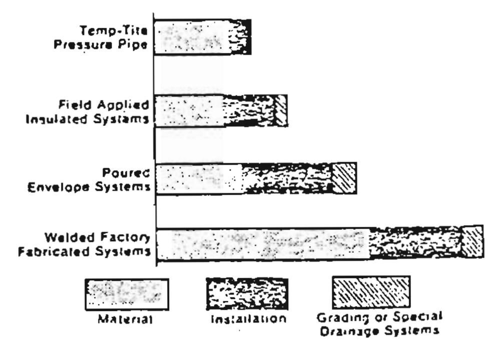
Approval or Acceptance

TEMP-TITE Pressure Pipe is manufactured and tested in accordance with Johns-Manville Material Specification. Performance requirements for individual component parts, as indicated in the J-M Specifications, meet or exceed those covered in the following specifications:

ASTM-C296	AWWA-C400
ASTM-C428	ANSI-A165.3, ANSI-J8.7
ASTM-D1869	Federal Specification SS-P-351c
ASTM-C541	(Upon application)

Cost Comparison Data

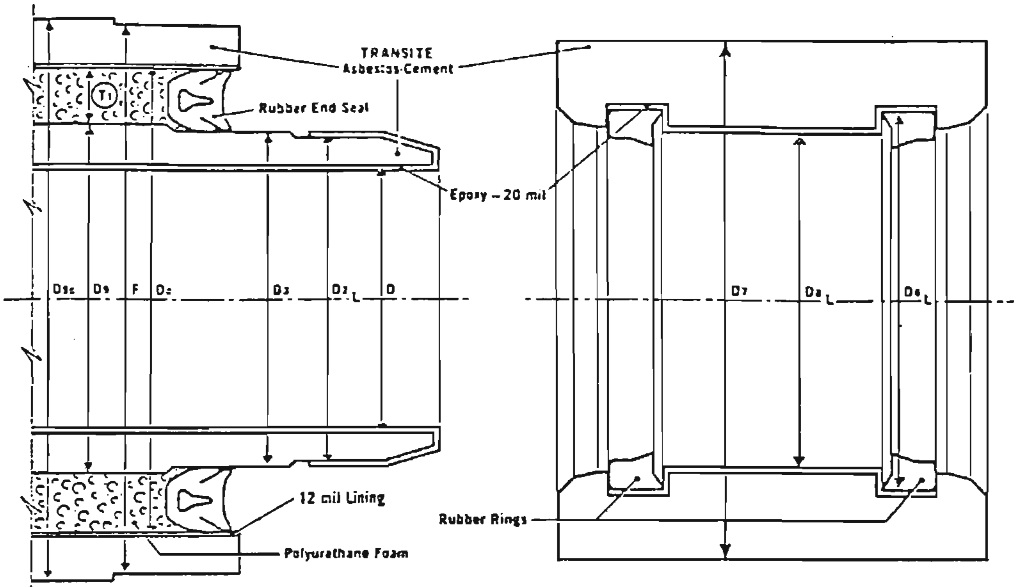
basis — 8" diameter
100 ft. of pipe • no expansion loops or joints



This chart shows the relative installed cost of 8" Temp-Tite pressure pipe as compared to a range of other systems. The cost of required expansion joints and/or loops is not included. The above comparison provides for all materials, labor and normal excavation and back fill costs. Special grading or draining systems normally required under wet trench conditions is estimated as shown.

Product Detail

TEMP-TITE Pressure Pipe conforms to the dimensions shown below. Each pipe is properly machined on each end so as to facilitate joining the pipe sections without damage and to automatically provide an end separation of pipes in each coupling assembly. The pipe ends are also compatible with the coupling so as to provide accurate confinement of the rubber sealing rings.

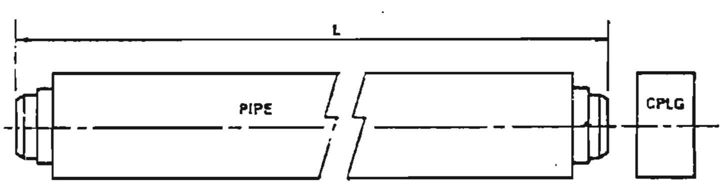


Pipe Size	D	D2L	D3	D9	Dc	D9c	D6L	D7, F	D8L	T1
3	3.00	3.89	4.00	4.06	6.00	6.92	4.58	5.59	4.02	0.97
4	3.95	4.86	4.97	5.03	8.00	9.02	5.55	6.67	4.99	1.48
6	5.85	6.96	7.07	7.13	9.00	9.88	7.65	8.96	7.09	0.94
8	7.85	9.16	9.27	9.33	12.00	13.22	9.85	11.52	9.29	1.33
10	10.00	11.71	11.82	11.88	14.00	15.07	12.40	14.51	11.84	1.06
12	12.00	13.97	14.08	14.14	16.00	17.48	14.66	17.15	14.10	0.93
14	14.00	16.27	16.38	16.44	18.40	20.15	17.10	20.00	16.41	0.98
16	16.00	18.51	18.62	18.68	20.80	22.80	19.34	22.64	18.65	1.06
18	18.00	20.99	21.10	21.00*	24.00	25.78	21.85	25.12	21.13	1.45
20	20.00	23.33	23.44	23.44*	25.45**	27.80**	24.16	27.65	23.47	1.00
24	24.00	28.01	28.12	28.12*	30.00	32.85	28.84	32.92	28.15	.94
30	30.00	35.05	35.16	35.12*	38.00	41.40	35.88	41.18	35.19	1.44

*Minimum value normally greater than this

**Dimension Dc is 26.85 from Long Beach Plant
** Dgc is 28.35 ** ** ** **

sizes, lengths (nominal) and weights



PIPE SIZES	STANDARD LENGTHS (L)	SHORT LENGTHS (L)	
		MOA	MEE
3" & 4"	10'	3'-3"	6'-9"
6"	13'	3'-3"	6'-6"
8" thru 30"	13'	6'-6"	6'-6"

APPROXIMATE WEIGHTS OF PIPE INCLUDING COUPLING

Sizes	Lbs./Ft.
3	13.2
4	19.3
6	23.1
8	39.9
10	50.7
12	72.8
14	96.4
16	123.8
18	147.5
20	190.0
24	271.0
30	417.0

For information on sizes 1", 1¼", 1½", 2", Copper Core Temp-Tite, and 2", 2½", 3", 4", 6", 8" Kool-Kore, see your Johns-Manville Pipe representative.

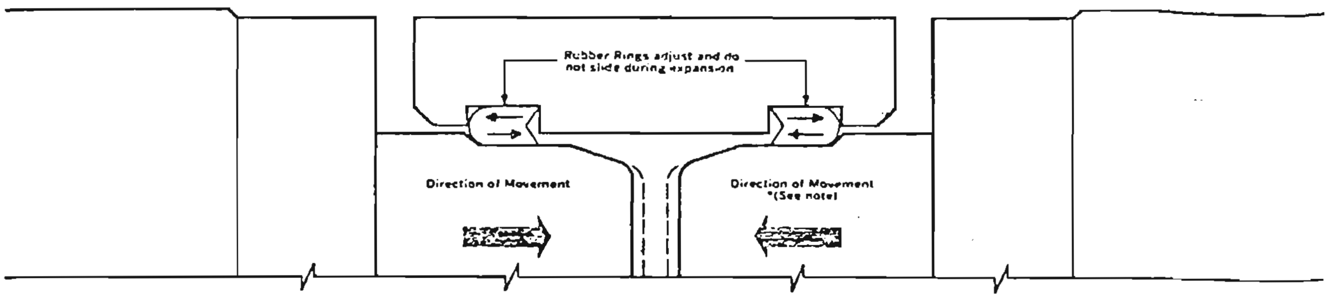
minimum crushing strength* (casing only)		Recommended Design Temperatures and Pressures		
Pipe Size	Lbs. Per Linear Ft.	Maximum Water Temperatures		Operating Pressure
		Continuous	Surge*	
3" thru 10"	1500	210°F	230°F	130 psi
12" thru 30"	2400	200°F	220°F	150 psi

*ASTM 3-edge bearing method.

*The temporary surge allowance shown provides for unforeseen operating malfunctions and is not recommended as an intermittent operating level. However, in no instance is Temp-Tite pipe recommended to be used in excess of the foregoing conditions, regardless of pressure.

thermal expansion

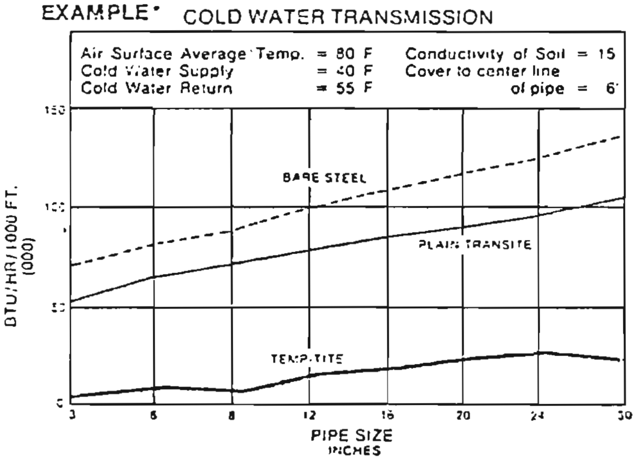
Coefficient of Expansion for Wet Transite = 4.5×10^{-6} in/in/°F



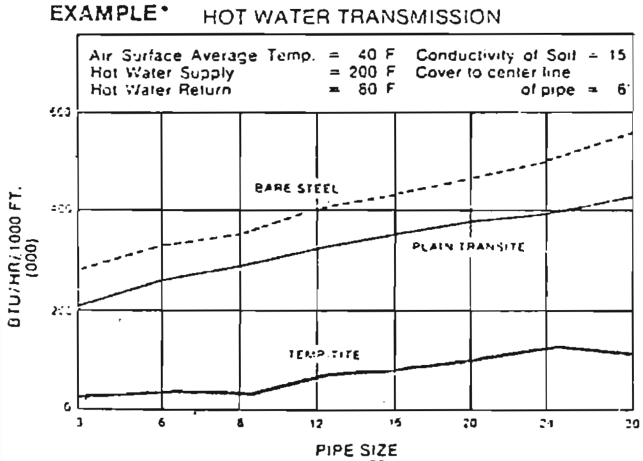
*Expansion takes place in each length of pipe and is not cumulative. Spacing between pipe ends varies, with a minimum of .25". This minimum provides a space safety factor of .11" for a 200°F temperature change.

Comparative Thermal Data

EXAMPLE* COLD WATER TRANSMISSION



EXAMPLE* HOT WATER TRANSMISSION



ECONOMICS
CHILLED WATER

Example:

5,000' of 8" Bare Steel	— Heat Gain =	405,000
5,000' of 8" Temp-Tite	— Heat Gain =	40,000
	Net Diff. =	355,000 BTU/HR.

In 1 year (8760 HRS.) Heat Gain = 3,109,800,000 BTU, or 259,150 Tons/Yr. Assuming 5c/Ton/Hr, the additional cost per year for not insulating will be approximately $12,957. If cost of money is 7%, the present worth of this Heat Gain is:

- $ 53,124 in 5 yr. period
- $ 91,010 in 10 yr. period
- $137,215 in 20 yr. period

This does not consider the further adverse effects of inflation, nor changes in energy costs.

ECONOMICS
HOT WATER

Example:

5,000' of 8" Bare Steel	— Heat Loss =	1,790,000
5,000' of 8" Temp-Tite	— Heat Loss =	230,000
	Net Diff. =	1,560,000 BTU/HR.

In 8 months (5840 HRS.) Heat Loss = 9,110,400,000 BTU. Assuming a million BTU's to be worth $1.50, the additional cost per year for not insulating will be approximately $13,581. However, if cost of money is 7%, the present worth of this Heat Loss cost is approximately:

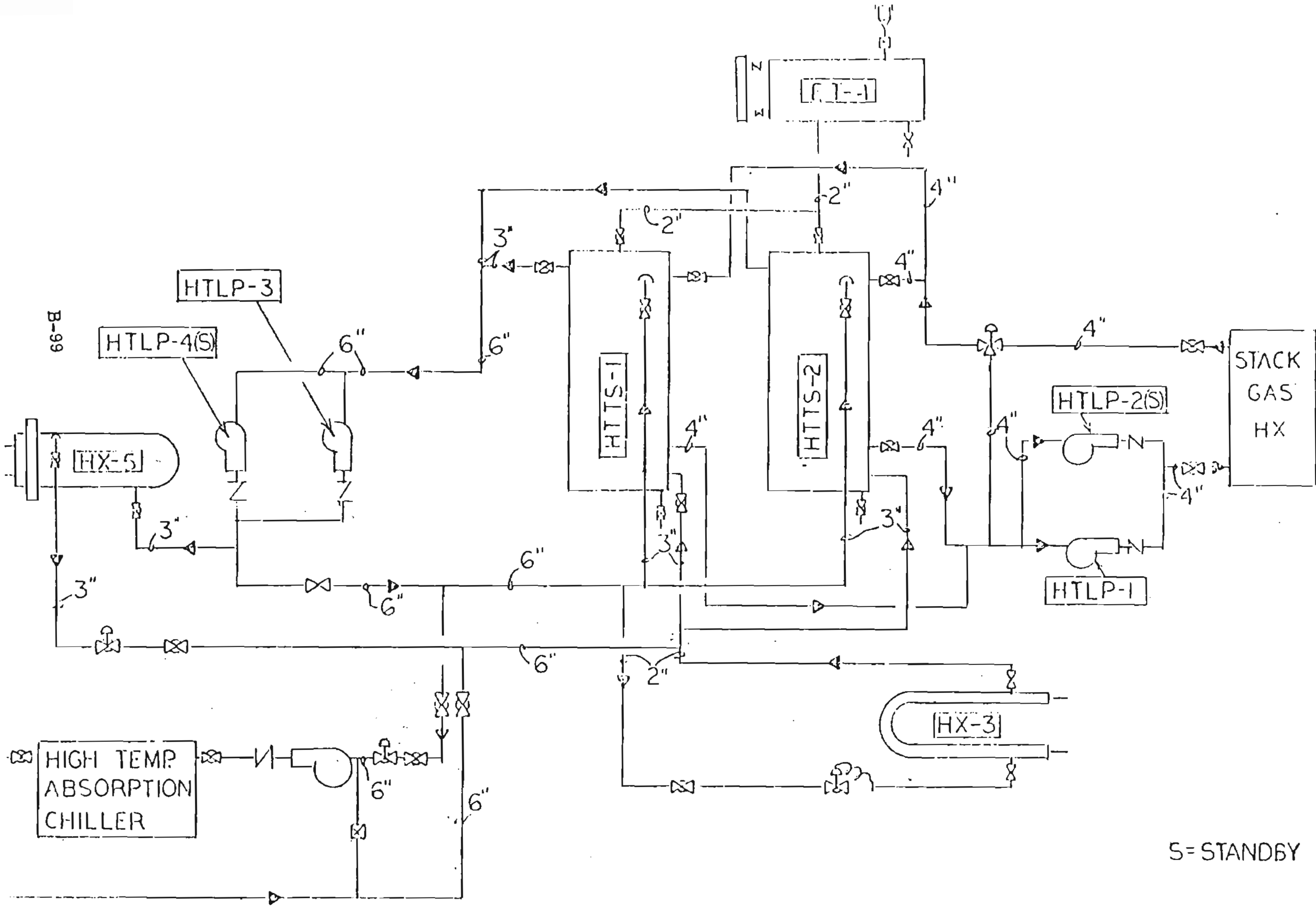
- $ 56,030 in 5 yr. period
- $ 95,990 in 10 yr. period
- $144,777 in 20 yr. period

This does not consider the further adverse effects of inflation, nor changes in energy costs.

*Johns-Manville can provide you with a detailed heat loss/gain computer analysis which will include a financial analysis if so desired. Your Johns-Manville representative will be pleased to advise you of the details.

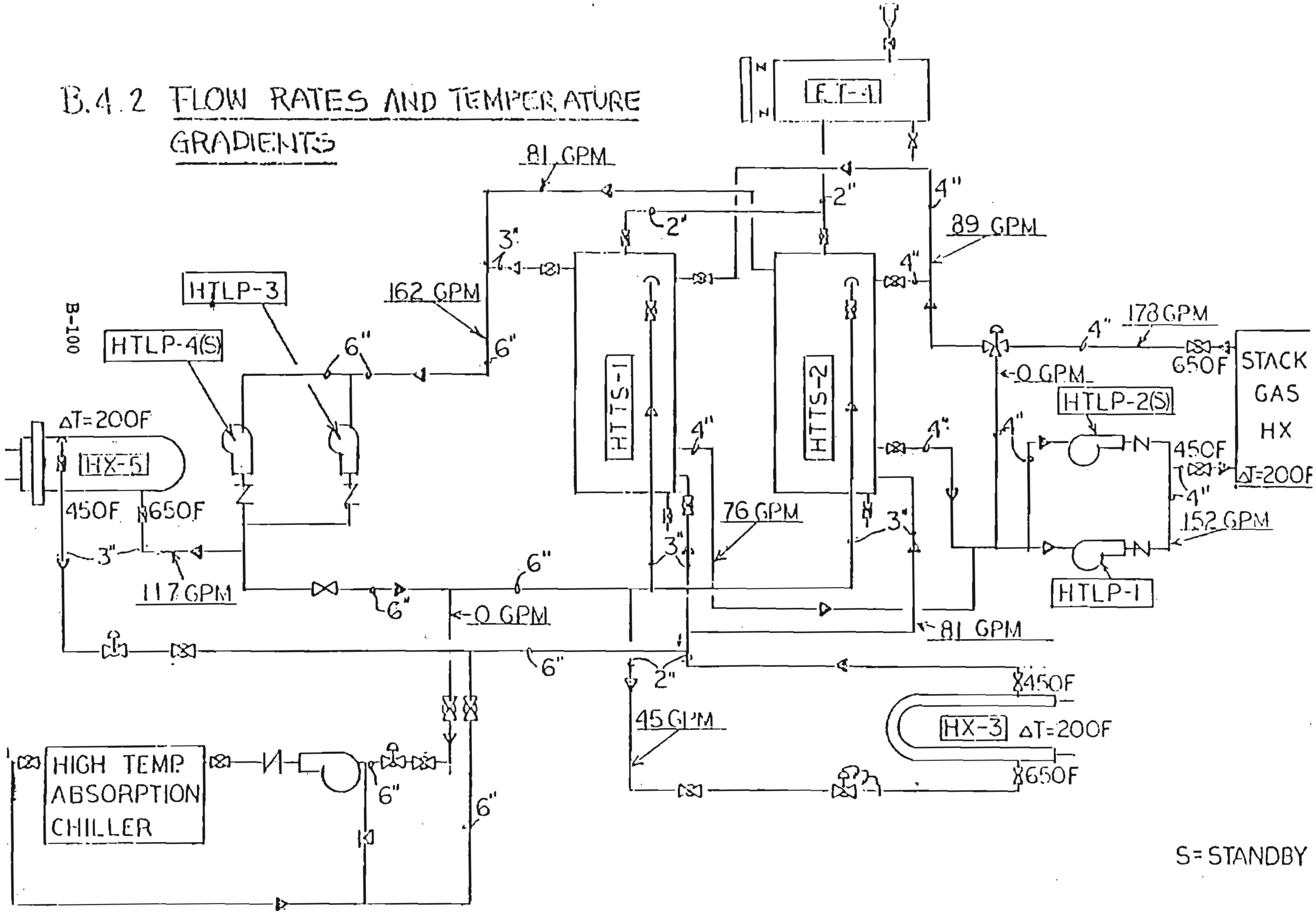
B.4 Thermal Fluid System Data

B-99

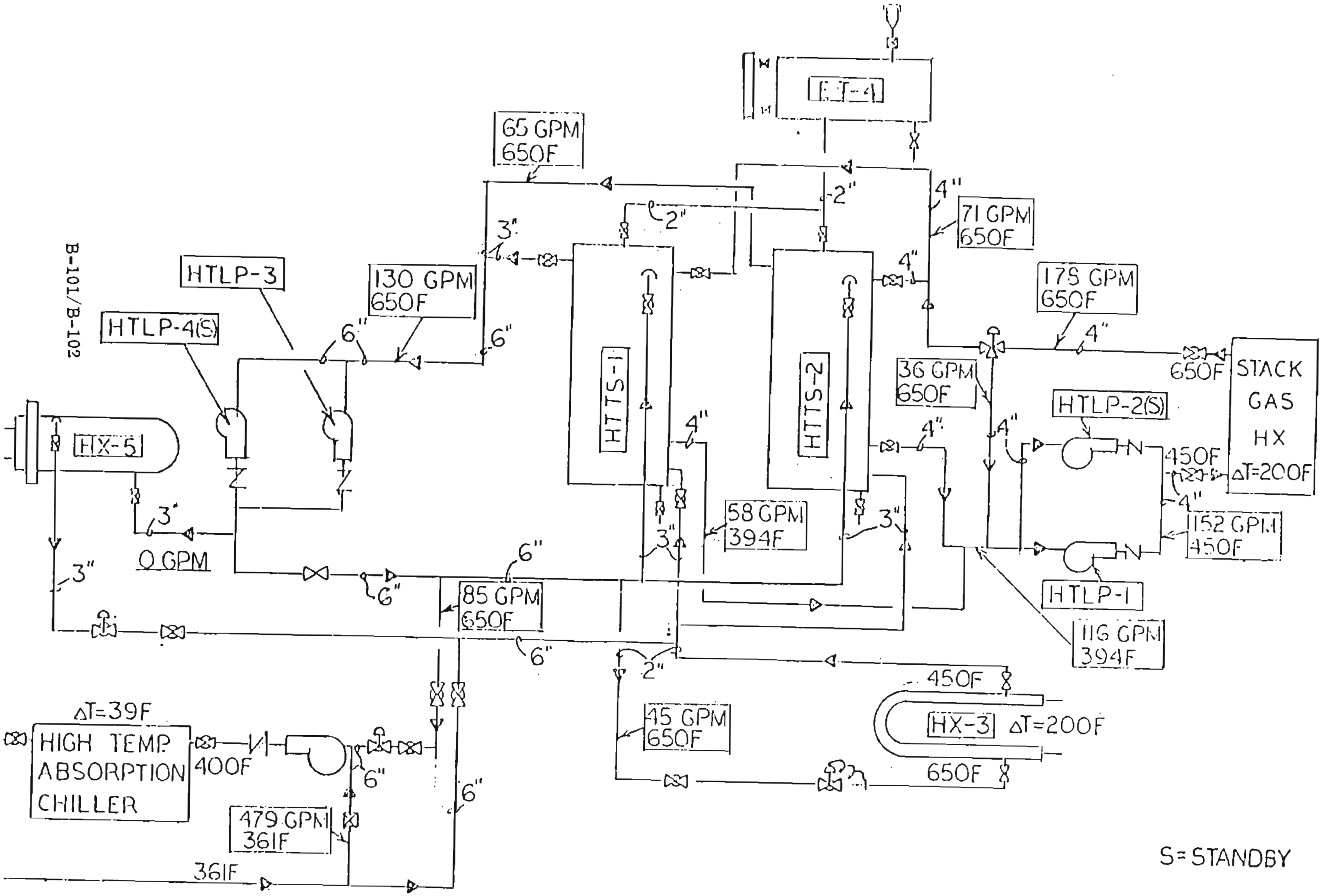


HIGH TEMPERATURE THERMAL FLUID SYSTEM
PIPE SIZES

B.4.2 FLOW RATES AND TEMPERATURE GRADIENTS

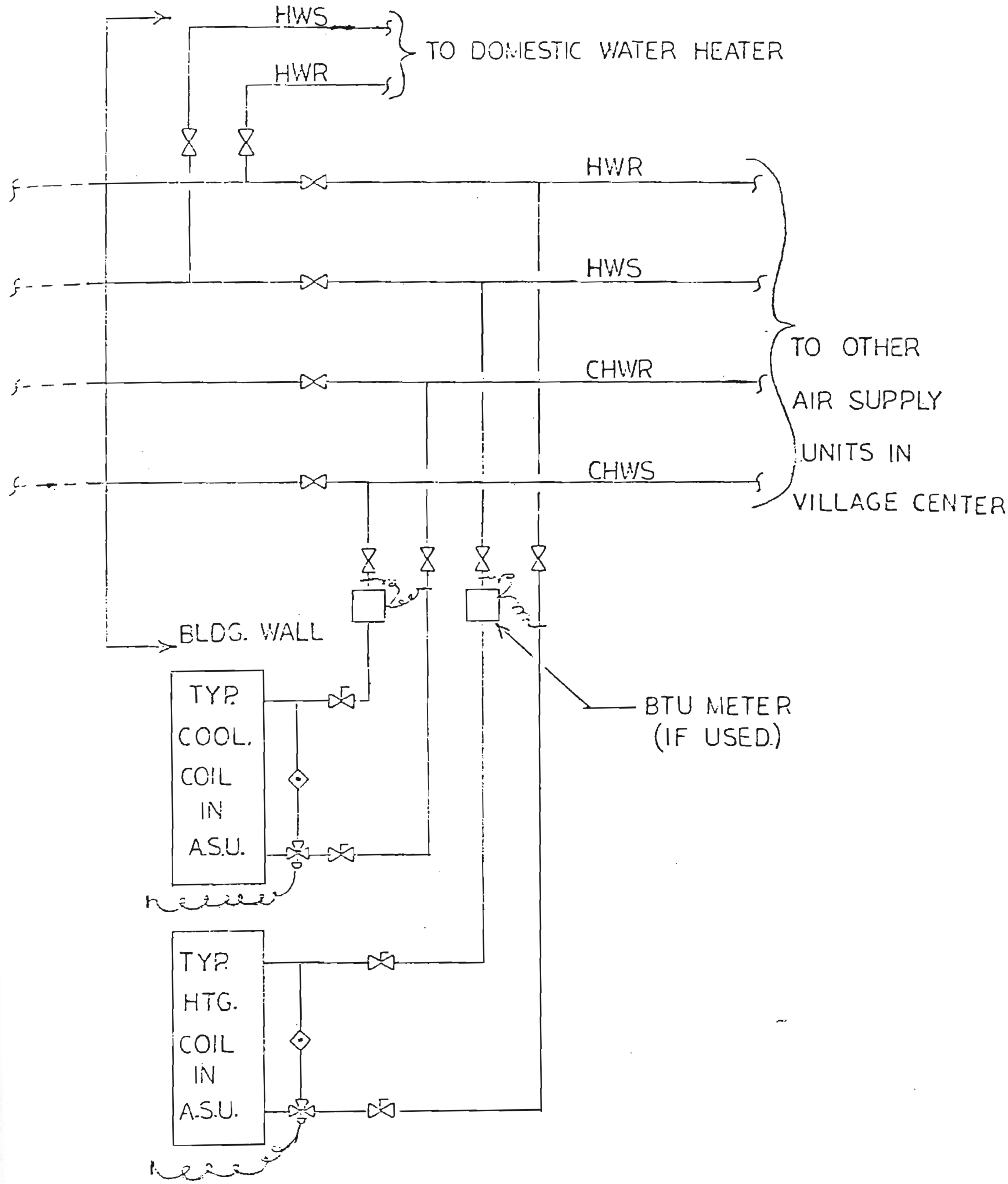


HIGH TEMPERATURE THERMAL FLUID SYSTEM
WINTER OPERATION



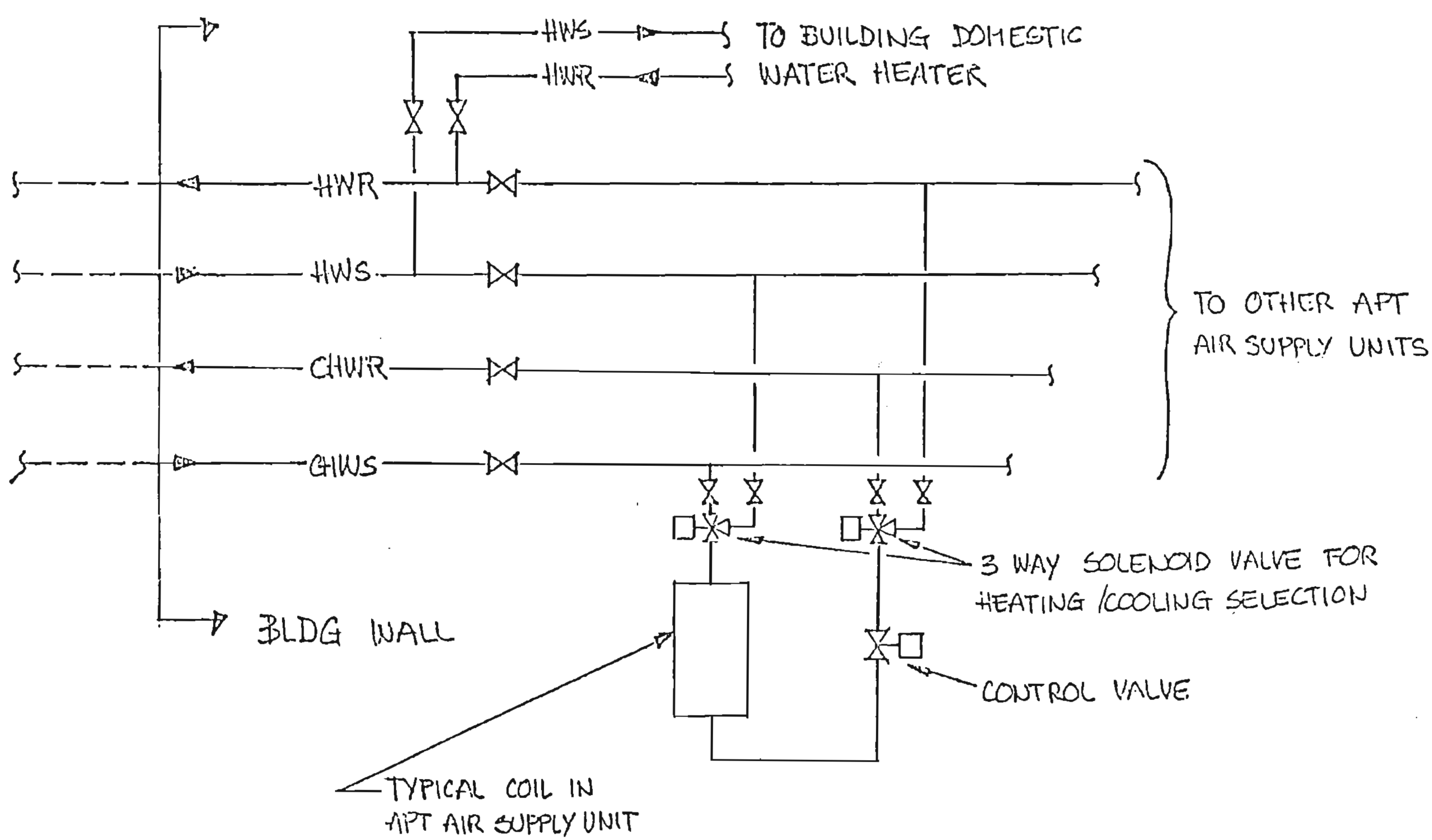
HIGH TEMPERATURE THERMAL FLUID SYSTEM
SUMMER OPERATION

B.5 Customer Connections



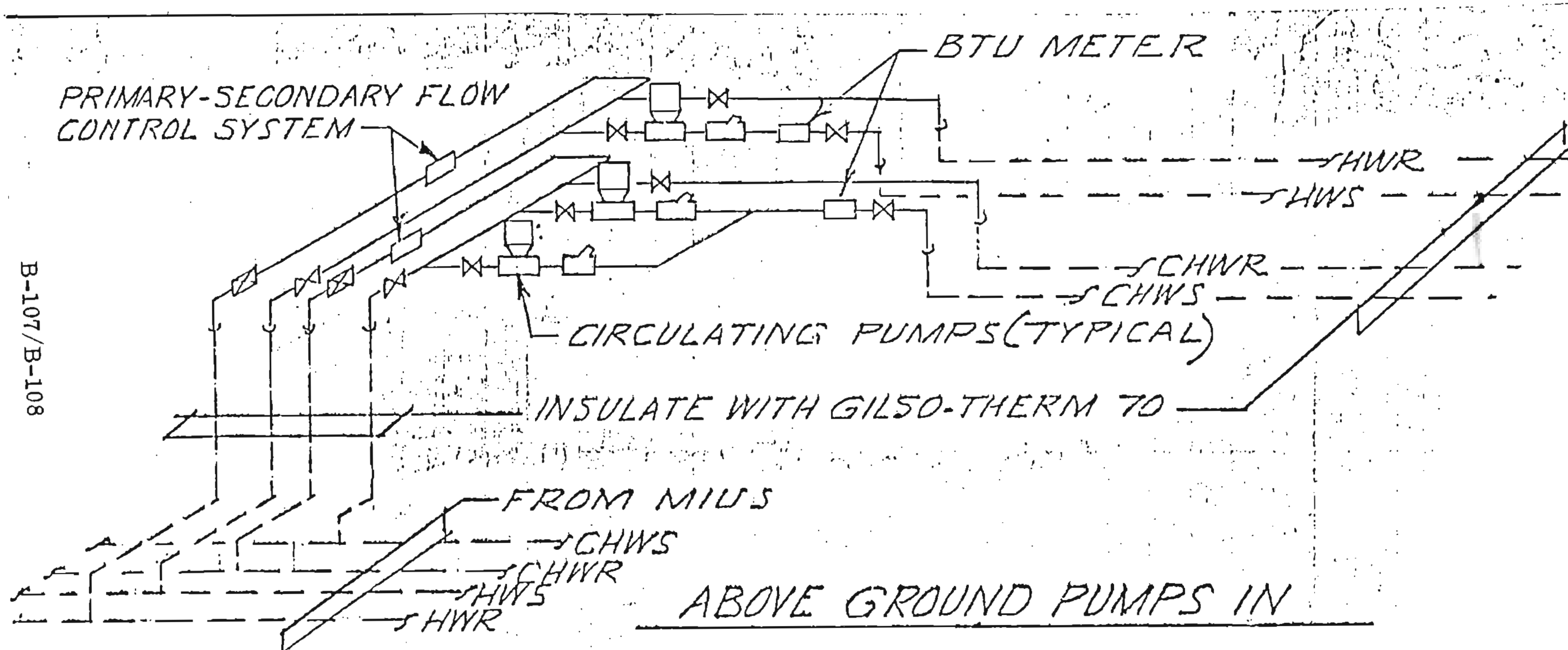
B.5.1 PIPING CONNECTION DIAGRAM FOR HEATING AND COOLING WITH SEPARATE COILS

B.5.2 PIPING CONNECTION DIAGRAM FOR HEATING AND COOLING WITH ONE COIL



SCHEMATIC HEATING - COOLING BUILDING AND APARTMENT ENTRANCE FLOW DIAGRAM

B.5.3 Detail of Hydronic Distribution System Building Takeoffs



ABOVE GROUND PUMPS IN PREFABRICATED BUILDING

B.6 Preliminary Reliability Assessments

B.6.1 PLANT

Reliability assessments for the MIUS plant subsystems are discussed in this section. Additionally, a Major Plant Machinery Equipment and Plant Sizing, Redundancy table is presented on the following page.

Electrical service. If the plant were to operate in the isolated mode, multiple engine generators would be mandatory. Prior experience and prudence would dictate at least two engine/generators beyond those based on one engine being out of service due to scheduled maintenance and one being available to replace a malfunctioning unit. In general, therefore, if N is the number of engines required for normal operation, N+2 should be installed. In addition, when operated "isolated" either an emergency utility connection is required or alternatively a third redundant engine is necessary, with its own separate cooling system. This would provide standby capacity for essential loads which are described as those necessary to prevent hazardous or unsafe conditions at the site under a complete electrical outage.

On the other hand, an interconnected MIUS is relatively free from the necessity of electrical redundancy since it has 100% backup from the electric utility.

Thermal service. The three sources of thermal energy in the MIUS are: Engine/generator heat reclaim, incinerator heat reclaim and oil-fired boilers. From the outset, even though, theoretically, the boilers are not required when the other subsystems are functioning normally, it was considered advisable to have full thermal capability with two oil-fired boilers. A further consideration in favor of providing boilers is that in the event the plant management decides to operate the plant without electrical generation, the boilers become mandatory.

Other components of the thermal subsystem need to be backed up if their malfunction is likely to impair operation of the system. Generally, the approach used is to either provide two components when one can operate at partial output or, where necessary, to provide a full standby unit.

Wastewater subsystem. This system consists of two separate equal trains and it is possible to treat the water to acceptable levels with one half of the system down through malfunction or scheduled maintenance. In a total plant emergency the influent can be diverted to the existing lagoons and the system bypassed.

Solid waste processing subsystem. This system was not planned with any equipment redundancy because, in the event of malfunction or failure. lasting for more than 2 or 3 days, the waste would be disposed of by commercial hauler. However, the incinerator capacity is approximately twice the projected initial collection rate. This will permit fast incineration of any accumulated waste by operating on a continuous basis at the rate of one ton per hour.

Project MIUS - ST CHARLES Structure

For

B.2 MAJOR PLANT MACHINERY

Equipment and Plant Sizing, Redundancy

Year [1]	Equipment	Total Demand	Selected Capacity	Redundancy
1980	Chillers	1322 TONS	351+391+1111 = 1853 TONS	531 TONS or 40%
	Boilers	17.1×10^6 BTU/H	$2 \times 13.4 \times 10^6 = 26.8 \times 10^6$ BTU/H	9.7×10^6 BTU/H or 57%
	Engine Generators	1790 KW (max.)	4 × 720 KW = 2880 KW	1090 KW or 61%
1981	Chillers	2059 TONS	1853+200 = 2053 TONS	(−) 6 TONS [2] or −0% [2]
	Boilers	27.54×10^6 BTU/H	$26.8 + 10 = 36.8 \times 10^6$ BTU/H	9.26×10^6 BTU/H or 34%
	Engine Generators	3048 KW (max)	6 × 720 KW = 4320 KW	1272 KW or 42%
1982	Chillers	2482 TONS	2053+300 = 2353 TONS	(−) 129 TONS [2] or −5% [2]
	Boilers	35.6×10^6 BTU/H	36.8×10^6 BTU/H	1.2×10^6 BTU/H or 3%
	Engine Generators	3389 KW (max)	4320 KW	931 KW or 27%

1) ~~Site definition table in "7.4 Monthly Energy Balance"~~

2) In reality the capacity will not be exceeded because of diversity and because of standby and emergency capacity of the school chiller (340 TONS)

B.6.2 DISTRIBUTION AND TERMINAL SYSTEM DEVICES

Pumping of hot and chilled water is performed with a pumping system which provides duplication backup. This measure greatly increases the reliability of the MIUS at reasonable cost.

B.7 Solid Waste Subsystem

STUDY OF THE SOLID WASTE SUBSYSTEM FOR ST. CHARLES MIUS

Introduction

This report has been prepared by Resource Recovery Services, Inc., Woodbridge, New Jersey, to assist in advancing the Conceptual Design of the MIUS Solid Waste Subsystem to the preliminary design phase.

Solid Waste Quantities and Characteristics

Solid waste generation rates and characteristics have been studied and reported by the United States Environmental Protection Agency and other groups such as the National Center for Resource Recovery. Estimates of the Municipal Solid Waste (MSW) rates of generation range up to 5.2 pounds/person/day. However, actual measured quantities have been on the order of 3.0 pounds/person/day. These figures were compiled in the late 1960's and have increased somewhat. However, 3.0 pounds/person/day seemed appropriate to use in the MIUS case because apartment dwellers generally generate slightly less MSW per person than those living in equity housing.

It has been suggested that the heat recovery incinerator be operated for approximately 10 hours per day; should waste production rates increase significantly, the additional material can be readily handled by simply adding operation hours. This, in fact, would lower the unit cost of operation and make the economic picture even more attractive. Should additional site energy be required, waste from outside sources could be brought in for processing within the system. Again, this would benefit the economics.

As a result of residency as provided by the expanded MIUS site, the waste generation rate will approximate 12,800 pounds of MSW per day. If the Pheasant Run Equity Townhouses are included, this would increase to about 14,300 pounds per day.

To determine the waste generated by the Village Center and peripheral commercial buildings (a total of approximately 250,000 sq. ft.), a figure of 2.0 pounds per 100 sq. ft. has been utilized. This yields 5,000 pounds of refuse per day.

The refuse generated by the Stoddert Middle School has been estimated at 750 pounds per day, on the basis of 900 students. The waste generation is summarized as follows:

	Pounds Per Day	Days Per Week	Pounds Per Week
Residential	12,800	7	89,600
Village Center and Periphery	5,000	7	35,000
Stoddert Middle School	750	5	3,750
TOTAL PER WEEK			128,350

On a 6 day per week operational basis for the processing facility, 21,390 pounds per day must be handled. This equals 10.7 tons per day for processing.

In the event that the Pheasant Run Equity Townhouses are included, collection would be increased to 11.4 tons per day for processing.

Just as the MSW generation rates vary, so do the estimates of composition. In 1973, the U.S. Environmental Protection Agency estimated the composition of MSW to be as follows:

Paper	36.8%
Ferrous Metals	7.8
Aluminum	0.7
Other Non-ferrous Metals	0.3
Glass, Ceramics	9.4
Food Waste (Garbage)	15.5
Yard Waste	17.4
Plastic, Rubber	6.1
Wood	3.4
Textiles	1.3
Other	1.3

MSW composition analyses have been conducted in various areas of the country, but for the purpose of this study, the analysis as presented above shall be utilized. This analysis is for the total MSW to be processed, which would include: household and commercial refuse, street sweepings, tree and landscape refuse, park refuse and catch basin refuse.

By Type, the MSW would include refuse from Type 0 through Type 3, with the total mixture being somewhere between Type 1 and Type 2 waste. From experimental work conducted by the National Center for Resource Recovery and project involvement by Resource Recovery Services, Inc., it is believed that this refuse mixture will contain a moisture content in the range of 25 to 40 percent, and will contain incombustible solids in the range of 15 to 20 percent.

SOLID WASTE COLLECTION

Presently, twice per week refuse collection is in practice in St. Charles. Since in the summer months frequency of collection tends to minimize vector and odor problems, the three-times per week collection with the MIUS demonstration will be a bonus benefit.

The following table summarizes waste generated per week as well as volume (volume calculated based on refuse density of 8 pounds per cubic foot):*

	Pounds/ Week	Cu.Yards Per Week	Cubic Yards Per Collection w/Safety Factor	4 Cu. Yards Containers Needed
Bannister Apts.	13,100	61	30	8
Crossland Apts.	4,400	21	10	3
Wakefield Terrace	12,700	60	30	8
Wakefield Hi-Rise	6,800	31	15	4
Wakefield Third Age	4,800	20	10	3
Huntington Apts.	37,800	175	90	23
TOTALS	89,600			49

Consideration of site layout plans along with the cubic yards to be handled at each collection indicates a total of approximately 49 containers (not including Pheasant Run) for the residential areas.

Altogether, eighty (80) 4 cu. yd. containers will be needed:

Classification of Use	Number of Containers
Residential	49
Commercial	25
School	3
Standby	3
Total	80

The scheduling of collection must be done to provide for three times per week collection on a 6 day per week basis yielding approximately 10.7 tons per day (assuming Pheasant Run not included).

In order to eliminate dumping of solid waste on a tipping floor prior to charging to the incineration system, and also to eliminate the utilization of a hopper and a conveyor system for the storage of municipal waste prior to incineration, two collection systems have been investigated. Both are containerized systems compatible with the incineration system and both meet the criteria set forth above.

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* Source: Based on project experience of Resource Recovery Services, Inc.

The first collection method utilized containers similar to the Dempster Dumpster Standard Universal Containers (combination containers will be used). Although they are available in capacities up to 8 cubic yards, the container sizes to be utilized at St. Charles would be in the 4 cubic yard range. The reason for this will be discussed later. The vehicle utilized to pick up and transport the container to the incinerator facility is similar to a Dempster Dumpster GRD as shown in Figure B-7.1.

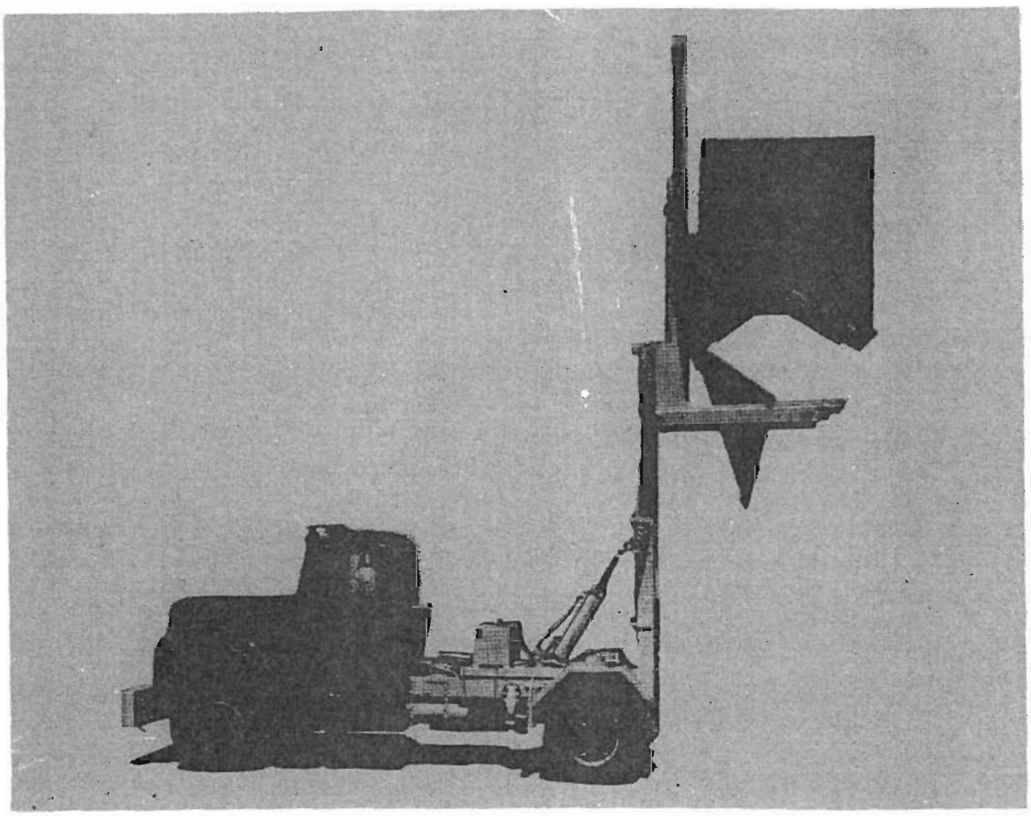


FIGURE B–7.1. DEMPSTER DUMPSTER GRD

This unit will pick up, transport and empty the containers directly into the incinerator charge hopper in the manner as shown in Figure 10. Additionally, a special container similar to a Dempster Kolecter Model L9 can be carried by the truck. A photo of this type of container is shown in Figure B-7.2. It will be kept at the plant for collection of oversized bulk waste and white goods.

In order to direct discharge the containers into the incinerator charge hopper, the containers must be limited to 4 cubic yard capacity range. The charge hopper for the incinerator is only capable of accepting a maximum of 4 cubic yards of material at one time, therefore, this is the limiting factor in determining container size.

An estimate of the Capital Cost of this system follows:

	Quantity	
Dempster-Dumpster GRD	1	$28,000
Model L9 Kolecter	1	2,500
Containers	80	80,000
TOTAL		$110,500

NOTE: This estimate assumes collection 3 times per week.

The second collection method is one similar to the Dempster Container Train System. These units are as shown in Figures B-7.3 and B-7.4. All containers are standard 2 cubic yard capacity units. Approximately 5 to 6 can be towed by a jeep or pickup truck at one time. Of course, these units could be utilized for single-family dwelling collection. Once they are towed to the incineration facility, they are dumped directly into the incinerator feed hopper with a container dumper similar to the one shown in Figure B-7.5. Certain disadvantages of this collection system when compared with the first one presented are as follows:

1. The containers will require substantial maintenance, since they will be utilized "over the road".

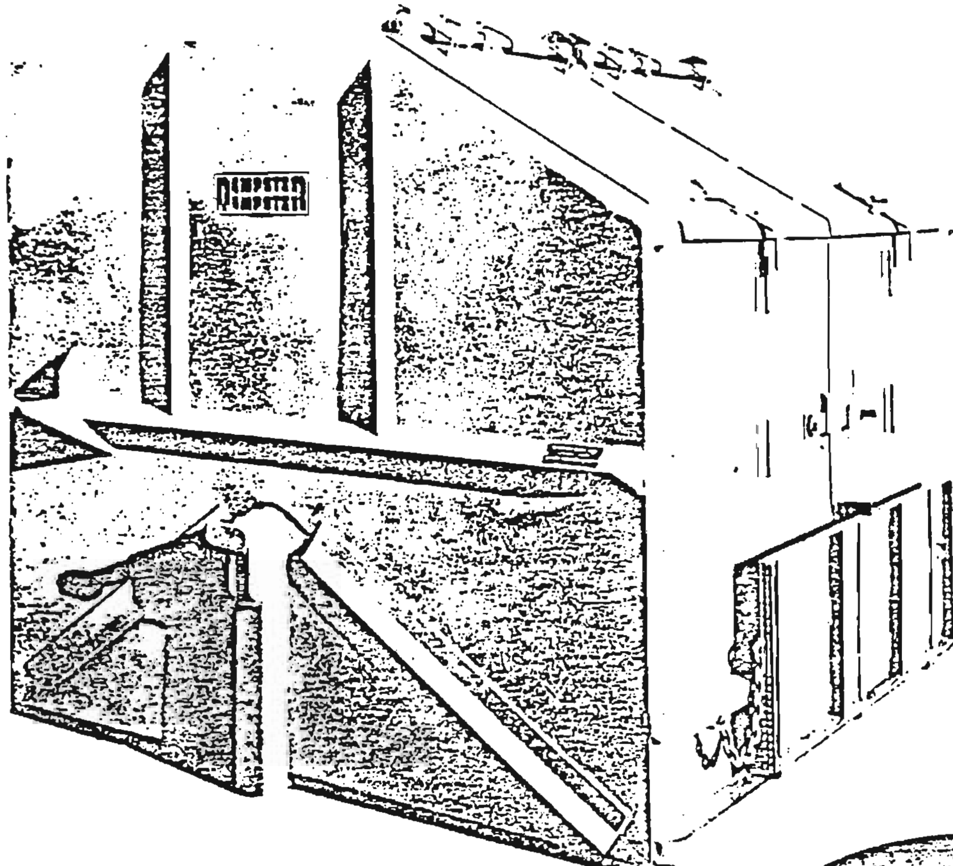
2. When left in apartment complexes, the containers could be subject to theft, as they could be towed by a car.

3. A greater number of units is required because of the small 2 cubic yard capacity.

4. The containers would not be suitable for long hauls to a landfill as required for OBW disposal or backup in the event of a breakdown at the incinerator.

MODEL L9 KOLECTER

This 9 cu. yd. Kolecter handles the same amount of materials as the average dump truck body. It is carried suspended at rear of Dempster-Dumpster and loaded in a point-to-point canvass of materials. Two doors in rear wall and two spring balanced doors in top are standard. Special Kolecters are available in other sizes.



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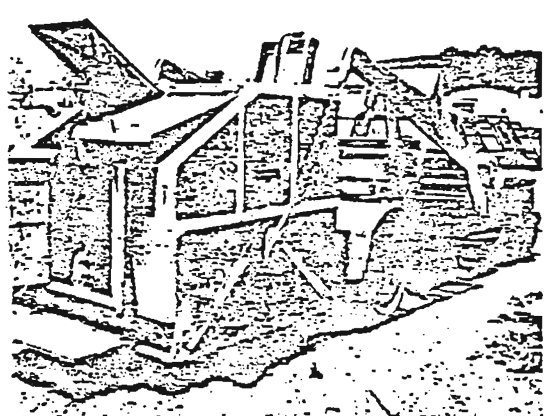
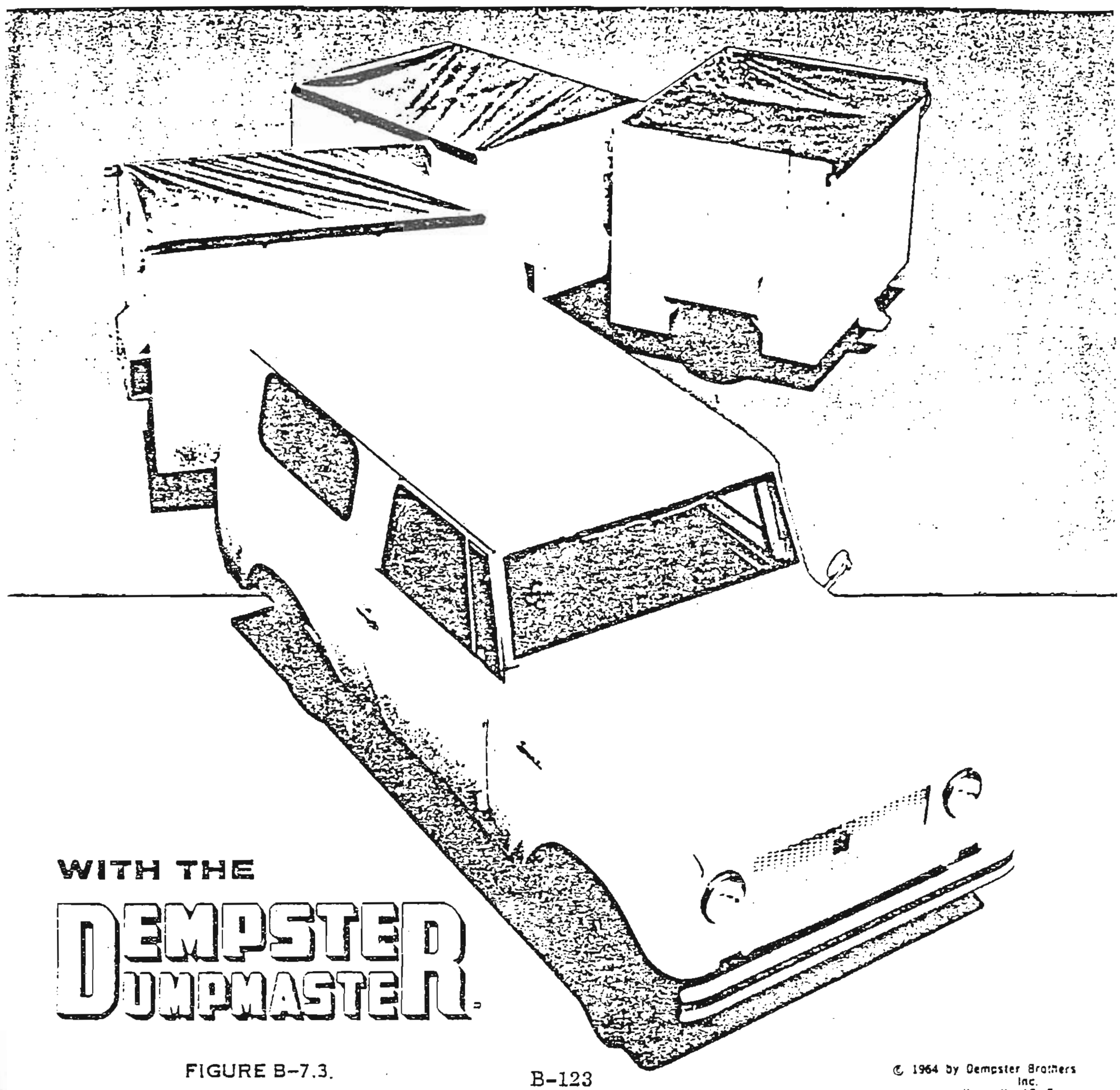


Photo 185 at left shows how Kolecter is suspended at rear of. Dempster-Dumpster. Note rear doors which allow for convenient loading of Kolecter. When materials have been loaded up to sufficient level. rear doors are closed and loading is completed by dumping materials through the top opening.

FIGURE B-7.2.

FOLDER NO. 9246

The DEMPSTER CONTAINER TRAIN SYSTEM

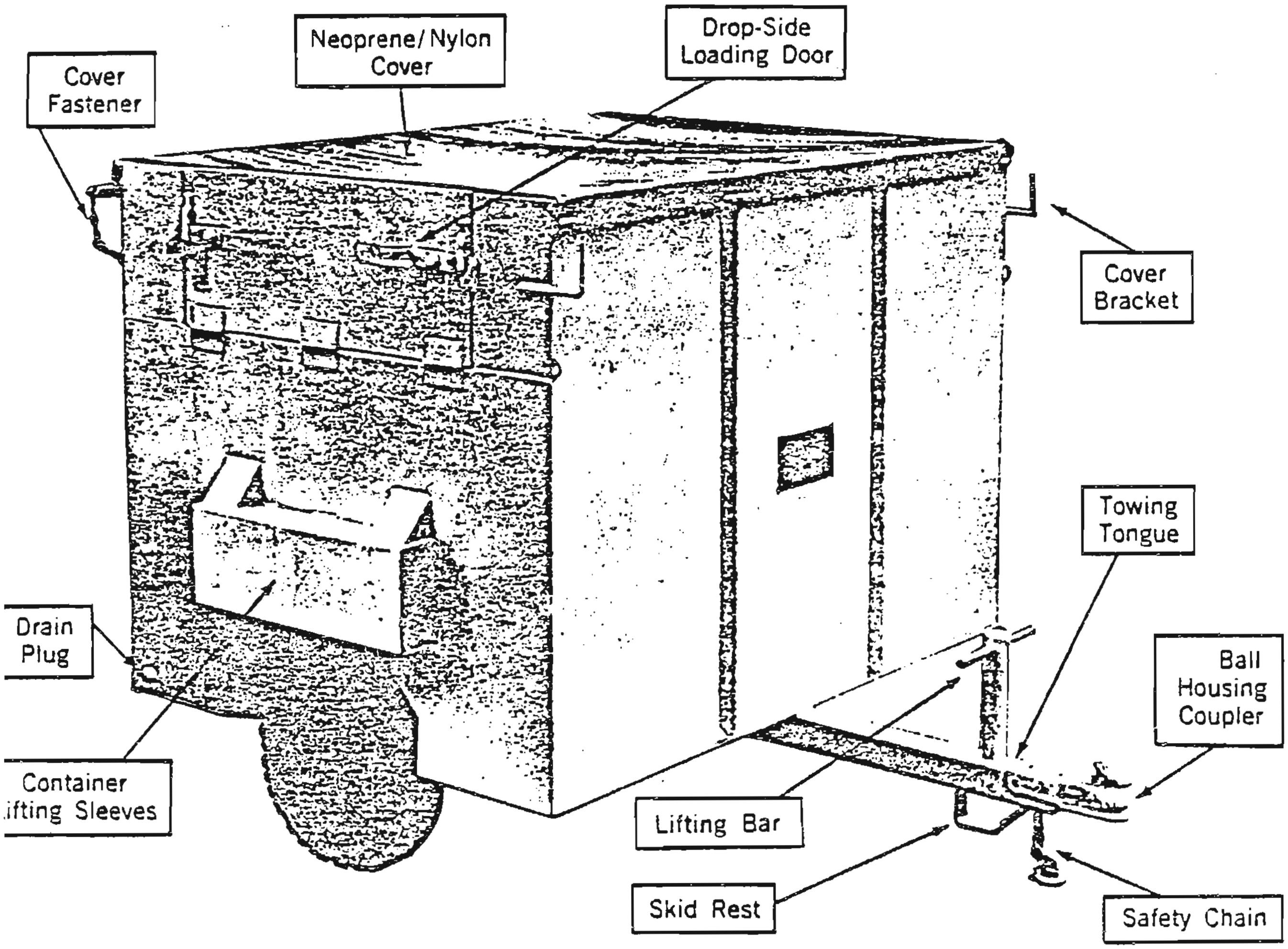


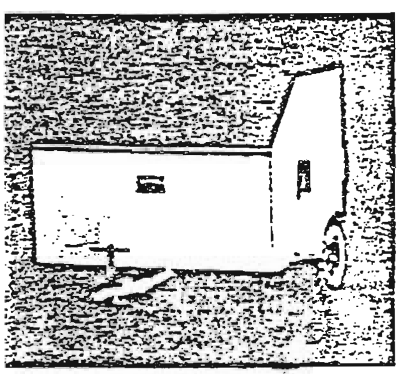
WITH THE

DEMPSTER DUMPMASTER

FIGURE B-7.3.

NOMENCLATURE...

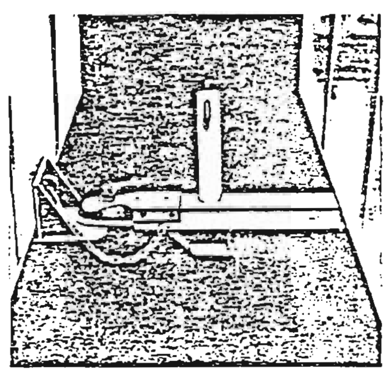




In addition to the drop-side models, an angle-front model with outrigger wheels is also available. This model has all the features of the drop-side model, including the long life, neoprene/nylon anti-scatter cover.

CONTAINER FACTS

■ Train containers are available in two models, the recessed wheel and outrigger wheel, and in two sizes—four and five cu. yd. All models are fabricated of the finest steel with extra strength welding, top quality components and reinforcement at all points of strain and wear. To reduce maintenance costs, each container receives the famous Dempster eight-step shot-blast and painting finish including a special epoxy paint which is tough and long-lasting. Each container is scientifically balanced so that one man at the lifting tube bar can easily move a fully loaded container.



Here is a close-up of the coupling mechanism and the lifting bar featured on the train containers. A simple flip latch releases the locking socket from the ball connection. The "T" lifting bar is designed to permit use by two men where necessary. A safety locking chain is provided.

FIGURE B-7.4.

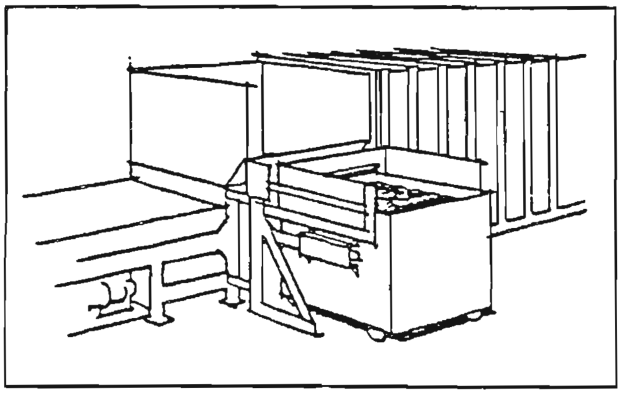
Dempster Dumpster Systems

Ground level type

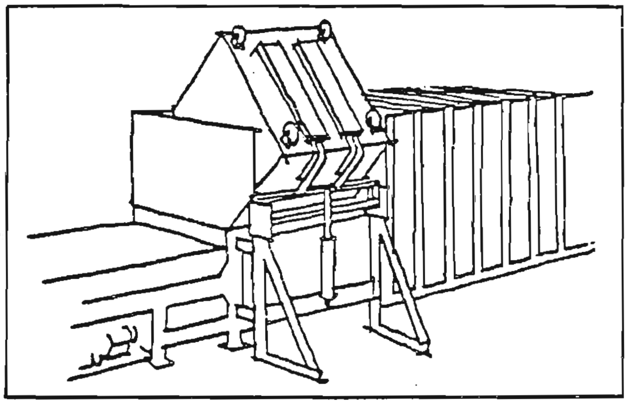
Single Cylinder
2000 lb. capacity

PACKER DUMPERS

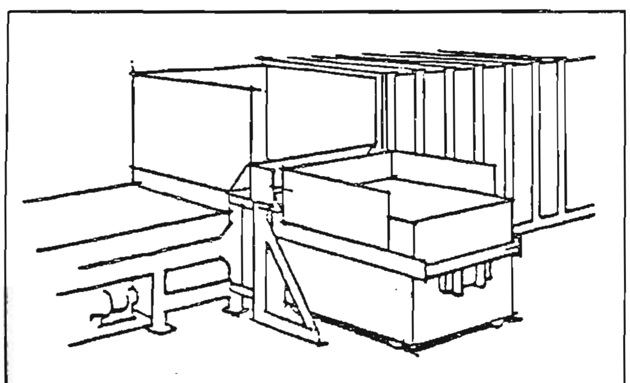
FOR USE WITH PACKER MODELS: SP40-42, SP48-42, SP62-42



STANDARD FORK — Recommended for ground level applications with use of existing containers. Dumping sleeves are welded to container sides at fork height. Container can be easily pushed into position for dumping.



DROP FORK — Recommended for ground level applications where side or end mounted dumping sleeves are not desirable. Bottom mounted dumping sleeves eliminate projections — provide best arrangement for containers handled in train.



DUMPMASTER ATTACHMENT — Designed for use with 2 or 3 cubic yard Dumpmaster containers — no container modifications required — container is rolled between forks; hinge gate is closed and locked for dumping. Dumpmaster units can serve as an alternate handling method.

HYDRAULIC POWER
Dumper's hydraulic power is drawn from packer's power unit. When dumper is in motion — packer head will not move.

CYLINDER
5" X 22" stroke double acting cylinder.

CONTROLS
Manually controlled dump action.

CONTROL VALVE
Self-centering, counter balanced valve regulates hydraulic flow, stabilizes load during dumping, reduces shock and prolongs machine life.

OPERATING SPECIFICATIONS
30 second cycle time (approximate).
45 degree dump angle (approximate).
2,000 pound dumping capacity at 36" from torque tube.

STANDARD FORK
45" Standard fork spacing.
29" Standard fork height.

DROP FORK
20" OD Standard fork spacing
8¼" Standard fork height

DUMPMASTER ATTACHMENT
Designed for use with 2 or 3 cubic yard Dumpmaster containers with six inch castors.

Optional loading hopper is recommended to facilitate proper feed, eliminate spillage, and provide additional material storage.

Dumper attachments are available for a variety of different applications.

FIGURE B-7.5.

Home Office: P.O. Box 3127, Knoxville, Tennessee 37917/With offices in principal cities throughout the world

An estimate of the Capital Cost of this collection method follows:

	Quantity	
Container Collection Vehicle	1	$ 6,000
Container Dumper and Hopper	1	3,600
Containers	150	75,000
TOTAL		$84,600

NOTE: This estimate assumes collection 3 times per week.

Due to the maintenance savings with the Dempster-Dumpster System (Option 1) and the fact that the containers and vehicle are more versatile, Option 1 is recommended. The same vehicle with larger containers can be utilized to collect and haul OBW to landfill, and also it can be used for transport of incineration ash. Option 1 also has a much better chance of being compatible with systems of local collectors and haulers should the use of their services ever be desired.

Oversize Bulky Waste Disposal

The Conceptual Design Report recommended separate collection of bulky wastes. The suggestion was made to designate certain days each month when the bulky items would be placed adjacent to the regular collection hopper. The Dempster-Dumpster type vehicle with a large, 9 cubic yard, container would then travel to the various pickup sites and remove these items.

An alternative would be to have these items collected along with the regular MSW. Then, as the material is emptied from the containers at the processing facility, these bulky items would be removed and deposited into containers at the processing facility. Since the containers of MSW will be dumped directly into the incinerator feed hopper and not on a tipping floor, separation of these items will be more difficult.

The recommended approach, therefore, is separate collection at the usual disposal container location. The bulky waste could then be hauled directly to landfill, or brought back to the processing facility for sorting and salvage. In most parts of the country, "white goods", major appliances, have a value to scrap processors. This value is typically about $1.00 per hundred pounds. A local scrap processor should be contacted regarding interest in this material. If "white goods" may be sold, they would be removed from the other bulky items. The other bulky items would be transported in containers to the sanitary landfill for disposal. The "white goods" would be transported by the same method to the scrap processor, or alternatively, the scrap processor would provide containers and transportation for this recoverable material.

Bulky wastes cannot be disposed of via the incineration/energy recovery system, however, "white goods" do have a value if the proper market is located. The remainder, furniture, etc. would be disposed of in sanitary landfill. The same Dempster-Dumpster type truck and containers (although larger, up to 15 cubic yard capacity) will be utilized to handle this material.

Solid Waste Processing System

The solid waste processing system recommended is the starved air type incinerator. This unit is proven and simple to operate and is a relatively inexpensive piece of equipment, with little or no additional air pollution control equipment required.

The basic unit consists of two combustion chambers, the primary chamber to which the MSW is introduced and the secondary chamber equipped with an afterburner for complete combustion of the off-gases.

Once the primary chamber attains operating temperature, auxiliary oil burners are shut off and the combustion is self-sustained. Oil burners continue to operate in the secondary chamber throughout operation. The exhaust gases may then be sent to a heat recovery unit or exhausted directly to atmosphere. A diagram of this unit and description is shown in Figure B-7.9.

Incinerator Manufacturers

The following firms manufacture and market small modular incinerators with heat recovery equipment. Incineration units are of the controlled air type and are available in the capacity range as required by the St. Charles MIUS. Therefore, they are all deemed as candidates to provide equipment for the project, although each have had varying amounts of actual field experience.

Comtro Division
Sunbeam Equipment Corporation
Lansdale, PA 19446
Tel: (215) 699-4421

Consumat Systems, Inc.
P.O. Box 9579
Richmond, VA 23228
Tel: (804) 746-5264

Environmental Control Products, Inc.
P.O. Box 15753
Charlotte, NC 28210
Tel: (704) 588-1620

Kelley Company, Inc.
6720 North Teutonia Avenue
Milwaukee, WI 53209
Tel: (414) 352-1000

Progressive Equipment Company, Inc.
1330 Blue Hills Avenue
Bloomfield, CT 06002
Tel: (203) 242-0721

Existing Installations

There are several modular incineration units with heat recovery installed in municipal facilities throughout the country. Two of these installations were visited in order to gather first hand operational information. A third installation, handling office type wastes, was also visited. This section presents a review of the installations visited as well as two others which handle municipal solid waste.

City of Siloam Springs, Arkansas
Eugene Green - Superintendent
Tel: (501) 524-8512

This facility which is owned and operated by the City of Siloam Springs has been on-line since June 1975. The installation consists of two Consumat Model C-550M/CRS-504 Units. Design capacity was 16 tons per day charged on a 10 hour basis. However, the facility has been handling more than the design tonnage since more refuse is available and a greater steam demand exists. Refuse trucks are scheduled for arrival to eliminate a pile up of material in the covered tipping area. Municipal waste is dumped on the concrete floor and then a bobcat type loader pushes the material to the incinerator charging units. When a unit is ready for charging, a green light comes on. When the loader operator sees the green light, he pushes a button on a pushbutton station suspended from the ceiling near the charge hopper. This opens the charge hopper door. The loader then pushes waste into the hopper. Then the operator pushes another button to close the hopper door. At this point the feeder unit automatically proceeds into the remaining steps of the charge cycle. When the cycle is complete, the green light appears again indicating that the unit is ready to begin the loading and charging cycle.

Ash removal is performed manually each morning. The waste in the units is allowed to burn down and cool overnight and the units are opened in the morning. A rake attachment on the bobcat type loader is utilized to pull the ashes from the unit onto a concrete pad. The ashes are then loaded into hoppers for disposal in a landfill. Natural gas is utilized as the supplemental and the afterburner fuel. Approximately 1 MCF of gas per ton of refuse is required. The operation produces approximately 4500 pounds of steam per hour which is sold to the Allen Canning Company which can utilize additional steam. No serious operating difficulties have been encountered. Only one problem with refractory lining was developed, and this was due to the ash removal operator. The ash removal rake struck the door of one unit and knocked out a 1 foot square section of refractory. This, of course, would not occur if automatic ash removal were installed.

The facility, including tipping floor, ash removal pad, etc., is kept clean by daily wash downs. No disagreeable odors were detected in the facility.

City of North Little Rock, Arkansas
Contact: Larry Faulkner
Director of Technical Services
U.S. Recycle Corporation
Little Rock, AR 72207
Tel: (501) 225-0660

This plant, designed to handle 100 tons per day of municipal waste, is still under construction. Scheduled to begin operation within the next month, the plant will be managed by the City of North Little Rock. The facility will be operated 24 hours per day to supply the entire steam requirements of the adjacent Koppers Company creosote plant. Equipment installed consists of four Consumat Model C-1200 Units with two dual ram feeders and two dual heat recovery systems (Model CRS-1005).

The system is designed so that three of the four incinerator units can supply the steam requirements of Koppers Company, however a small package fuel-oil fired boiler has been installed as a backup. All of the existing Koppers boilers are scheduled to be shut down.

Automatic ash removal systems have been installed on each incinerator unit. A hydraulically activated ram pushes the ash into a quench tank. This tank is equipped with a drag type conveyor which moves the quenched ash up and into hoppers for disposal.

Operating procedure at the plant will consist of dumping the refuse directly onto the tipping floor, where two small front-end loaders will push the solid waste to one of two ram type feeders, located at opposite ends of the building. These feeders will be activated by push button stations suspended from the building ceiling. This procedure is the same as is practiced at the Siloam Springs Facility. Only one operator is required for each pair of units. Two operators and one assistant will be scheduled for the evening and night shifts. However, during the day shift, mechanics and other plant personnel (superintendent, weigh clerk, etc.) will be on duty.

Pentagon Heating Plant, VA

Contact: Lee Wiles
Alfred W. Rogers, P.E.
Air Pollution Control Products, Inc.
Mechanicsville, VA 23111
Tel: (804) 746-4535

The facility has been designed to burn Type 0 waste, consisting principally of classified documents. The unit, a Consumat Model C-1000 with with a Model CRS-804 heat recovery system, has been in operation for several months. Although equipped with an automatic wet ash removal system (similar to those described in North Little Rock, Arkansas) and capable of operating 24 hours per day, the unit is only charged for approximately 8 hours per day, 5 days per week.

Waste is hand loaded onto a flat belt conveyor which feeds the ram feeder device. The operator activates a push button on the control panel to open the charging hopper. From this point on, the charging operation is the same as in Siloam Springs and North Little Rock, Arkansas.

The present unit produces 3000 to 5000 pounds of 140 psi steam per hour. Sufficient space has been provided in the building to install another C-1000 unit. This additional unit would be utilized to burn office and other types of solid waste generated in the Pentagon rather than classified documents.

A brief description of two other facilities which burn municipal solid waste and recover energy, but which were not inspected, follows:

City of Blytheville, Arkansas

This facility was installed early in 1975 and consists of four Consumat Model C-760M Units along with four Model CRS-804 energy recovery units. The facility was designed to handle 50 tons of municipal waste per day. The four units are batchfed on a 10 hour per day basis and ash is removed manually each morning. Approximately 24,000 pounds of steam per day are produced for use by a nearby chrome plating plant.

Groveton Paper Products
Division of Diamond International
Groveton, New Hampshire

Contact: Walter McDonald
Vice President-Engineering
Groveton Paper Products

This facility was installed in 1975 to handle up to 30 tons per day of paper mill waste and municipal solid waste. The unit is an Environmental Control Products, Inc. Model 2500 T equipped with an automatic ash removal system. Operational 24 hours per day, the unit produces 4000 to 6000 pounds of steam per hour for use in the paper mill. One day per week, the unit burns the municipal waste generated by the town of Groveton. A conveyor system transports wastes to the ram feeder mechanism which charges the unit.

Operational Experience

As presented earlier in this report, there are several facilities in operation throughout the country which are recovering waste heat from incineration of municipal solid waste in controlled air units. In order to assist municipalities considering this approach to solid waste disposal, during 1975-1976 the U.S. Environmental Protection Agency sponsored a project to evaluate small modular incinerators in municipal plants. This study examined the operations of three facilities utilizing controlled air incinerators of the type considered for use in the St. Charles MIUS. However, only one of the three included waste heat recovery. The three facilities studied were Pahokee, Florida; Orlando, Florida; and Siloam Springs, Arkansas. Siloam Springs is the installation with heat recovery.

Key findings of the EPA sponsored study are as follows:

1. All the incinerators examined operate on a batch feed basis, rather than continuously, within a 24-hour cycle; normally being charged for seven to eight hours; then burning down with the use of auxiliary fuel for approximately three more hours; allowed to cool overnight; with ash residue removed by an operator each morning before start of the next 24 hour cycle.

2. Due to combustion design, and without mechanical or water-operated air pollution control devices, the gases expelled by the incinerators into the atmosphere have very low particulate readings. Stack emissions from the tested incinerators ranged from 0.03 to 0.08 grains of particulate matter per standard cubic foot of dry flue gas corrected to 12 percent CO_2.

3. The efficiency of thermal processing was excellent. Weight reduction of the raw waste averaged 68% and volume reduction averaged 93%. Laboratory testing of the incoming waste and the residue revealed excellent burning rates.

4. One plant used #2 oil as auxiliary fuel; the other two used natural gas. Natural gas consumption per ton of waste burned averaged from 440 cubic feet to 1239 cubic feet (approximately 500,000 to 1,300,000 Btu per ton). Oil consumption per ton of waste burned averaged 18 gallons.

5. Variations in moisture content of the raw refuse ranged from 20.8% to 49.9%. Variations in heat content of the municipal waste on an "as received" basis ranged from 2408 to 4353 Btu per pound.

6. The waste heat recovery system (Siloam Springs) produced 47,425 pounds of steam at 100 psig from 8.3 tons of waste with an average value of 4353 Btu per pound. This gave a boiler efficiency of 72.8%.

7. Capital costs per ton of designed capacity for all buildings, site improvements and incinerators, completely installed were from $9,093 to $9,494 for straight incinerator plants. With energy recovery (steam production at Siloam Springs) these rose to $17,667 per ton of design capacity.

Since the Siloam Springs, Arkansas Facility has waste heat recovery (steam production) and it was designed to handle approximately 20 tons of municipal solid waste per day, pertinent operating details, cost data and results of the EPA Test PRogram will be presented here. A summary description of the Siloam Springs Project was presented in the August, 1975 issue of THE AMERICAN CITY.

The primary differences between the Siloam Springs facility and the one proposed for the St. Charles MIUS is that Siloam Springs has two Consumat Model C-550M Units with manual ash removal, while St.Charles proposes one Consumat Model C-1200, or approved equal, with automatic ash removal.

The City of Siloam Springs had operated a landfill for waste disposal, however due to poor soil conditions and increased waste generation operation of the landfill in an environmentally acceptable manner was becoming extremely difficult and more costly. Allen Canning Company, a major employer in the city was faced with ever increasing costs for natural gas to operate its steam generating boilers. As a result an agreement was reached whereby a plot of land owned by Allen Canning Company was leased to Siloam Springs for construction of a heat recovery incineration facility. The city constructed and now operates the facility which sells steam to Allen Canning Company.

Siloam Springs has retained its landfill for disposal of ash and other non-combustibles, including oversize bulky wastes (OBW). Waste collection and delivery to the facility are performed by three compactor trucks. OBW and other non-combustibles are hauled directly to landfill.

A diagram of the layout of the facility is shown in Figure B-7.6. Photographs and a description of the facility are shown in Figures B-7.7 and B-7.8. Figure B-7.9 is a diagram of one of the two incinerator units, while Figure B-7.10 indicates the flow of gases through the unit. Figure B-7.11 indicates and discusses the gas flow control system for each incinerator. Figure B-7.12 is a materials flow diagram for the entire Siloam Springs solid waste disposal system. These figures should adequately serve to present and describe the overall system.

Stack Emissions

The EPA Report indicates that visible emissions are infrequent. Occasionally, pieces of flyash are emitted and it is believed that these are associated with the explosion of aerosol, paint or other volatile containers in the lower chamber. It should be noted at this point that no other problems have been reported due to explosions within the units. No refractory or structural damage has been experienced at facilities. However, explosions do cause the off gases to pass through the afterburner chamber too quickly for complete combustion to occur, hence the visible flyash emissions. Other short periods of visible emissions are reported to be caused by disturbances in combustion air feed. These can be caused by air controls, loader jams, and lag time in sensing and controlling systems. Brief periods of opacity of 5 to 10 percent were noted periodically, lasting as long as 30 seconds. These occurred sometimes during the injection of water into the lower chamber for temperature control and at others just after explosions in the waste.

Since the burning rate in the lower chamber is controlled with water sprays, some steam is emitted when the sprays are activated. Because most of the visible emissions from the units tested are in the 5 to 10 percent opacity range and not black in color, it is difficult to determine whether steam was the main contributor to plume opacity. It should be noted at this point that the St. Charles MIUS Facility will include sludge disposal along with solid waste disposal, steam will be emitted perhaps more frequently than was noted during the tests discussed.

A series of three stack tests were conducted at the Siloam Springs Facility in October 1975. The first two were conducted entirely on the gas emitted by the waste heat boiler exhaust stack. Full steam production was called for during these tests and consequently 100 percent of the exhaust flow passed through the boiler and out the boiler stack.

The results of the two tests averaged 0.0302 grains per standard cubic foot of dry exhaust gases corrected to 12% CO_2.

The third test was conducted with steam production not in operation. All gases from the incinerator were exhausted directly to atmosphere, bypassing the boiler. The result of this test was 0.0367 grains per standard cubic foot of dry exhaust corrected to 12% CO_2.

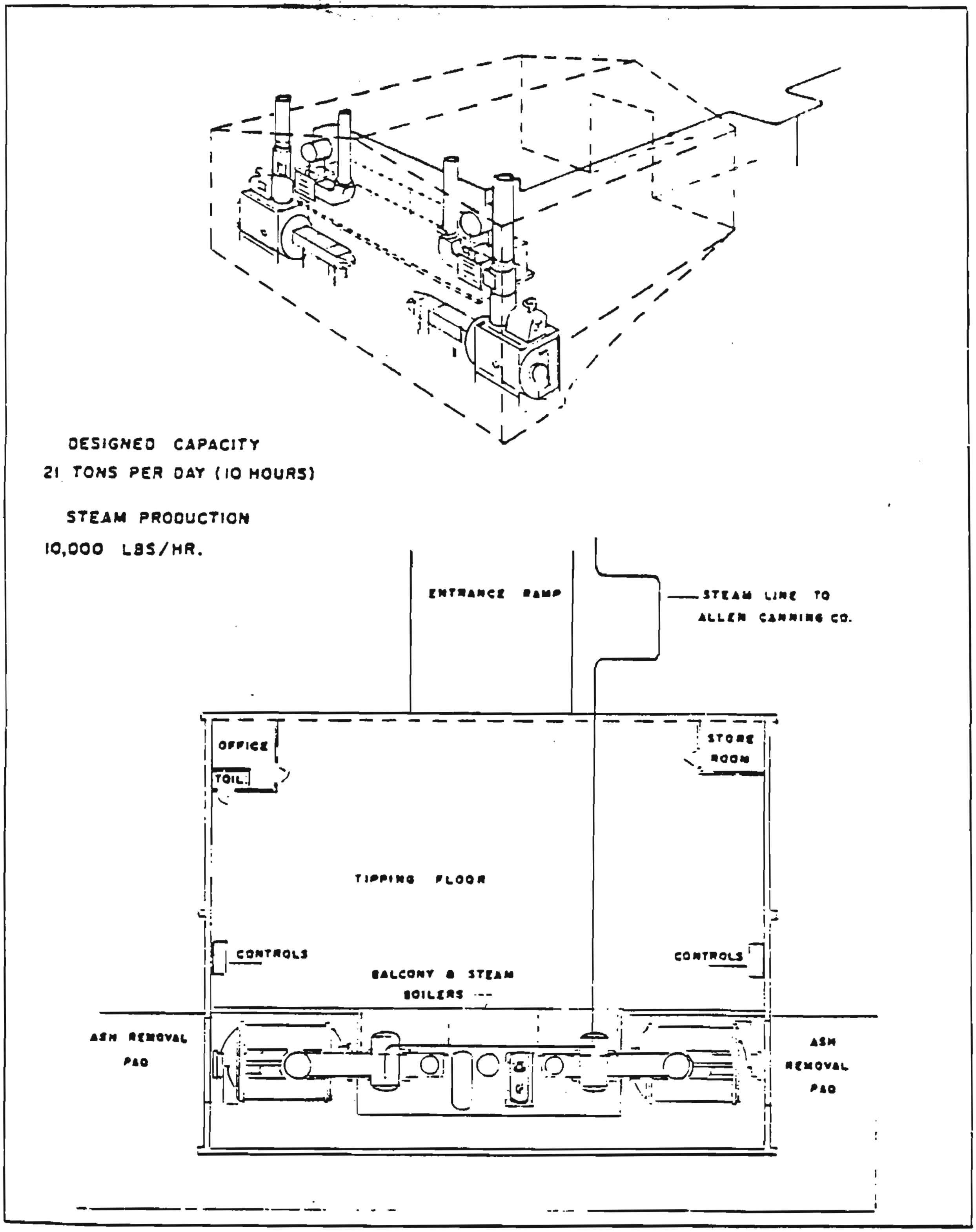
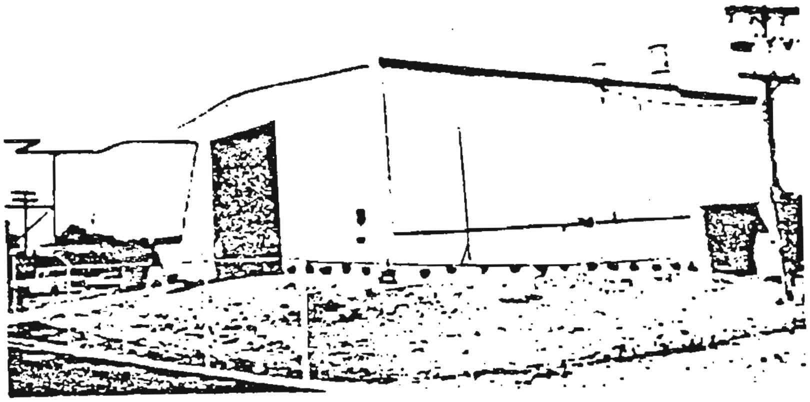
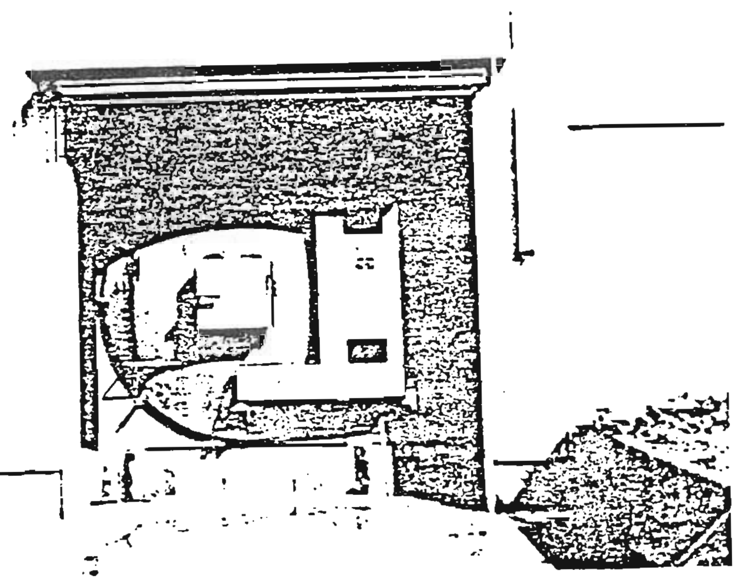


FIGURE B-7.6. MUNICIPAL INCINERATOR PLANT WITH STEAM BOILER
SILOAM SPRINGS, ARKANSAS

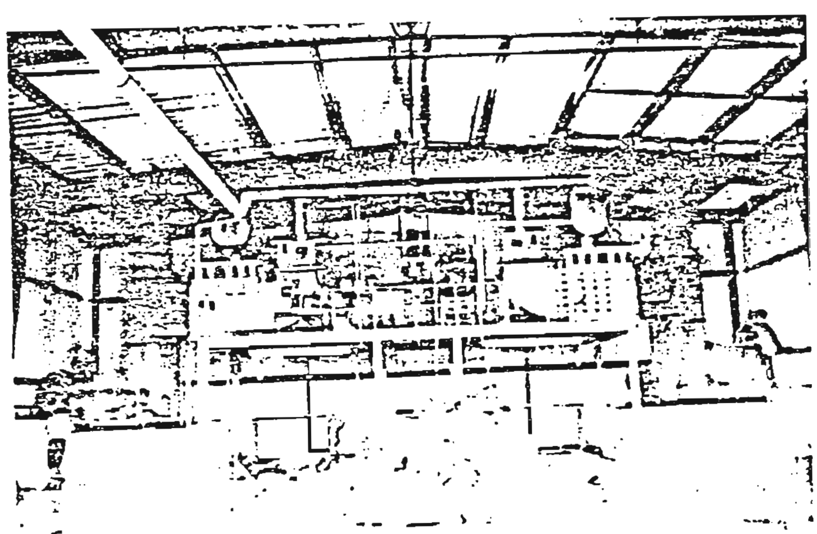


Siloam Springs has installed a 21 ton per day plant. Energy recovery from incinerating the municipal waste produces steam at the rate of 120,000 pounds for a 12 hour day.

The photograph shows the insulated steam line as it exits the front of the building. The canning company that purchases the steam is located directly across the street.

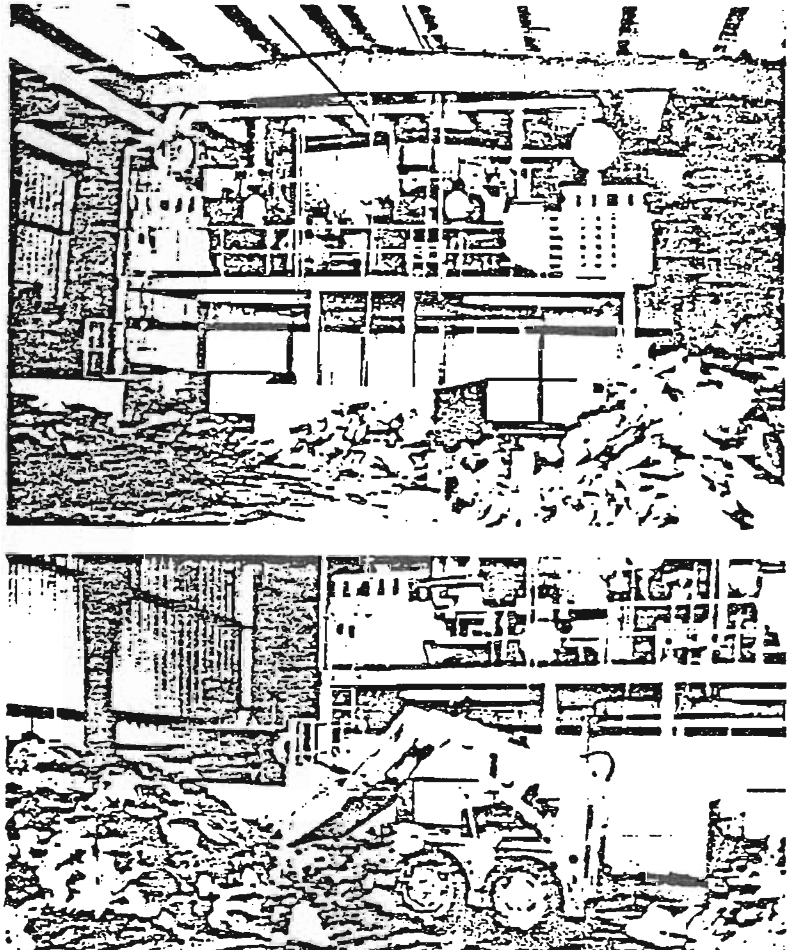


In this plant both of the 10.5 ton per day incinerators are enclosed by the building. Large overhead doors permit complete opening of the units for ash removal.



Steam production equipment is installed on a balcony above and between the two incinerators.

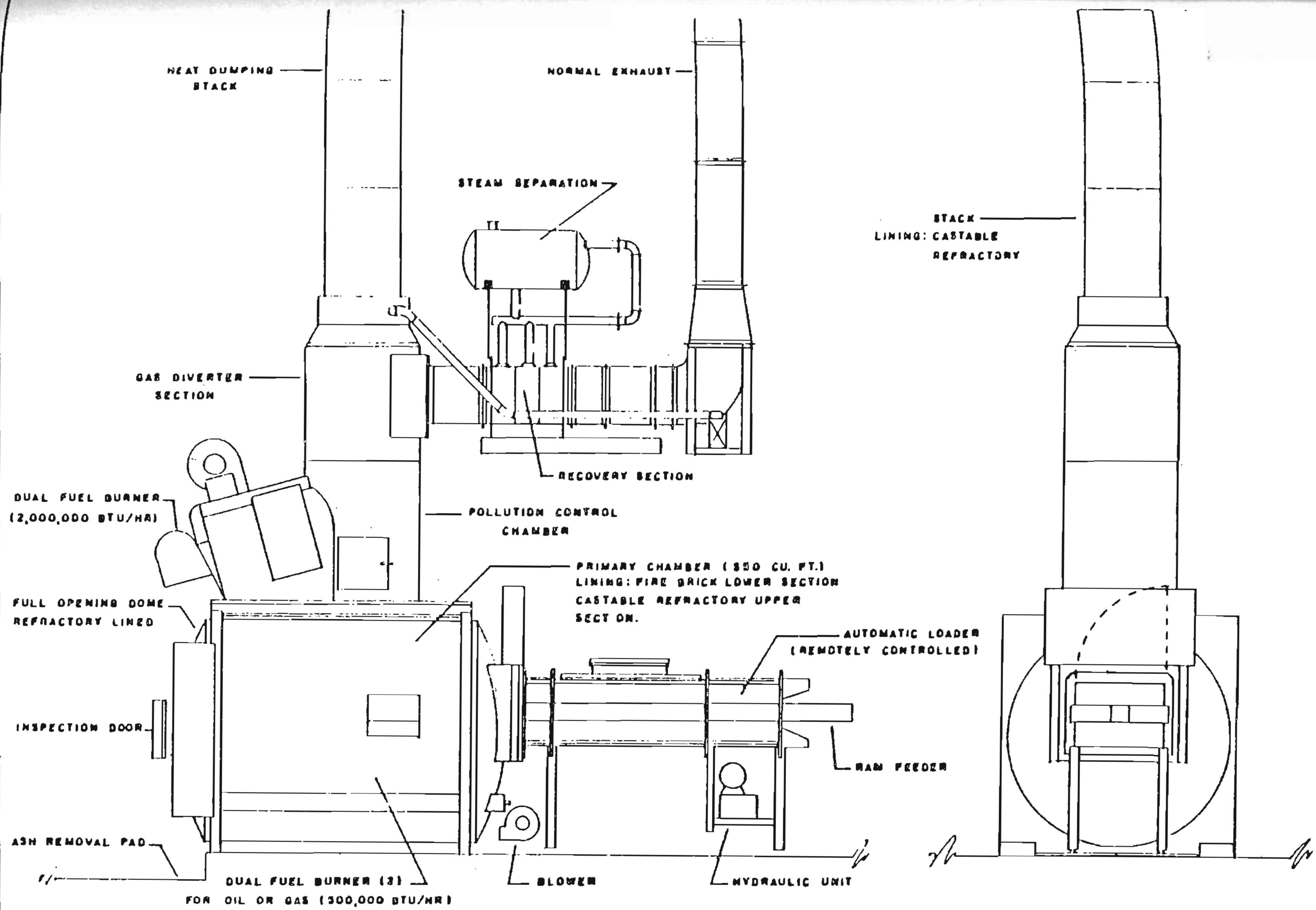
FIGURE B-7.7. SILOAM SPRINGS, ARKANSAS



When the gases from the secondary chamber are diverted through the waste heat boiler they enter at around 1800°F and exit at less than 350°F. The steam is generated in excess of 100 psig and at a rate of 5,000 pounds per hour from each boiler. This equals the production of an in-house boiler at the canning plant. The average efficiency of the waste heat boiler is 70%.

A front loading tractor feeds the two incinerators at Siloam Springs.

FIGURE B-7.8. SILOAM SPRINGS, ARKANSAS



MUNICIPAL INCINERATOR MODULE

SILOAM SPRINGS, ARKANSAS

FIGURE B–7.9.

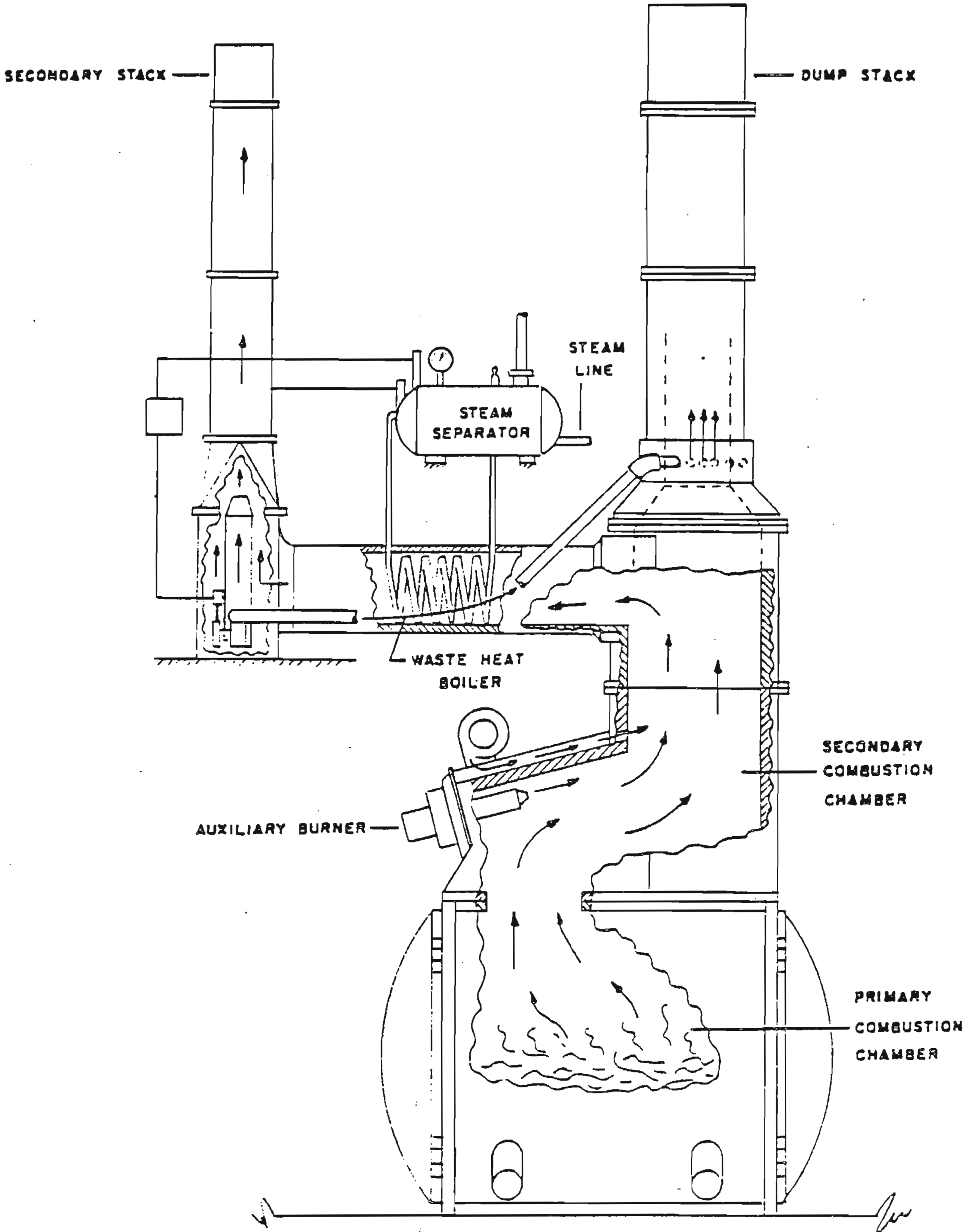


FIGURE B-7.10. GAS FLOW IN STEAM PRODUCTION SYSTEM
SILOAM SPRINGS, ARKANSAS

Figure 6 shows how the waste heat energy system operates. Two stacks are provided to give the system a wide range of operational flexibility. The large stack is used to operate the equipment as an incinerator only. The smaller stack carries the flow when the system is producing steam. Partial heat extraction can be maintained by dividing the flow. This flow control is maintained by a patented aerodynamic valving arrangement.

In the event of a power failure or control failure the system will immediately direct the hot gases through the dump stack. Once the incinerator is operating, this rapid response feature will control the system from full steam production to zero in less than ten seconds. This results in capital savings by eliminating the need for a condenser or other heat dissipating device.

The aerodynamic valving also eliminates the need for mechanical valving in either stack, reducing maintenance costs.

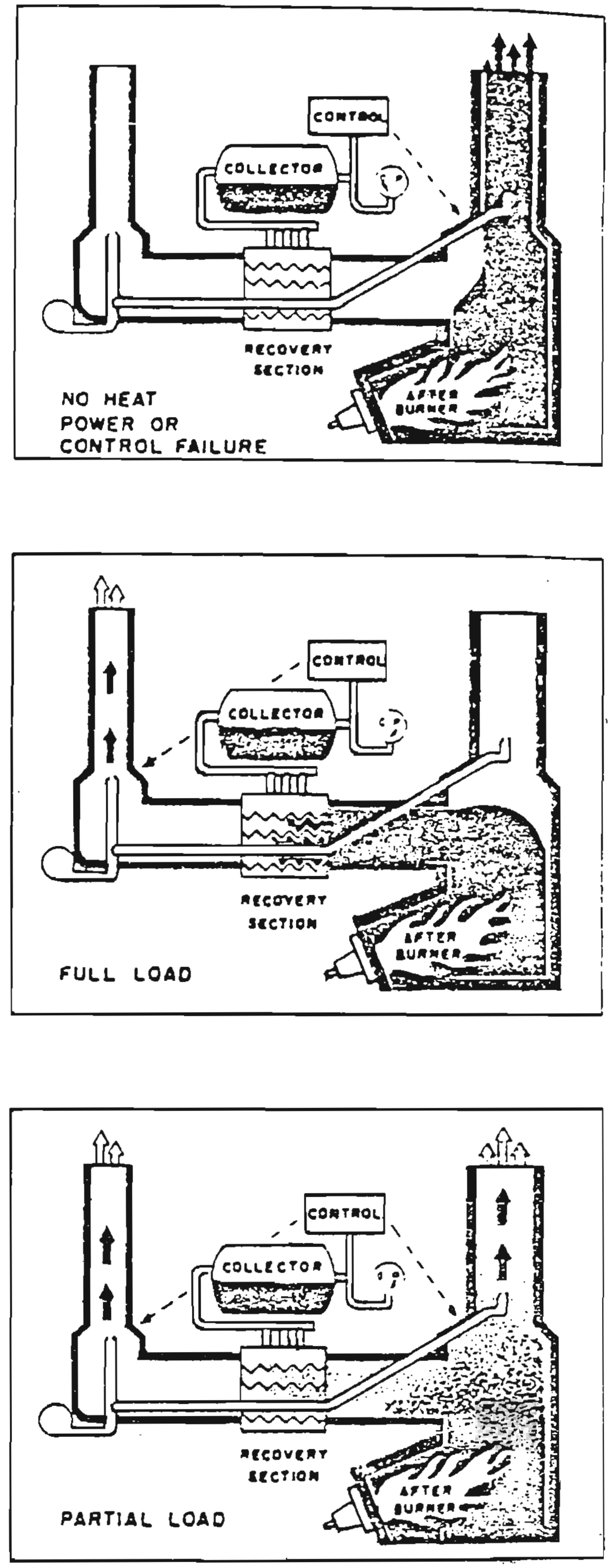


FIGURE B-7.11. CONTROL SYSTEM FOR GAS FLOW, SILOAM SPRINGS, ARKANSAS

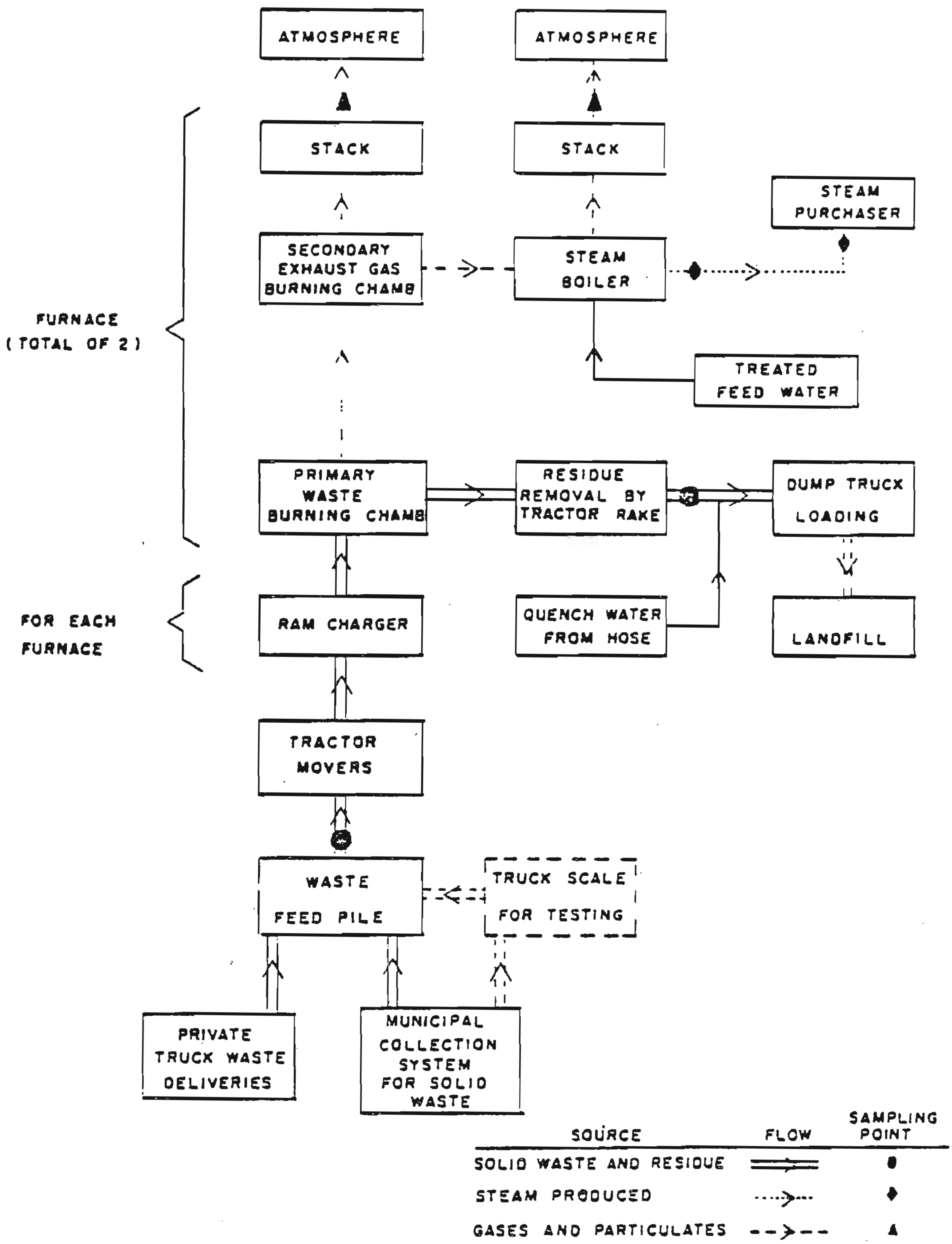


FIGURE B-7.12. FLOW DIAGRAM FOR SILOAM SPRINGS MUNICIPAL INCINERATOR

The data for each of the tests conducted for the EPA are presented in Tables 1 through 4.

The emissions are quite low even without mechanical or wet scrubbers being utilized on the exhaust. However, in order to assure compliance with a standard of 0.03 grains of particulates per standard cubic foot, a high energy wet scrubber must be included in the system. These are package type units which have been installed on this type of incinerator. Manufacturers of the incinerator units have arrangements with scrubber manufacturers to supply the equipment and will therefore take responsibility for this add-on. It has been reported that one manufacturer (Consumat) is developing its own scrubber unit to be offered along with the incinerator and heat recovery units.

Efficiency of Steam Production

Tests at the Siloam Springs Facility were conducted to determine the efficiency of steam production. During one day of test operation 47,425 pounds of 100 psig steam was produced from the burning of 16,696 pounds of solid waste and 3,610 cubic feet of natural gas. This means 2.84 pounds of steam were generated per pound of waste. This would be improved if the system utilized condensate return. At Siloam Springs the feed water is 50°F and it must be raised to 338°F the temperature at which the steam is produced. Figure 8 shows the calculation of boiler efficiency. Note that the theoretical boiler efficiency determined is 72.8%.

The efficiency is dependent on a number of variables including the heat value of the waste and charging rates. In addition, automatic ash removal systems should improve the efficiency. It should be noted that manufacturers claim efficiencies of 40 to 75% in their systems.

Capital and Operating Costs - Siloam Springs

The capital cost of the Siloam Springs, Arkansas Facility, constructed in early 1975 was as follows:

Plant Building, Road, Fence and Utilities	$118,000
Incinerators (2)	146,000
Energy Recovery Units (2)	107,000
TOTAL	$371,000

TABLE 1
SUMMARY OF PARTICULATE TEST RESULTS

SILOAM SPRINGS, ARKANSAS

Date	Test #		Emission Concentration: Dry Catch GN/SCFD*	Emission Concentration: Wet Catch @ 12% CO_2	Emission Concentration: Total Catch @ 12% CO_2	Mass Emission Rate Dry Catch (lbs/hr)	Stack Exhaust Conditions: Volumetric ACFM ≠	Stack Exhaust Conditions: Exhaust Flow SCFMD ‡	Stack Exhaust Conditions: Stack Temp. (°F)
10/3/75	1	(A)	.0267	.0402	.0668	.2923	7192	4754	273
10/3/75	2	(A)	.0336	.0303	.0640	.5613	9553	6616	254
Avg. of 2 runs			.0302	.0353	.0654	.4268	8373	5685	264
10/4/75	3	(B)	.0367	.0102	.0463	.4456	9046	2519	1333

(A) During these two tests all gas was being emitted from the boiler stack, as full steam production was in effect. The aero-dynamic valving prevented any gas from escaping through the main or dump stack. Note the low heat of the gas as it entered the boiler stack, indicating an extremely high rate of efficiency in heat extraction by the boiler tubes.

(B) During the third test the boiler was shut down and all gases diverted to the main stack. Note the extreme rise in gas temperature.

* Grains/Standard Cubic Feet, Dry. ≠ Actual Cubic Feet / Min. ‡ Standard Cubic Feet / Min., Dry

TABLE 2
SUMMARY OF PARTICULATE EMISSION TEST RESULTS

PARTICULATE EMISSIONS TEST SILOAM SPRINGS, ARKANSAS, INCINERATOR

	Test Run No. & Date			
	1 10/3/75	2 10/3/75	Avg. of 2 Test Runs	3 10/4/75
Charge Rate (Lbs/Hr)	2478	2392	2435	2680
Burn Rate (Lbs/Hr)	1635	1673	1654	1527
Testing Periods:				
Start-up Time	9:00	9:00		8:00
First Charge	10:00	10:00		9:00
Start Test	11:34	14:47		10:02
TOTAL TEST TIME	2 hr. 32 min.	2 hr. 30 min.		2 hr. 32 min.
DRY CATCH				
Lbs/Hr	.2923	.5613	.4268	.4456
GN/ACF*	.0047	.0069	.0058	.0057
GN/SCFD≁	.0069	.0090	.0080	.0202
GN/SCFD 12 CO_2	.0267	.0336	.0302	.0367
GN/SCFD 3.5 CO_2	.0078	.0098	.0088	.0107
GN/SCFD 50 Excess Air	.0165	.0250	.0208	.0374
Lbs/100 Lbs Charged	.0122	.0236	.0179	.0165
Lbs/100 Lbs Burned	.0182	.0351	.0267	.0314
Lbs/1000 Lbs Flue Gas	.0119	.0166	.0143	.0343
CONDENSER CATCH				
Lbs/Hr	.4403	.5069	.4736	.1235
GN/ACF	.0071	.0062	.0067	.0016
GN/SCFD	.0104	.0081	.0093	.0056
GN/SCFD 12 CO_2	.0402	.0303	.0353	.0102
TOTAL				
Lbs/Hr	.7326	1.0682	.9004	.5691
GN/ACF	.0119	.0130	.0125	.0073
GN/SCFD	.0173	.0171	.0172	.0258
GN/SCFD 12 CO_2	.0668	.0640	.0654	.0463

* Grains/Actual Cubic Feet

≁ Grains/Standard Cubic Feet, Dry

TABLE 3
EXHAUST GAS CONDITIONS IN STACK

SILOAM SPRINGS, ARKANSAS, INCINERATOR

	Test Run No. & Date			
	1 10/3/75	2 10/3/75	3 10/4/75	
Velocity, Ft/Min	1950.65	2591.11	2550.44	Two separate stacks tested. Averaging not applicable.
Temperature, Deg F	273	254	1333	
Volume, Actual Cubic Feet, Min	7192	9553	9046	
Volume, Standard Cubic Feet, Min. Dry	4754	6616	2519	
Moisture, By Volume Condensate Method	7.78	5.92	4.53	
Auxiliary Fuel Consumed (ft^3/min)	1.066	0.0	0.132	
Average Velocity of Sampled Gases at Nozzle Ft/Min	1962.6	2400.	2565	
% Isokinetic	100.6	92.6	102.	

TABLE 4
SUMMARY OF EXHAUST GAS ANALYSIS

SILOAM SPRINGS, ARKANSAS INCINERATOR

	Test Run No. & Date			
	1 10/3/75	2 10/3/75	3 10/4/75	
CO_2 (Total)	3.10	3.20	6.60	Two separate stacks tested. Averaging not applicable.
CO_2 in Fuel	.02	.0	.006	
Net CO_2 in Stack Gas	3.08	3.20	6.594	
CO ppm	10.	10.	25.	
O_2%	15.5	16.20	13.50	
N_2%	81.40	80.60	79.90	
Dry Molecular Weight	29.12	29.16	29.60	
Mol. Wt. w/Moisture	28.25	28.50	29.07	

A summary of the operating costs for the Siloam Springs Facility as determined in early 1976 follows:

Labor (with fringes) Plant Supervisor and 2 Laborers	$ 28,195
Auxiliary Fuel	4,366
Utilities	6,350
Supplies and Services	3,482
Maintenance Fund*	3,125
Vehicle Fuel	672
TOTAL OPERATING COSTS	$ 46,190

*NOTE: Maintenance fund is based on $0.48 per design ton charged per year. However, if this figure were based on 5% of original purchase cost, this amount would increase by $2.93 per ton.

The major maintenance item in this type of plant is the refractory lining of the incinerators. Operational experience has shown that during the first three years of operation only minor patching of refractory linings has been required. It has been found, also, that refractory repair can be performed in-house, simply and quickly, and at far lower cost than by hiring outside contractors. The actual life of refractory linings is not really known. However, estimates of from 3 to 8 years have been made by various manufacturers. The life is dependent upon whether or not automatic ash removal is included with the system and what is the operating schedule of the unit. Manual ash removal yields more wear than automatic ash removal. Also, continual operation rather than startup and shutdown of the unit on a daily basis adds life to the refractory lining. Since the St. Charles MIUS unit will be scheduled to operate only 10 hours per day, it is estimated that the refractory lining will last 3 to 5 years.

Residue Quantities

The "typical" MSW discussed previously has an ash content of approximately 20 percent. This value is reported by the U.S. Environmental Protection Agency. However, this is for total burnout of the refuse. Since combustion will not be 100 percent, the ash will be somewhat more. Therefore, for the design of this project, the ash to be generated will be between 25 to 30 percent, by weight, of the MSW as received. On a daily basis, when processing 10.5 tons, this results in approximately 3 tons per day. If residue is handled dry, the weight per day will be 3 tons and the volume will be approximately 3 to 4 cubic yards. Incineration typically reduces the MSW volume by approximately 90 percent.

Experience of firms such as Consumat and Comtro Division of Sunbeam Equipment Corporation report excellent burnout with this type of equipment. Volume reduction of 90 percent is reported as well as weight reduction of 70 to 80 percent.

Residue Disposal

Residue from the incinerator/energy recovery system as well as non-recoverable bulky wastes must be disposed of in sanitary landfill.

St. Charles plans to design and operate a sanitary landfill within the confines of the community sometime in the future. The site under consideration is located approximately 2 miles south of the MIUS Plant on Piney Church Road (See map on the following page).

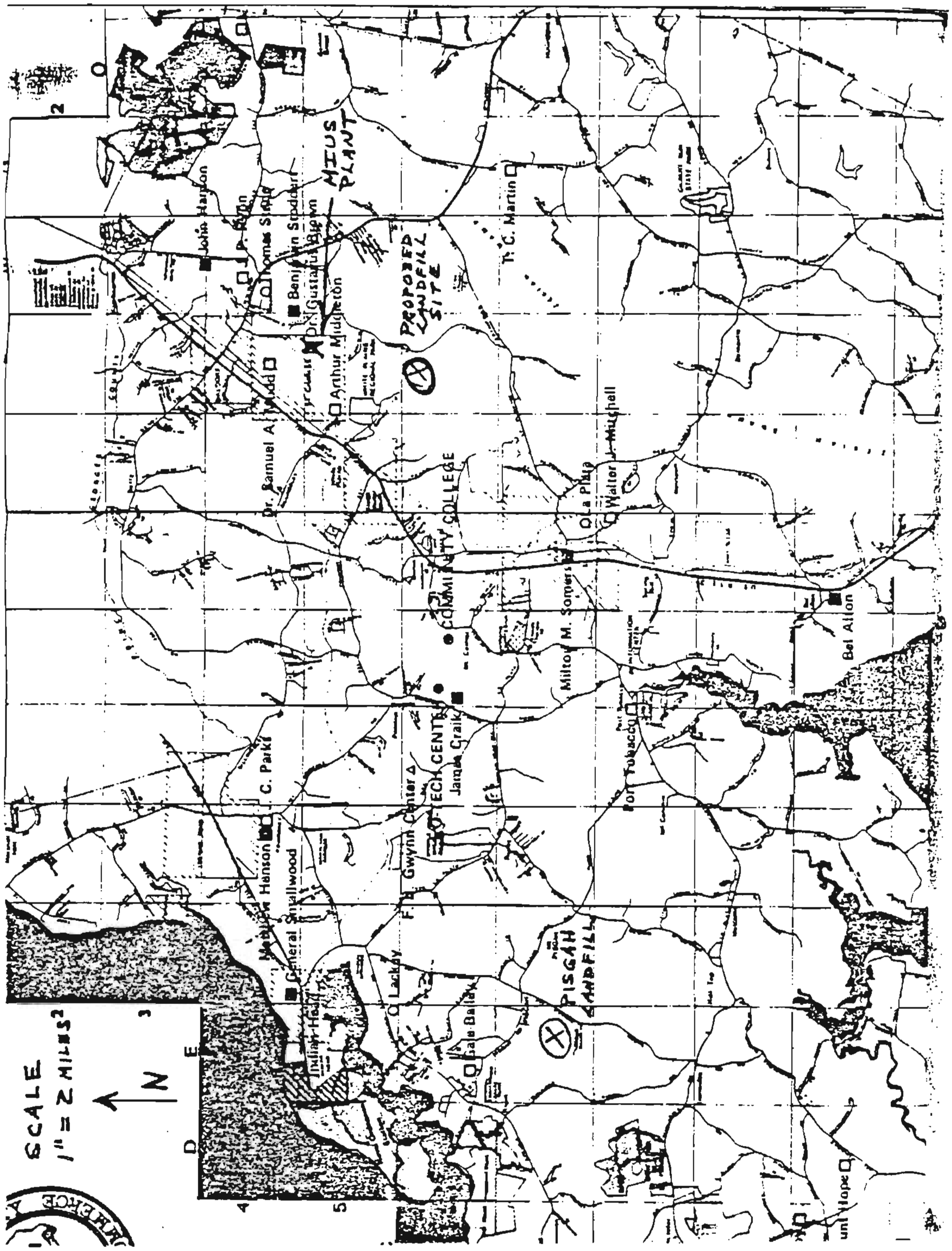
At the present, solid waste is transported to the Charles County Landfill located at Pisgah (See map on the following page). This site is approximately 18 miles from the proposed MIUS Plant Site. Until plans can be developed and all necessary approvals received for the implementation of a landfill site at St. Charles, all residue and non-recoverable bulky wastes will be disposed of at the Pisgah Landfill.

Facility Tipping Procedures

As discussed in the Conceptual Design Report, MSW will be transported to the Processing Facility in individual containers. The truck will back into the tipping area with the container. The incinerator/energy recovery system is fed automatically from a receiving hopper with conveyor by a hydraulic ram mechanism. The truck will be backed to the receiving hopper, so that as the refuse container is lifted from the truck, the bottom opens discharging its contents into the feed hopper and conveyor (See Loading System 6 on following pages). This is repeated with each refuse container. No refuse will be deposited on the floor. All containers are closed and they will be emptied directly into the feed system, thus eliminating the need for a front-end loader. This also keeps odor and trash problems at a minimum.

A refuse container stationed nearby this tipping area will be used for any bulky wastes which were mixed in with the MSW and deemed hazardous to the incinerator. This will be trucked to the landfill for disposal when necessary.

Ash from the incinerator will be automatically ejected from the system into a container (See Ash Cleanout System 3 on following pages).


SCALE
1" = 2 MILES²
N
PROPOSED LANDFILL SITE
MIUS PLANT
PISGAH LANDFILL
T. C. Martin
Arthur Middleton
Dr. Samuel A. Mudd
Ola Plata
Walter J. Mitchell
Milton M. Somers
Bel Alton
Port Tobacco
C. Parks
Matthew Henson
General Smallwood
Lackey
Gale-Bailey
F. B. Gwynn Center
Jarda Craik
John Hanson
Thomas Stone
Benjamin Stoddert
Dr. Gustavus Brown

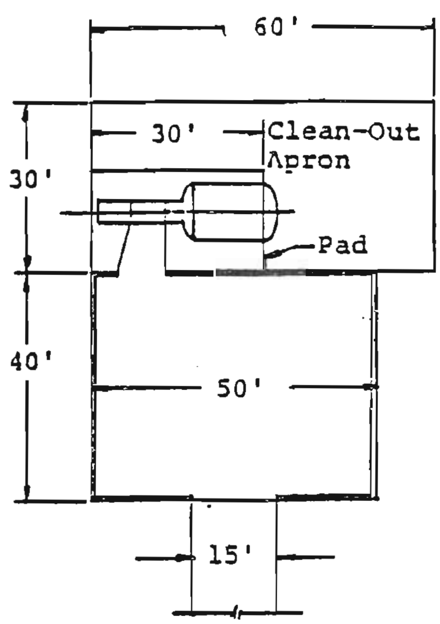
As discussed previously, this container will be covered and airtight so that when it is transported to landfill, no leakage or blowing problems will result. Depending upon size of container utilized, this residue will have to be disposed of no more than once per day and possibly even less frequently.

Solid Waste Subsystem Space Requirements

A basic floor plan of a system to handle 12½ tons per day of MSW as specified by Consumat is shown below. It specifies an area of 60 feet by 90 feet with a height clearance of 19 feet. However, that system utilizes a standard tipping floor approach. Since the system proposed for MIUS empties containers directly into a feed hopper and conveyor, rather than on the floor, the tipping floor requirement of 2000 square feet (40' x 50') may be lessened. Of course, it would be beneficial to have an area for extra container storage, etc., but even allowing for that, the tipping floor area could be cut in half.

The space requirements for the actual incinerator/energy recovery equipment is approximately 30' wide x 60' long with height of 20'. The unloading area adjacent to the equipment should be approximately 30' x 40' with approximately 18 to 20 feet of clearance.

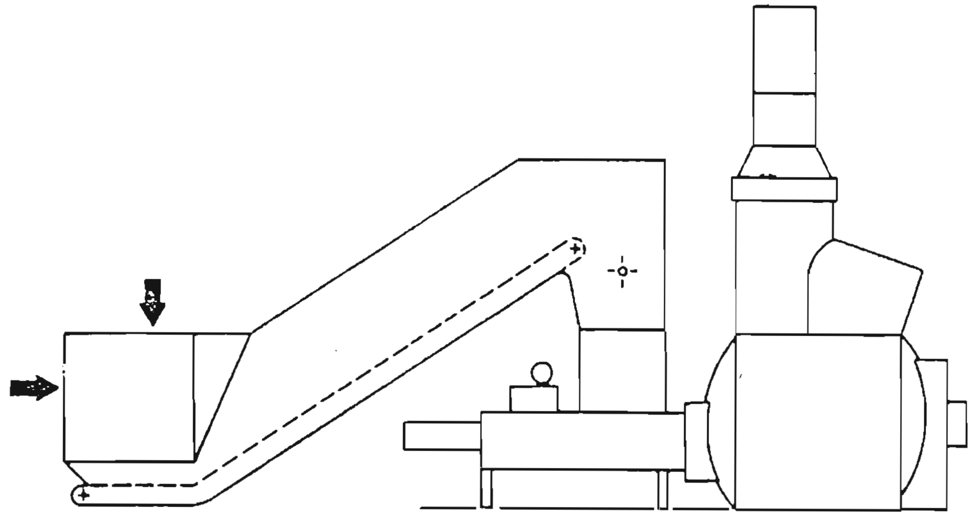
Various arrangements of the equipment may be developed depending upon the space available. Therefore, the requirements as indicated above are presented only as a guide.



BASIC FLOOR PLAN

C-760M

12½-Ton Plant



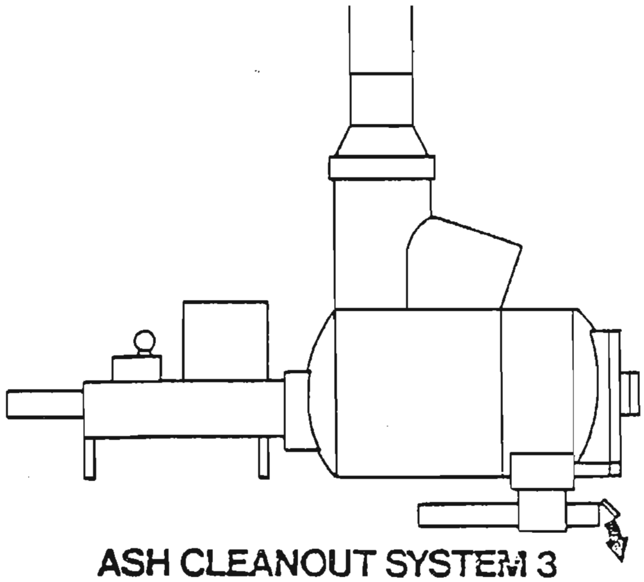
LOADING SYSTEM 6
Automatic loader With Conveyor

The automatic loader models ST-150 and ST-350 are designed to automatically load all waste materials that will fall freely into the loader through the upper opening when delivered by a conveyor or other means. The waste receiving openings are 28" x 36" and 40" x 48" respectively. In operation, waste may be delivered to the loader from a receiving hopper or from some other source by a belt conveyor. The belt conveyor may be automatically controlled to deliver material to the loader as needed. When the incinerator is in ready-to-load condition and the automatic conveyor has delivered a predetermined volume of waste material, the loader will automatically go into a loading cycle and complete the cycle when the predetermined volume of waste has been loaded into the incinerator. Suceeding batches of waste will be loaded when the incinerator is again in ready-to-load condition after a preset time and the conveyor has delivered additional waste to the loader.

The automatic loader employs a double ram mechanism. The main or lower ram operates continuously with a stuffing action similar to that of a stationary compactor. This action continues until all waste material has been removed from above the loader chute. Both rams then operate together to completely clear the loader chute of waste material so that the fire door may be closed and the loading cycle completed. Sonic sensor systems are used to detect the presence of waste for control of the delivery conveyor and for starting and completing the loading cycle.

APPLICATION GUIDE

LOADER	INCINERATOR MODEL				
MODEL	C-125	C-225	C-325	C-550	C-760
ST-150	X	X			
ST-350			X	X	X



ASH CLEANOUT SYSTEM 3
Ash Removal Systems
[With Extended Lower Chamber & High-Thrust Loader]

The mechanical ash removal system consists simply of a very powerful ram located at the bottom of an ash sump which is an integral part of a lower chamber extension. The apparatus is designed so that ashes may be removed from the lower chamber as required while the incinerator is in normal operation without allowing uncontrolled flow of air into the lower chamber. Since the ash and burning material within the lower chamber are forced to move in the direction of the ash sump, the loader must have a suitable driving force and be located in a more effective lower position on the incinerator. (Only loaders having a ram force of 6,000 to 10,000 pounds are used with the mechanical ash removal system.)

There are three important reasons for the selection of this type ash removal device as compared with moving grates or bomb-bay door devices:

a. With the ram-type ash remover, there are no moving parts in the high temperature area of the incinerator, greatly reducing the probability of damage from heat or molten slag.

b. The ram-type ash remover can operate without opening the lower chamber to atmosphere and disrupting the incinerator operation.

c. Since there is normally no reason to completely remove the bed of ashes from the incinerator, the ram-type ash remover needs only to operate as required to remove excess ash build-up and is not intended to completely evacuate the incinerator of ashes.

APPLICATION GUIDE

LOADER MODEL	INCINERATOR MODEL C-125	C-225	C-325	C-550	C-760
ST-150	X	X			
ST-350			X	X	X
ML-250A	X	X	X		
ML-350A		X	X	X	X
ML-525A			X	X	X
ML-960			X	X	X
ML-1280				X	X

Sludge Incineration

The quantity of sludge to be disposed of should not present any operational difficulties if the system is designed accordingly. Retrofitting a facility for sludge burning may pose difficulties. Since the quantity to be introduced in the incinerator with the refuse is not great, no problems are anticipated.

One potential difficulty which has been examined is the possible decrease in refractory life due to sludge incineration. Manufacturers of this type incinerator select the refractory type depending on feed material to be incinerated. Acids resulting from sludge burning may be harmful if the proper type of refractory is not selected. If upon placing an order for this equipment, the specifications require sludge burning, the refractories are selected accordingly. Most manufacturers are willing to warrant the equipment and post a performance bond for the first year of operation. Following this time, maintenance contracts are available for the equipment. The approximate cost is 3 percent of the equipment cost. However, this would not include cost of total rebricking, only patching. Refractory life is estimated to be about 12 years and the present cost is $8,000.

Due to the experience of the manufacturers with the combustion of sludge in their equipment, it appears that there are no major problems, provided that this duty is specified at time of order and no attempt is made to burn 100 percent sludge (no solids) in the unit.

Energy Recovery

Assuming 10.5 tons of MSW per day (Pheasant Run not included) and considering an average heat content of 4800 Btu per pound (this is an average figure for MSW as received, based on data reported by the U.S. Bureau of Mines and the U.S. Environmental Protection Agency sponsored City of St. Louis Energy Recovery Project), approximately 100 million Btu's per day are available in the MSW. On a 10 hour per day operational basis, this means 10 million Btu's per hour. However, if the incinerator is to be utilized to dispose of sewage sludge at 10 percent solids (estimated to be 500 gallons per day), this would require approximately 0.4 million Btu per hour. If, however, the sludge was introduced at approximately 4 percent solids, the heat required would be 1.0 million Btu per hour. Considering overall efficiency (heat losses in the refractories, heat exchanger, etc.) the net energy available for the three cases reported above are as follows:

	Approximate Available Btu's*
No Sludge	6.0 million
10% Solids Sludge	5.5 million
4% Solids Sludge	5.0 million

*Per hour assuming 10 hour per day operation

Should the incinerator be used to dispose of or dry the 4% solids sludge, the 5.0 million Btu per hour available will yield approximately 3500 gallons of 200° to 220°F hot water per hour. This could be introduced into the hot water system as needed. Alternatively, the hot water could be utilized for part of the domestic hot water system. For this purpose, a hot water storage tank should be included in the heat recovery unit loop to maintain the temperature when the incinerator is not operational. When the temperature of the water in the tank drops, an oil burner or electric heater would then automatically function to supplement the heat provided by the incinerator.

It is recommended that the incinerator be used in conjunction with sewage sludge disposal. Even after this purpose is served, substantial heat remains and should be utilized in the form of hot water for the system or domestic hot water. This is true in both the case of incinerating the sludge or using the heat for the purpose of drying the sludge.

Another potential method of energy recovery which may be tested at some point after installation, is the use of pyrolytic gas as a fuel supplement to the diesel engines in the system. This is only mentioned here so that when the plant is laid out, consideration may be given to locating the engines in the proximity of the incinerator to facilitate this test.

Since the incinerator primary combustion chamber is of "starved" air operation, incomplete combustion takes place, producing carbon monoxide rather than carbon dioxide. The afterburner is utilized to complete combustion of the off-gases. However, these gases (prior to the afterburner) following removal of harmful particulates, could be injected into the intake manifold of the diesel engines and thus utilized as a fuel. This has potential and could be tested at the St. Charles MIUS Facility if the system is designed to facilitate such experimentation.

Another method of energy recovery would be the elimination of the heat exchanger at the incinerator itself. Instead, the hot gases could be channeled with the exhaust gases of the diesel engines, thereby utilizing those same heat exchangers. This would allow the heat to be transferred directly to the system through an existing heat exchanger, thereby eliminating the one at the incinerator.

The fuel oil requirements of the incinerator would be 20 to 25 gallons per hour (#2 fuel oil), or about 250 gallons per day. However, if the 5 million Btu's per hour produced by the incinerator (30 million Btu's per day) may be utilized, this results in a savings equivalent to 360 gallons of #2 fuel oil per day with a value of approximately $150. Annually, this would amount to about $50,000.

Operation Schedule

As mentioned previously, a 10 hour per day operating schedule is recommended. This better coincides with the collection schedule resulting in an operational cost savings. Little MSW storage is required, thereby decreasing the building space requirements. Although the energy recovery efficiency is lowered by this schedule of operation, the system can be operated to be available for "on-peak" energy demands.

Since the energy available on a 24 hour operating basis would be only about 40 percent as much per hour as on a 10 hour basis, the amount becomes less significant. If scheduled to operate at the time of peak demands, the energy produced may have much more value to the overall system.

A benefit of sizing the solid waste processing system to handle all the waste on a 10 hour basis is the excellent potential afforded for expansion. Should the MSW production rate substantially increase or additional waste from other areas become available, it can be readily handled by simply extending operating hours. The tonnage to be handled can be easily doubled.

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B.8 Wastewater Management Subsystem

B.8.1 WASTEWATER MANAGEMENT SUBSYSTEMS DESCRIPTION

The Wastewater Management Subsystem for the St. Charles MIUS will be a 200,000 gallon per day plant that will service the following:

- Bannister Apartments
- Wakefield High-Rise
- Wakefield Terrace Apartments
- Third Age Center
- Crossland Manor Apartments
- Village Center (retail shopping and office)
- Stoddert Middle School

The treatment plant features a unique combination of unit processes which take advantage of the available heat from the remainder of the MIUS system. Although the combination of processes is unique, each process has been frequently used in sanitary waste treatment and is a proven, tested one. In order to ensure reliability and availability and to maximize maintainability, the plant will be a dual train system, i.e., each process will have duplicate pieces of equipment. Each train will normally operate at half-flow, but can accommodate full-flow with only a slight degradation of the final effluent quality.

The sewage from the MIUS-connected units will be delivered to the plant by force mains. Short-term flow patterns will therefore be a function of the design of the force main pumping stations (pumping station sump capacity, pump capacity, and pump cycling). Maximum inflow will be equivalent to the sum of the capacities of pumping station pumps and MIUS gravity flow. The character of the sewage sources is such that there will be little or no flow during the period from midnight to 5 a.m.

These factors influence design. Other important factors are: fixed cost budget, maximum energy efficiency, fixed space, absolute odor control, and strict effluent limitations.

Incoming sewage will travel by force main to a surge tank in the plant.

Overflow from the surge tank will pass through two rotostrainers, each capable of handling 250,000 gallons per day. The rotostrainers consist of a fine mesh screen (0.001 inch) in cylindrical form. Raw sewage is introduced at the outside of the cylindrical screen, passes through, and leaves the equipment at the ends of the cylinder. A comparative dry sludge (20% solids) is left behind on the exterior cylindrical surface of the screen where it is scraped off by blades. The consistency of the sludge is dependent on the screen mesh size; the finer the screen the the dryer the sludge. Potential sludge handling problems are minimized by locating rotostrainers adjacent to the sludge sump where transfer can be made directly. Possibly a small comminuter will be needed to reduce the size of the larger sludge components previously filtered at the rotostrainer inlet screen.

The strained sewage then flows by gravity to a wetwell or equalization chamber of 60,000 gallons capacity. The wetwell will serve as an equalization chamber, smoothing out flows for subsequent processes. Three 70 GPM pumps will deliver sewage to downstream processes. Minimum flow will be 70 GPM. When incoming flows are negligible during the night, treated sewage will be recycled to maintain a 70 GPM flow rate. During the day, a second pump will turn on, giving a uniform flow rate of 140 GPM through the plant. Preliminary analysis indicates that this will occur for 10 to 14 hours per day. The third pump serves as a standby unit in case of routine maintenance or emergency outage of any pump, and as an emergency unit to keep the wetwell from overflowing.

Sewage pumped from the wetwell passes through heat exchangers and then flows by gravity to two biological units. A biological unit is a large cylinder, approximately 26 feet long and 12 feet in diameter, which has activated biological microorganisms on its surface. The cylinder is half-submerged in the sewage and rotates in it. The microorganisms on the surface of the cylinder consume biologics in the sewage. This consumption increases with temperature, and to ensure maximum efficiency, the sewage is preheated in the upstream heat exchangers to 85°F with low temperature waste heat from the Thermal Subsystem.

Under normal operations, the microorganisms will slough off the biological cylinder and pass with the sewage by gravity flow into the settling tanks or clarifiers. Nearly all remaining BOD and suspended solids will be removed in the settling tanks. Sludge from the clarifiers (2 to 3% solids) will be collected using a suction system rather than scrapers or flights and pumped to the sludge holding tank where it is combined with the sludge from the rotostrainers. During the recycling period,this sludge may be recycled to the wetwell to ensure that the biological units have sufficient "food" to consume.

The secondary effluent from the settling tanks will then flow over weirs into a clearwell from which it is subsequently pumped into a set of dual media pressure filters that give the effluent a final polishing. Each filter consists of two layers of filtering material, one sand and one anthrafit, which has a total depth of three feet. (Pressure filters are recommended since they require the least space and can be stacked vertically; the pressurized effluent discharge will assist in providing good chlorine mixing and flow into the non-pressurized clear water contact tanks.

At least three units are recommended to maximize process system operating efficiency. As sludge accumulates in the filter, the pressure differential across the unit increases. When the pressure differential increases to a pre-determined point, the equipment is removed from the main process stream by valving, and then flushed or backwashed to remove accumulated sludge. The time needed for the backwash cycle is of the order of 15 to 20 minutes. The time between cycles varies between 8 and 20 hours. Alternatively, backwashing may be cycled on a time basis only, rather than waiting for the pressure differential to increase to the cutoff point. It is anticipated that the St. Charles system will be run on a time basis, with backwashing taking place primarily during periods of low flow, (during the period from midnight to 5 a.m.) although backwashing may be accomplished at any time). Each filter is capable of taking one-half of the capacity flow. Any two units can handle capacity flow, leaving one unit as a standby. Two units will always be capable of operating at any given time while the third unit is in the backwash cycle.

After passing through the dual media filters, the effluent is chlorinated by a hypochlorite system and then is stored in two 6,000 gallon non-pressurized tanks. These tanks serve a dual purpose: as a chlorine contact chamber and as storage of backwash water for the dual media filters. Overflow from the tanks will be pumped to a lagoon and finally to a golf course for irrigation.

Sludge from the dual media filters will have a very low solids content and will, therefore, be recycled to the wetwell. Sludge from the rotostrainers and clarifiers will be collected in a sump. This sludge will be pumped through a unit where heat will be used to break down the sludge gel structure releasing the entrained water, and then decanted. Supernatant is routed back to the wetwell. Conditioned sludge will be placed in a tank from which it will be transferred to the incinerator, most likely by a screw pump system. At 200,000 GPD of wastewater treatment flow, about 2,500 GPD of 5% solids sludge is expected.

The quality of the major effluent stream from the WMS will be substantially better than EPA's definition of Secondary Treatment. It is estimated that for normal operation at capacity flow, effluent quality will be approximately 10 mg/l BOD and less than 10 mg/l suspended solids. During periods when effluent is recycled to keep the plant running at a fixed flow rate, the effluent that will be emitted during and shortly after this cycle will be a very high quality. Operating only one biological unit at full flow will result in an effluent quality of 20 mg/l BOD and 15 mg/l of suspended solids.

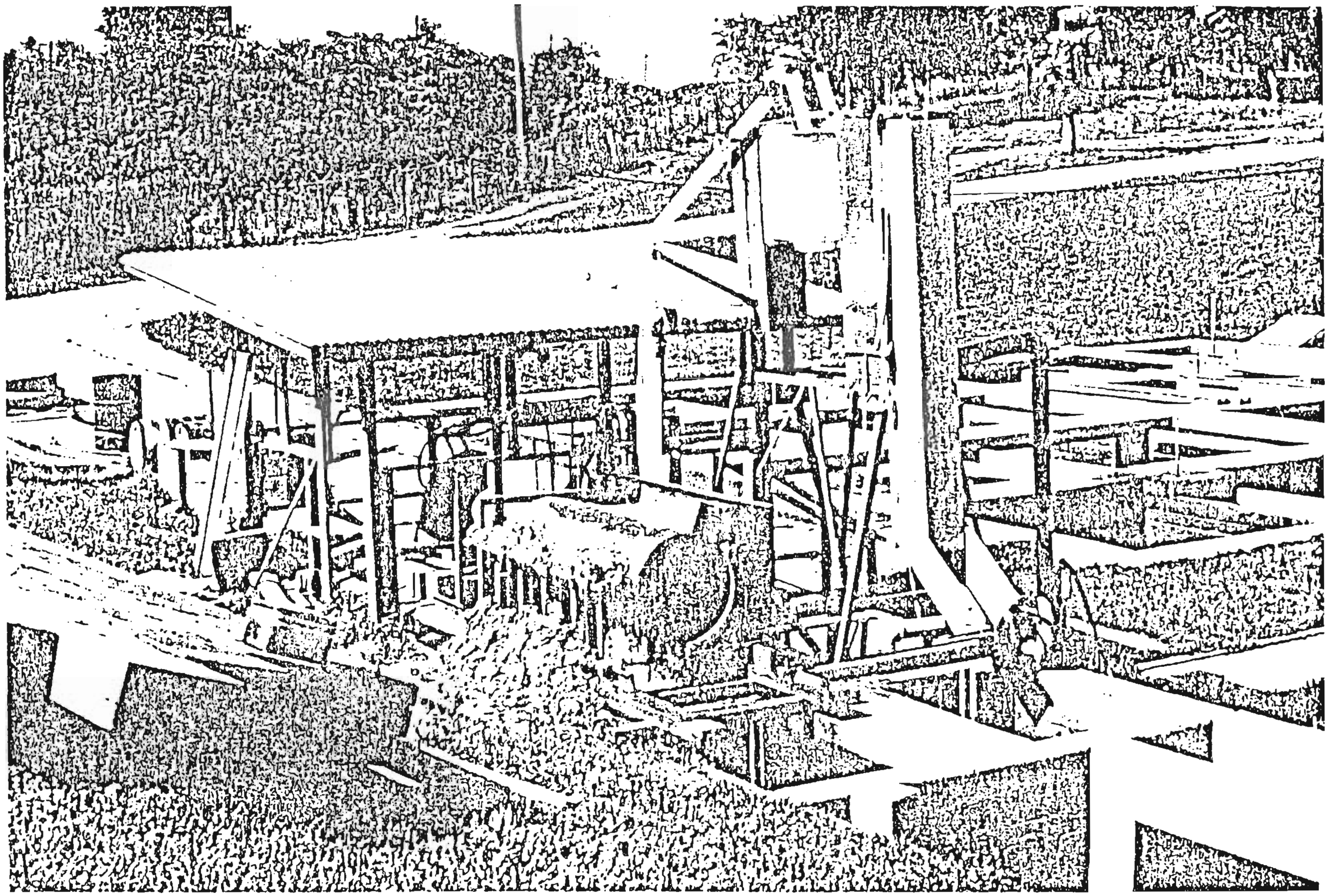
B.8.2 BIOLOGICAL UNIT INFORMATION AND DESIGN COMPUTATIONS

In order to meet stringent BOD_5 effluent quality criteria, it is essential that biological units operate at 95% BOD removal efficiency. All proprietary literature shows strong relationship between temperature and BOD removal efficiency, particularly below 55°F. Curves are given for Autotrol and Envirodisk.

Epco Hormell data is as follows:

BOD Removal (%)		Temperature	
With Actinomyces	Without Actinomyces	°F	°C
88%	95%	68°	21°
85%	91%	63°	18°
83%	90%	58°	15°

Also BOD removal varies with hydraulic loading, decreasing with increase in loading. This phenomenon can be effectively compensated for by heating effluent. (Actinomyces are filimentous microbes which inhibit the normal biological unit BOD consumption process).



ROTATING WEDGE WIRE SCREEN AT NORTH CHICAGO S.T.P.
(Courtesy of Hydrocyclonics Corp.)

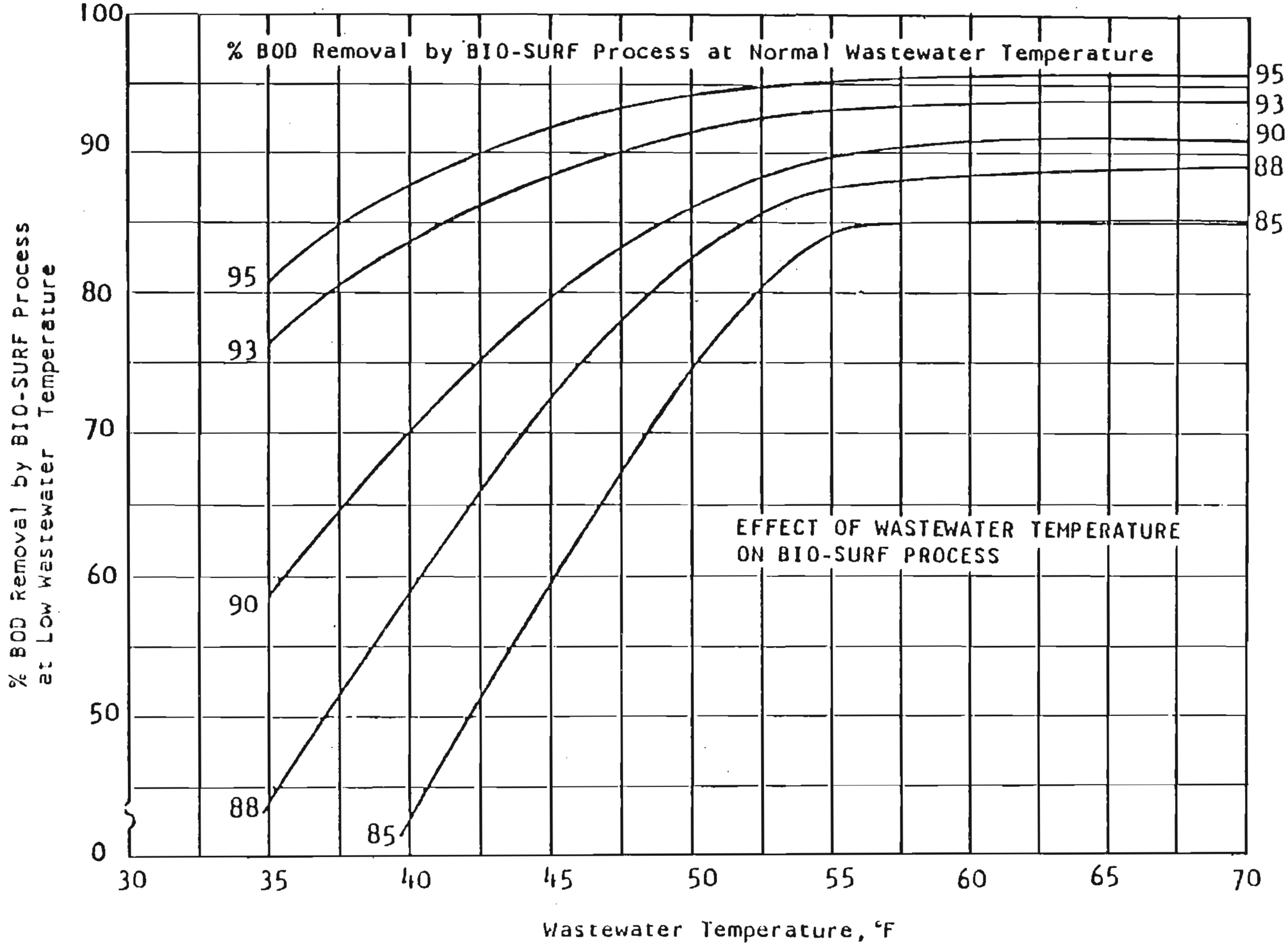


Figure C-3

EFFECT OF WASTEWATER TEMPERATURE ON BIO-SURF PROCESS

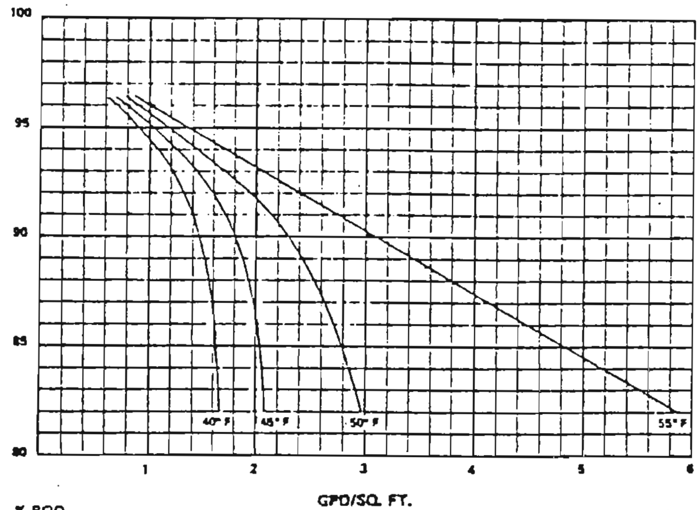
Drg. No. A-0023

...t Process: ENVIRODISK

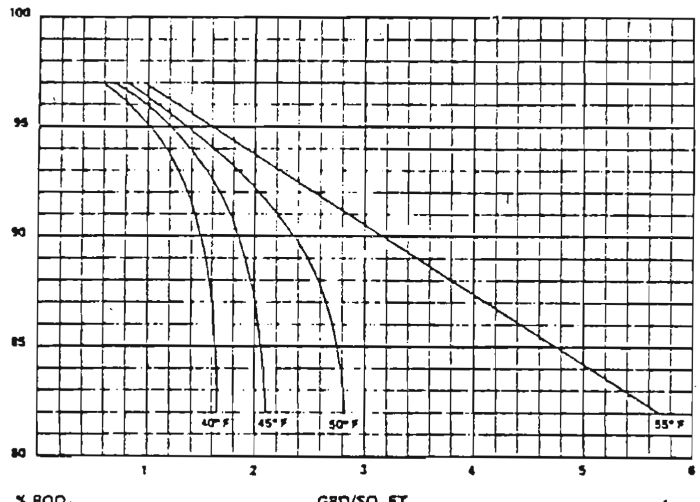
BOD AND AMMONIA NITROGEN REMOVAL FROM TYPICAL DOMESTIC WASTEWATERS

Additional Design Curves

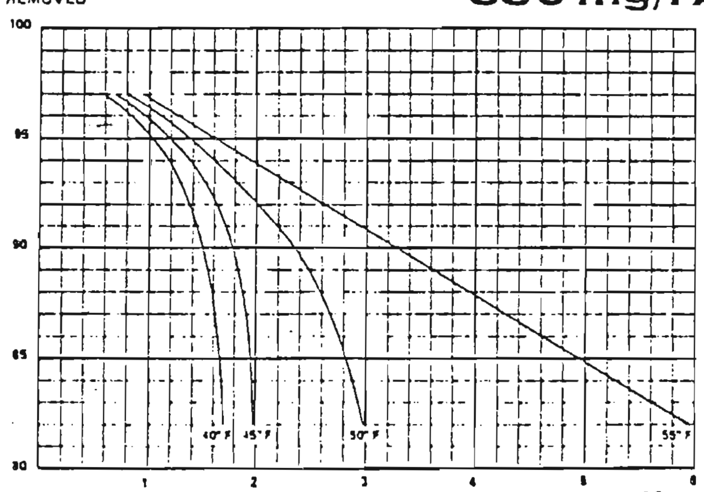
250 mg/l APPLIED BOD_5—figure E.



300 mg/l APPLIED BOD_5—figure F.



350 mg/l APPLIED BOD_5—figure S.



Description *DEMONSTRATION - WET WELL 133,000 gal/day*

ENDING TIME	DAILY FLOW IN (GAL)	BACKWASH FLOW IN (GAL)	TOTAL FLOW IN (GAL)	PUMPED FLOW OUT (GAL)	RECYCLE FLOW (GAL)	NET FLOW (GAL)	NET FLOW FT^3	WETWELL VOL. GAL	WETWELL VOL. FT^3	NET ELEV. FT
12AM	1150		+1150	-4200	+3050	0	0	4500	600	1.
1	1150		+1150	-4200	+3050	0	0	4500	600	1.
2	1150		+1150	-4200	+3050	0	0	4500	600	1.
3	1150		+1150	-4200	+3050	0	0	4500	600	1.
4	1150		+1150	-4200	+3050	0	0	4500	600	1.
5	5000		+5000	-4200		+800	+107	5300	707	1.
6	5000		+5000	-4200		+800	+107	6100	814	2.
7	8625		+8625	-8400		+225	+30	6325	844	2.
8	8625	6000	+14625	-8400		+6225	+830	12550	1674	4.
9	8625		+8625	-8400		+225	+30	12775	1704	4.
10	8625		+8625	-8400		+225	+30	13000	1734	4.
11	7200		+7200	-8400		-1200	-160	11800	1574	3.
12PM	7200		+7200	-8400		-1200	-160	10600	1414	3.
1	7200		+7200	-8400		-1200	-160	9400	1254	3.
2	7200		+7200	-8400		-1200	-160	8200	1094	2.
3	7200	6000	+13200	-8400		+4800	+640	13000	1734	4.
4	7200	6000	+13200	-8400		+4800	+640	17800	2374	5.
5	10350		+10350	-8400		+1950	+260	19750	2634	6.
6	10350		+10350	-8400		+1950	+260	21700	2894	7.
7	6125		+6125	-8400		-2275	-303	19425	2591	6.5
8	6125		+6125	-8400		-2275	-303	17150	2288	5.
9	6125		+6125	-8400		-2275	-303	14875	1995	5.0
10	3050		+3050	-8400		-5350	-713	9525	1272	3.2
11	3050		+3050	-8100		-5025	-672	4500	600	1.5

Description DEMONSTRATION - WET WELL (MANUAL) 154,000 GAL/d.

TIME	DAILY FLOW IN GAL	BACKWASH FLOW IN (GAL)	TOTAL FLOW IN (GAL)	PUMPED FLOW OUT (GAL)	RECYCLE FLOW (GAL)	NET FLOW (GAL)	NET FLOW FT³	VOL IN WETWELL GAL	VOL IN WETWELL FT	EL
12AM	1300		+1300	-8400		-7100	-947	12770	1704	4
1	1300		+1300	-8400		-7100	-947	5670	757	1
2	1300		+1300	-4900	+2425	-1175	-157	4500	600	1
3	1300		+1300	-4200	+2900	0	0	4500	600	1
4	1300		+1300	-4200	+2900	0	0	4500	600	1
5	5650		+5650	-4200		+1450	+193	5950	793	2
6	5650		+5650	-6500		-850	-113	5100	680	1
7	9725		+9725	-7280		+2445	+326	7545	1006	2
8	9725	6000	+15725	-8400		+7325	+977	14870	1983	5
9	9725		+9725	-8400		+1325	+177	16195	2160	5
10	9725		+9725	-8400		+1325	+177	17520	2337	5
11	8100		+8100	-8400		-300	-40	17220	2297	5
12PM	8100		+8100	-8400		-300	-40	16920	2257	5
1	8100		+8100	-8400		-300	-40	16620	2217	5
2	8100		+8100	-8400		-300	-40	16320	2177	5
3	8100	6000	+14100	-8400		+5700	+760	22020	2937	7
4	8100	6000	+14100	-8400		+5700	+760	27720	3697	9
5	11675		+11675	-8400		+3275	+437	30995	4134	10
6	11675		+11675	-8400		+3275	+437	34270	4571	11
7	6900		+6900	-8400		-1500	-200	32770	4371	10
8	6900		+6900	-8400		-1500	-200	31270	4171	10
9	6900		+6900	-8400		-1500	-200	29770	3971	9
10	3450		+3450	-8400		-4950	-660	24820	3311	8
11	3450		+3450	-8400		-4950	-660	19870	2651	6

Description DEMONSTRATION WET WELL 195,000 gal/day

TIME	DAILY FLOW IN (GAL)	BACKWASH FLOW IN (GAL)	TOTAL FLOW IN (GAL)	PUMPED FLOW OUT (GAL)	RECYCLE FLOW (GAL)	NET FLOW GAL	NET FLOW FT³	VOL IN WETWELL gal	VOL IN WETWELL FT³	NE ele FT
12AM	1300		+1300	-8400		-7100	-947	12770	1704	4.[illegible]
1	1300		+1300	-8400		-7100	-947	5670	757	1.[illegible]
2	1300		+1300	-4900	+2425	-1170 (overwritten)	-157	4500	600	1.5
3	1300		+1300	-4200	+2900	0	0	4500	600	1.5
4	1300		+1300	-4200	+2900	0	0	4500	600	1.5
5	6775		+6775	-5950		+825	+110	5325	710	1.8
6	6775		+6775	-6300		+475	+63	5800	773	1.9
7	11675		+11675	-8400		+3275	+437	9075	1210	3.0
8	11675	6000	+17675	-8400		+9275	+1237	18350	2447	6.1
9	11675		+11675	-8400		+3275	+437	21625	2884	7.2
10	11675		+11675	-8400		+3275	+437	2[illegible]800	3321	8.3
11	9700		+9700	-8400		+1300	+173	26200	3494	8.7
12	9700		+9700	-8400		+1300	+173	27500	3667	9.2
1	9700		+9700	-8400		+1300	+173	28800	3840	9.6
2	9700		+9700	-8400		+1300	+173	30100	4013	10.0
3	9700	6000	+15700	-8910		+6790	+905	36890	4918	12.3
4	9700	6000	+15700	-12600		+3100	+413	39990	5331	13.[illegible]
5	14000		+14000	-12600		+1400	+187	41390	5518	13.8
6	14000		+14000	-12600		+1400	+187	42790	5705	14.3
7	8275		+8275	-12600		-4325	-577	38465	5128	12.8
8	8275		+8275	-12600		-4325	-577	34140	4551	11.4
9	8275		+8275	-12600		-4325	-577	29815	3974	9.9
10	4150		+4150	-12600		-8450	-1127	21365	2847	7.1
11	4150		+4150	-12600		-8450	-1127	12915	1720	4.3
12AM	1550		+1550	-8400		-6850	-913	6065	807	2.0
1	1550		+1550	-[illegible]875	+1740	-1565	-207	4500	600	1.5
2	1550		+1550	-4200	+2650	0	0	4500	600	1.5
3	1550		+1550	-4200	+2650	0	0	4500	600	1.5

rca

January 11, 1977

Mr. Ion Caloger
Gamze-Korobkin-Caloger
205 West Wacker Drive
Chicago, Illinois 60606

Dear Ion:

In response to your letter of December 30th 1976, we are pleased to submit the following information.

Based on one year's wastewater analysis, we have plotted the monthly averages and high value for five parameters:

(1) pH
(2) Temperature
(3) BOD (also shows soluble where available)
(4) COD
(5) Suspended solids (includes % volatiles).

For concept design, we used the geometric mean of the monthly averages for BOD and SS. These values are 260 mg/l and 240 mg/l respectively. This information has already been given to Jerry Poradek in Houston.

We have computed sludge volumes for 3 concentrations:

(1) 1000 gals/day mixed primary and secondary at 3.2%
(2) 1600 gals/day mixed at 2%
(3) 2000 gals/day mixed at 1.6%.

We anticipate that the achievable concentration of mixed sludge will be between 2% and 3% prior to centrifuging. Conservatively, 10% to 12% sludge should be achieved from the centrifuge. The sludge volume delivered to the incinerator would then be, assuming 10%, 250 gallons/day. This would be introduced at the rate of 25 gallons/hour, based on 10 hour incinerator operation.

With the small volume of sludge generated, we do not recommend any further de-watering prior to incineration. It is our opinion that the additional cost required for thermal dewatering equipment is not justified. In addition, the mixed sludge will have an opportunity to settle prior to centrifuging (which is proposed as a batch operation) and thus the feed to the centrifuge, and the sludge from the centrifuge will be a higher percentage solids than assumed here.

As regards the matter of equipment specifications, we will as discussed by phone with you, respond to your marked comments on the information already transmitted.

Yours sincerely,

Ian C. Watson
Project Manager

bb
enc. Calculation sheets 5 of 5
Charts of influent quality (5)

cc: Bill Reeves, ILA
Ed Young, Hamilton-Standard

JOB

DESCRIPTION RDC Calcs. ST. Charles.

GEOMETRIC MEAN VALUE OF TOTAL SUSPENDED SOLIDS FROM CHARLES CCC DATA $= \sqrt[12]{3.9246022 \times 10^{28}}$

$= \underline{240 \text{ mg/l}}$

$12 \overline{)28.59395}$
2.38283

GEOMETRIC MEAN VALUE OF TOTAL BOD

$= \sqrt[12]{8.2725 \times 10^{28}}$

$= 256$

$\simeq 260 \text{ mg/l}$

$12 \overline{)28.9178}$
2.4098

USING THESE FIGURES AS DESIGN VALUES, WE HAVE THE FOLLOWING:

IN THE ROTOSTRAINERS, ASSUME 25% SUSPENDED SOLIDS REMOVAL, AND 25% TOTAL BOD_5 REMOVAL

∴ FEED TO BIODISC UNITS =

$240 \times .75$ mg/l S.S. = $\underline{180 \text{ mg/l}}$

$260 \times .75$ mg/l BOD_5 = $\underline{195 \text{ mg/l}}$

BIODISC SIZE FROM DESIGN MANUAL TO ACHIEVE AN EFFLUENT OF 10 mg/l BOD WE NEED A $\frac{185}{195} \times 100\%$ REMOVAL = 93.4%.

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JOB

DESCRIPTION RDC. CAlcs. ST. CHARles

FROM THE DESIGN CURVES, HYDRAULIC LOADING SHOULD BE 1.7 gpd/ft^2 of MEDIA.

LET US SIZE EACH UNIT FOR 2/3 TOTAL FLOW
= 133,400 gpd

∴ No of SQUARE FEET REQUIRED $= \frac{133,400}{1.7} = 78,470$

∴ REQUIRED = 2 4 STAGE SINGLE SHAFTS 25-4
84,000 sqft/shaft.

NORMAL OPERATION

1/2 flow is TREATED IN EACH DISC UNIT.

∴ HYDRAULIC LOADING IS $\frac{100,000}{84,000} = 1.19$ gpd/ft^2

THEORETICAL BOD IN EFFLUENT, FROM DESIGN CURVES =
195 x .05 = 9.75 mg/l.

1 DISC TAKING FULL FLOW

HYDRAULIC LOADING $= \frac{200,000}{84,000} = 2.38$ gpd/ft^2

REMOVAL ≙ 91% = 195 x .08 = 15.6 mg/l
IN EFFLUENT.

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JOB

DESCRIPTION RDC. Calcs. ST. Charles.

WORST CASE

BOD = 355 mg/l

25% REMOVAL IN ROTOSTRAINER

∴ FEED TO RDC = 355 x 0.75 mg/l

= 266.25 mg/l

Hydraulic Loading = $\frac{100,000 \text{ gpd}}{84,000 \text{ ft}^2}$ = 1.19 gpd/ft²

FROM DESIGN CURVES, BOD REMOVAL = 96%

∴ EFFLUENT BOD = 266.25 x 0.04

= 10.65 mg/l

∴ EQUIPMENT will HANDLE THE WORST CASE WITH BOTH BANKS OPERATING

if 1 BANK is DOWN

Hydraulic Loading = 2.38 gpd/ft²

BOD REMOVAL = 92.5%

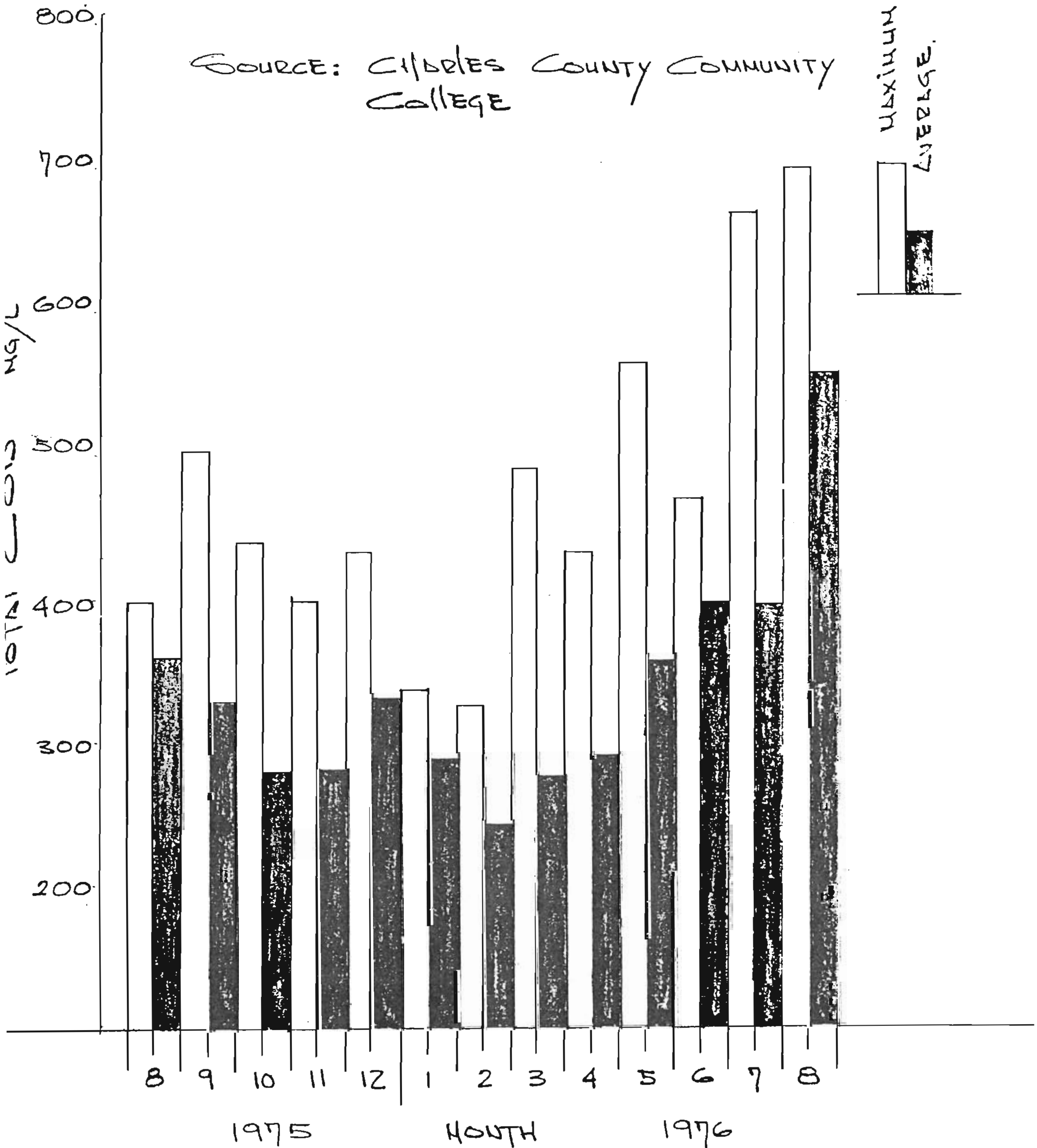
∴ EFFLUENT BOD = 266.25 x 0.075

= 19.97 mg/l

THIS IS less THAN STATE BOD limit for SPRAY DISPOSAL.

JOB

DESCRIPTION ST. CHARLES SEWAGE - ANNUAL VALUES



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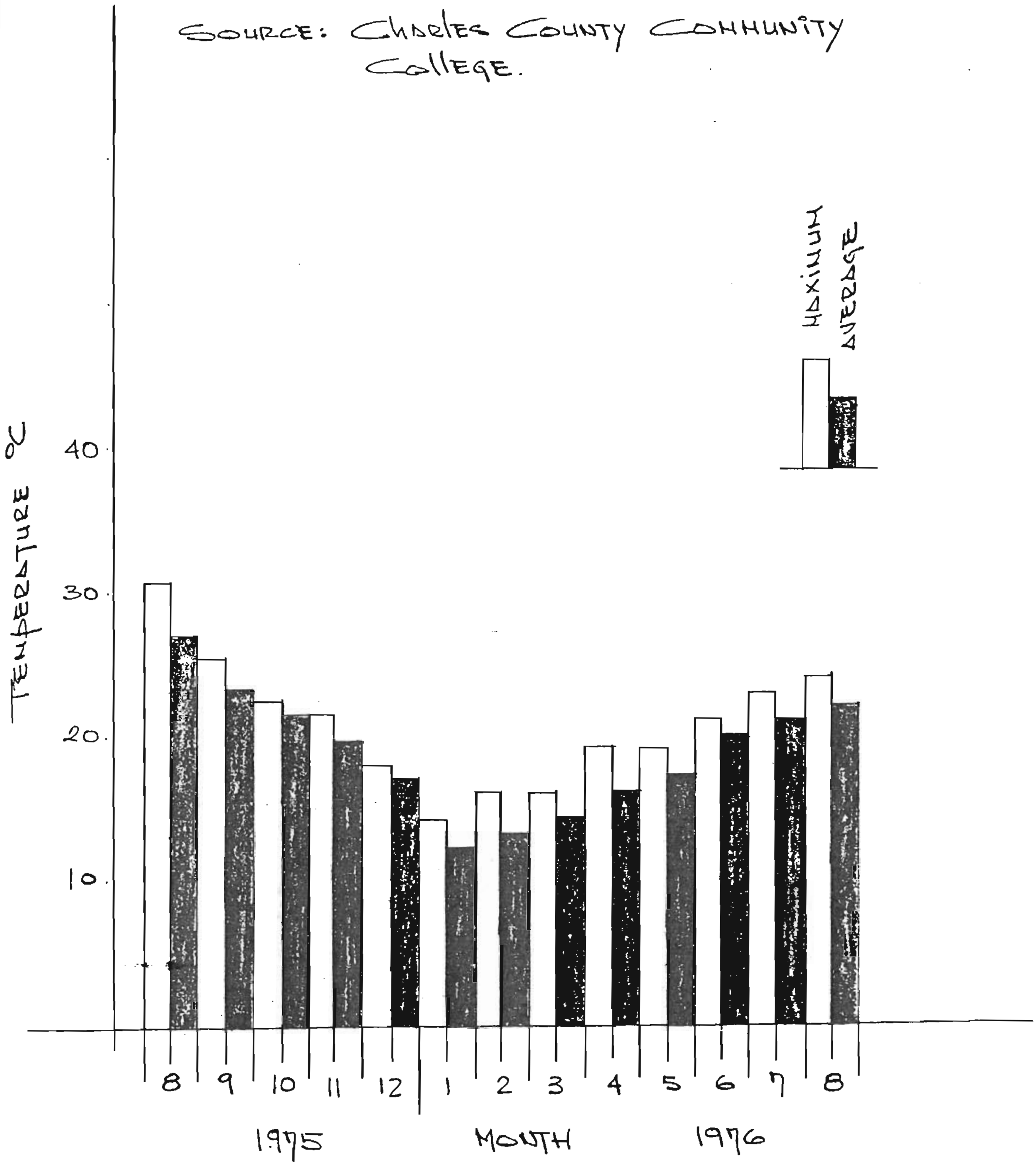
DESCRIPTION ST. Charles Sewage. - Annual Values



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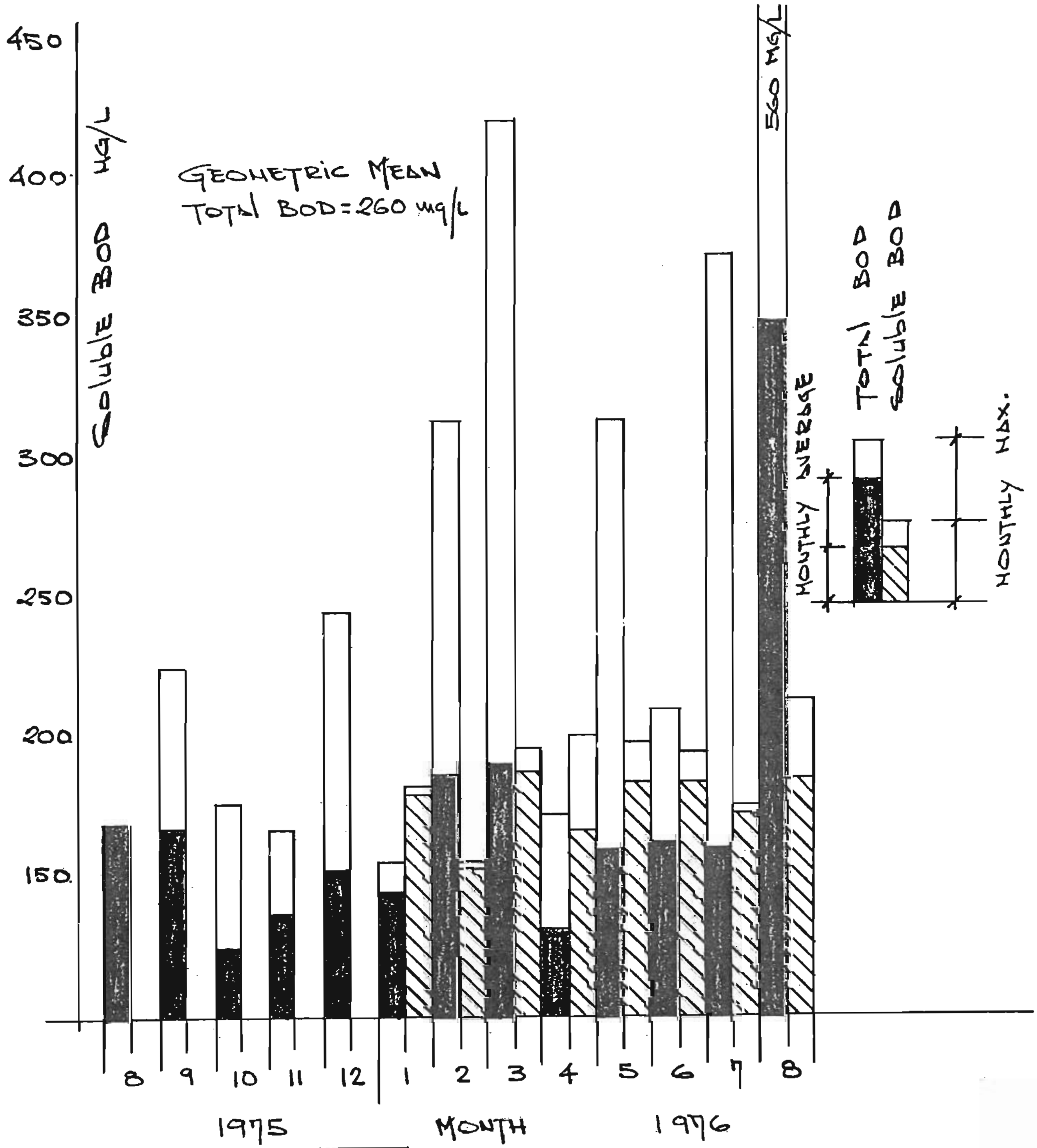
DESCRIPTION ST. Charles Sewage - Annual Values



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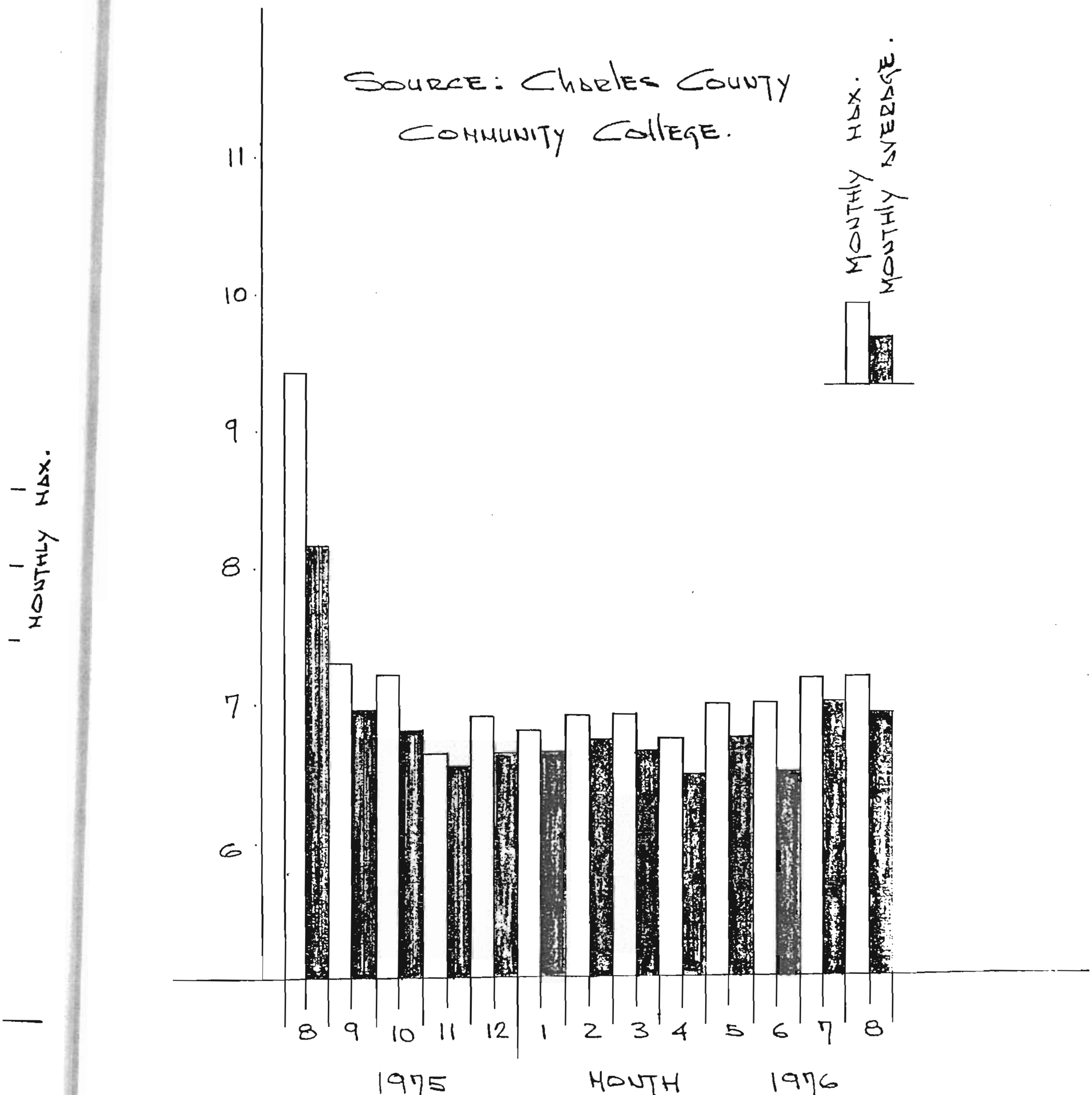
DESCRIPTION ST. Charles Sewage - Annual Values



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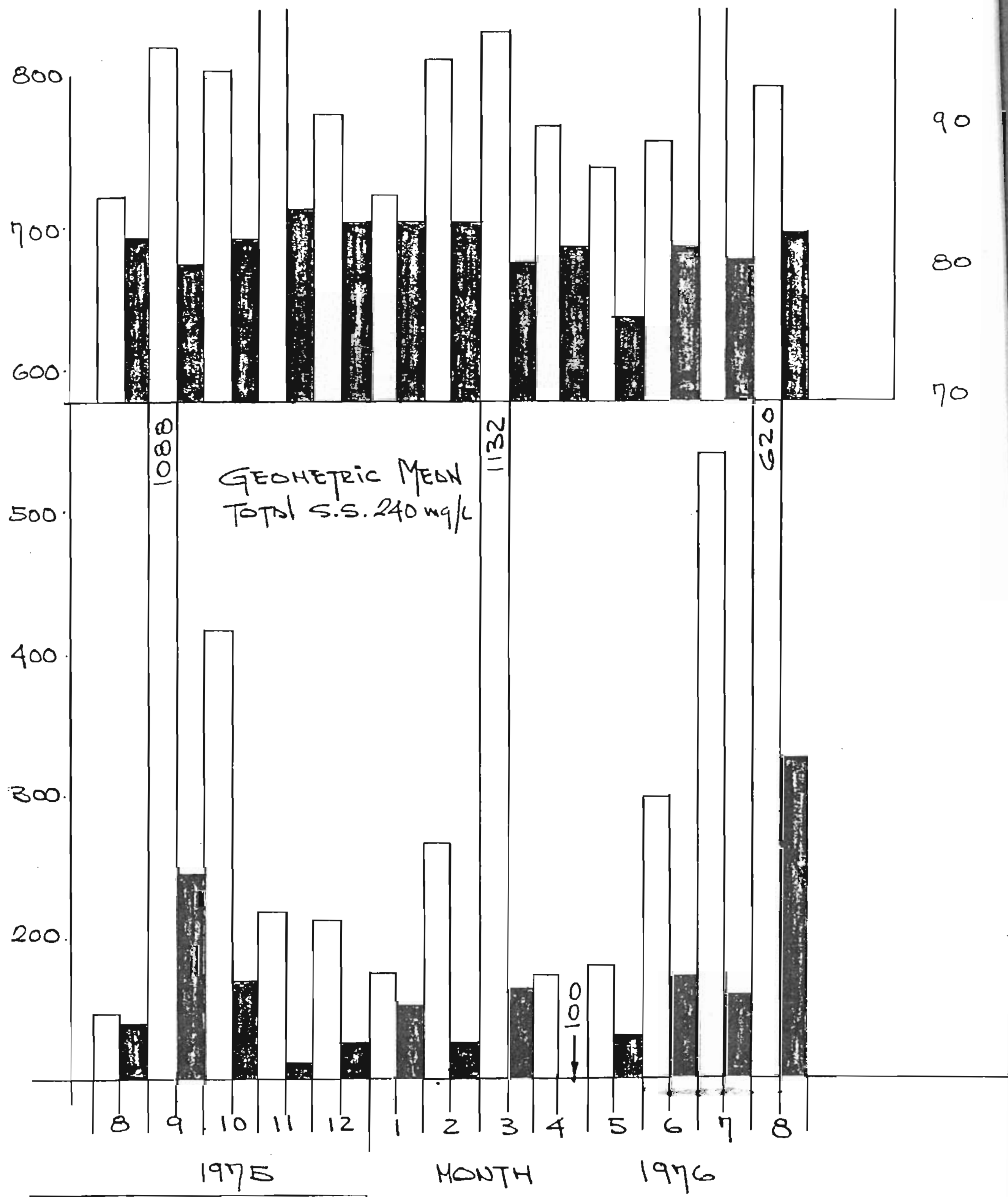

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APPENDIX C - ENERGY ANALYSIS

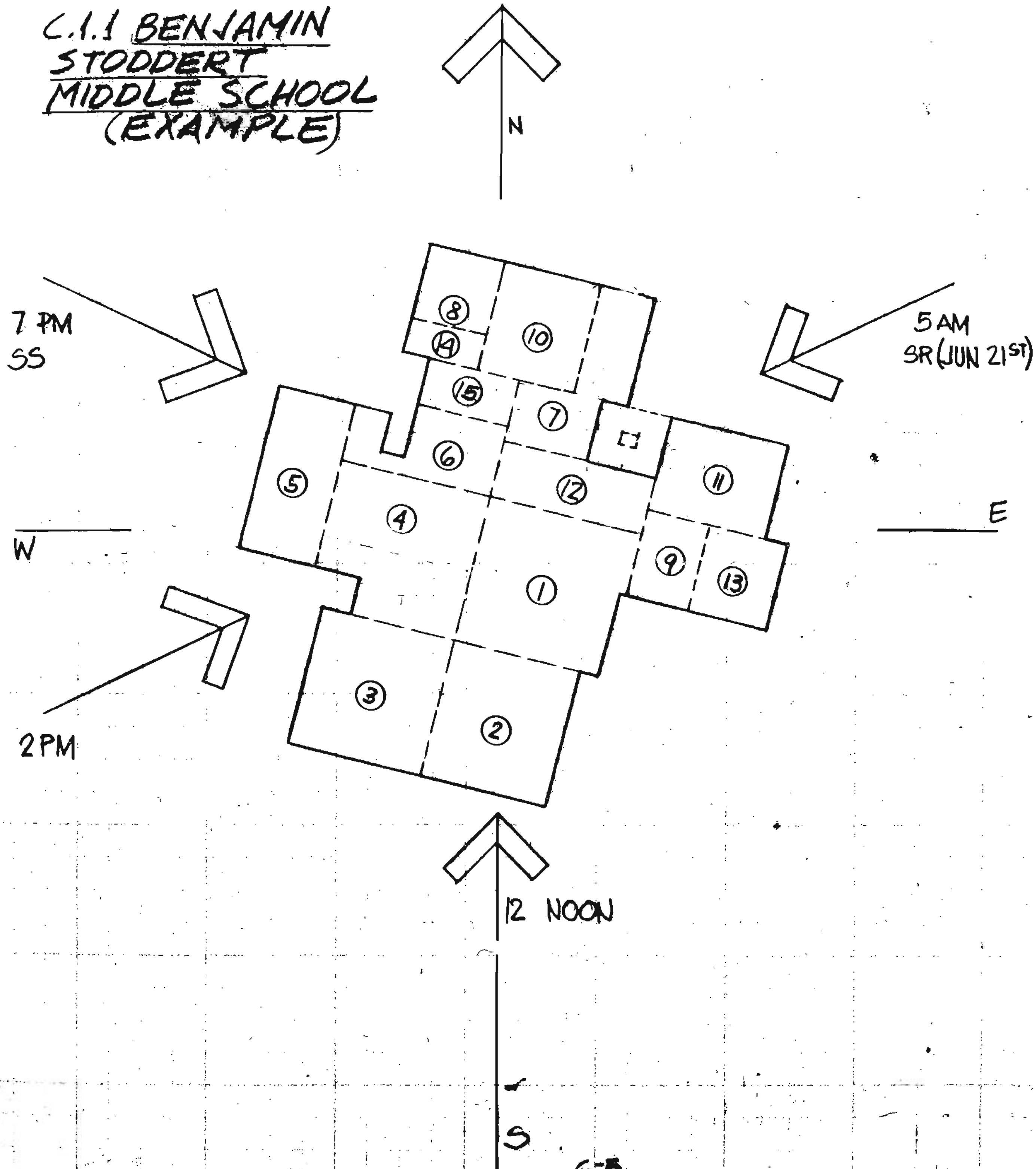
C.1 Examples of Heat Loss/Heat Gain Calculations

- School

Project MIUS - ST. CHARLES Structure BENJAMIN STODDERT MIDDLE SCHOOL

For

C.1.1 BENJAMIN STODDERT MIDDLE SCHOOL (EXAMPLE)



Project MIUS – ST. CHARLES Structure SCHOOL

For

NET FLOOR AREA TAKEOFF

ZONE 1: EDUCATIONAL POD #1	10,370	SF
ZONE 2: " POD #2	10,400	
ZONE 3: " POD #3	10,400	
ZONE 4: INST. MEDIA, MULTI-MED. + EL. CLASSR.	9,300	
ZONE 5: HOME ECON. + INDUSTR. ARTS	8,000	
ZONE 6: ART	3,800	
ZONE 7: COMMONS + CHORAL MUSIC	7,440	
ZONE 8: KITCHEN	3,120	
ZONE 9: LOCKER	3,140	
ZONE 10: CAFETERIA – STAGE	7,010	
ZONE 11: GYMNASIUM	8,740	
ZONE 12: ADMINISTRATION	5,300	
ZONE 13: AUX GYMNASIUM	4,200	
ZONE 14: LOUNGE	1,000	
ZONE 15: MECHANICAL ROOM	2,280	
TOTAL BUILDING NET FLOOR AREA =	94,500	SF*

* 10,000 SF FUTURE POD NOT INCLUDED

Project MILLS-ST. CHARLES Structure SCHOOL

For

GROSS WALL AREA TAKE-OFF - SF

ZONE	N	E	S	W	SLAB EDGE-F
1	—	900	360	—	84
2	—	1560	1500	—	204
3	—	—	1500	1560	108
4	—	—	330	423	46
5	990	—	840	1860	246
6	—	—	—	540	30
7	970	2100**	180	—	186
8	810	—	—	840	110
9	—	—	735	—	50
10	1230	—	—	—	85
11	2400*	1920	—	1150*	230
12	225	—	—	—	15
13	—	1140	931	—	110
14	—	—	300	390	36
15	—	—	—	—	0
TOTAL	6625	7620	6675	6763	1540

* 100% SHADED WALL

** 34% SHADED WALL

Project MIUS - ST. CHARLES Structure SCHOOL

For

EQUIPMENT TAKE-OFF

ZONE	TAG	HEATING MBH	COOLING MBH	CFM	HP	KW	OA
1	AHU-1	349	396	11,430	10.5	12	2143
	EF-10			940*	0.17	0.18	
	CH-1	28.6		150	0.1	0.1	
2	AHU-2	362	404	11,670	10.5	12	2188
	CH-2	26.3		150	0.1	0.1	
	EF-7			900*	0.17	0.18	
	EF-16			1920*	0.33	0.35	
3	AHU-3	362	404	11,670	10.5	12	2188
	CH-2	26.3		150	0.1	0.1	
	CH-2	26.3		150	0.1	0.1	
4	AHU-4	320	368	10,610	10.5	12	1989
	CH-1	28.6		150	0.1	0.1	
	FT	16.8					
	EF-9			900*	0.25	0.27	
5	AHU-5	337	329	9200	10.5	12.0	2169
	FT	13.4					
	CH-1	28.6		150	0.1	0.1	
	EF-17			1820*	0.5	0.53	
	EF-18			1820*	0.5	0.53	
	EF-19			940*	0.13	0.13	
	EF-21			1820	0.5	0.53	
6	AHU-6	10	135	3900	3	3.2	919
	UH-1	27.4		815	0.1	0.1	
	UH-2	15.0		591	0.1	0.1	
	FT	25.3					
	EF-14			1305*	0.25	0.27	
	EF-20			940	0.17	0.18	
7	AHU-7	323	332	9600	10.5	12	1800
	CH-1	28.6		150			
	CH-1	28.6		150			
	CH-1	28.6	4-10	150			
	FT	7.7					

Project MIUS - ST. CHARLES   Structure SCHOOL

For   KW SHOULD BE 136 LESS

ZONE	TAG	HEATING MBH	COOLING MBH	CFM	HP	KW	OA
8	AHU-8	604	—	12,600	10	10.6	8325
	EF-1			9,800*	2	2.1	
	EF-2			9,800*	2	2.1	
	EF-4			1000*	.17	.18	
	EF-12			250*	—	—	
	FT	18.7					
	FF-1			2530*	0.33	0.35	
	FF-2			2530*	0.33	0.35	
9	AHU-9	195	—	4400	5	5.3	1650
	EF-8			4400	0.75	0.80	
	FT	4.4					
10	AHU-10	276	348	10,060	9.5	10.1	1868
	CH-1	28.6		150	0.1	0.1	
11	AHU-11	550	429	9000	12.5	13.3	4821
12	AHU-12	167	148	4290	5	5.3	797
	CH-1	28.6		150	0.1	0.1	
	CH-1	28.6		150	0.1	0.1	
	EF-6			900*	0.17	0.18	
13	AHU-13	164	185	5170	5	5.3	1108
	CH-2	26.3		150	0.1	0.1	
	FT	8.8					
14	EF-3			1265*	0.3	0.35	
	EF-11			1000*	0.17	0.18	
	UV-1	51	63	1835	0.2	0.2	344
15	EF-13			150*	0.03	0.03	
	CP-1A				15	16	
	CP-1B				15	16	
	CP-2				5	5.3	
	CP-3				15	16	
	CP-4				0.75	0.8	
	CP-5			SUPPLY	0.33	0.35	
	CP-6		<11	AIR	0.37	0.40	
TOTAL		4670	3541	118,800*	175	191	32,300

*EXHAUST FAN CFM NOT INCLUDED IN HVAC CFM   195

Project MIUS - ST. CHARLES Structure

For

OUTDOOR AIR (VENTILATION) TAKE-OFF

$$CFM_{OA} = \frac{(72\ ^\circ F - EA\ ^\circ F)(CFM_{SA})}{56\ ^\circ F}$$

AHU	EA(°F)	CFM_{SA}	CFM_{OA}	%
1	61.5	11,430	2143	19
2	"	11,670	2188	19
3	"	11,670	2188	19
4	"	10,610	1989	19
5	58.8	9,200	2169	24
6	"	3,900	919	24
7	61.5	9,600	1800	19
8	35	12,600	8325	66
9	"	4,400	1650	38
10	61.6	10,060	1868	19
11	42	9,000	4821	54
12	61.6	4,290	797	19
13	60	5,170	1108	21
14	61.5	1,835	344	19
TOTAL			32,300	

Project MIUS-ST. CHARLES Structure

For SCHOOL

SLAB EDGE LOSS 45 BTU/H.FT.

SOLAR HEAT GAIN - GLASS BTU/H. FT²

JUNE 21ST 40°N LAT.	N	E	S	W
2:00 PM	35	35	69	145

WITH SHADING COEFF. = 0.8

JUNE 21ST	N	E	S	W
2:00 PM	28	28	55	116

SOLAR HEAT GAIN - WALL

U = 0.10 GROUP "C" DARK

TOTAL EQUIV. TEMP. DIFF. (TETD)

	N	E	S	W
2:00 PM	14	40	22	14

SOLAR HEAT GAIN - ROOF

U = 0.12 (MEDIUM CONSTRUCTION - DARK)

TOTAL EQUIV. TEMP. DIFF. (TETD)

	HORIZ.	C-13
2:00 PM	237	

Project MIUS – ST. CHARLES Structure
For SCHOOL

VENTILATION HEAT GAIN

TOTAL HEAT GAIN: $THG = \dot{m} \times \Delta h = \frac{32,300 \times 60 \times 12.5}{13.5}$

$= 1,794,440$ BTU/HR

SENS. HEAT GAIN: $SHG = \dot{m} \times C_p \cdot \Delta t = \frac{32,300 \times 60 \times 0.24 \times 39}{13.5}$

$= 1343,680$ BTU/HR

LAT. HEAT GAIN: THG – SHG $= 450,760$ BTU/HR

VENTILATION HEAT LOSS

TOTAL HEAT LOSS: $THL = \dot{m} \times C_p \cdot \Delta t = \frac{32,300 \times 60 \times 0.24 \times 56}{13}$

$= 2,003,590$ BTU/HR

Project MIUS - ST. CHARLES   Structure SCHOOL

For

DESCRIPTIVE BUILDING DATA SUMMARY

GROSS SF/FLOOR ______ 94,500 SF

OCCUPANCY ______ 900

	N	E	S	W	TOTA
GROSS WALL AREA (SF)	6625	7620	6675	6763	27,68
GLASS AREA (SF)	268	429	246	681	1,62
NET WALL AREA * (SF)	6357	7191	6429	6082	26,0
% GLASS	4	6	4	10	6

HEATING (PEAK) 32.6 BTU/H G.SF
COOLING (PEAK) 43.1 BTU/H G.SF
ELECTRICAL (PEAK) 4.6 W/G.SF

BUILDING MASS ESTIMATE FOR THERMAL INERTIA FACTOR

ROOF 65 LB/SF
EXTERIOR WALL 65 LB/SF
INTERIOR WALL 50 LB/SF
FLOOR 65 LB/SF

* INCLUDING DOORS

Project MIUS - ST. CHARLES Structure SCHOOL

For

BUILDING MASS SUMMATION

ITEM	DIMENSION	PER UNIT MASS	LOAD (KIPS)
ROOF	94,500 SF	30 LB/SF	2835
EXTERIOR WALL	27,680 "	100	2770
INTERIOR WALL	45,000 "	50	2250
FLOOR	94,500 "	65	6140
TOTAL			13,995 KIPS

BUILDING MASS PER GROSS SF FLOOR AREA =

$$\frac{13,995,000}{94,500} = 148 \text{ LB/SF}$$

Project .... Structure ....

For ....

THERMAL INERTIA FACTORS

W - 148 LB/SF
12-HOUR EQUIPMENT OPERATION
GLASS RATIO - 6%
TEMP. SWING - 2°F
JUNE 21ST, 40°N LATITUDE, 2:00PM

TEMP. SWING REDUCTION -

94,500 SF x 2°F TEMP. SWING x 0.85 BTU/H °F SF = 161 MB[H]

GLASS SOLAR HEAT GAIN REDUCTION =

DIR.	A_G		SHGF		$F_{STORAGE}$	REDUCTION
N	268	x	28	x	(1-0.98)	150
E	429		28		(1-0.24)	9130
S	246		55		(1-0.77)	3110
W	681		116		(1-0.44)	44,240
TOTAL						56,630

= 57. MBH

TOTAL THERMAL INERTIA REDUCTION FROM PEAK COOLING = 161 + 57 = 218 MBH = 18.2 TONS

MIUS- ST. CHARLES

SCHOOL

EQUIVALENT GLASS CALCULATION & % FOR COMPUTER INPUT

% = EFFECTIVE STANDARD GLASS AREA FOR DIRECTION / TOTAL EFFECTIVE STANDARD GLASS AREA

EFFECTIVE STAND. GLASS AREA = WALL, ROOF OR GLASS SOLAR LOAD / SHGF FOR THAT DIRECTION

GLASS:	FT²	S.C.	(SHGF)	MBH LOAD	STD. FT²	%
N	—	.8	28	—	—	—
E	—	"	28	—	—	—
S	246	"	55	10.82	196.7	4.6
W	681	"	116	63.20	544.8	12.6
SHADED GLASS:						
N	268	"	28	6.00	216.1	5.0
E	429	"	28	9.61	343.9	8.0
S	-	"	55	—	—	—
W	—	"	116	—	—	-
WALL:		U	Atsol (SHGF)			
N	6357	0.1	— (28)	—		—
E	7191	"	21 (28)	15.1	539.3	12.5
S	6429	"	3 (55)	1.93	35.1	0.8
W	6082	"	— (116)	—	—	—
ROOF:	94,500	0.12	51 (237)	578.34	2440	56.5
					4315.9	100.0

N	: 5.0 %	5
E	: 20.5 %	20
S	: 5.4 %	5
W	: 12.6 %	13
R	: 56.5 %	57
	100.	

Project MILLS-ST. CHARLES Structure SCHOOL

HEAT GAIN & LOSS SUMMARY SHEET

WINTER LOAD

			QUANTITY (FT²)	U (BTU / H-FT²-°F)		ΔT (°F)	UΔT	TRANS LOAD (MBH)	INFILT LOAD (MBH)	VENT. LOAD (MBH)
1	WALL	N	6357	0.10		56	5.6	35.6		
2	"	E	7191	"		"	"	40.3		
3	"	S	6429	"		"	"	36.0		
4	"	W	6082	"		"	"	34.1		
5	GLASS	N	—	WINTER 1.13	SUMMER 1.06	"	63.3	—		
6	"	E	—	"		"	"	—		
7	"	S	246	"		"	"	15.6		
8	"	W	681	"		"	"	43.1		
9	SHADED GLASS	N	268	"		"	"	17.0		
10	"	E	429	"		"	"	27.2		
11	"	S	—	"		"	"	—		
12	"	W	—	1.13	1.06	"	"	—		
13	ROOF		94,500	0.14	0.12	56	7.8	740.9		
14	GRADE SLAB EDGE		1920 FT	45 BTU/H.FT		—	—	86.4		
15	ELECTRICAL HVAC									
16	ELECTRICAL LIGHTS									
17	PEOPLE		900	(250/250)						
18										
19	VENTILATION (OUTS. AIR)		32,300 CFM							2,003
20										
21										
22										
23	TOTALS							1076.2	0.	2,003

Project MILLS - ST. CHARLES Structure

For HEAT GAIN & LOSS SUMMARY SHEET

SUMMER LOAD

	TRANS ΔT °F	TRANS UAT	SUMMER TRANS LOAD MBH	SOLAR TETD °F	SOLAR UAT	TOTAL LOAD (WALL & ROOF) MBH	SOLAR LOAD (4 - 2) MBH	SHGF (GLASS) BTU/H-FT²	GLASS SOLAR LOAD MBH
1	19	1.9	12.01	19	1.9	12.10			
2	"	"	13.66	40	4.0	28.76	15.10		
3	"	"	12.22	22	2.2	14.14	1.92		
4	"	"	11.56	19	1.9	11.56			
5	"	20.14						28	
6	"	"						28	
7	"	"	4.95					55	13.53
8	"	"	13.72					116	79.0
9	"	"	5.40					28	7.5
10	"	"	8.64					"	12.01
11	"	"						"	
12	"	20.14						"	
13	19	2.28	215.46	70	8.4	793.8	578.3		
23			297.62			860.36	595.32		112.04

Project MILLS - ST. CHARLES Structure SCHOOL

For HEAT GAIN & LOSS SUMMARY SHEET

	1	2		3		4		5		6		
	TOTAL GLASS LOAD	INFILTRATION		VENTILATION		PEOPLE		ELECTRICAL		CLG. CAPAC.		HTG.
		SENS.	LAT.	SENS.	LAT.	SENS.	LAT.	KW	MBH	SENS.	LAT.	
	MBH	MBH	MBH	MBH	MBH	MBH	MBH			MBH	MBH	ME
1										12.10		35.
2										28.76		40.
3										14.14		36.
4										11.56		34.
5												
6												
7	18.48									18.48		15.
8	92.72									92.72		43.
9	12.90									12.90		17.
10	20.65									20.65		27.
11												
12												
13										79.38		740
14												86.
15								191	651			
16								240	820	820		
17						225	225			225	225	
18												
19				1,343.7	450.8					1,343.7	450.8	2,00
20												
21												
22												
23	144.75	0	0	1,343.7	450.8	225	225	431	1,471	3,394.	675.8	3,08
24												
25												
26												
27												
28												
29												
30												

C21/C22

C21/C22

C.2 Calculation Samples for Energy Consumption

Project MIUS - ST. CHARLES Structure WAKEFIELD TERRACE APT'S

For

TOTAL YEARLY ENERGY CONSUMPTION (SAMPLE)

1. HEATING

ENERGY CONSUMPTION COMPUTED BY THE ASHRAE DEGREE - DAY METHOD : FORMULA AND CONSTANTS DEFINED IN ASHRAE 1976 SYSTEMS HANDBOOK (CHAPTER 43.E

$$E = \left(\frac{H_L \times D \times 24}{\Delta t \times \eta} \right) (C_D)(C_F)$$

$$E = \frac{3.46 \times 10^6 \times 4224 \times 24}{54 \times 1} (0.79)(1.36)$$

$$E = 6{,}979 \times 10^6 \text{ BTU / YEAR}$$

C-25

Project MIUS - ST. CHARLES Structure WAKEFIELD TERRACE

For

2. DOMESTIC HOT WATER (SAMPLE)

ASSUMPTION USED TO COMPUTE D.H.W ENERGY CONSUMPTION OBTAINED FROM ELECTRIC UTILITY DATA:

ENERGY FOR D.H.W USE IN MEDIUM SIZED APARTMENT BUILDINGS : 4870 KWH/DU YEAR

$$E = 4870 \times 204 \times 3413$$

$$E = 3,390 \times 10^6 \text{ BTU / YEAR}$$

Project MIUS-ST. CHARLES   Structure WAKEFIELD TERRACE

For

3. COOLING (SAMPLE)

ENERGY CONSUMPTION FOR COOLING IN MEDIUM SIZED APARTMENT BUILDINGS :

2050 TONH/DU YEA

$$E = 2050 \times 204$$

$$E = 418{,}000 \text{ TONH}$$

Project MIUS - ST. CHARLES Structure WAKEFIELD HIGH RISE

For

4. HEATING (SAMPLE)

ENERGY CONSUMPTION COMPUTED BY THE ASHRAE DEGREE-DAY METHOD: *

$$E = \left(\frac{H_L \times D \times 24}{\Delta t \times \eta} \right) (C_D)(C_F)$$

$$E = \frac{2.00 \times 10^6 \times 4224 \times 24}{54 \times 1.0} (0.79)(1.36)$$

$$E = 4{,}034 \times 10^6 \text{ BTU/YEAR}$$

* FORMULA AND CONSTANTS DEFINED IN ASHRAE 1976 SYSTEMS HANDBOOK, CHAPTER 43.8

5 DOMESTIC HOT WATER (SAMPLE)

ASSUMPTION USED TO COMPUTE D.H.W ENERGY CONSUMPTION OBTAINED FROM ELECTRIC UTILITY DATA:

ENERGY FOR D.H.W. USE IN MEDIUM SIZED APARTMENT BUILDINGS : 4870 KWH/DU YEAR

$$E = 4870 \times 106 \times 3413$$

$$E = 1{,}762 \times 10^6 \text{ BTU / YEAR}$$

Project MIUS - ST. CHARLES   Structure WAKEFIELD HIGH-RISE.

For

6. COOLING (SAMPLE)

ENERGY CONSUMPTION FOR COOLING IN MEDIUM SIZED HIGH-RISE APARTMENT BUILDINGS:

2290 TONH/DU YEAR

E = 2290 x 106

E = 243,000 TONH

C.3 Thermal Tracking Energy Analysis

C.3.1 Hourly Weather Data Printout and Daily/Monthly Averages

DUMP OF WEATHER DATA FOR   WEATEHER DATA FOR WASHINGTON DC • TYPICAL YEAR ******************************

30	30	29	32	33	32	32	31	35	41	47	50	53	56	58	60	58	54	52	52	51	48	43	420	1	DB
16	19	19	20	20	19	16	14	17	18	20	21	22	23	25	16	16	19	20	21	19	21	33	300	1	DP
0	1	0	7	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	00	1	CC
37	34	34	33	31	31	30	30	33	40	45	49	52	54	54	56	53	49	47	47	43	43	43	430	2	DB
26	25	23	24	25	28	24	24	25	27	29	31	32	32	32	34	36	37	38	39	37	36	31	290	2	DP
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0D	2	CC
45	44	45	45	43	45	44	44	44	46	47	47	47	48	48	47	47	45	44	43	42	41	40	390	3	DB
28	29	28	31	32	32	35	35	36	35	36	37	41	42	35	33	31	28	27	28	28	25	26	260	3	DP
8	0	7	8	9	10	10	9	8	8	9	10	10	8	10	9	6	9	4	5	2	0	0	CD	3	CC
38	38	36	36	36	36	35	35	35	36	38	39	40	42	42	43	42	40	38	37	35	33	32	310	4	DB
26	25	27	27	25	25	25	25	25	25	24	26	26	27	26	27	26	25	24	26	25	24	27	270	4	DP
0	0	0	3	10	10	10	7	0	0	0	0	0	0	0	0	1	1	0	0	0	0	2	3D	4	CC
30	30	30	29	30	31	31	31	32	33	38	39	41	44	47	48	47	45	39	39	39	38	37	370	5	DB
27	27	27	27	27	28	28	28	29	30	33	32	32	34	35	35	36	36	33	33	33	34	35	340	5	DP
3	3	2	1	0	0	4	10	10	6	4	10	10	5	10	10	10	10	10	10	10	10	10	100	5	CC
37	36	35	34	34	33	33	33	34	36	37	39	39	40	40	40	39	38	37	36	34	32	32	330	6	DB
32	31	29	27	25	24	25	25	29	26	23	19	19	20	20	19	20	19	20	20	23	22	19	180	6	DP
10	10	3	1	0	0	0	2	1	1	1	3	3	4	5	6	4	7	8	8	10	3	4	8D	6	CC
34	36	36	35	36	35	34	33	34	35	37	38	42	41	43	42	41	39	38	37	37	36	35	350	7	DB
18	21	26	19	19	18	16	17	18	21	19	20	19	20	20	20	20	22	21	22	21	22	22	220	7	DP
10	10	10	9	10	9	8	6	6	10	3	3	3	1	1	0	0	0	0	0	0	0	2	8D	7	CC
35	34	33	33	32	30	29	31	33	34	36	38	39	40	41	42	40	40	39	34	34	34	33	330	8	DB
22	22	21	20	19	20	20	21	22	20	19	20	18	18	17	15	15	17	18	22	22	21	22	210	8	DP
2	0	0	0	0	0	0	0	0	0	0	0	1	3	1	2	5	7	1	0	0	0	0	0D	8	CC
32	32	31	31	30	31	33	33	33	38	44	47	49	51	53	54	54	50	49	47	46	48	47	460	9	DB
22	19	19	19	22	26	28	27	29	30	32	33	34	34	35	35	36	40	42	42	42	42	41	420	9	DP
3	2	6	4	4	9	6	7	2	5	6	5	10	10	4	10	10	10	10	10	10	10	6	100	9	CC
45	43	45	45	45	44	44	44	44	45	44	43	42	41	40	39	38	37	36	34	32	30	29	270	10	DB
42	41	41	43	42	41	42	42	42	43	42	41	38	38	36	35	34	35	34	32	30	28	27	250	10	DP
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	100	10	CC
26	25	24	23	23	23	22	22	21	21	21	22	23	23	23	23	23	23	23	23	23	23	24	240	11	DB
24	24	22	21	20	20	19	17	16	16	16	17	18	18	18	20	20	20	19	19	19	18	18	180	11	DP
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	9D	11	CC
23	22	20	18	17	17	18	26	26	27	27	27	27	27	26	26	24	23	22	21	21	21	21	210	12	DB
18	17	16	16	14	14	13	19	14	12	13	11	7	3	6	6	9	8	8	7	8	6	7	8D	12	DP
6	1	0	0	0	0	4	0	0	0	0	5	3	4	4	4	1	0	0	0	0	0	0	0D	12	CC
21	20	19	18	17	17	16	16	17	19	22	23	23	24	24	26	24	22	21	19	19	19	18	18D	13	DB
4	4	4	4	5	5	4	4	5	7	8	11	8	6	6	6	7	7	10	10	12	11	11	120	13	DP
0	0	0	0	0	0	0	0	2	2	8	10	10	10	8	3	2	3	2	1	8	2	4	100	13	CC
19	19	21	22	23	23	24	24	25	26	27	29	31	32	31	30	29	29	30	30	31	32	32	320	14	DB
13	13	11	11	11	10	14	17	18	16	15	14	14	15	15	21	26	26	27	27	30	30	30	310	14	DP
2	8	6	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	100	14	CC
33	33	33	33	33	32	33	33	33	33	34	35	35	37	36	37	36	36	36	36	35	35	35	350	15	DB
31	31	32	32	31	32	31	31	31	32	32	31	32	32	33	33	34	33	33	33	33	33	34	330	15	DP
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	100	15	CC
34	34	34	34	34	34	34	34	35	35	36	39	40	42	43	43	43	42	40	41	40	39	39	400	16	DB
34	34	33	34	34	33	34	33	33	33	33	33	35	35	34	35	35	35	35	32	31	29	29	28D	16	DP
10	10	10	10	10	10	10	10	10	10	10	10	7	6	3	4	10	10	4	3	0	0	0	2D	16	CC
38	38	38	38	38	38	38	34	32	30	30	28	27	28	28	27	26	25	24	24	22	21	21	210	17	DB
29	29	29	27	27	27	26	26	19	15	15	16	14	14	10	7	9	8	9	8	8	10	8	9D	17	DP
10	9	8	10	10	10	10	10	9	3	7	10	6	6	2	1	1	0	0	0	0	0	0	0D	17	CC
20	20	20	18	17	16	16	16	18	20	24	26	28	31	34	34	35	34	34	34	34	34	35	36D	18	DB
10	5	3	4	5	7	8	6	8	6	9	9	9	9	11	14	15	17	21	22	24	24	24	250	18	DP
0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	7	7	4	4	3	1	1	2D	18	CC
36	37	36	36	34	33	33	32	34	37	40	44	46	49	51	53	52	49	46	44	42	41	42	420	19	DB
27	29	29	29	29	28	29	29	29	30	32	33	36	35	35	37	38	39	39	39	37	38	38	380	19	DP

DB = DRY BULB TEMPERATURE

DP = DEW POINT TEMPERATURE

CC = CLOUD COVER (10 = 100%)

41	41	41	41	40	39	39	40	41	42	47	55	54	57	58	60	60	59	60	60	60	60	59	59D	20	DB
39	39	39	38	38	39	39	40	41	42	47	54	54	56	56	57	58	57	57	57	56	57	57	57D	20	DP
10,	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	4	10	10	10	10	10	10D	20	CC
56	58	57	58	57	56	54	53	53	55	53	58	58	50	47	47	45	45	43	42	41	40	39	36D	21	DB
55	56	56	56	55	54	53	52	52	53	53	55	51	48	43	42	38	36	34	32	33	31	29	30D	21	DP
10	10	10	10	8	10	10	10	10	10	10	10	10	10	10	10	8	8	6	4	10	10	10	10D	21	CC
34	32	31	30	29	28	28	26	25	23	22	22	22	22	22	24	23	24	24	23	24	24	22	21D	22	DB
26	28	29	27	26	25	25	23	22	21	20	19	20	20	17	12	14	11	12	12	12	13	11	10D	22	DP
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	8D	22	CC
21	20	19	18	16	15	14	13	14	17	18	21	22	24	25	26	26	26	27	26	25	25	26	26D	23	DB
9	9	9	6	6	4	4	4	5	2	4	8	10	14	15	17	18	18	18	19	18	17	18	19D	23	DP
4	4	2	3	1	1	5	2	9	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10D	23	CC
26	26	27	27	27	27	27	28	28	29	30	33	32	33	34	36	36	35	35	35	35	35	34	34D	24	DB
18	18	21	20	21	22	22	22	22	23	24	25	25	28	29	28	28	29	30	30	30	30	30	30D	24	DP
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10D	24	CC
34	34	34	34	34	34	34	34	34	35	37	36	39	40	43	44	45	43	41	40	40	39	41	40D	25	DB
30	30	30	30	30	30	30	31	31	31	31	33	32	33	33	35	34	34	32	33	33	33	35	35D	25	DP
10	10	10	10	10	10	10	10	8	8	8	8	10	10	4	4	4	4	2	10	10	10	10	10D	25	CC
38	39	37	38	39	39	38	39	40	41	44	52	54	54	59	58	57	54	53	52	51	47	51	51D	26	DB
35	35	35	35	36	35	35	36	38	37	39	41	42	43	44	44	44	40	43	43	43	43	45	45D	26	DP
10	10	10	10	10	10	10	10	10	1	2	2	2	2	1	1	0	0	0	0	1	1	2	2D	26	CC
51	50	50	50	49	48	53	53	53	56	59	61	66	69	71	71	70	66	57	51	47	43	41	40D	27	DB
45	46	45	45	46	46	50	50	51	51	52	53	53	54	53	52	52	33	29	29	28	24	22	22D	27	DP
3	3	5	2	10	10	10	10	10	8	3	8	0	1	3	4	5	3	1	0	0	0	1	9D	27	CC
39	38	35	33	32	32	32	32	32	33	34	36	37	38	39	39	38	36	34	33	33	32	31	30D	28	DB
21	20	25	14	15	17	17	19	16	13	13	11	11	12	11	11	12	11	10	12	9	9	10	12D	28	DP
6	8	10	6	7	10	10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0D	28	CC
30	28	28	28	27	27	26	26	27	29	30	35	35	37	39	39	40	39	37	36	36	35	34	32D	29	DB
10	9	13	13	14	13	14	15	13	9	12	14	11	11	10	15	16	19	23	17	16	14	14	18D	29	DP
0	0	0	0	0	0	0	4	8	10	7	4	4	3	2	7	8	7	10	10	8	2	0	0D	29	CC
31	32	32	32	32	32	31	32	32	34	37	41	44	47	49	54	54	50	47	45	43	42	40	37D	30	DB
19	19	20	20	20	20	20	20	19	21	22	23	26	28	30	17	5	11	16	9	2	3	4	8D	30	DP
0	0	0	0	0	1	10	10	10	10	10	10	10	8	6	1	0	0	1	0	0	0	0	0D	30	CC
37	35	34	33	31	30	29	28	28	28	29	30	32	32	35	36	35	34	32	31	30	29	28	27D	31	DB
7	9	9	11	13	15	12	13	12	13	12	12	10	14	8	5	8	8	6	7	10	10	8	11D	31	DP
0	0	5	5	3	6	10	8	10	10	7	4	5	2	0	0	0	0	0	0	0	0	0	0D	31	CC
39	39	38	38	38	38	38	38	38	38	38	39	39	40	43	43	45	44	43	42	39	38	38	37D	32	DB
29	29	29	28	28	27	28	28	28	25	27	26	25	28	29	27	28	28	28	29	29	28	28	28D	32	DP
10	10	10	10	10	10	10	10	10	10	10	10	10	10	0	0	0	0	0	0	2	2	7	6D	32	CC
36	36	36	35	34	33	33	34	35	36	36	37	38	39	40	40	40	38	37	34	32	31	30	30D	33	DB
27	26	26	24	24	24	24	24	22	19	21	15	17	16	14	17	14	15	16	17	18	17	16	16D	33	DP
10	10	10	5	9	8	8	8	8	8	8	8	5	5	4	1	1	0	0	0	0	0	0	0D	33	CC
28	26	25	23	23	23	23	22	23	26	28	31	33	36	39	41	42	43	40	38	35	34	33	33D	34	DB
14	14	9	10	10	10	9	12	10	13	12	12	14	16	20	15	15	17	16	18	19	21	23	21D	34	DP
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0D	34	CC
32	31	31	31	29	28	28	28	30	32	38	42	45	47	49	51	52	51	49	45	44	42	41	40D	35	DB
20	21	21	21	21	21	20	20	20	22	22	20	21	18	20	23	23	22	23	24	23	20	25	23D	35	DP
0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	2	4	4	5	4	4	7	6	4D	35	CC
36	35	33	33	34	36	36	37	37	39	40	45	47	48	48	45	45	44	43	42	42	47	49	49D	36	DB
29	24	26	27	26	26	25	24	25	23	24	26	25	25	23	27	26	32	35	38	40	46	47	47D	36	DP
3	2	1	7	10	10	10	10	10	10	10	7	10	10	10	10	10	10	10	10	10	10	10	10D	36	CC
50	49	50	51	50	49	47	46	46	46	49	52	55	58	61	61	54	54	53	51	49	48	47	45D	37	DB
48	49	49	50	47	46	45	43	42	42	43	43	42	42	40	38	46	46	42	35	33	31	30	30D	37	DP
10	10	10	10	4	9	10	10	10	9	2	0	0	3	3	10	10	10	10	5	3	3	2	0D	37	CC
44	44	44	43	41	40	40	40	40	40	41	42	44	44	43	43	42	41	39	35	34	34	34	33D	38	DB
31	30	28	28	25	22	18	17	17	19	20	22	21	19	19	18	18	16	20	24	29	23	19	20D	38	DP
7	8	10	10	5	2	2	5	7	10	2	4	4	8	10	9	4	4	7	4	7	0	2	8D	38	CC
33	33	33	32	31	31	31	30	31	32	36	38	40	40	44	43	44	44	43	42	41	41	41	42D	39	DB
21	19	18	18	17	17	18	19	17	19	18	20	17	16	15	20	16	15	17	17	20	20	22	20D	39	DP
8	8	8	6	6	0	0	0	1	1	7	10	10	10	9	9	10	10	10	2	4	10	10	10D	39	CC

FEB

43	43	44	45	46	46	46	45	45	47	50	52	55	57	58	56	56	56	54	54	52	51	51	510	40	DB
20	21	23	24	25	26	25	28	29	28	29	31	31	33	35	34	36	37	37	37	37	37	37	380	40	DP
10	10	10	10	8	10	10	10	6	8	7	8	8	6	3	10	10	10	10	4	2	7	8	80	40	CC
51	55	54	55	54	55	53	55	54	54	57	60	61	63	66	68	67	63	62	61	57	56	55	550	41	DB
39	39	40	42	43	44	44	46	47	46	46	47	46	47	49	49	48	46	46	46	49	48	48	520	41	DP
8	8	8	9	10	10	10	10	7	7	8	7	9	9	9	10	10	10	10	10	10	10	10	100	41	CC
58	59	57	58	59	59	59	59	57	58	60	60	63	62	61	54	53	51	47	46	45	43	42	410	42	DB
55	55	55	56	56	56	56	56	53	55	55	53	45	42	41	35	34	33	29	29	27	24	22	210	42	DP
10	10	10	10	10	10	4	4	10	10	9	8	8	6	8	10	3	0	2	10	10	2	4	70	42	CC
40	39	38	36	36	36	35	35	35	35	36	37	38	40	41	42	43	41	40	38	36	34	33	320	43	DB
21	17	18	15	17	17	19	19	19	15	13	15	16	14	16	16	12	17	17	17	17	18	20	190	43	DP
6	2	2	2	7	8	5	8	8	4	4	3	2	1	0	0	1	2	1	0	0	0	3	40	43	CC
33	33	32	31	30	30	30	30	30	30	30	31	32	30	28	28	27	27	26	26	26	26	27	260	44	DB
18	20	19	20	15	15	15	15	15	15	17	15	18	25	26	27	27	26	25	25	25	25	26	260	44	DP
8	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	100	44	CC
27	26	26	26	25	23	23	22	23	24	24	25	25	26	27	30	30	29	28	28	28	28	27	270	45	DB
26	25	25	25	24	22	20	20	20	21	20	18	13	11	12	11	11	11	9	11	10	11	12	100	45	DP
10	10	10	10	10	10	10	10	10	10	10	9	10	10	7	3	7	6	2	1	1	2	4	20	45	CC
26	26	25	25	24	24	23	23	24	25	27	29	31	32	34	36	36	36	32	31	30	29	27	270	46	DB
9	9	8	8	6	6	5	5	7	12	13	15	17	16	16	18	12	13	15	17	17	18	19	200	46	DP
0	0	0	0	0	0	0	0	0	1	1	2	1	0	1	1	1	2	1	1	0	0	0	00	46	CC
26	24	24	23	21	20	20	20	23	28	34	39	41	42	41	42	42	41	40	38	37	35	36	360	47	DB
20	19	20	19	17	17	17	18	19	21	14	15	14	10	13	11	11	19	20	22	23	23	22	220	47	DP
0	0	0	0	0	0	1	1	2	4	2	1	5	6	8	7	4	3	3	4	3	8	8	100	47	CC
35	35	35	34	34	34	33	34	35	36	38	42	45	47	50	53	52	50	47	44	43	43	41	400	48	DB
23	26	25	25	25	25	26	26	25	25	24	23	24	21	25	27	28	27	27	27	27	28	28	290	48	DP
10	10	10	10	10	10	10	10	10	10	10	8	7	3	3	2	1	1	0	0	0	0	0	00	48	CC
38	36	34	34	33	33	33	33	34	37	39	43	46	47	48	45	44	43	43	43	44	45	45	440	49	DB
28	30	30	29	30	30	30	31	32	29	33	34	34	32	35	38	40	39	41	40	42	41	42	430	49	DP
0	0	0	0	2	2	2	4	8	8	10	10	10	10	10	10	10	10	10	10	10	10	10	100	49	CC
36	36	37	39	36	36	34	34	33	34.	32	34	33	34	34	33	31	31	30	29	28	28	28	300	50	DB
33	33	34	34	31	26	27	23	19	19	18	18	16	13	13	17	11	7	5	4	4	6	8	80	50	DP
10	10	10	10	10	8	4	5	5	2	2	4	2	1	0	0	1	2	3	3	1	2	3	10	50	CC
30	29	29	28	28	28	28	28	28	30	31	32	35	35	37	37	38	37	36	34	32	31	30	290	51	DB
9	11	12	11	12	11	12	12	12	11	14	14	16	15	16	18	15	17	24	17	18	17	16	170	51	DP
7	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	2	4	40	51	CC
29	29	28	28	27	27	27	27	28	29	30	31	32	33	34	35	35	35	35	36	36	31	31	300	52	DB
18	16	16	17	17	16	17	17	17	18	17	17	18	20	18	21	20	20	20	19	19	31	30	290	52	DP
5	3	0	0	0	0	0	2	5	10	10	10	10	10	10	10	10	10	10	10	10	10	10	100	52	CC
30	30	31	31	31	31	32	32	32	33	36	42	42	42	43	43	43	40	36	37	35	34	33	330	53	DB
29	29	28	29	30	31	31	32	32	30	24	26	26	24	16	10	11	15	17	17	20	21	20	200	53	DP
10	10	10	10	10	10	10	10	10	10	5	5	10	7	2	0	0	0	1	0	0	0	0	00	53	CC
32	31	31	31	31	31	31	30	31	32	35	37	39	40	42	44	42	41	40	38	36	35	34	330	54	DB
20	20	20	20	21	20	20	19	19	18	19	18	19	16	20	18	21	19	18	20	18	20	20	200	54	DP
0	0	4	2	3	5	3	4	6	5	3	1	1	1	0	0	0	1	1	1	1	1	1	10	54	CC
32	32	31	31	30	30	28	28	31	34	35	37	38	40	41	42	42	42	42	42	41	40	39	370	55	DB
20	20	20	20	19	18	18	19	19	18	19	21	20	22	19	19	20	19	20	20	22	22	21	230	55	DP
0	0	0	0	0	0	0	3	4	5	10	10	7	10	10	10	10	5	10	10	10	10	10	100	55	CC
37	37	37	36	35	36	36	34	35	33	32	32	33	35	36	37	38	38	40	42	43	44	44	430	56	DB
25	24	25	25	26	25	25	28	26	30	32	31	32	32	33	34	35	37	39	40	42	43	43	410	56	DP
10	10	10	4	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	100	56	CC
43	41	40	39	37	37	37	36	38	38	40	43	44	46	46	46	45	42	41	39	38	37	36	350	57	0H
41	39	38	35	33	34	33	33	34	36	36	32	28	28	27	26	24	22	19	20	18	18	19	200	57	DP
10	9	10	4	6	10	8	10	10	10	5	3	0	0	0	2	6	4	2	0	0	0	0	00	57	CC
34	36	35	34	33	32	32	31	32	35	36	38	39	41	42	44	44	43	40	39	38	37	36	340	58	DB
21	19	20	18	17	10	10	12	14	13	12	14	14	11	8	9	9	9	14	15	15	15	16	180	58	DP
2	3	3	4	7	3	0	0	0	1	1	1	0	2	1	1	0	0	0	0	0	0	0	00	58	CC
33	32	33	32	33	32	32	32	32	33	35	36	36	38	39	41	43	43	43	40	39	38	38	380	59	DB
18	19	19	19	17	18	19	18	18	17	17	20	22	21	20	21	24	21	22	23	23	23	25	250	59	DP
0	0	3	2	2	2	2	10	10	10	10	10	10	10	4	5	6	10	10	10	3	8	10	80	59	CC

MAR.

41	40	39	37	35	33	32	31	30	31	32	33	33	35	35	36	35	35	33	31	29	29	28	27D	60	DB
28	25	24	22	18	16	13	12	9	4	6	7	8	9	10	10	8	7	6	7	6	4	3	3D	60	DP
10	10	10	10	7	3	3	2	1	0	0	0	0	0	0	0	1	0	3	1	0	0	0	0D	60	CC
26	25	23	22	21	20	19	17	17	19	23	24	27	29	31	31	32	31	29	29	27	27	26	25D	61	DB
4	3	4	1	-3	-3	-2	-1	-2	-1	-1	-1	-1	0	1	1	4	4	6	5	6	6	6	7D	61	DP
0	0	0	0	0	1	1	2	1	1	0	2	2	2	1	1	1	2	3	1	0	0	0	0D	61	CC
24	23	23	22	21	20	19	19	20	22	25	27	31	33	36	37	37	37	34	32	33	31	31	29D	62	DB
5	3	3	-1	-3	-6	-5	-3	-4	-4	-2	-2	-1	-3	-1	-4	-3	-2	1	4	6	7	6	7D	62	DP
0	0	0	0	0	0	0	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0D	62	CC
30	27	27	27	24	25	24	24	25	27	29	33	36	39	41	44	45	43	41	38	36	35	35	33D	63	DB
6	10	10	8	10	4	1	1	1	0	1	2	5	7	9	9	10	11	18	16	14	15	17	17D	63	DP
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	7	7	7	10	10	7D	63	CC
33	31	31	31	29	29	29	30	31	33	34	35	35	35	34	35	35	36	37	37	36	35	35	35D	64	DB
18	17	15	17	17	17	18	20	20	22	23	24	25	25	26	26	29	29	29	30	30	30	31	30D	64	DP
3	1	2	3	2	3	6	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10D	64	CC
35	34	34	34	34	34	34	34	35	37	38	38	37	37	37	37	34	34	34	34	34	34	34	34D	65	DB
30	30	30	30	30	30	30	31	31	34	33	31	31	30	29	31	30	30	30	30	30	29	29	29D	65	DP
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10D	65	CC
33	33	34	35	35	35	34	33	34	34	35	36	37	38	39	39	39	39	38	36	35	35	34	33D	66	DB
29	27	24	23	23	23	22	22	21	21	21	21	22	23	22	21	22	20	20	18	19	18	19	18D	66	DP
10	10	10	10	10	5	3	3	4	5	5	6	6	7	6	6	5	3	3	3	2	3	3	1D	66	CC
32	31	33	32	31	31	30	31	33	35	37	38	40	40	42	41	41	41	38	36	35	34	33	33D	67	DB
18	17	15	18	17	16	16	15	16	19	20	19	22	21	23	20	20	21	20	21	24	22	23	22D	67	DP
0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0D	67	CC
32	32	32	32	32	32	31	31	33	35	36	38	38	37	37	37	37	37	36	36	36	36	36	36D	68	DB
23	23	23	23	24	24	24	24	25	26	27	28	29	31	31	31	32	32	31	31	31	31	32	33D	68	DP
7	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10D	68	CC
36	36	36	36	35	35	35	35	36	36	37	39	39	41	43	43	43	43	43	42	42	42	42	41D	69	DB
33	33	33	32	32	32	32	32	32	32	32	32	34	34	33	33	33	34	32	33	32	31	31	30D	69	DP
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10D	69	CC
38	38	37	37	37	37	37	36	38	39	41	43	44	45	45	47	47	46	45	44	43	42	42	41D	70	DB
31	31	30	30	31	30	30	29	29	30	31	33	34	36	36	37	36	37	37	38	38	37	37	38D	70	DP
10	10	10	10	10	10	10	6	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10D	70	CC
41	41	42	42	42	43	43	45	43	44	46	49	50	54	56	58	59	58	54	53	49	50	48	51D	71	DB
38	38	39	40	40	41	42	44	40	42	42	44	44	43	44	44	42	41	41	40	39	41	41	40D	71	DP
10	10	10	10	10	10	10	10	10	10	10	10	7	3	3	3	0	0	0	0	1	10	A	8D	71	CC
46	47	43	42	44	44	44	43	47	49	49	50	52	51	50	47	45	47	47	46	45	44	43	42D	72	DB
41	38	36	35	35	33	32	34	31	30	31	32	30	33	31	34	36	34	31	28	27	25	24	25D	72	DP
0	3	1	2	2	3	2	4	10	10	10	10	10	10	10	10	10	3	4	3	3	1	1	7D	72	CC
43	42	43	42	42	41	41	40	41	44	44	47	49	49	51	49	49	48	47	44	43	42	41	40D	73	DB
25	25	26	25	24	23	23	24	24	25	24	25	25	24	25	22	23	23	22	21	24	23	23	23D	73	DP
10	10	9	8	8	8	7	0	0	7	7	7	8	8	5	8	9	10	8	2	0	0	0	0D	73	CC
40	39	40	40	39	39	37	37	40	43	43	46	47	49	49	50	51	50	49	45	45	44	43	41D	74	DB
22	22	22	22	22	22	22	24	24	24	24	24	24	25	24	24	25	24	24	22	23	23	23	23D	74	DP
0	0	4	7	4	2	2	1	1	8	6	4	4	4	3	3	1	2	3	3	4	4	7	10D	74	CC
39	38	39	38	37	37	36	36	39	41	43	46	46	47	47	45	44	43	42	41	39	39	38	37D	75	DB
23	23	21	23	22	22	22	21	21	20	21	20	17	16	15	14	13	14	14	16	16	17	17	17D	75	DP
10	10	10	10	10	10	7	4	0	0	0	2	2	2	3	3	5	7	4	3	2	0	0	2D	75	CC
35	35	34	35	35	35	36	36	39	43	45	48	49	51	52	52	51	51	49	48	45	44	41	41D	76	DB
18	19	19	19	18	19	20	21	21	20	20	19	18	17	17	16	15	16	16	17	17	18	19	21D	76	DP
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41	40	40	39	36	36	35	36	39	42	45	47	50	52	51	53	53	52	50	47	47	44	43	40D	77	DB
20	18	13	13	13	10	11	12	12	13	14	14	16	16	17	16	15	15	15	15	16	17	16	19D	77	DP
3	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.0	0D	77	CC
40	39	35	34	33	33	31	33	37	41	47	50	53	54	53	53	47	46	45	45	45	45	44	44D	78	DB
18	19	22	24	19	20	22	25	27	29	27	25	24	21	21	22	35	36	38	38	38	39	39	39D	78	DP
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44	44	44	43	41	41	41	43	45	47	53	58	59	61	61	61	61	60	54	52	50	49	48	47D	79	DB
39	38	38	37	36	36	36	37	38	39	40	41	39	39	38	39	39	39	39	37	37	37	38	38D	79	DP
10	10	5	4	1	0	8	9	10	10	1	1	4	7	6	3	2	1	1	3	3	3	10	10D	79	CC

53	53	53	53	53	53	53	54	54	56	57	62	66	69	73	74	77	77	71	67	67	66	62	61D100	DB
48	49	50	51	52	52	52	52	52	53	54	55	56	56	57	58	59	58	60	57	40	34	34	38D100	DP
6	10	10	10	10	10	10	10	10	10	10	3	3	4	3	3	4	4	6	5	1	0	0	0D100	CC
58	58	56	55	53	52	52	54	55	57	59	61	65	67	69	71	70	70	68	65	62	58	58	55D101	DB
36	32	35	36	35	34	35	36	37	36	36	36	37	36	35	33	35	33	33	36	38	42	42	43D101	DP
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53	52	51	50	49	51	51	53	55	57	60	61	58	57	55	55	55	55	55	53	53	52	52	51D102	DB
43	44	45	47	47	49	49	48	49	49	51	50	54	54	55	55	55	54	53	53	49	50	49	49D102	DP
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50	49	49	49	49	49	48	48	48	49	49	47	44	42	43	46	48	49	48	47	46	45	44	43D103	DB
48	47	47	47	46	46	47	47	47	48	47	45	40	38	40	41	37	36	34	33	32	31	32	31D103	DP
6	1	6	10	6	10	10	10	10	10	10	10	10	10	10	0	10	9	4	6	4	1	2	0D103	CC
43	41	41	41	41	40	40	43	43	44	46	48	48	49	51	53	53	53	53	51	49	49	47	46D104	DB
35	34	29	26	23	21	22	23	23	22	20	20	21	21	23	23	24	22	24	23	23	23	23	22D104	DP
7	2	1	0	0	0	0	6	6	6	4	4	5	7	4	2	1	0	0	0	0	0	0	0D104	CC
46	43	42	41	40	38	38	44	49	51	54	55	59	60	60	59	58	58	56	53	53	52	52	53D105	DB
19	20	18	16	16	21	23	20	20	19	19	18	23	19	20	24	24	29	32	33	33	34	38	40D105	DP
0	0	0	0	0	0	3	3	2	2	4	2	3	6	9	9	10	9	9	10	10	10	10	10D105	CC
53	54	52	50	49	49	49	51	55	56	58	58	59	59	60	57	56	52	49	48	47	46	45	44D106	DB
40	39	43	46	46	47	46	47	47	45	40	36	35	33	32	31	30	29	27	30	28	27	28	28D106	DP
10	10	10	10	10	10	7	6	9	9	9	10	10	9	8	3	2	2	3	7	3	4	0	0D106	CC
44	43	43	43	42	41	41	47	52	55	58	61	62	65	65	67	69	69	66	65	63	64	63	61D107	DB
29	28	29	28	25	25	26	24	22	20	20	23	21	22	22	22	20	23	25	28	30	32	33	36D107	DP
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57	56	57	54	56	55	54	54	56	57	56	58	58	59	59	60	59	59	59	57	57	56	53	50D108	DB
38	40	40	44	39	41	41	42	43	45	46	47	48	50	51	51	52	54	55	56	54	53	50	46D108	DP
8	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	7D108	CC
48	48	45	43	42	42	43	43	43	42	46	48	50	53	51	51	51	50	48	46	42	40	39	38D109	DB
45	43	37	36	33	32	32	32	31	31	29	29	28	28	27	26	25	25	22	24	26	22	24	24D109	DP
8	10	5	3	10	10	10	10	10	10	5	6	5	5	7	7	9	10	5	7	0	0	0	0D109	CC
36	37	37	36	35	33	34	38	42	44	44	45	46	48	49	41	41	44	45	44	43	42	41	40D110	DB
24	19	19	18	18	20	18	20	20	19	22	24	23	18	22	32	34	32	29	25	27	27	27	28D110	DP
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39	38	38	38	37	37	39	39	42	44	46	46	47	49	50	53	53	53	53	51	48	45	44	41D111	DB
26	25	25	24	26	26	25	27	23	19	18	20	19	20	20	20	22	22	24	26	29	32	32	33D111	DP
0	1	6	7	1	9	8	1	3	4	6	8	7	7	7	6	1	0	0	0	0	0	0	0D111	CC
41	38	38	38	37	39	40	45	50	57	60	63	67	69	70	72	70	70	69	68	67	66	65	65D112	DB
31	30	31	31	31	32	34	34	34	26	25	26	28	27	27	28	31	33	34	35	34	33	33	34D112	DP
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64	63	62	61	60	60	60	61	63	65	67	73	77	77	80	82	79	80	77	73	71	68	64	59D113	DB
38	39	38	39	37	40	41	42	42	43	47	47	50	50	53	53	52	50	46	38	38	38	39	43D113	DP
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57	66	63	62	61	59	60	60	61	62	63	65	68	70	70	71	73	72	69	64	62	60	59	58D114	DB
45	36	37	33	30	31	31	28	30	29	30	23	25	22	22	27	29	32	34	39	39	35	36	40D114	DP
1	2	1	1	2	3	3	6	8	8	6	2	5	7	6	5	5	4	4	3	0	0	2	3D114	CC
57	57	56	55	56	56	57	59	64	68	73	80	84	85	87	85	83	81	81	79	77	76	74	74D115	DB
41	42	43	41	42	45	46	46	48	52	53	57	54	52	51	52	52	53	51	53	54	55	56	56D115	DP
1	2	0	2	1	3	2	3	2	1	1	0	1	3	5	10	10	10	10	10	10	10	10	10D115	CC
73	68	66	65	64	64	64	64	66	68	70	74	77	78	79	79	79	77	76	74	72	57	52	53D116	DB
57	61	63	63	63	63	62	63	63	63	63	62	62	59	58	57	55	53	54	53	53	54	48	47D116	DP
10	10	10	10	10	10	10	10	10	10	4	2	7	4	3	2	3	3	7	7	10	10	10	10D116	CC
53	51	51	51	52	51	50	52	54	56	56	58	59	60	59	59	57	56	54	52	52	50	49	49D117	DB
46	45	45	45	42	40	42	40	40	39	39	37	36	35	35	35	37	37	35	35	34	36	35	33D117	DP
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49	49	48	48	48	48	49	49	50	53	53	56	57	60	62	62	62	62	60	58	57	56	55	55D118	DB
35	36	35	33	32	31	28	30	30	28	29	32	32	33	33	36	37	38	39	42	43	42	42	41D118	DP
6	10	10	1	9	9	10	10	9	5	7	5	5	2	4	9	10	10	10	10	10	10	10	10D118	CC
54	54	54	54	54	55	55	56	58	60	63	66	66	68	71	73	70	68	66	64	62	60	58	56D119	DB
42	43	42	42	44	39	41	39	37	36	35	39	41	42	41	43	47	45	46	45	45	45	47	49D119	DP
10	10	10	8	10	10	7	2	3	1	2	1	0	0	0	2	3	4	5	3	1	0	0	1D119	CC

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56	55	55	54	53	54	55	57	59	62	64	66	68	68	69	71	71	68	66	66	65	63	62	62D120	DB
49	48	48	49	47	48	49	49	50	51	53	54	56	57	59	60	62	65	65	63	63	62	60	60D120	DP
2	2	0	3	2	9	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10D120	CC
49	49	48	48	48	48	48	48	48	48	50	50	50	50	51	51	52	53	53	53	51	52	51	51D121	DB
46	46	45	45	45	45	45	45	45	45	46	46	46	46	46	46	46	46	47	47	46	45	41	40D121	DP
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50	49	48	48	46	45	46	49	50	53	55	57	58	59	62	61	61	59	57	54	51	50	48	48D122	DB
39	36	35	35	35	35	35	36	35	35	36	37	38	41	40	38	39	39	40	41	39	38	37	36D122	DP
10	10	10	10	4	3	3	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0D122	CC
48	48	48	47	47	47	46	47	48	49	52	54	58	62	63	63	62	62	62	61	60	57	57	55D123	DB
36	37	38	39	39	41	41	40	42	43	44	45	48	50	51	51	51	50	49	47	45	44	45	45D123	DP
8	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	9	7	8D123	CC
53	53	51	49	50	48	51	56	59	62	65	67	70	72	73	72	74	71	69	66	62	62	59	57D124	DB
43	43	44	42	43	41	44	44	46	44	44	47	49	50	50	49	48	50	48	49	49	48	49	47D124	DP
1	8	1	2	6	6	1	0	0	0	0	0	1	2	2	2	2	2	0	1	1	0	0	0D124	CC
55	54	52	51	53	50	51	58	62	66	69	71	72	73	75	74	73	71	67	66	64	61	61	58D125	DB
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56	56	53	53	53	52	52	54	58	63	66	69	71	72	73	74	75	73	70	66	64	62	62	59D126	DB
50	50	48	48	48	47	47	48	50	52	51	53	50	47	49	50	48	49	50	51	49	49	48	43D126	DP
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58	55	55	54	53	54	54	56	61	68	70	74	76	78	81	81	79	78	77	75	73	70	68	67D127	DB
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67	64	63	62	62	60	62	66	68	75	78	82	84	88	89	90	88	82	84	75	75	73	73	75D128	DB
56	58	57	56	56	55	56	58	59	60	61	61	59	57	60	59	57	59	56	60	60	60	60	56D128	DP
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75	74	70	70	70	69	68	70	74	79	80	89	92	92	92	90	91	88	84	81	81	80	79	78D129	DB
55	55	58	58	56	56	60	60	57	57	60	56	57	56	54	50	50	53	49	49	47	46	48	46D129	DP
1	4	10	10	10	10	10	10	10	7	4	5	5	5	7	10	5	10	10	10	10	10	10	10D129	CC
78	76	74	74	73	70	70	73	75	77	79	78	81	81	83	84	83	82	80	78	74	70	69	69D130	DB
39	39	38	37	39	43	46	46	46	45	46	43	43	42	42	40	41	40	40	40	42	44	46	46D130	DP
7	6	2	0	1	2	4	4	2	3	3	3	3	3	3	1	1	0	2	1	1	2	2	7D130	CC
66	70	70	63	62	61	60	68	71	74	76	77	79	80	80	81	79	76	76	76	71	68	68	65D131	DB
46	45	45	45	46	47	47	48	42	41	40	42	43	42	40	41	44	46	44	43	56	49	49	51D131	DP
4	1	0	0	0	0	0	0	0	0	0	0	0	3	2	3	10	10	10	8	5	0	1	3D131	CC
65	64	64	63	62	61	62	65	67	70	73	75	77	79	81	80	79	79	76	71	70	70	69	68D132	DB
51	54	52	54	51	50	51	51	53	55	55	55	56	57	58	60	63	60	65	65	66	66	65	64D132	DP
10	10	8	2	4	7	8	7	8	10	7	10	10	8	5	9	10	10	10	10	8	5	1	1D132	CC
67	66	66	67	67	66	66	67	67	68	68	71	73	78	78	75	64	65	66	66	65	65	65	65D133	DB
63	62	64	64	64	63	63	63	63	63	64	65	65	66	65	65	61	61	61	62	61	61	61	61D133	DP
4	4	10	10	10	10	10	10	10	10	10	10	10	0	10	10	10	10	10	10	6	10	10	10D133	CC
65	64	62	61	60	60	60	64	65	68	69	70	70	70	67	70	72	71	68	65	62	60	59	56D134	DB
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10	1	0	1	4	7	3	2	1	2	3	5	9	10	10	7	5	3	3	3	2	7	10	8D134	CC
54	52	51	50	49	48	50	52	55	56	58	60	61	61	63	65	65	66	66	63	61	60	58	57D135	DB
42	40	39	39	39	40	41	43	45	46	47	48	49	49	50	51	51	49	49	50	50	50	51	51D135	DP
9	3	0	0	0	0	3	9	10	10	10	10	10	10	10	2	6	3	2	2	0	0	0	0D135	CC
55	56	54	54	52	52	52	54	61	65	67	71	73	76	78	79	78	78	76	73	70	67	66	66D136	DB
50	50	49	49	47	49	51	52	52	54	54	53	53	56	54	55	58	57	55	56	57	56	57	56D136	DP
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64	63	63	62	61	60	61	63	64	66	73	80	82	82	80	67	69	73	73	71	71	66	67	64D137	DB
56	56	56	56	56	55	56	55	56	58	61	55	55	57	56	62	61	63	62	62	62	62	63	61D137	DP
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66	65	63	62	62	60	61	66	70	75	77	78	80	80	83	84	83	83	81	80	72	70	70	68D138	DB
61	62	60	58	55	54	55	54	52	52	50	47	49	50	50	50	50	51	51	49	63	62	60	56D138	DP
3	0	0	0	2	1	0	0	0	0	0	0	0	1	2	2	1	0	0	3	3	2	2	2D138	CC
68	67	66	65	64	64	65	68	72	77	82	84	85	87	89	89	89	88	85	83	81	79	78	78D139	DB
55	53	54	53	53	55	55	52	54	55	55	56	58	60	60	59	59	60	60	60	59	59	58	57D139	DP
1	1	0	0	0	0	0	1	1	2	1	3	3	3	4	3	2	1	1	1	1	1	1	4D139	CC

76	76	76	79	74	72	74	77	78	77	78	81	82	82	81	81	81	79	78	73	70	69	66	65D140	DB	
57	57	55	55	56	57	56	57	57	57	56	56	51	54	51	50	49	50	46	48	48	47	46	41D140	DP	
7	8	4	3	2	2	2	2	4	6	3	2	1	0	0	0	0	0	1	2	3	7	2	2D140	CC	
63	60	59	56	54	53	54	57	60	62	64	67	67	69	71	73	75	74	72	69	66	64	63	62D141	DB	
42	40	37	36	35	35	35	38	39	39	37	40	40	40	40	42	44	46	44	43	45	43	47	49D141	DP	
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61	61	60	58	58	58	59	62	67	72	73	77	79	81	85	85	85	84	83	82	77	76	75	74D142	DB	
49	48	48	47	47	48	49	50	51	54	56	58	60	61	60	60	61	61	61	58	63	61	65	65D142	DP	
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73	71	70	67	67	68	68	72	75	79	84	90	90	92	92	92	92	90	88	85	80	78	77	76D143	DB	
62	64	63	61	62	61	61	63	65	67	67	59	57	56	57	57	57	56	58	60	67	69	70	65D143	DP	
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75	75	72	70	70	69	70	74	75	76	80	86	88	90	91	89	90	90	87	85	83	82	81	80D144	DB	
64	65	65	65	64	64	65	65	67	67	67	64	61	61	61	60	60	60	61	61	64	63	59	58D144	DP	
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81	78	77	75	76	74	73	79	75	76	78	78	79	81	83	84	84	83	79	77	75	72	69	67D145	DB	
56	55	54	55	56	56	56	50	45	44	46	46	45	42	43	42	41	39	40	40	38	39	35	35D145	DP	
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53	53	53	54	52	50	51	52	54	56	58	61	59	60	62	60	59	58	54	55	55	54	49	44D147	DP	
3	3	10	10	4	5	5	5	7	8	8	8	7	8	5	8	5	4	0	0	3	5	2	0D147	CC	
69	66	64	64	63	60	64	66	67	67	69	69	68	67	67	67	65	64	64	63	63	62	62	62D148	DB	
42	42	41	40	39	42	40	40	40	39	38	38	38	39	39	40	42	45	45	46	47	48	48	51D148	DP	
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57	56	56	54	53	52	54	56	62	65	66	70	72	72	74	75	75	73	72	69	67	67	65	64D150	DB	
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56	56	56	56	55	56	56	57	58	59	58	59	56	57	55	56	58	59	61	59	57	54	54	54D152	DB	JUN
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56	55	56	57	55	56	59	62	64	68	70	74	75	76	78	78	78	77	76	73	70	68	64	63D153	DB	
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64	62	60	58	57	57	60	63	68	72	75	77	78	79	79	81	81	80	78	75	71	68	65	65D154	DB	
48	50	52	51	50	50	49	50	51	50	49	48	42	43	43	46	44	47	47	49	54	55	56	56D154	DP	
6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0D154	CC	
63	62	61	61	61	60	63	64	67	72	76	78	81	82	84	86	86	86	80	80	77	77	76	75D155	DB	
55	56	56	54	53	52	55	56	56	58	61	59	61	61	62	61	58	60	65	65	62	60	58	59D155	DP	
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72	71	69	68	69	69	70	72	74	76	77	81	81	85	87	88	88	86	86	81	79	76	74	76D156	DB	
59	60	61	61	58	57	57	56	58	62	63	65	65	64	64	60	61	65	64	65	64	65	65	62D156	DP	
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73	72	71	70	70	70	71	72	76	79	80	83	86	87	90	91	91	88	85	82	81	69	71	71D157	DB	
62	61	60	60	60	60	61	62	62	63	66	67	68	68	64	63	65	67	69	70	71	67	68	68D157	DP	
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70	70	70	70	70	70	70	69	70	74	76	78	74	80	79	82	83	82	81	80	77	75	75	73D158	DB	
69	69	69	68	69	68	67	67	68	68	68	69	70	71	70	70	70	67	71	72	71	70	69	68D158	DP	
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72	71	70	69	70	70	71	71	72	73	74	73	73	75	77	82	84	82	80	78	75	74	74	73D159	DB	
68	67	67	67	67	67	68	68	69	69	70	69	69	69	69	69	71	71	72	71	71	70	71	71D159	DP	
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74	74	74	73	73	73	74	76	76	78	80	83	86	88	88	89	89	88	87	82	80	77	77	76D160	DB
72	72	72	71	70	71	71	72	72	72	72	73	74	74	74	75	75	76	73	62	64	67	69	70D160	DP
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76	75	73	72	73	72	74	75	77	78	80	82	83	84	85	84	82	79	78	77	75	74	73	72D161	DB
68	67	67	68	66	64	60	60	59	58	57	58	58	58	55	56	56	53	53	54	57	60	60	61D161	DP
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70	70	68	67	67	67	68	70	72	74	75	76	77	80	80	80	79	79	79	77	72	70	70	67D162	DB
62	61	60	59	56	54	55	52	53	53	53	53	53	56	53	52	49	50	50	50	58	57	56	59D162	DP
9	8	4	0	0	2	0	0	0	0	0	0	3	5	5	3	1	1	0	0	0	0	0	1D162	CC
66	66	65	65	64	64	65	66	69	71	75	77	76	75	73	71	70	67	65	66	66	66	66	66D163	DB
58	57	57	58	59	57	59	58	59	60	61	58	61	58	56	55	55	55	57	58	58	60	61	62D163	DP
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67	67	67	67	67	67	66	66	67	67	72	73	73	76	76	75	76	70	66	66	66	65	65	64D164	DB
64	62	62	63	62	63	64	64	63	64	64	66	64	65	64	64	64	61	63	64	63	62	61	60D164	DP
10	10	10	10	10	10	10	10	10	10	9	10	10	7	8	10	7	10	9	10	10	10	10	10D164	CC
62	62	61	60	60	59	59	59	59	58	59	60	61	60	61	62	62	62	63	63	62	62	61	61D165	DB
59	59	58	58	57	57	56	54	54	53	54	55	55	55	54	53	54	53	54	55	55	55	55	56D165	DP
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60	59	58	57	56	57	59	62	65	68	70	70	73	73	75	75	75	75	72	70	68	67	65	64D166	DB
55	54	54	55	54	54	54	56	57	56	54	53	51	51	49	50	50	50	54	53	53	53	55	56D166	DP
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62	61	60	59	59	59	64	65	69	72	74	76	76	77	78	78	77	77	75	73	71	70	69	68D167	DB
56	56	55	56	55	55	56	59	59	55	54	54	55	56	55	55	58	57	59	60	61	60	60	61D167	DP
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66	66	65	65	65	66	67	69	70	70	71	71	69	70	69	69	70	69	68	67	67	67	67	67D168	DB
62	61	62	62	62	62	61	62	62	63	64	65	66	66	66	64	63	63	63	63	63	63	63	63D168	DP
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66	66	65	65	64	65	65	67	68	70	72	72	73	74	77	78	78	77	76	74	72	70	70	68D169	DB
63	63	63	62	63	63	63	63	64	64	63	63	63	63	63	64	63	63	63	65	65	65	65	63D169	DP
10	10	10	10	10	10	10	10	10	10	10	10	10	10	5	5	10	10	5	0	0	0	0	0D169	CC
67	66	66	65	65	64	66	69	71	77	79	81	84	84	85	83	82	82	82	79	77	76	75	73D170	DB
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71	71	69	69	68	68	70	73	75	79	82	87	87	89	89	88	89	88	86	83	80	80	78	77D171	DB
67	68	67	67	67	67	68	68	68	70	69	67	65	64	66	66	64	68	69	70	73	72	70	70D171	DP
2	2	2	1	3	2	2	3	4	4	3	0	0	0	0	3	3	3	3	3	2	0	0	0D171	CC
75	74	74	73	72	72	74	76	78	82	85	88	88	90	91	92	91	91	89	86	83	81	80	78D172	DB
71	71	70	70	69	69	70	70	71	72	73	72	73	71	72	70	71	70	73	72	72	72	70	71D172	DP
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77	77	77	76	75	75	76	77	81	82	84	86	86	87	85	87	82	84	84	82	77	74	73	72D173	DB
70	70	71	71	71	69	69	67	68	69	68	69	70	69	70	60	67	65	55	57	62	66	67	66D173	DP
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71	70	70	70	69	69	72	77	81	84	87	89	90	91	92	91	91	90	89	85	82	80	77	75D174	DB
66	67	67	66	65	64	64	65	63	62	60	61	62	61	62	63	63	62	59	57	58	54	54	52D174	DP
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73	70	70	70	67	66	68	69	70	72	73	75	77	78	79	80	79	79	77	74	72	71	70	70D175	DB
51	51	49	48	48	48	48	48	51	53	49	47	48	47	48	52	51	50	52	45	50	50	55	59D175	DP
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68	68	67	66	66	66	68	70	74	76	78	80	82	84	86	87	86	84	82	80	78	77	76	75D176	DB
61	62	62	62	62	62	61	61	57	59	60	61	63	65	64	63	66	68	66	64	65	63	61	63D176	DP
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74	73	73	72	71	72	74	77	81	84	84	87	89	91	90	91	91	89	88	85	83	81	80	78D177	DB
66	68	69	69	69	69	70	68	69	68	70	69	68	69	68	65	64	65	68	68	67	68	69	70D177	DP
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77	77	76	75	75	75	75	76	78	81	82	85	87	88	90	90	90	88	86	85	82	81	79	77D178	DB
71	72	71	70	69	68	68	66	66	67	68	68	66	65	63	63	64	66	66	62	61	64	64	66D178	DP
4	4	9	10	10	10	10	10	10	6	2	0	1	0	0	0	5	0	0	1	0	0	0	2D178	CC
76	75	75	74	74	74	75	76	79	82	82	85	87	87	87	90	90	89	87	85	74	76	75	74D179	DB
67	68	69	70	71	71	71	70	71	72	72	71	71	71	71	69	70	71	73	73	71	71	71	73D179	DP
1	2	2	3	4	10	10	9	8	9	9	7	8	8	7	7	8	9	9	10	10	8	10	10D179	CC

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78	74	74	74	74	74	75	76	79	82	83	85	86	87	89	90	90	89	88	86	84	83	81	80D180	DB
71	71	71	71	72	72	72	72	69	71	69	69	69	68	69	68	70	69	70	71	75	73	73	72D180	DP
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80	79	77	77	76	76	77	80	81	85	87	89	90	90	90	91	91	91	90	87	84	82	80	80D181	DB
70	69	70	70	70	69	70	69	68	68	69	64	60	61	64	59	61	59	60	63	63	68	68	68D181	DP
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81	78	77	76	75	75	76	79	80	88	91	42	93	93	94	92	91	89	87	86	83	81	81	80D182	DB
65	67	67	65	63	63	65	65	67	68	63	64	54	66	68	61	65	62	62	62	64	65	65	65D182	DP
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80	79	79	77	76	76	76	77	78	81	84	86	88	88	91	89	80	78	80	80	79	79	77	77D183	DB
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9	9	7	8	10	10	10	10	10	7	7	9	8	4	4	10	10	10	10	5	9	10	6	7D183	CC
78	77	76	74	74	74	73	75	77	81	83	85	88	90	91	91	91	89	87	87	85	83	82	80D184	DB
71	67	67	66	66	66	66	67	67	68	69	71	71	69	68	71	71	70	72	73	70	70	68	68D184	DP
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79	78	78	76	75	75	76	79	81	80	78	76	78	78	80	82	82	82	82	81	77	75	72	70D185	DB
67	67	69	68	69	68	67	66	66	64	62	65	64	63	64	66	62	62	62	54	51	49	48	48D185	DP
2	2	8	3	0	3	3	5	6	10	10	10	10	10	9	10	10	10	10	10	3	3	0	0D185	CC
68	67	66	65	65	65	65	69	72	76	77	80	84	85	87	87	87	86	84	82	79	78	76	76D186	DB
49	50	50	50	50	50	50	51	52	54	52	53	51	50	50	50	47	47	46	46	46	47	47	47D186	DP
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74	73	66	65	63	62	65	70	75	79	80	83	83	85	87	87	89	87	87	84	79	78	75	74D187	DB
47	48	49	50	51	50	51	50	52	51	52	50	50	48	46	46	41	42	43	47	52	51	56	57D187	DP
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72	69	69	68	67	66	68	71	75	78	80	83	87	89	89	89	91	84	88	85	80	78	77	77D188	DB
56	56	56	56	55	55	55	57	57	58	59	59	59	54	56	52	57	58	52	56	62	59	57	58D188	DP
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77	77	76	76	76	74	71	71	69	68	68	68	70	71	73	73	76	76	77	76	74	72	71	70D189	DB
61	61	62	61	61	64	65	65	65	65	65	65	65	65	66	67	68	68	68	64	64	63	63	63D189	DP
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	8	10	10	5	5	3	0	1D189	CC
68	67	68	67	66	66	67	71	73	73	75	77	80	80	82	80	81	80	79	77	75	72	71	70D190	DB
62	61	61	61	61	61	61	61	61	61	61	61	62	62	60	61	61	61	59	60	61	61	61	61D190	DP
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61	61	61	61	60	59	60	60	60	60	63	64	63	62	61	61	59	58	64	61	64	64	64	63D191	DP
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73	72	72	71	71	70	70	72	77	81	84	85	88	90	90	91	89	91	88	85	81	79	77	75D192	DB
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3	0	3	3	3	3	4	3	2	1	0	0	0	1	1	2	3	2	1	4	3	1	2	3D192	CC
75	74	74	72	71	70	70	71	75	76	81	85	84	82	83	81	80	78	77	76	74	73	73	72D193	DB
64	63	62	62	62	63	64	65	66	67	68	66	65	65	65	65	65	65	67	67	68	68	69	68D193	DP
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73	75	76	75	73	73	74	76	76	76	77	79	81	81	82	82	79	79	78	79	78	78	77	78D194	DB
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77	76	70	71	71	70	71	75	78	81	82	85	86	85	87	86	86	86	84	82	80	78	77	77D195	DB
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76	75	74	72	71	71	71	74	78	81	85	87	87	90	90	90	90	89	87	85	82	80	79	78D196	DB
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78	75	74	74	73	71	72	76	80	84	88	90	91	91	90	90	91	92	86	88	85	83	82	80D198	DB
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75	74	75	74	75	75	75	77	79	80	82	86	87	90	92	93	90	90	88	83	80	79	78	770200	DB	
67	67	68	68	68	68	69	68	68	68	68	68	67	68	68	68	68	68	67	70	69	69	67	670200	DP	
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76	75	75	75	74	74	74	76	77	78	79	83	84	87	86	86	85	84	78	77	77	77	76	750202	DB	
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69	69	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	700203	DP	
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77	77	76	76	75	75	75	77	78	80	79	78	79	77	76	77	76	76	75	74	73	72	72	710205	DB	
72	72	71	71	71	71	70	70	70	70	70	69	69	67	67	67	66	66	66	66	66	66	66	640205	DP	
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74	73	72	70	70	70	70	72	76	78	81	84	86	86	89	89	89	88	86	84	82	79	78	770208	DB	
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72	72	73	73	73	73	73	73	72	72	72	73	73	72	71	71	71	68	68	68	67	67	66	660219	DP	
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77	76	76	74	71	71	73	77	79	83	86	88	91	91	91	92	91	90	89	87	77	76	73	73D220	DB
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72	71	71	71	71	71	71	71	73	74	77	79	79	72	78	79	79	77	76	75	73	72	71	70D221	DB
67	67	66	65	66	66	67	67	66	67	69	68	68	61	59	59	57	59	61	62	62	63	63	63D221	DP
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62	62	62	62	61	61	61	64	67	70	71	74	74	77	75	77	76	77	76	72	69	67	67	66D223	DB
57	57	57	57	57	57	57	58	57	57	58	57	57	58	57	58	58	58	58	61	61	60	59	59D223	DP
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64	63	63	61	61	61	62	65	68	72	75	77	80	81	81	82	81	80	78	75	72	71	69	69D224	DB
59	59	59	58	58	58	58	61	63	60	59	57	56	53	55	59	60	60	59	60	59	59	59	58D224	DP
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67	67	65	66	66	67	67	68	71	73	76	77	81	81	81	81	81	80	80	78	77	77	76	75D225	DB
59	61	61	62	63	63	63	63	63	64	62	63	62	62	63	64	66	66	67	67	68	68	69	69D225	DP
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75	75	75	73	73	72	72	75	77	80	83	83	83	83	83	83	84	83	80	77	75	73	71	70D226	DB
68	68	68	67	68	67	67	68	66	64	61	61	61	59	59	59	59	58	57	57	55	55	55	55D226	DP
6	10	10	10	10	7	7	9	10	4	4	4	4	6	6	6	0	0	0	3	2	1	0	2D226	CC
68	67	67	64	62	63	63	67	71	74	75	77	79	81	82	83	84	83	81	79	78	75	74	73D227	DB
55	55	54	55	55	55	55	56	56	56	52	54	55	55	57	58	59	61	60	61	62	65	65	65D227	DP
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73	71	72	72	71	71	71	72	73	77	78	81	85	87	88	88	88	86	78	78	79	79	78	77D228	DB
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76	70	73	73	72	71	71	71	71	77	77	87	89	85	85	83	83	83	80	79	77	76	75	75D229	DB
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75	73	72	71	68	65	64	66	69	72	74	77	77	79	80	80	80	82	81	77	74	73	70	69D230	DB
61	60	59	57	55	50	49	49	50	50	49	47	46	47	47	45	45	46	45	50	52	52	54	55D230	DP
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67	66	65	66	64	62	63	67	71	76	80	82	84	84	86	85	85	84	83	80	79	77	75	75D231	DB
55	50	50	57	55	53	55	58	59	65	64	66	64	66	66	65	64	66	65	64	64	64	66	67D231	DP
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76	76	75	75	75	74	74	76	81	83	86	89	93	98	99	96	96	95	93	91	88	87	86	85D232	DB
67	67	68	69	69	69	70	71	72	72	73	75	73	71	68	71	70	73	74	73	73	74	74	73D232	DP
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85	83	83	82	79	79	79	79	81	81	85	89	88	91	91	93	91	88	85	81	81	81	78	78D233	DB
73	73	74	74	75	74	75	75	75	75	67	63	64	63	63	62	63	64	67	69	69	68	70	69D233	DP
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76	76	73	71	71	71	72	73	76	79	82	84	85	86	86	87	86	85	82	79	76	75	73	71D234	DB
70	69	67	66	68	67	62	58	58	58	58	58	55	56	53	50	54	53	54	58	57	56	56	57D234	DP
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70	68	67	66	65	65	64	66	70	73	76	79	79	78	80	81	79	78	76	73	72	71	69	69D235	DB
59	61	62	61	61	61	60	61	64	62	59	56	57	56	55	56	55	55	56	57	58	59	59	59D235	DP
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68	67	67	67	64	65	64	67	70	71	73	75	78	79	81	80	82	80	79	76	74	73	72	69D236	DB
57	57	57	57	56	56	57	58	58	55	55	54	53	54	55	55	57	56	57	56	58	57	59	61D236	DP
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61	62	61	61	61	63	63	64	63	64	61	60	60	61	60	59	61	60	61	60	60	61	63	65D237	DP
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71	70	69	69	69	68	67	70	74	75	79	81	82	85	87	87	87	86	82	80	78	77	74	73D238	DB
65	65	65	65	66	65	65	67	69	68	67	65	64	64	62	61	61	60	62	63	62	63	65	65D238	DP
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71	72	71	71	71	70	71	72	73	78	82	83	86	84	77	76	78	79	78	77	75	75	74	74D239	DB
66	68	68	68	68	68	69	69	70	72	71	70	70	70	73	74	73	73	73	72	71	71	70	64D239	DP
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WB 69 69 70 71 71 71 71 72 74 75 77 77 78 78 77 78 77 79 79

78 77 77 77 76

WB = WET BULB TEMPERATURE

10 10 5 10 9 8 9 10 10 80239 CC

73	73	73	73	73	73	73	73	75	76	77	77	80	81	81	83	81	81	81	78	77	77	75	750240	DB
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73	73	71	71	69	69	67	70	72	75	79	81	84	86	87	88	88	87	86	84	80	80	79	790241	DB
57	57	57	57	57	57	57	58	59	60	61	60	60	60	59	59	59	59	58	59	59	60	60	600241	DP
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74	69	71	68	69	69	67	71	77	82	85	89	90	91	92	93	93	91	90	84	82	81	77	740242	DB
59	61	60	60	60	61	61	63	62	63	64	62	58	57	56	57	56	56	57	58	62	61	63	640242	DP
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71	72	71	69	69	68	69	71	75	79	83	87	90	93	93	93	92	91	89	84	83	81	79	780243	DB
61	63	64	62	62	62	64	64	65	65	68	67	63	63	61	63	65	64	65	66	67	69	71	710243	DP
0	0	0	0	0	1	2	2	3	3	2	1	2	1	1	2	3	2	3	0	2	3	2	00243	CC
80	80	78	77	76	75	74	79	81	86	89	92	95	96	97	90	96	93	89	86	84	83	82	810244	DB
68	69	69	67	69	68	68	68	71	69	69	67	66	66	64	65	66	72	72	71	73	73	74	730244	DP
5	9	9	5	5	3	5	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	00244	CC
81	80	79	78	76	75	74	76	81	84	88	91	94	97	98	98	97	94	90	88	86	84	84	820245	DB
72	69	68	66	65	65	65	64	65	68	64	68	62	60	53	61	62	68	72	72	71	72	71	720245	DP
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81	80	79	78	77	76	76	79	81	83	87	91	94	97	97	96	94	92	88	85	83	81	81	800246	DB
72	72	72	72	71	72	71	72	72	73	72	71	69	65	65	66	67	71	74	73	74	74	75	750246	DP
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79	79	79	78	77	77	76	78	82	84	86	88	89	90	90	89	90	86	84	83	81	80	80	800247	DB
76	76	75	75	74	74	74	74	74	73	71	69	69	69	68	69	69	72	72	72	73	73	73	720247	DP
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79	78	78	77	77	77	77	77	77	82	84	85	87	89	88	77	73	72	72	69	68	68	67	630248	DB
71	72	71	71	71	72	72	72	72	72	71	71	70	69	69	71	72	71	70	68	68	68	64	620248	DP
0	3	10	10	10	10	10	10	10	8	7	6	7	8	8	10	10	10	10	10	10	10	10	100248	CC
63	62	62	63	62	62	62	62	62	63	63	63	63	61	61	62	62	63	62	63	63	63	63	630249	DB
61	60	60	61	61	61	60	60	59	60	60	61	61	61	61	61	61	60	61	60	60	60	60	600249	DP
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63	63	63	63	63	62	63	64	65	69	73	76	78	78	79	80	80	79	76	74	73	71	69	680250	DB
60	60	58	58	57	56	56	55	55	56	55	53	53	51	51	52	52	53	55	55	54	55	55	540250	DP
10	10	10	10	10	10	10	10	7	7	2	1	2	0	0	0	0	0	0	0	0	0	0	00250	CC
67	66	65	63	62	62	62	64	66	69	71	73	74	74	76	77	75	74	72	69	68	66	65	640251	DB
53	54	55	54	55	54	54	54	54	54	54	51	50	48	48	45	43	47	49	50	51	51	51	500251	DP
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63	63	62	62	59	58	57	61	65	69	71	72	73	74	75	75	75	74	71	69	65	63	61	600252	DB
50	48	47	47	48	47	47	48	50	47	44	42	43	42	42	43	43	42	48	48	53	53	52	520252	DP
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58	57	56	55	55	54	55	58	65	70	73	75	75	76	75	76	75	74	72	70	64	63	61	600253	DB
51	52	52	51	51	50	50	51	52	52	44	44	45	48	47	46	46	46	45	51	52	53	53	540253	DP
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58	57	57	56	56	56	56	61	66	70	72	73	75	75	76	76	75	74	72	69	68	67	66	660254	DB
54	53	54	54	53	53	53	54	53	55	50	52	50	50	51	53	55	52	54	54	53	53	56	580254	DP
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65	65	65	65	65	64	64	64	65	67	70	73	74	78	80	81	79	77	76	75	75	73	70	690255	DB
58	59	59	60	59	61	61	62	61	62	63	63	63	63	66	63	64	65	65	66	64	62	62	620255	DP
4	7	3	10	10	10	10	10	10	10	4	3	2	5	6	5	10	10	10	10	10	10	10	30255	CC
67	66	65	66	64	63	61	61	62	62	63	62	63	64	65	66	67	66	63	61	59	58	57	550256	DB
62	62	62	56	55	51	48	44	43	40	40	41	39	40	38	37	37	38	36	37	38	37	37	370256	DP
5	10	6	3	0	0	0	0	0	1	5	6	5	1	1	1	0	0	1	1	0	0	0	00256	CC
52	52	51	52	50	52	53	57	62	63	65	67	68	67	68	70	71	69	68	67	66	65	65	640257	DB
40	39	39	38	39	37	38	39	37	37	38	40	41	40	41	42	40	40	46	49	46	50	49	520257	DP
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64	62	62	59	57	57	57	60	65	70	73	78	81	84	83	83	83	82	79	78	78	76	75	730258	DB
53	53	55	55	54	54	52	53	53	52	53	55	53	55	56	62	61	61	59	59	58	59	60	580258	DP
9	6	2	0	0	0	1	0	0	1	2	2	3	1	0	0	0	0	3	4	3	7	7	10258	CC
71	68	66	66	63	63	62	65	72	75	76	79	81	82	84	82	83	80	76	75	74	73	72	700259	DB
58	59	58	58	58	56	55	54	54	49	52	53	51	51	50	51	47	55	57	58	57	58	54	530259	DP
0	4	1	0	0	0	0	0	0	0	0	0	0	0	0	2	1	2	2	2	4	5	0	00259	CC

SEP

WB: 71 72 71 70 71 70 70 71 73 74 75 74 75 75 74 75 75 78 77 75
76 76 76 75

WB = WET BULB TEMPERATURE

68	66	66	66	63	61	60	62	64	66	67	69	71	74	73	74	75	73	70	67	64	62	61	60D260	DB	
51	52	52	46	46	46	47	49	47	47	46	47	46	48	44	45	45	46	47	49	52	53	52	55D260	DP	
0	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0D260	CC	
59	59	57	56	55	55	55	56	59	61	65	69	70	72	74	75	74	73	70	68	67	66	65	64D261	DB	
52	53	52	50	48	47	45	45	46	46	47	49	49	47	50	50	51	53	55	55	56	58	58	59D261	DP	
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63	64	64	64	64	64	65	66	68	69	70	72	72	74	77	78	77	74	72	70	69	68	67	67D262	DB	
59	59	59	59	58	58	58	58	58	59	60	60	59	59	60	58	58	59	58	57	59	58	59	61D262	DP	
1	9	10	10	10	10	10	10	10	10	10	10	10	10	3	4	9	6	6	6	1	3	3	3D262	CC	
66	66	66	65	65	65	66	67	71	74	77	80	80	80	80	79	78	76	75	72	71	68	68	67D263	DB	
61	61	62	62	62	62	62	63	63	64	64	63	64	62	63	64	65	66	66	66	68	64	63	63D263	DP	
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67	67	66	66	66	65	65	66	69	72	76	77	78	80	82	82	70	63	61	61	59	57	57	57D264	DB	
64	63	63	63	63	63	63	63	64	64	66	64	63	62	62	60	54	51	53	52	52	53	55	55D264	DP	
10	10	10	8	5	4	10	10	9	3	3	7	5	8	3	5	9	10	10	10	10	10	10	10D264	CC	
56	56	55	54	54	53	53	55	57	60	62	64	65	66	66	67	67	66	63	61	60	58	57	55D265	DB	
54	52	51	50	49	49	48	46	47	45	42	40	42	41	41	41	40	39	42	42	42	43	42	44D265	DP	
9	4	5	1	0	0	0	0	0	0	2	3	4	4	3	3	3	0	0	0	0	0	0	0D265	CC	
54	53	52	51	50	50	50	52	58	60	62	63	64	64	65	66	65	64	62	61	57	55	52	51D266	DB	
42	43	43	42	42	42	42	42	40	38	32	34	35	35	37	38	37	40	39	42	44	45	46	45D266	DP	
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51	49	49	48	47	46	47	50	57	62	64	66	68	68	69	70	69	67	64	61	61	60	59	57D267	DB	
44	45	44	44	45	44	43	44	46	45	44	46	47	47	46	45	45	46	46	48	48	49	51	50D267	DP	
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55	55	54	54	53	53	53	57	61	63	67	71	73	74	73	73	72	71	69	68	68	67	66	65D268	DB	
50	51	51	51	51	51	51	52	55	57	60	59	58	55	53	53	55	58	59	60	61	61	61	62D268	DP	
1	3	5	3	3	4	9	8	10	10	3	4	4	6	6	10	10	10	10	9	10	7	9	7D268	CC	
45	65	64	63	62	61	61	63	65	71	74	74	75	77	78	77	75	73	71	70	70	70	69	69D269	DB	
61	62	61	61	61	60	59	60	62	58	58	58	57	57	56	60	60	62	63	62	63	64	65	64D269	DP	
4	8	5	4	4	3	8	6	4	4	5	5	8	7	7	10	10	10	10	10	10	10	10	10D269	CC	
68	68	67	67	67	66	66	66	67	69	69	71	73	74	73	74	76	74	70	69	67	65	65	63D270	DB	
64	64	63	62	62	62	63	63	63	64	64	64	64	63	63	63	62	63	64	63	63	63	63	63D270	DP	
10	10	10	10	10	10	10	10	10	10	10	7	10	8	10	8	2	2	2	2	0	1	0	0D270	CC	
63	63	62	63	65	63	62	62	65	66	68	71	72	74	75	76	76	75	71	66	64	62	61	59D271	DB	
61	61	60	62	60	58	57	56	52	50	49	47	46	47	46	46	46	47	56	54	54	52	54	53D271	DP	
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57	56	56	55	54	53	53	57	63	70	76	81	84	86	88	88	87	81	78	76	73	71	69	68D272	DB	
52	52	52	51	50	49	49	50	54	57	55	51	44	48	46	47	49	53	57	54	56	57	58	58D272	DP	
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66	64	64	63	63	61	61	64	69	74	79	83	85	86	86	86	83	79	76	74	74	73	72	70D273	DB	
60	60	59	59	59	57	57	58	58	56	55	54	53	52	56	60	61	63	63	62	62	62	62	62D273	DP	
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67	64	63	60	58	56	54	54	56	58	59	61	63	63	64	64	64	62	59	56	57	55	54	50D274	DB	OCT
56	53	51	51	47	46	46	46	44	42	42	39	40	41	40	39	40	40	41	40	43	44	45	45D274	DP	
8	6	7	3	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0D274	CC	
50	50	49	49	48	47	48	50	53	57	60	63	67	68	70	70	72	70	69	68	67	66	66	64D275	DB	
43	44	44	44	43	44	44	46	47	49	50	50	50	50	52	55	56	57	58	59	59	59	59	60D275	DP	
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64	64	63	61	61	60	61	61	63	67	71	72	73	74	73	73	72	68	66	65	64	60	60	58D276	DB	
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58	58	57	57	58	57	56	56	57	58	60	62	62	65	64	63	63	62	61	60	60	59	56	55D277	DB	
46	47	49	50	47	47	47	48	48	47	45	45	44	48	46	49	48	47	48	47	46	46	47	50D277	DP	
6	10	10	10	10	10	6	10	10	10	10	10	10	10	10	10	10	10	10	10	10	9	2	8D277	CC	
54	53	52	52	50	51	51	52	54	59	63	66	67	69	69	69	69	68	66	65	63	62	61	61D278	DB	
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62	62	62	63	63	63	63	63	65	67	69	70	71	71	72	72	71	70	69	67	66	64	64	63D279	DB	
58	58	58	59	60	60	61	61	63	63	64	64	66	67	66	66	66	65	61	53	50	51	49	49D279	DP	
10	1	10	10	10	10	6	6	10	10	10	10	10	10	10	10	10	10	10	10	10	10	7	5D279	CC	

63	61	57	57	54	53	53	53	57	62	65	66	67	69	70	69	69	68	65	63	58	58	56	54D280	DB
48	49	48	51	48	46	46	46	48	46	46	43	44	45	43	44	44	44	44	45	49	50	50	50D280	DP
7	10	6	3	4	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0D280	CC
54	51	51	50	49	50	50	52	54	54	57	61	63	63	62	59	60	60	58	58	58	58	58	57D281	DB
49	47	46	47	47	45	46	49	48	49	50	52	51	50	52	52	53	53	52	53	53	53	54	54D281	DP
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57	57	57	57	57	58	58	58	59	59	59	59	59	59	59	60	60	60	60	60	60	59	58	57D282	DB
54	54	54	54	54	54	54	54	55	56	56	55	56	57	57	57	57	56	56	57	57	56	56	55D282	DP
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	8	0	0D282	CC
55	52	51	52	51	51	49	51	55	60	65	69	72	74	75	75	75	74	71	66	62	60	61	58D283	DB
54	52	51	52	50	50	48	50	53	57	58	58	57	57	54	50	47	44	46	49	53	53	52	50D283	DP
2	6	6	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0D283	CC
58	57	58	56	54	54	55	55	60	65	70	77	79	81	81	82	82	78	75	73	71	68	66	66D284	DB
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63	64	62	60	59	59	61	60	62	66	71	74	75	75	76	76	75	72	70	66	65	65	63	61D285	DB
54	52	51	53	52	51	53	53	55	54	49	50	51	50	51	52	53	54	57	50	45	46	51	51D285	DP
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58	58	56	57	56	55	56	55	58	60	62	66	69	73	75	75	76	74	71	69	67	66	65	65D286	DB
50	51	50	52	51	49	51	51	56	57	60	62	63	63	64	64	63	64	62	62	62	62	61	61D286	DP
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63	61	61	61	60	59	59	60	60	62	63	68	73	76	79	80	79	76	72	70	70	69	68	67D287	DB
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0	0	0	4	3	10	10	10	10	10	10	5	2	3	3	2	2	1	1	0	0	0	2	1D287	CC
66	65	64	64	60	62	61	61	62	63	67	72	76	80	80	80	78	77	73	71	71	70	69	68D288	DB
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67	67	66	65	63	64	64	63	65	65	68	70	72	76	78	79	79	76	74	73	71	70	67	66D289	DB
64	63	63	62	61	61	61	61	63	64	65	65	65	65	63	60	58	59	59	59	60	54	59	58D289	DP
1	1	1	2	1	7	8	9	10	10	10	7	3	5	5	0	3	7	8	3	8	7	2	6D289	CC
66	65	63	61	60	59	57	58	60	65	68	70	71	72	73	73	73	70	70	65	62	61	61	64D290	DB
57	55	54	55	54	54	53	53	54	55	53	51	50	49	50	50	51	50	50	54	53	52	50	44D290	DP
10	8	0	0	0	0	0	2	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0D290	CC
62	58	59	58	58	55	54	55	61	68	71	73	74	75	75	75	73	71	67	66	64	64	62	60D291	DB
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43	43	43	43	43	42	42	42	43	46	48	51	53	54	55	55	55	54	51	49	47	44	43	43D298	DB
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38	37	36	35	34	34	35	35	36	38	40	38	35	36	36	36	37	37	37	37	36	36	36	350331	DB
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28	29	28	27	26	24	24	24	24	25	27	29	30	31	31	30	29	28	27	26	25	25	24	230340	DB
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26	24	25	25	23	22	22	23	25	29	31	34	37	39	41	40	39	37	37	38	40	40	40	400342	DB
10	11	10	12	11	12	12	12	12	13	17	16	16	13	13	16	18	22	19	18	14	15	16	160342	DP
0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	2	3	5	7	10	7	10	9	60342	CC
40	40	40	40	39	38	38	38	38	38	39	40	42	44	44	45	46	46	45	43	43	41	39	380343	DB
16	15	11	11	26	28	31	32	34	35	37	39	40	43	43	44	44	44	43	34	31	31	28	300343	DP
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	8	2	100343	CC
38	38	39	38	37	35	35	35	36	38	41	43	44	43	43	43	42	40	40	40	39	39	39	390344	DB
30	31	29	24	22	24	24	25	23	24	26	23	22	23	21	21	22	23	23	22	22	24	24	230344	DP
10	6	10	10	4	4	2	2	7	1	1	3	4	4	8	10	9	10	10	8	10	10	10	100344	CC
37	38	37	37	37	37	36	36	35	35	37	37	39	39	40	40	39	37	35	34	33	31	31	300345	DB
23	25	26	26	25	24	25	22	22	21	22	22	20	20	20	20	19	20	20	22	20	21	20	200345	DP
10	10	10	10	10	10	10	10	10	7	6	9	3	1	1	0	0	0	0	0	0	0	0	00345	CC
30	30	30	28	28	26	27	28	30	32	35	36	38	38	37	38	37	37	36	33	34	34	34	340346	DB
19	20	20	19	20	19	20	19	20	22	21	23	20	22	22	22	22	22	25	31	31	31	32	320346	DP
0	0	0	0	0	1	6	4	8	10	10	10	10	10	10	10	10	10	10	10	10	10	10	100346	CC
33	33	33	33	33	34	34	35	36	36	36	36	37	36	36	36	37	36	37	38	38	38	38	390347	DB
31	31	31	32	32	33	33	33	34	34	34	34	35	34	35	35	35	35	35	37	36	36	37	370347	DP
10	9	10	10	8	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	100347	CC
38	39	40	40	40	41	42	43	43	45	45	46	45	43	42	42	42	42	42	42	43	43	43	440348	DB
37	38	39	39	40	40	41	42	43	44	45	45	45	43	41	40	40	40	40	38	39	37	37	360348	DP
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	8	8	30348	CC
45	43	42	43	40	39	37	39	40	41	42	44	44	43	40	40	41	40	39	39	40	39	39	380349	DB
35	36	35	34	35	35	34	35	35	35	35	32	32	28	33	33	31	33	34	31	30	32	32	310349	DP
1	0	0	2	3	1	5	10	10	10	10	10	10	10	10	10	10	10	10	10	10	5	10	70349	CC
39	40	40	40	40	40	40	40	40	40	41	41	42	43	43	43	42	41	40	39	38	37	36	340350	DB
25	24	26	27	27	26	27	26	26	27	27	27	26	25	25	25	26	25	25	26	27	26	27	270350	DP
1	10	5	10	10	8	7	10	10	10	10	10	10	10	9	8	9	8	10	4	7	10	1	00350	CC
34	34	34	33	33	33	33	33	33	35	35	36	37	38	39	40	39	39	39	39	39	39	38	390351	DB
29	29	29	29	30	30	29	28	30	28	31	29	28	27	30	31	31	31	32	32	32	34	35	360351	DP
0	3	1	3	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	100351	CC
40	42	41	42	42	42	43	43	44	46	45	43	44	45	46	46	46	45	44	43	42	40	40	380352	DB
37	37	38	38	40	42	43	43	44	46	45	40	37	36	35	37	29	28	27	28	28	29	31	290352	DP
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	2	10	8	60352	CC
38	37	35	33	34	33	32	32	34	37	40	44	45	44	43	43	43	39	37	35	34	33	31	300353	DB
28	25	26	26	26	26	26	26	27	26	26	26	25	22	24	23	18	22	20	20	19	19	19	190353	DP
9	1	0	0	0	0	0	1	1	0	0	0	3	6	7	6	9	8	1	0	0	0	0	00353	CC
30	30	29	29	28	28	28	28	27	28	30	31	32	32	31	30	30	29	28	26	26	25	23	220354	DB
17	16	17	18	17	17	17	17	15	13	11	5	4	4	9	11	12	11	13	16	12	9	8	70354	DP
0	0	1	2	2	1	5	3	2	0	1	5	5	4	4	4	3	3	2	0	0	0	0	00354	CC
22	21	21	20	20	19	19	19	20	21	24	24	26	27	28	29	27	27	26	25	24	24	23	220355	DB
5	7	5	5	6	8	8	8	9	7	6	4	1	2	1	8	4	9	5	4	5	4	4	60355	DP
0	0	0	0	0	1	1	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	00355	CC
22	21	21	20	20	20	20	20	21	23	25	27	29	30	31	31	31	29	28	27	27	28	27	260356	DB
8	9	9	9	8	8	7	7	7	7	7	10	11	11	9	11	10	13	10	12	13	14	13	170356	DP
0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	10	1	00356	CC
26	26	25	26	25	25	26	26	28	30	33	39	44	48	52	53	52	49	49	49	48	47	47	460357	DB
16	15	13	14	13	13	14	15	17	19	24	19	22	25	28	28	28	29	29	29	29	30	31	300357	DP
3	1	0	10	8	2	6	10	10	8	6	4	3	2	2	0	0	0	0	0	0	0	3	80357	CC
46	46	48	46	46	46	46	45	46	47	47	47	47	46	47	47	45	43	41	41	39	39	39	380358	DB
31	30	28	29	29	30	29	28	29	28	30	28	29	29	29	28	30	25	21	18	20	21	21	210358	DP
6	3	0	0	1	6	3	6	10	10	10	10	10	10	10	10	9	8	10	8	2	6	3	00358	CC
37	37	36	35	33	31	31	31	33	35	37	39	41	44	45	45	42	39	39	34	33	33	32	310359	DB
21	21	22	21	20	21	22	21	20	16	15	17	15	17	15	16	19	18	18	22	24	20	19	210359	DP
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	00359	CC

30	30	27	27	26	25	26	25	28	33	36	40	44	47	48	47	45	44	43	42	42	36	33	330360	DB
20	20	21	21	20	20	22	20	24	24	25	24	23	21	22	23.	25	25	24	24	24	26	24	250360	DP
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	00360	CC
32	31	32	31	30	30	30	31	33	36	41	44	49	56	60	58	56	52	48	45	43	41	40	400361	DB
24	27	26	25	24	25	26	27	27	28	30	30	32	36	38	37	37	38	38	38	37	37	36	360361	DP
0	0	0	0	0	0	0	0	0	3	2	0	0	0	0	0	0	1	1	2	2	2	4	30361	CC
39	39	38	43	43	43	44	45	47	49	53	55	58	61	62	61	62	61	60	54	58	58	57	560362	DB
36	35	35	39	40	40	42	42	43	46	49	50	51	51	51	50	53	54	55	51	55	56	55	550362	DP
2	2	1	0	0	0	0	0	1	4	8	10	10	9	8	8	10	10	10	10	10	10	10	100362	CC
57	56	56	53	55	57	57	57	57	54	51	49	48	48	45	44	44	43	43	44	44	44	44	440363	DB
56	55	55	53	54	56	57	57	57	52	49	47	48	47	45	43	43	43	43	44	44	44	44	440363	DP
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	100363	CC
45	46	50	48	45	44	43	45	45	46	50	52	50	50	50	49	48	45	43	43	41	41	39	390364	DB
45	46	50	47	43	43	42	42	40	38	37	33	32	32	32	31	29	28	27	27	28	28	29	270364	DP
10	9	10	10	8	0	6	9	6	5	1	1	0	1	0	0	0	0	0	0	0	0	0	00364	CC
38	36	36	36	35	35	35	33	34	36	39	43	43	46	47	46	45	44	43	41	40	38	39	390365	DB
28	28	31	30	29	30	30	30	29	29	32	31	30	32	31	31	32	32	31	34	33	35	32	310365	DP
0	0	0	0	2	1	3	3	3	4	4	4	7	6	5	5	9	8	8	3	7	7	5	60365	CC

DATA FOR   WEATHER DATA FOR WASHINGTON DC - TYPICAL YEAR ***************

AVERAGE DAILY VALUES FOR ** JAN **

DATE	DRY BLB	DEW PNT	WET BLB	CLD CVR
1	43.7	20.2	34.6	.7
2	42.1	30.2	36.9	.0
~~3~~	~~44.6~~	~~31.8~~	~~39.1~~	~~6.0~~
4	37.2	25.6	32.6	2.0
5	36.9	31.4	34.5	7.0
6	35.9	23.1	31.1	4.2
7	37.0	20.1	30.9	4.5
~~8~~	~~35.3~~	~~19.7~~	~~29.7~~	~~.9~~
9	42.0	32.1	37.7	7.0
10	39.8	37.2	38.6	10.0
11	23.0	19.0	21.7	10.0
12	22.8	10.8	19.3	1.3
~~13~~	~~20.1~~	~~7.1~~	~~17.1~~	~~3.5~~
14	27.1	19.0	24.6	9.4
15	34.5	32.2	33.5	10.0
16	37.9	33.1	35.8	7.0
17	29.7	16.6	25.7	5.1
~~18~~	~~25.4~~	~~12.3~~	~~22.4~~	~~1.5~~
19	41.2	33.4	37.7	5.3
20	50.5	48.9	49.6	9.7
21	50.0	45.7	48.0	9.3
22	25.2	19.0	23.3	9.9
~~23~~	~~21.2~~	~~11.3~~	~~18.7~~	~~7.5~~
24	31.2	25.2	29.0	10.0
25	37.9	32.0	35.4	8.3
26	46.9	39.8	43.3	4.5
27	55.2	43.0	49.0	4.5
~~28~~	~~34.5~~	~~13.8~~	~~27.9~~	~~2.4~~
29	32.5	13.9	26.6	3.9
30	39.6	16.7	32.5	3.6
31	31.4	10.1	25.3	3.1

$$\frac{\Sigma\ DBLB}{31} = 35.90\ ^{\circ}F$$

DATA FOR WEATHER DATA FOR WASHINGTON DC - TYPICAL YEAR ****************

FEB

AVERAGE DAILY VALUES FOR ** 0[illegible] **

DATE	DRY BLB	DEW PNT	WET BLB	CLD CVR
1	39.6	27.8	34.8	6.5
2	35.4	19.5	29.9	4.8
~~3~~	~~31.2~~	~~14.6~~	~~25.9~~	~~.0~~
4	39.0	21.4	32.3	1.7
5	41.2	29.8	36.6	8.7
6	50.9	41.7	46.4	6.4
7	40.2	21.8	33.3	5.8
~~8~~	~~37.3~~	~~13.2~~	~~30.5~~	~~6.1~~
9	50.1	30.7	41.5	8.0
10	58.0	45.7	51.2	9.1
11	54.6	43.5	49.3	7.3
12	37.3	16.8	30.3	3.0
~~13~~	~~29.1~~	~~20.8~~	~~26.4~~	~~9.9~~
14	26.1	16.6	23.4	7.2
15	28.4	12.5	23.8	.5
16	32.2	17.7	27.3	3.3
17	40.8	25.7	34.7	5.6
~~18~~	~~40.2~~	~~34.7~~	~~37.7~~	~~6.9~~
19	32.9	17.8	28.4	4.1
20	31.7	14.5	26.3	1.0
21	31.0	19.5	27.1	6.9
22	35.6	23.7	31.3	5.4
~~23~~	~~35.3~~	~~19.3~~	~~29.6~~	~~1.9~~
24	36.0	19.9	30.2	6.0
25	37.2	32.2	35.2	9.7
26	40.2	28.9	35.7	4.5
27	36.9	13.9	29.4	1.2
~~28~~	~~36.3~~	~~20.4~~	~~30.5~~	~~6.5~~

$$\frac{\Sigma \text{ DBLB}}{28} = 38.03\ ^\circ F$$

DATA FOR WEATHER DATA FOR WASHINGTON DC - TYPICAL YEAR ***************

AVERAGE DAILY VALUES FOR ** 030 ** MAR

DATE	DRY BLB	DEW PNT	WET BLB	CLD CVR
1	33.3	11.0	27.0	2.5
2	25.0	1.8	20.1	.9
3	27.7	4.1	21.9	.4
4	32.8	8.4	26.2	2.1
5	33.4	23.7	29.9	7.8
6	35.0	30.3	33.1	10.0
7	35.5	21.6	30.4	5.4
8	35.3	19.4	29.7	.3
9	34.8	27.9	32.1	9.9
10	39.0	32.4	36.2	10.0
11	41.2	33.6	37.8	9.8
12	48.4	41.2	44.7	6.6
13	46.1	31.9	39.9	5.4
14	44.2	23.9	36.1	5.8
15	43.6	23.2	35.5	3.6
16	40.7	18.6	32.7	4.4
17	42.9	18.3	33.8	.5
18	44.1	14.8	33.7	.2
19	42.8	27.8	36.7	4.6
20	50.3	38.1	44.2	5.1
21	46.6	41.9	44.3	10.0
22	47.4	33.2	41.0	5.7
23	49.0	31.8	41.3	4.2
24	49.4	26.5	39.7	3.6
25	50.1	18.7	38.0	3.8
26	50.7	23.1	39.3	3.5
27	53.8	22.0	40.8	.7
28	53.3	25.3	41.4	.0
29	58.8	35.4	47.2	1.9
30	66.2	47.0	55.2	3.1
31	64.6	54.5	58.5	6.9

$$\frac{\Sigma\ DBLB}{31} = 44.07\ ^{\circ}F$$

DATA FOR WEATHER DATA FOR WASHINGTON DC - TYPICAL YEAR ***************

AVERAGE DAILY VALUES FOR ** [illegible] ** APR

DATE	DRY BLB	DEW PNT	WET BLB	CLD CVR
1	55.9	45.2	50.1	7.9
2	55.6	45.4	50.1	7.5
~~3~~	~~57.3~~	~~40.7~~	~~48.7~~	~~4.2~~
4	57.5	44.7	50.7	7.5
5	56.6	28.8	44.2	3.2
6	54.8	42.4	48.5	9.6
7	56.2	51.2	53.4	9.9
~~8~~	~~56.3~~	~~42.2~~	~~48.9~~	~~6.0~~
9	54.6	48.7	51.2	6.0
10	61.8	51.1	55.7	5.9
11	60.3	36.1	48.4	1.0
12	54.0	50.0	51.8	6.8
~~13~~	~~47.0~~	~~41.1~~	~~44.3~~	~~6.9~~
14	46.4	23.7	37.3	2.3
15	50.6	24.1	39.7	5.0
16	52.3	36.7	45.0	6.7
17	55.2	25.5	42.9	2.1
~~18~~	~~56.5~~	~~46.9~~	~~51.4~~	~~9.8~~
19	45.5	29.6	38.8	6.3
20	41.0	23.5	34.3	3.9
21	44.6	24.3	36.5	3.4
22	56.8	30.9	44.7	3.3
~~23~~	~~68.6~~	~~43.5~~	~~54.7~~	~~5.0~~
24	64.0	31.5	48.7	3.6
25	71.0	49.8	58.2	4.9
26	69.1	58.3	62.3	7.6
27	53.8	38.5	46.3	7.5
~~28~~	~~54.4~~	~~34.9~~	~~43.2~~	~~8.0~~
29	61.0	42.3	51.1	3.9
30	62.0	55.3	58.0	8.2

$$\frac{\Sigma \, DBLB}{30} = 56.06$$

DATA FOR WEATHER DATA FOR WASHINGTON DC - TYPICAL YEAR ****************

AVERAGE DAILY VALUES FOR ** 033 ** MAY

DATE	DRY BLB	DEW PNT	WET BLB	CLD CVR
1	50.0	45.2	47.5	10.0
2	52.7	37.3	45.1	2.3
3	54.3	44.2	48.9	9.7
4	61.3	46.3	52.8	1.6
5	62.8	49.1	54.8	.4
6	62.7	49.0	54.7	.3
7	67.3	53.3	58.6	3.2
8	74.4	55.2	63.8	3.9
9	79.8	53.9	63.7	8.0
10	76.3	42.2	57.3	2.6
11	71.5	45.1	56.6	2.5
12	70.4	57.4	62.2	7.4
13	68.0	63.0	64.6	8.9
14	64.9	48.9	55.7	4.8
15	57.5	46.2	51.3	4.5
16	65.5	53.3	58.0	.5
17	68.5	58.4	62.1	3.6
18	72.5	54.2	61.3	1.0
19	77.2	56.6	63.9	1.5
20	76.0	52.4	61.6	2.6
21	63.9	40.7	51.6	.2
22	72.2	55.9	61.8	.9
23	79.8	61.8	67.9	.8
24	80.3	63.0	68.6	3.5
25	77.0	45.7	59.2	3.3
26	72.0	45.8	57.0	2.5
27	77.7	54.8	63.3	5.1
28	65.1	42.0	52.6	6.6
29	63.5	41.3	51.8	3.0
30	64.4	44.3	53.3	2.1
31	66.7	46.9	55.5	5.3

$$\frac{\Sigma \text{DBLB}}{31} = 63.26\,^{\circ}\text{F}$$

AVERAGE DAILY VALUES FOR ** JUN *** **

DATE	DRY BLB	DEW PNT	WET BLB	CLD CVR
1	56.7	53.0	54.5	7.0
2	67.0	47.8	56.0	.2
~~3~~	~~69.7~~	~~49.2~~	~~57.7~~	~~.3~~
4	73.2	53.5	63.6	1.6
5	77.3	61.7	66.9	.5
6	73.3	64.7	68.9	2.8
7	74.9	69.1	70.8	7.0
~~8~~	~~74.3~~	~~69.2~~	~~70.7~~	~~5.8~~
9	79.8	71.4	73.7	5.7
10	77.2	59.7	65.9	3.7
11	73.1	54.7	61.8	1.7
12	68.3	58.2	61.9	9.0
~~13~~	~~66.8~~	~~63.2~~	~~65.1~~	~~9.6~~
14	60.7	55.3	57.5	10.0
15	66.4	53.4	58.5	3.3
16	69.5	57.0	61.6	2.8
17	67.9	63.1	64.7	8.9
~~18~~	~~70.5~~	~~63.5~~	~~65.8~~	~~7.3~~
19	74.9	66.1	68.8	4.5
20	79.0	67.9	71.2	1.9
21	81.8	71.0	74.0	1.0
22	79.8	66.9	70.9	3.7
~~23~~	~~80.9~~	~~61.5~~	~~65.0~~	~~.7~~
24	72.9	49.9	59.2	.3
25	76.0	62.5	66.9	1.3
26	81.6	68.0	72.0	.9
27	81.5	66.4	71.0	3.9
~~28~~	~~80.3~~	~~70.7~~	~~73.4~~	~~7.4~~
29	81.5	70.7	73.7	7.2
30	83.7	65.8	71.4	2.0

$$\frac{\Sigma \, DBLD}{30} = 74.25\,°F$$

DATA FOR WEATHER DATA FOR WASHINGTON DC - TYPICAL YEAR ****************

AVERAGE DAILY VALUES FOR ** JUL **

DATE	DRY BLB	DEW PNT	WET BLB	CLD CVR
1	84.1	64.4	70.5	7.2
2	80.6	66.0	70.5	8.3
~~3~~	~~82.1~~	~~68.8~~	~~72.6~~	~~3.2~~
4	77.9	62.1	67.5	6.1
5	76.1	49.4	60.1	1.4
6	77.1	49.2	60.5	.3
7	78.5	56.6	64.5	2.0
~~8~~	~~72.9~~	~~64.3~~	~~67.2~~	~~8.4~~
9	73.5	61.0	65.2	5.4
10	76.5	61.4	66.4	1.8
11	80.1	60.8	67.3	2.0
12	76.1	65.4	68.8	7.7
~~13~~	~~77.3~~	~~67.8~~	~~70.7~~	~~9.3~~
14	79.2	63.5	68.6	3.0
15	80.9	64.0	69.5	1.0
16	81.0	64.8	69.9	3.0
17	82.7	66.9	71.6	2.2
~~18~~	~~79.2~~	~~67.1~~	~~70.7~~	~~5.0~~
19	81.4	68.0	71.9	5.9
20	79.3	70.1	72.7	4.7
21	78.7	70.4	72.7	5.2
22	78.9	69.9	72.5	7.8
~~23~~	~~80.9~~	~~70.8~~	~~73.6~~	~~6.0~~
24	75.9	68.5	70.7	9.0
25	70.7	63.7	66.1	10.0
26	73.2	65.8	68.1	7.8
27	79.3	68.3	71.5	.5
~~28~~	~~80.7~~	~~72.1~~	~~74.5~~	~~6.2~~
29	83.5	71.1	74.5	6.5
30	80.0	53.0	64.4	2.2
31	74.1	51.4	60.4	1.3

$$\frac{\Sigma \text{ DBLB}}{31} = 78.46\ ^\circ F$$

DATA FOR WEATHER DATA FOR WASHINGTON DC - TYPICAL YEAR ****************

AVERAGE DAILY VALUES FOR ** AUG **

DATE	DRY BLB	DEW PNT	WET BLB	CLD CVR
1	78.8	62.7	68.1	3.5
2	77.0	58.3	64.9	1.8
~~3~~	~~74.9~~	~~62.8~~	~~66.8~~	~~6.4~~
4	74.2	66.3	68.8	8.7
5	79.6	72.9	74.7	9.0
6	76.5	71.9	73.7	5.0
7	80.3	70.8	73.5	8.7
~~8~~	~~81.3~~	~~66.2~~	~~70.7~~	~~4.2~~
9	73.9	64.1	67.3	8.4
10	67.3	59.8	62.5	8.2
11	68.7	57.9	61.9	5.9
12	71.3	58.6	63.1	1.7
~~13~~	~~74.1~~	~~64.1~~	~~67.3~~	~~5.6~~
14	77.4	61.7	67.1	5.0
15	73.7	57.5	63.4	.6
16	78.0	70.0	72.3	7.1
17	77.6	66.4	69.9	4.3
~~18~~	~~73.7~~	~~50.8~~	~~60.1~~	~~2.1~~
19	75.2	61.2	65.9	2.9
20	85.3	71.2	75.0	4.1
21	83.8	69.3	73.6	7.0
22	78.1	59.1	65.9	2.7
~~23~~	~~72.2~~	~~58.7~~	~~63.6~~	~~2.3~~
24	72.5	56.4	62.4	3.7
25	74.2	61.5	65.8	3.2
26	76.6	64.3	68.3	2.6
27	75.7	70.2	71.8	7.3
~~28~~	~~76.6~~	~~64.5~~	~~68.5~~	~~7.5~~
29	78.2	58.7	65.5	.0
30	80.4	60.0	66.9	.0
31	80.4	64.8	69.6	1.5

$$\frac{\Sigma \text{ DBLB}}{31} = 76.44\ ^\circ F$$

DATA FOR WEATHER DATA FOR WASHINGTON DC - TYPICAL YEAR ****************

AVERAGE DAILY VALUES FOR ** SEP **

DATE	DRY BLB	DEW PNT	WET BLB	CLD CVR
1	85.3	69.0	73.7	1.8
2	85.6	66.5	72.3	.0
~~3~~	~~84.8~~	~~71.2~~	~~75.0~~	~~.0~~
4	82.7	72.3	75.2	3.2
5	76.7	70.0	71.9	6.6
6	62.4	60.4	61.2	10.0
7	70.5	55.0	60.9	4.1
~~8~~	~~68.5~~	~~51.2~~	~~58.3~~	~~1.0~~
9	66.5	46.9	55.5	.1
10	65.5	49.4	56.2	.2
11	66.5	53.2	58.5	.2
12	70.8	62.2	65.1	7.6
~~13~~	~~62.7~~	~~44.0~~	~~52.9~~	~~1.9~~
14	61.8	41.5	51.1	4.7
15	71.6	56.0	61.7	2.2
16	73.2	54.4	61.6	1.0
17	66.7	48.2	56.1	.3
~~18~~	~~64.3~~	~~50.9~~	~~56.4~~	~~.0~~
19	69.1	58.7	62.5	7.2
20	71.7	63.5	66.2	8.5
21	67.9	59.8	62.7	7.9
22	59.6	44.7	51.6	1.7
~~23~~	~~57.5~~	~~40.2~~	~~48.7~~	~~.0~~
24	58.7	45.9	51.6	.3
25	64.0	55.6	58.8	6.7
26	69.2	60.6	63.7	7.2
27	68.9	63.1	65.1	6.7
~~28~~	~~66.3~~	~~53.1~~	~~58.3~~	~~.0~~
29	70.0	52.0	59.1	.0
30	73.1	58.7	63.9	.1

$$\frac{\Sigma\ DBLB}{30} = 69.42\ ^\circ F$$

DATA FOR WEATHER DATA FOR WASHINGTON DC - TYPICAL YEAR ****************

AVERAGE DAILY VALUES FOR ** 000 ** OCT

DATE	DRY BLB	DEW PNT	WET BLB	CLD CVR
1	59.2	44.2	51.2	1.1
2	60.0	50.9	54.6	4.3
3	65.6	53.2	58.3	1.4
4	59.3	47.2	52.5	9.2
5	60.2	52.7	55.7	5.4
6	66.3	59.9	62.3	9.0
7	61.1	46.5	53.0	1.4
8	56.1	50.2	52.7	7.4
9	58.6	55.5	56.7	9.1
10	61.8	51.9	55.9	.7
11	67.5	51.7	58.0	.9
12	66.7	51.6	57.7	2.3
13	64.2	58.0	60.3	3.0
14	67.3	62.0	63.8	3.7
15	69.2	64.0	65.7	4.5
16	69.5	61.5	64.3	5.2
17	65.3	52.1	57.5	1.0
18	64.9	47.6	55.0	1.2
19	63.4	59.5	60.9	7.8
20	58.3	48.3	53.2	6.5
21	47.0	31.4	40.1	2.0
22	48.9	37.2	43.2	1.0
23	52.3	45.2	48.6	7.9
24	49.3	28.8	40.8	3.7
25	47.2	28.1	39.0	.0
26	46.3	35.4	41.4	5.3
27	52.5	46.2	49.0	9.7
28	52.6	43.4	50.3	9.7
29	53.5	44.7	48.8	8.2
30	53.6	41.1	47.2	4.2
31	53.2	50.3	51.6	10.0

$$\frac{\Sigma \, DBLB}{31} = 58.75\,^{\circ}F$$

DATA FOR WEATHER DATA FOR WASHINGTON DC - TYPICAL YEAR ****************

AVERAGE DAILY VALUES FOR ** ??? ** NOV

DATE	DRY BLB	DEW PNT	WET BLB	CLD CVR
1	54.6	38.5	46.7	3.1
2	57.1	41.0	48.6	.6
3	60.2	40.9	50.1	2.1
4	56.1	28.4	43.8	7.3
5	43.0	24.4	35.6	6.0
6	32.7	28.0	30.9	10.0
7	36.2	25.5	32.0	3.4
8	41.4	25.7	33.0	.0
9	45.9	27.2	36.1	1.6
10	45.1	30.7	38.9	6.0
11	44.1	32.0	38.7	.1
12	44.5	36.1	40.5	.7
13	44.3	37.9	41.2	1.9
14	40.4	37.3	38.9	5.5
15	49.5	38.3	43.8	4.2
16	54.4	40.7	47.2	.0
17	52.7	36.9	44.9	.7
18	50.0	36.1	43.3	.2
19	50.9	38.0	44.4	.5
20	53.1	43.9	48.1	.8
21	56.0	53.5	54.5	9.5
22	61.4	59.5	60.2	9.6
23	57.5	47.9	52.5	7.7
24	47.2	40.5	43.9	7.9
25	46.5	38.3	42.9	8.5
26	40.3	23.0	33.6	4.2
27	36.2	27.8	33.0	7.5
28	36.9	29.3	34.0	6.5
29	38.0	25.0	32.9	2.6
30	43.6	29.0	37.5	8.2

$$\frac{\Sigma \text{ DBLB}}{30} = 47.53\ °F$$

DATA FOR WEATHER DATA FOR WASHINGTON DC - TYPICAL YEAR ***************

AVERAGE DAILY VALUES FOR ** 033 ** DEC

DATE	DRY BLB	DEW PNT	WET BLB	CLD CVR
1	39.8	25.8	34.2	9.7
2	36.0	26.2	32.3	5.3
3	32.3	20.2	28.1	2.9
4	34.5	22.2	29.9	7.1
5	38.7	28.1	34.4	7.6
6	26.8	10.7	22.4	3.5
7	27.7	10.2	22.9	.0
8	32.4	14.3	26.5	2.5
9	41.0	32.1	37.6	9.6
10	39.3	24.0	33.4	6.8
11	36.1	21.9	30.8	4.9
12	32.9	23.1	29.4	7.0
13	35.7	34.1	35.1	9.9
14	42.3	40.4	41.3	9.5
15	40.7	33.2	37.4	7.2
16	40.0	26.0	34.4	7.8
17	36.3	30.4	33.9	8.6
18	43.0	36.1	40.0	9.4
19	36.9	23.5	31.8	2.2
20	28.3	12.3	24.0	2.0
21	23.2	5.1	19.4	.2
22	25.2	10.0	21.1	.5
23	30.3	22.0	32.0	3.6
24	44.5	26.7	37.2	6.3
25	36.4	19.2	30.3	.0
26	35.7	22.8	30.7	.0
27	41.2	31.6	36.9	.8
28	51.9	47.2	49.3	6.0
29	49.7	49.2	49.4	10.0
30	43.7	35.7	41.3	3.2
31	39.5	30.9	35.8	4.2

$$\frac{\Sigma \text{DBLB}}{31} = 37.16\ ^\circ F$$

C.3.2 Daily Energy Use Profiles (with examples of heat generation)

Project MIUS - ST. CHARLES Structure

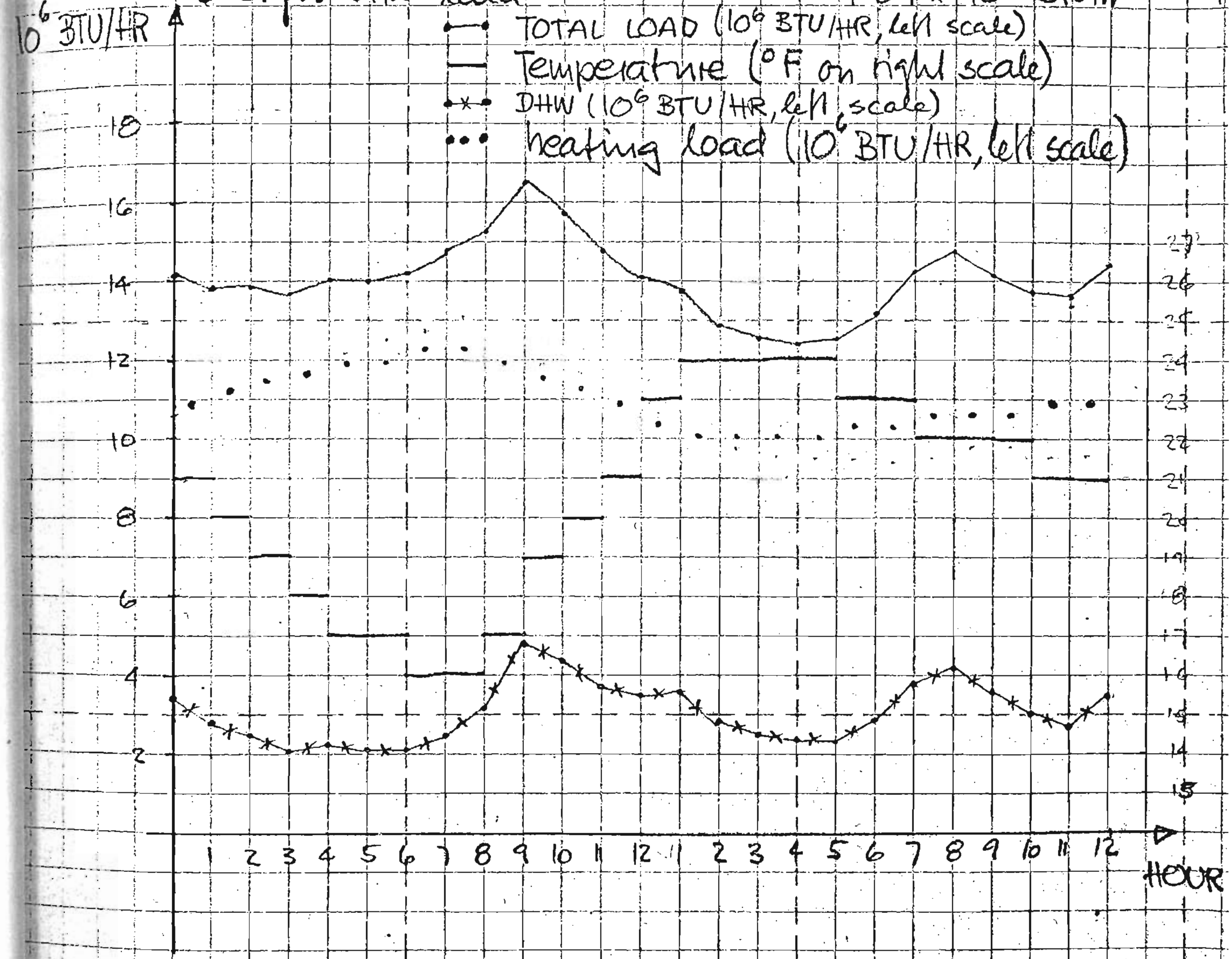
For

Daily energy use profiles

Daily energy use profile (winter design day)

Design heating load (16°F) : 12.22×10^6 BTU/h

Design DHW load : 4.89×10^6 BTU/h

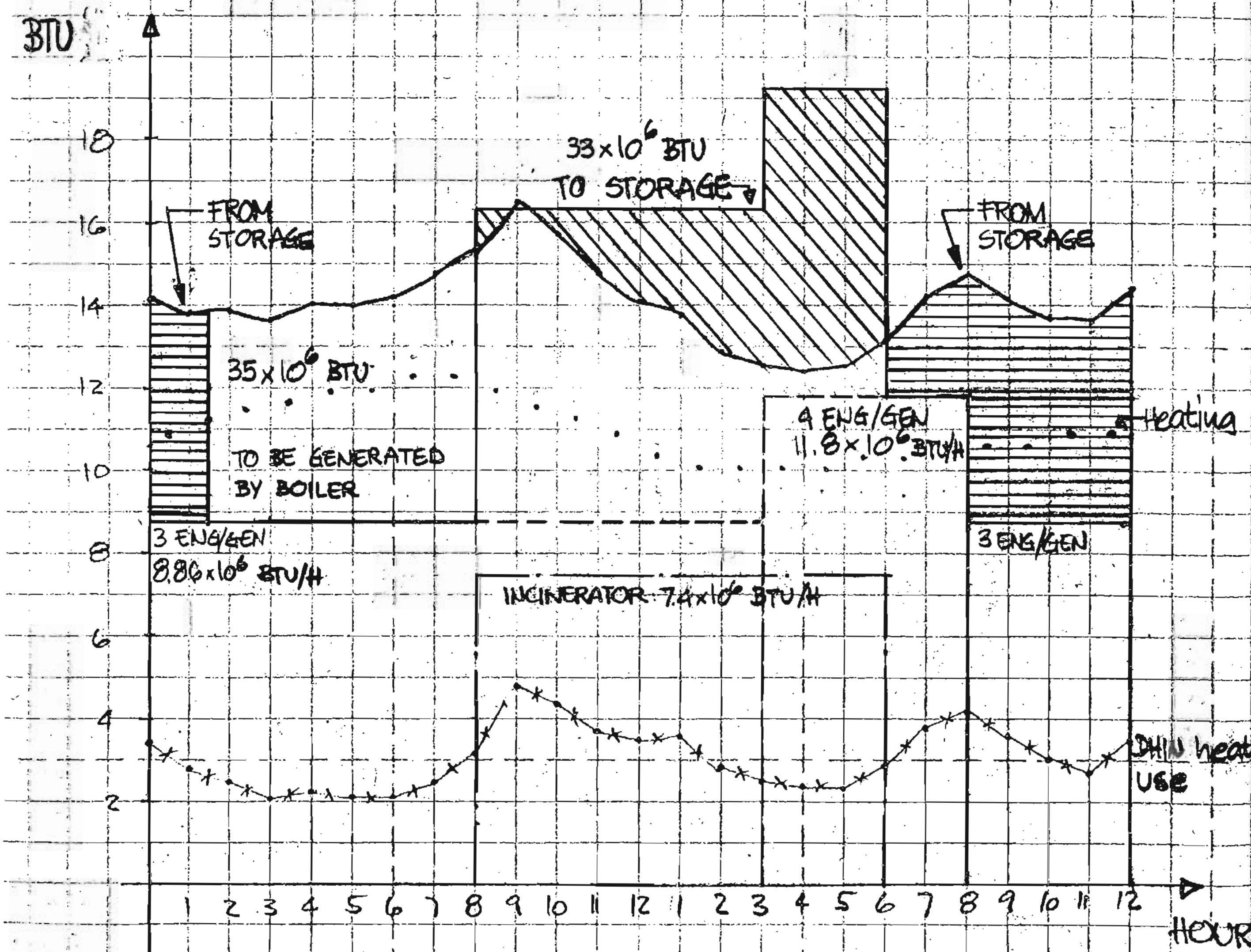


Project MIUS - ST. CHARLES Structure

For

Daily energy generation (winter design day)
(Incineration during daytime)

Conclusions:
- 3 Engine Generators run 19 hours a day
- 4 Engine Generators run 5 hours a day
- Boiler runs 6½ hours a day for 35×10^6 BTU a day

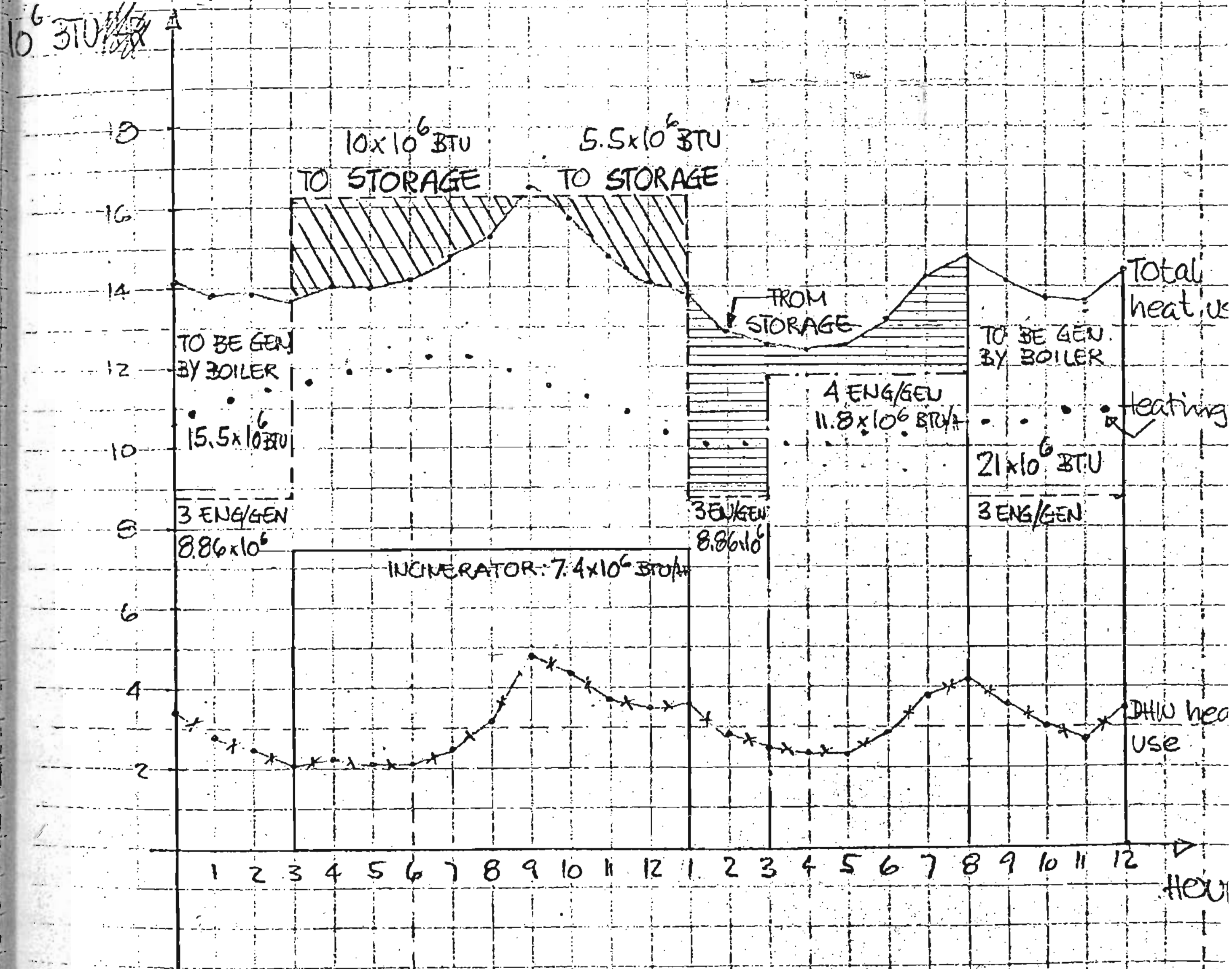


Project MIUS - ST. CHARLES Structure

For

Daily energy generation (winter design day)
(night incineration)

Conclusions: -3 Engine Generators run 19 hours a day
-4 Engine Generators run 5 hours a day
-Boiler runs 7 hours a day for 36.5 BTU

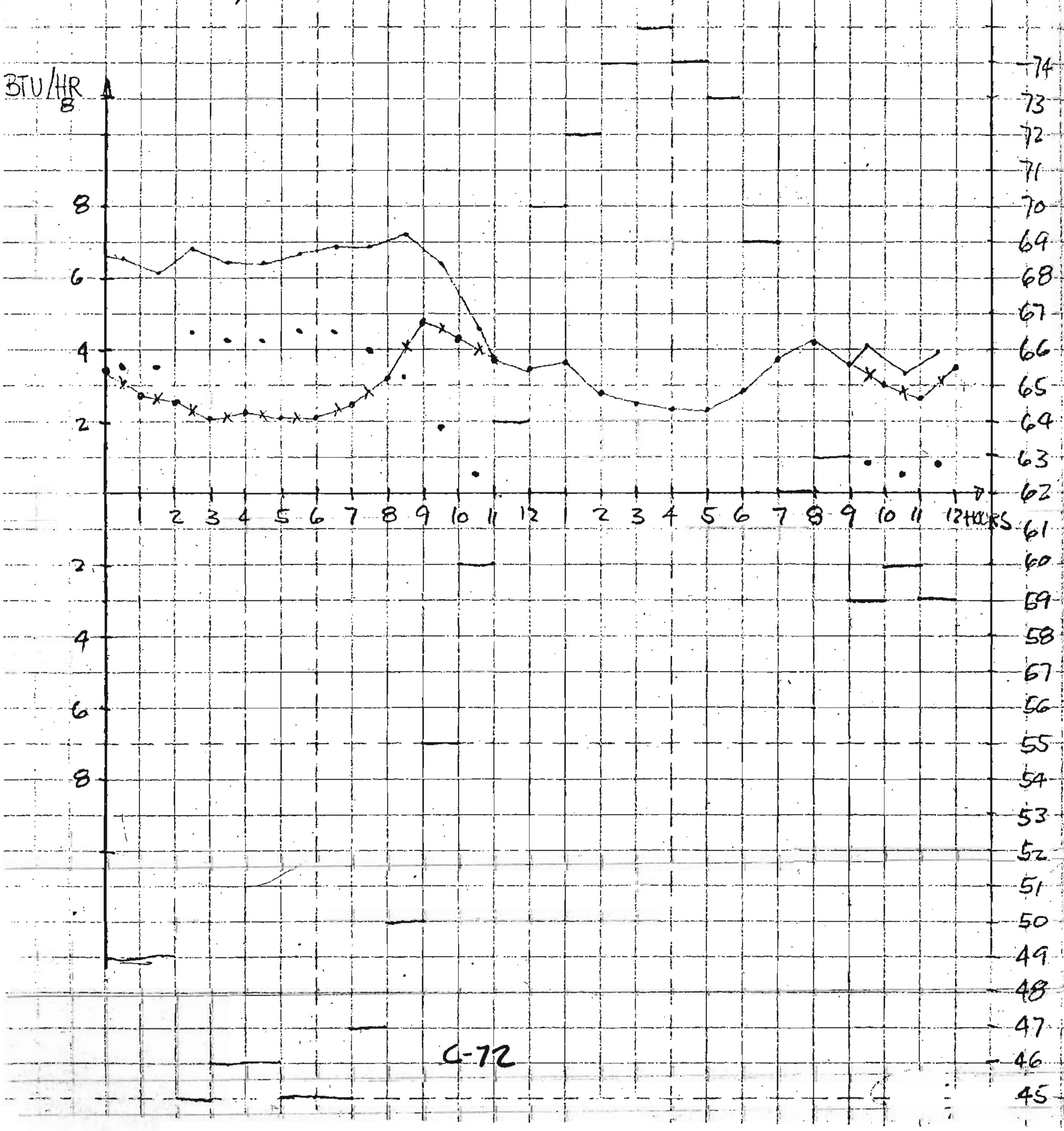


Project MIUS - ST. CHARLES Structure

For

Daily energy use profile (spring and fall)

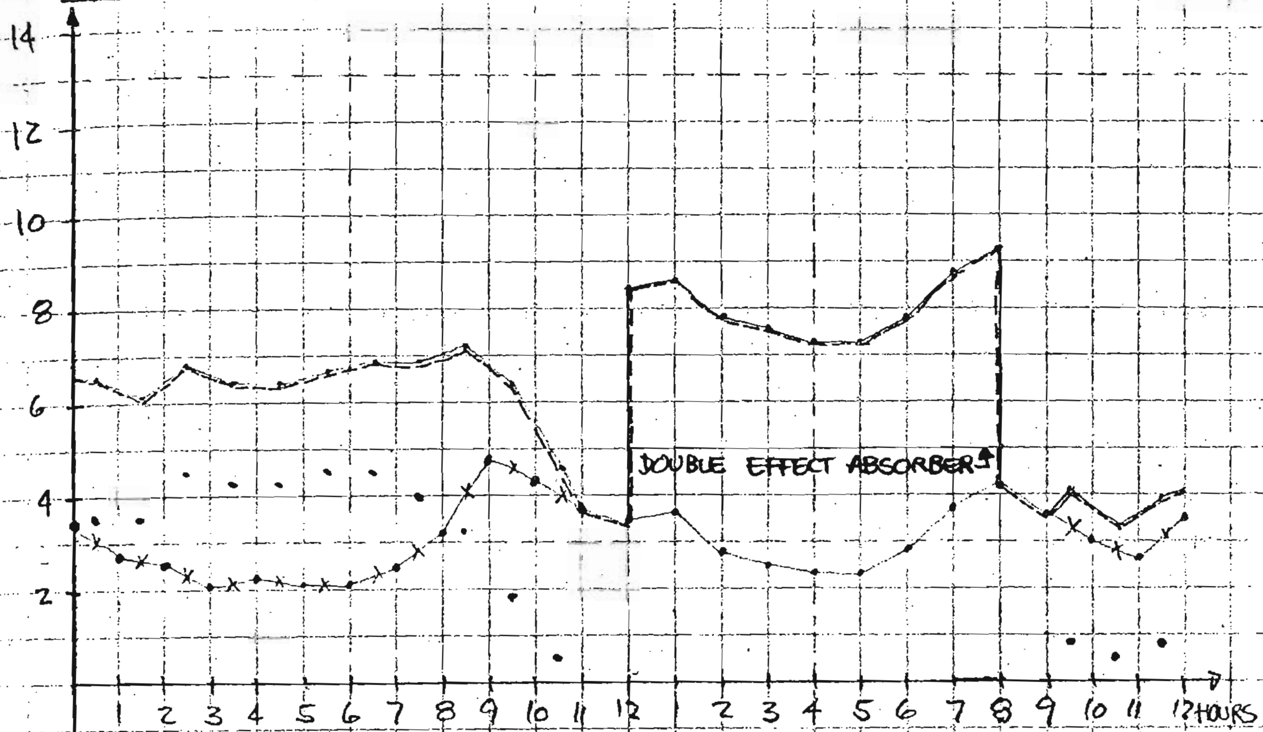
Average "design" temp. for heating load : 45°
(assumed, data from weathertape printout)



Project MIUS – ST. CHARLES Structure

For

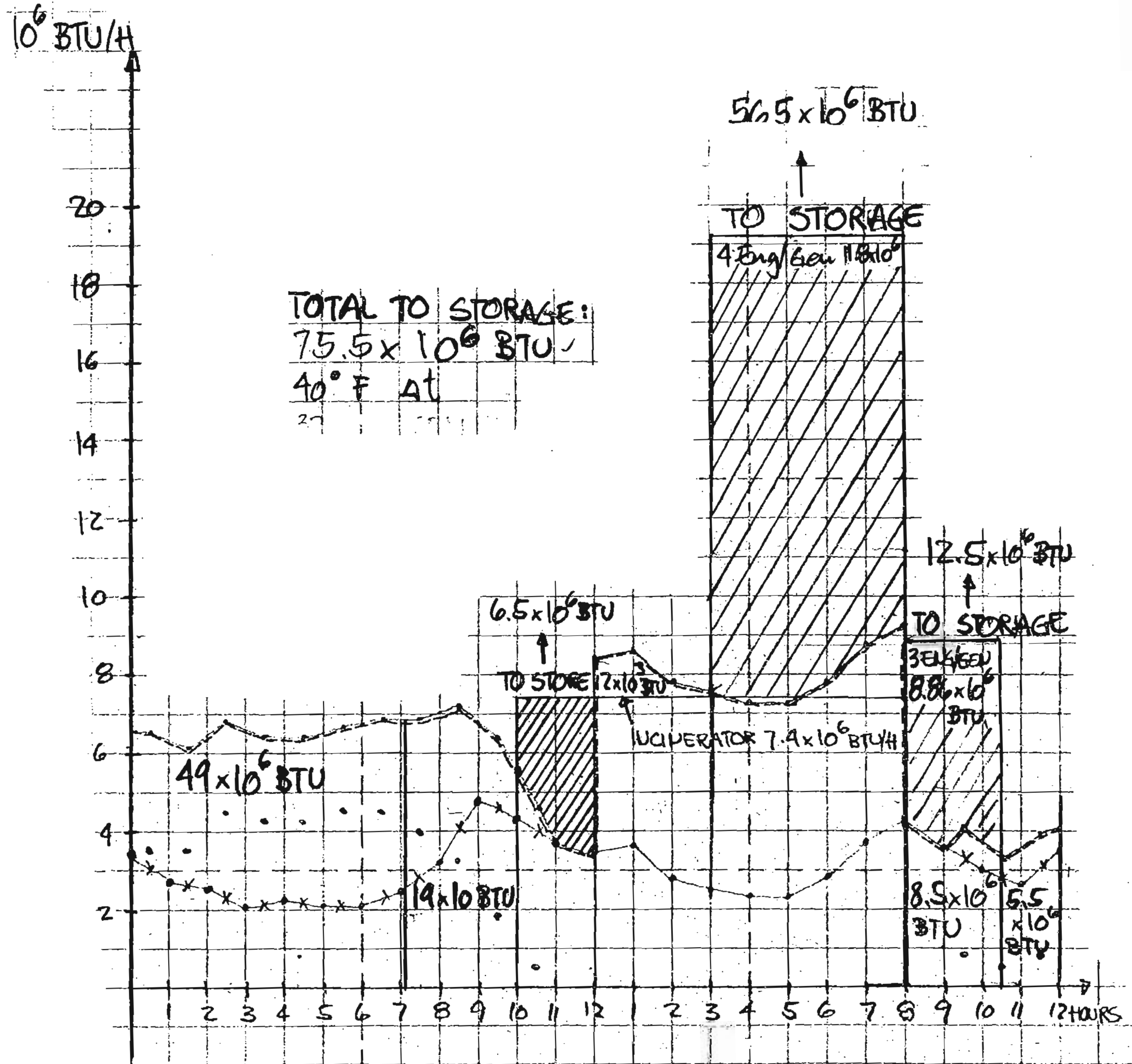
Daily energy use profile (spring and fall), heat for double effect absorption chiller included



Project MIUS - ST. CHARLES Structure

For

Daily energy generation (spring & fall)



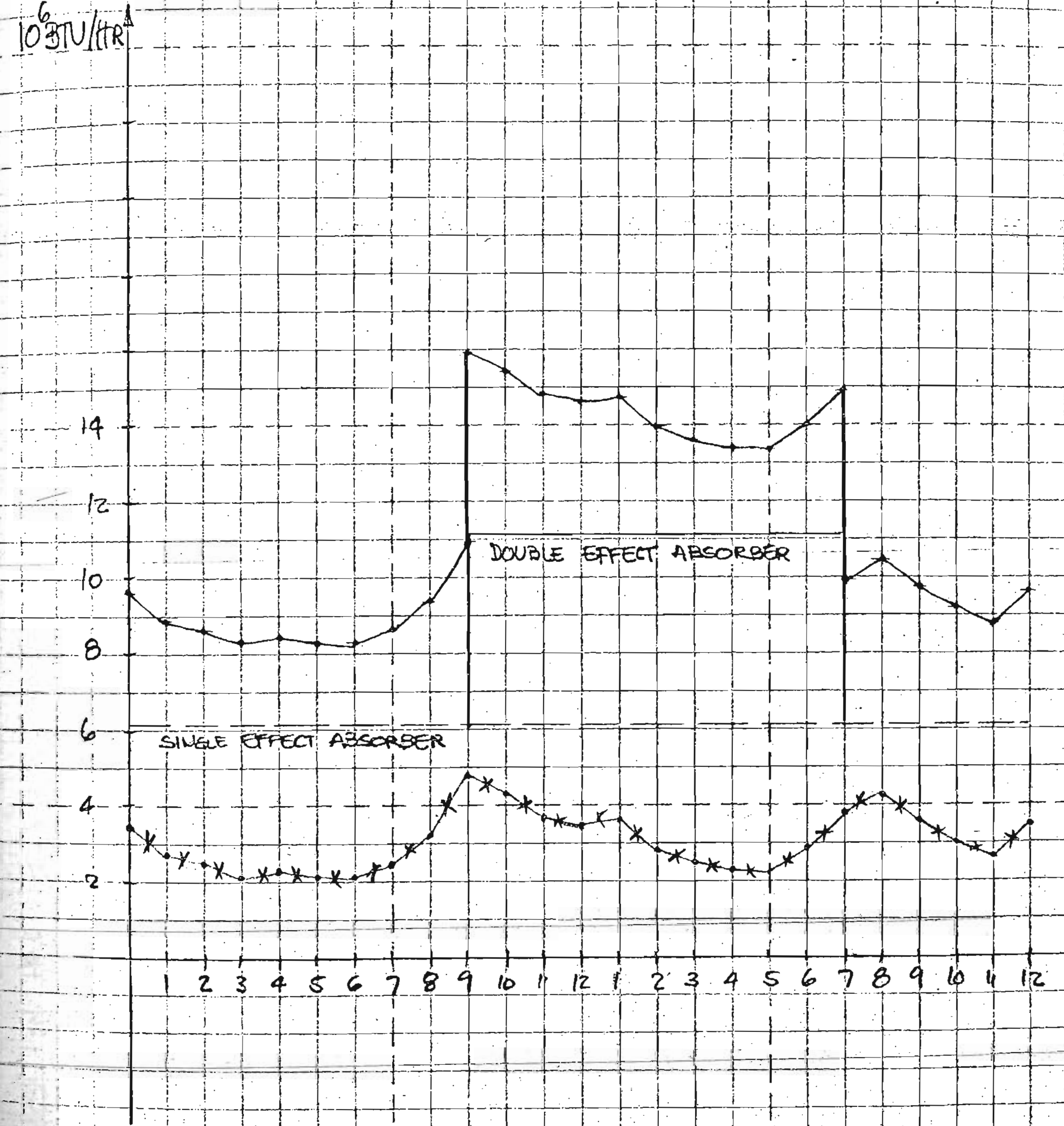
Conclusions: 3 Engine Generators run 2 1/2 hours a day
4 Engine Generators run 5 hours a day
Boiler does not operate

Project MWS - ST. CHARLES Structure

For

Daily energy use profile (summer)

(design day)

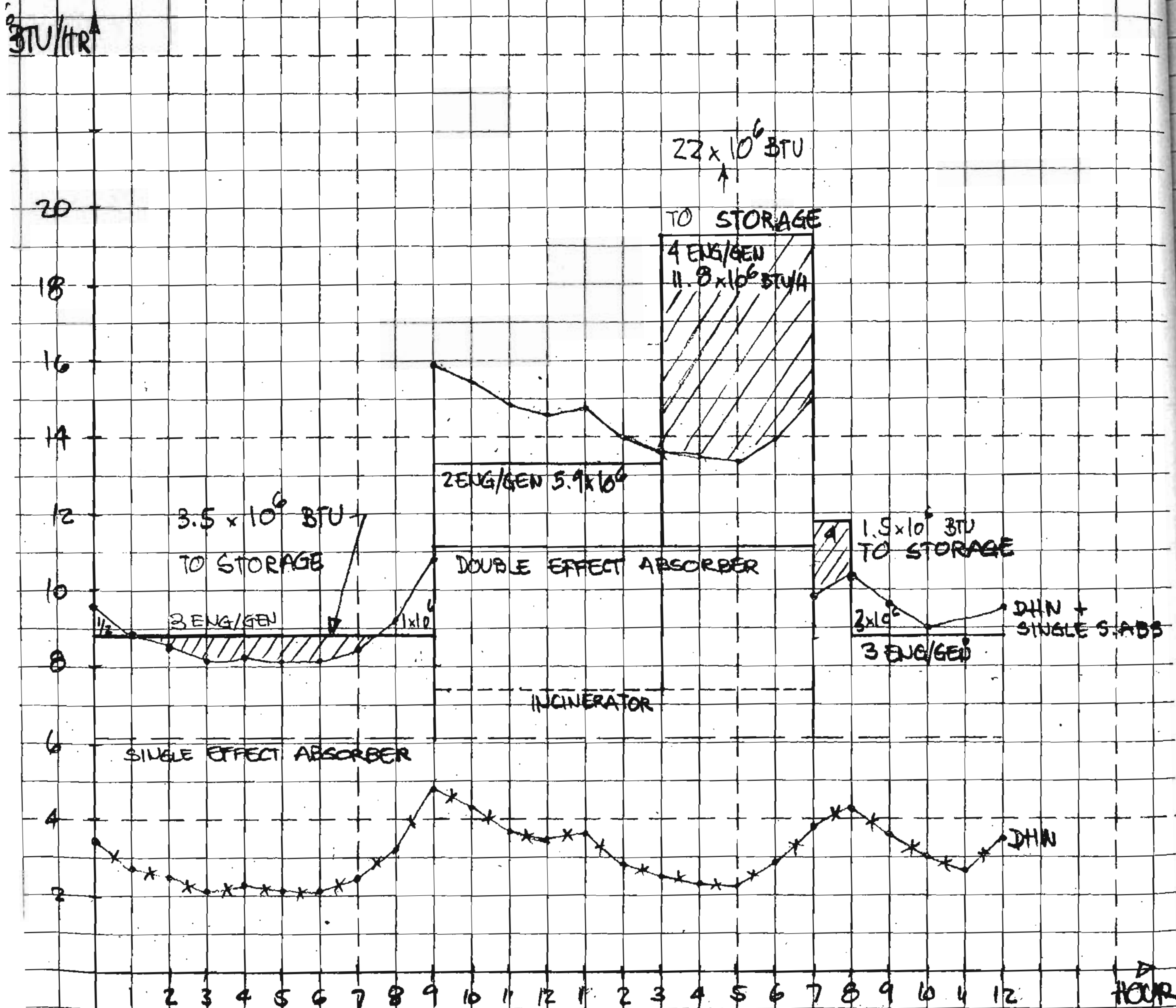


Project MWS - ST. CHARLES Structure

For

Daily energy generation (summer)

(design day)



Conclusions: 2 Eng. Gen. run 6 hours a day
3 Eng. Gen. run 13 hours a day
4 Eng. Gen. run 5 hours a day
Boiler does not operate

The domestic hot water demand profile is based on the "hourly flow profile for apartments" ASHRAE Handbook Systems 1974, S-37.16. The design DHW load is assumed as maximum DHW load. The heating load profile is plotted from values of "Weather Data for Washington" and with the assumption that load is proportional to outdoor temperature. The discontinuity in the heating load profile for winter, spring and fall is due to a daily temperature profile from "Weather Data for Washington, D.C." which represents a typical winter or spring and fall day. The outdoor temperature at 12 Midnight will very rare be identical to the temperature on the preceding day.

To arrive at a reasonable true picture of the component site cooling load profile, there are several factors to consider, including:

Project MIUS - ST. CHARLES Structure

For

- individual building orientation and building peak loads, diversity.
- variety of building uses (school, apartments, commercial)
- variety of room temperature settings in apartments
- different night setback and "morning cool down" schedules
- shading from other buildings or trees
- relative importance of the factors above is dificult to identify without definitive site information.

Therefore only a hypothetical profile can be generated
The profile will have a qualitative rather than a quantitative value.
Possible temperature profiles (Fig. 1) originate from the computer tape "Weather data for Washington, D.C.".
The indicated profile number shows the day of a year.
Along with this profile, solar radiation and shading and internal heat gains determine the shape of possible cooling

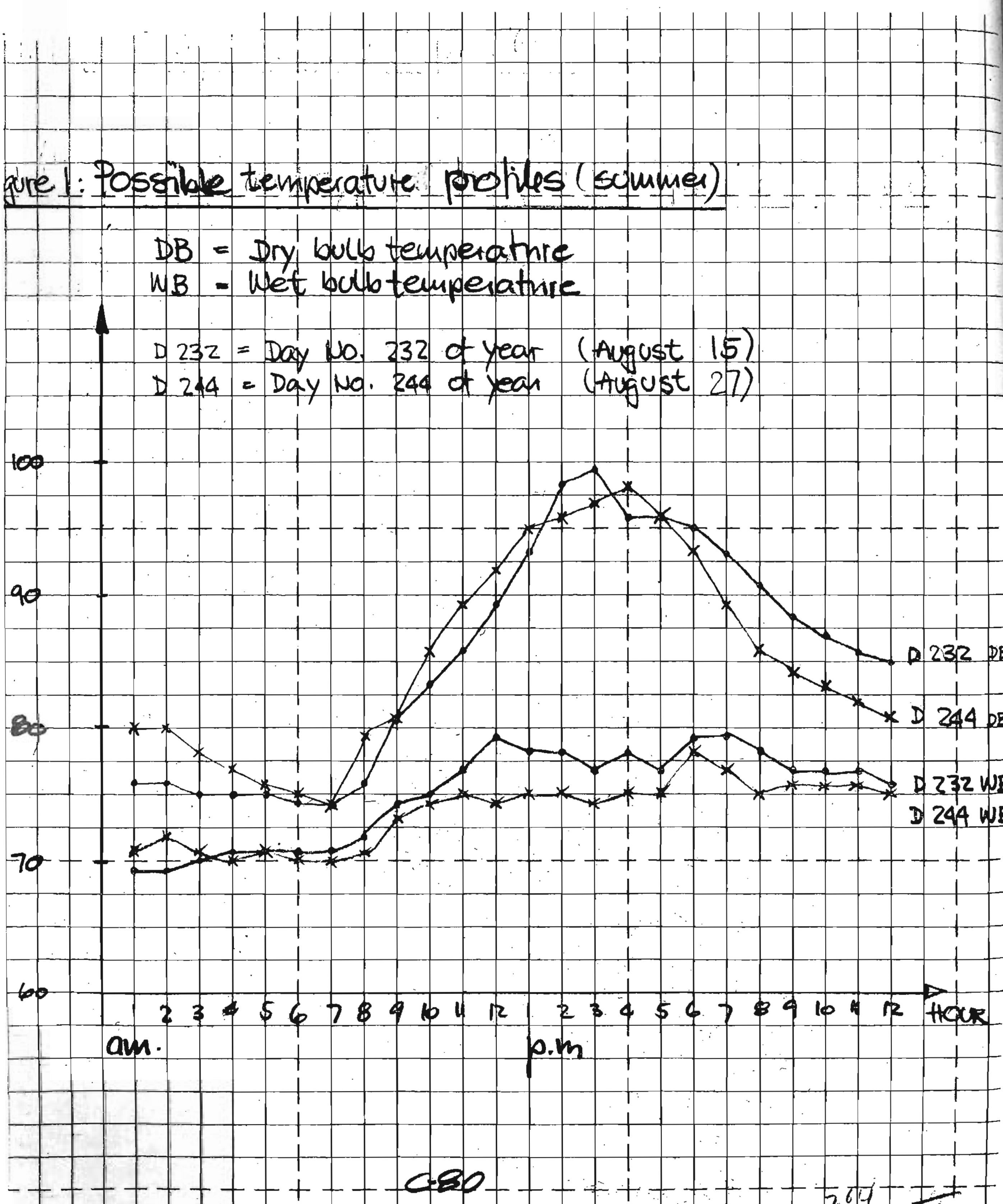
Project MIUS ST. CHARLES Structure

For

load profiles (Fig. 2). The actual figures originate from an extrapolated TCR hourly printout. (TCR = Total Coincident Requirements). The computer program from Meriwether and Associates may be used by anyone paying a royality fee. The program simulates one year of operation of one building or a building group and will provide coincident energy requirements.

Project MIUS - ST. CHARLES Structure

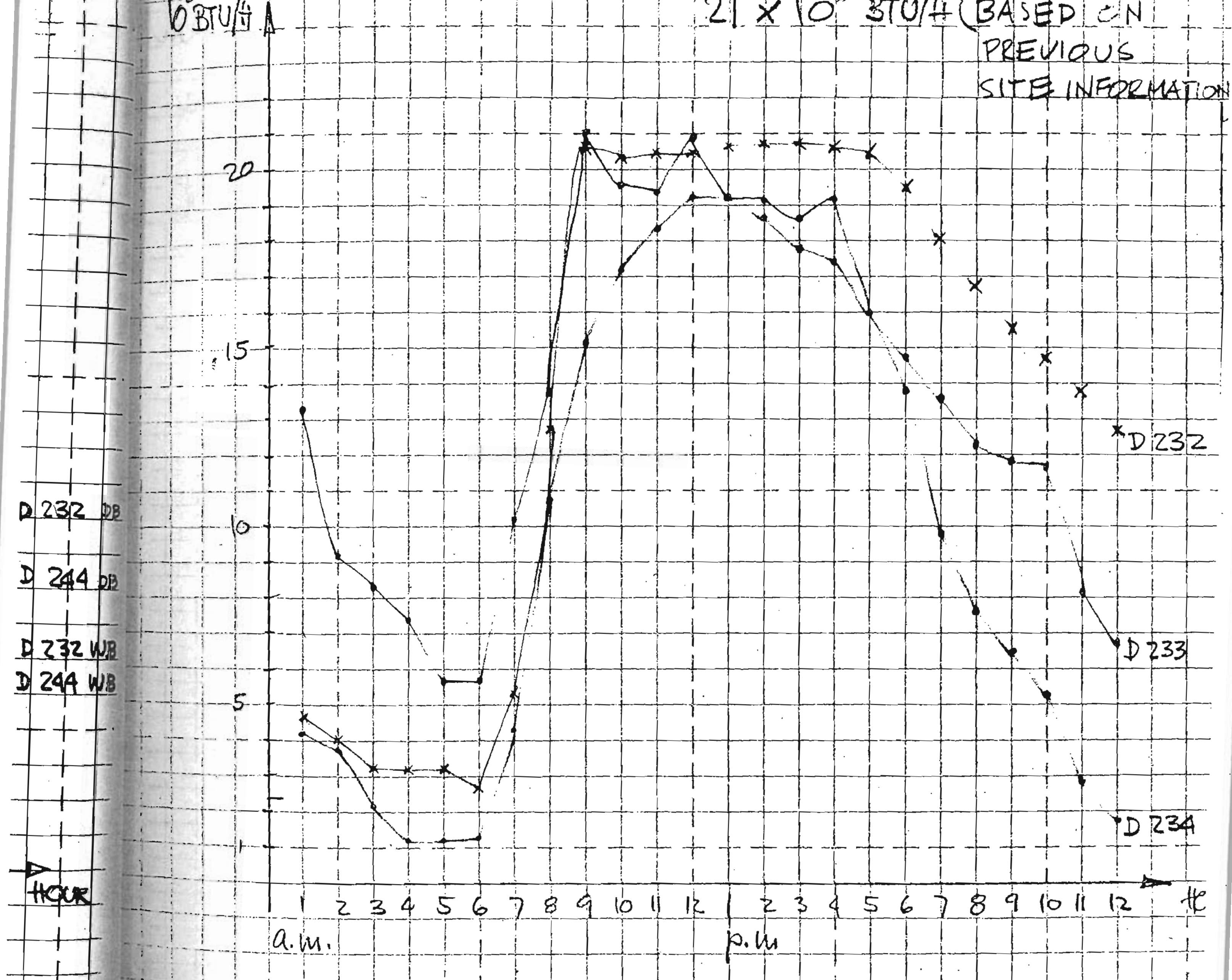
For



Project MIUS - ST. CHARLES Structure

For

Figure 2 : Possible cooling load profiles
(TCR DATA) REFERENCE PAGE C79
Assumed peak load for all buildings combined :
21 × 10^6 BTU/H (BASED ON PREVIOUS SITE INFORMATION

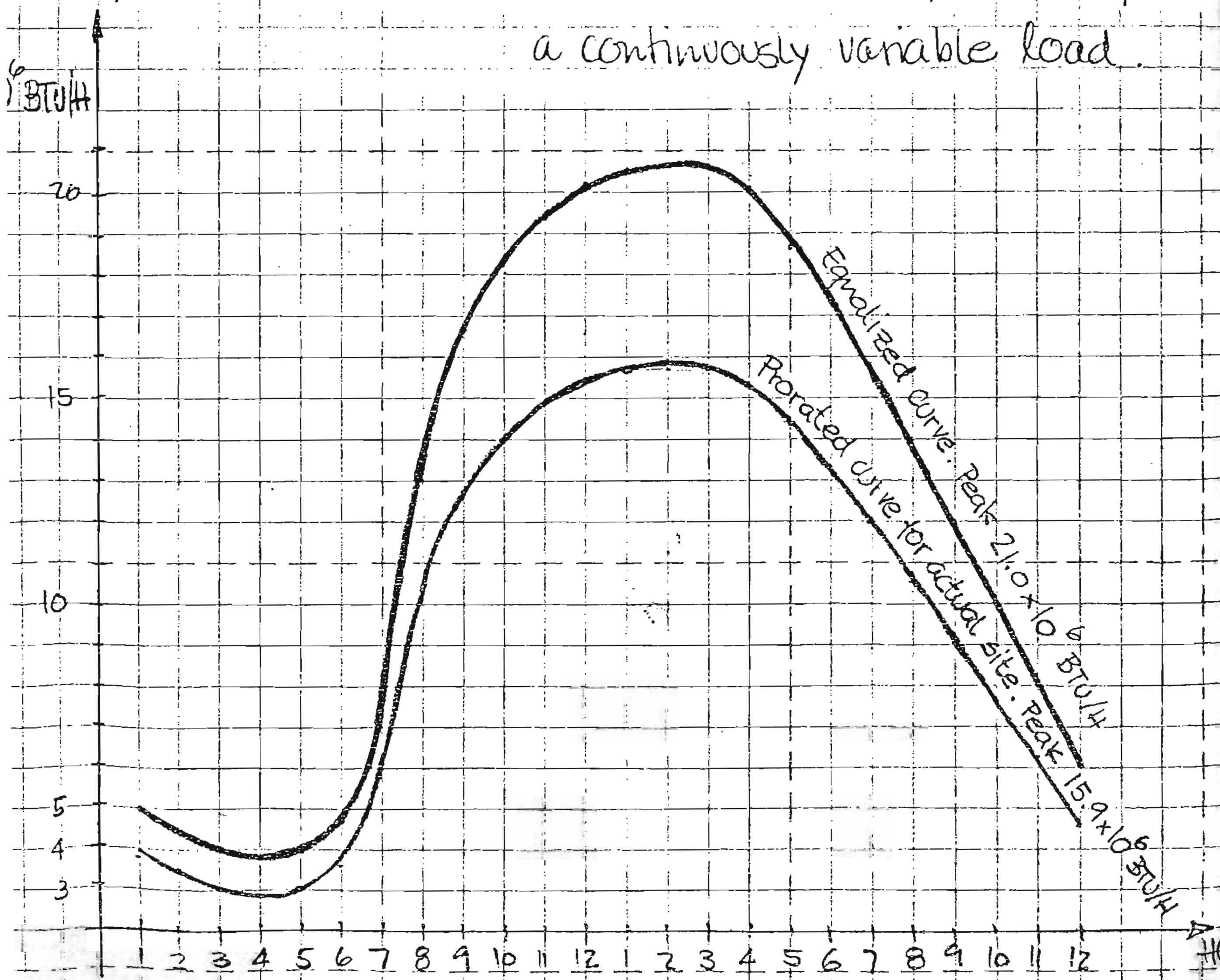


Project MIUS- ST. CHARLES Structure

For

Figure 3 : Site cooling load profile

This profile is based on possible cooling load profiles from Fig. 2. The combined effect of occupancy, thermostat settings, individual needs of tenants and other factors shown above will give the profile a final shape. What is important is the ability of the central plant to modulate its capacity to satisfy a continuously variable load.

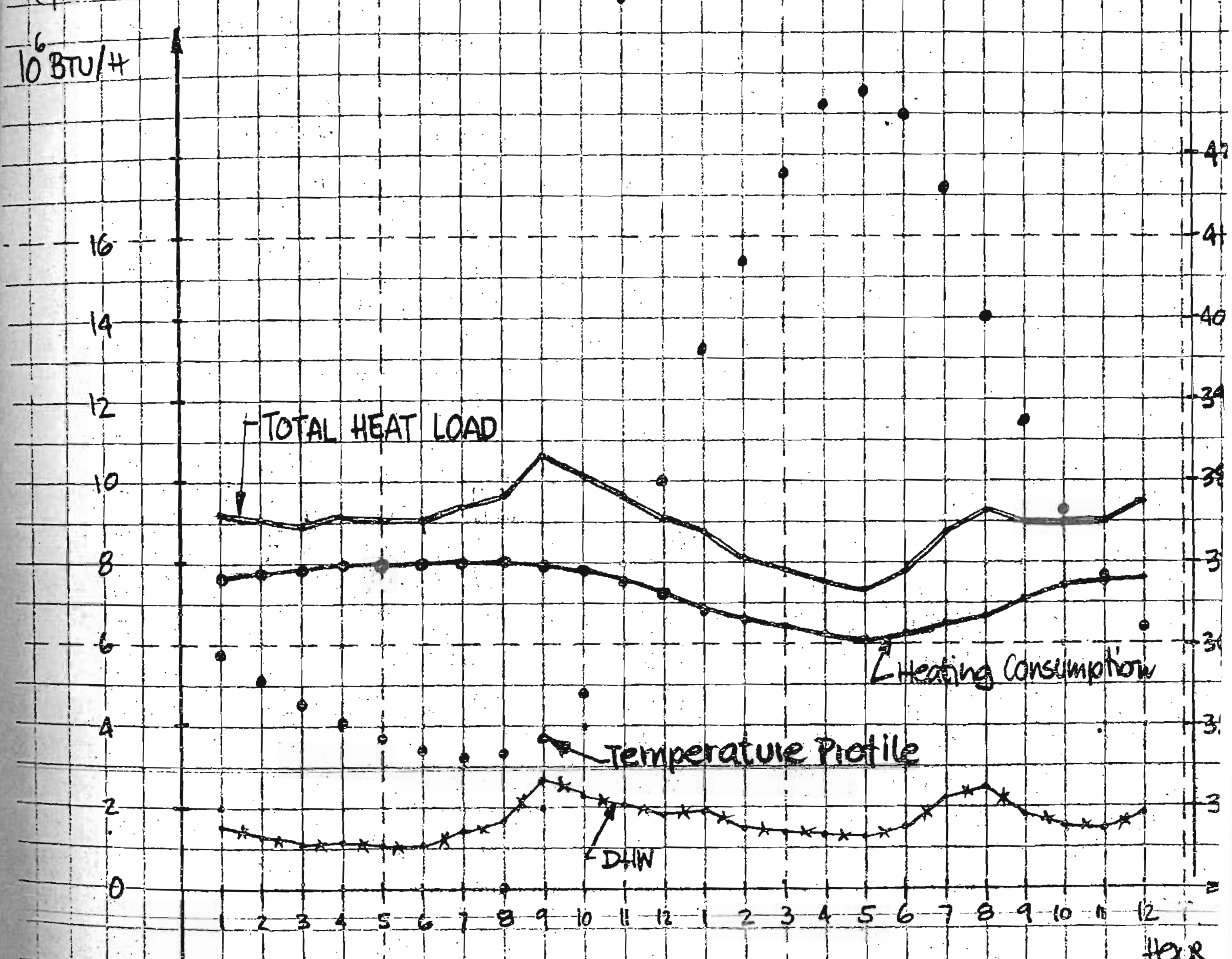


Project: MIUS - ST. CHARLES
Structure:
For:

Average Day Profiles

Average Energy Use Profile (Winter)

January, February, December Average Temperature* 37 °F
(from "Weather Data for Washington")



* METHOD OF PRORATING: NEXT PAGE

Project MIUS – ST CHARLES Structure
For

Procedure to provide demand for heating:

Δt_{Design} : 54°F , Design Heat Load : 12.22×10^6 BTU/H
($\Delta t_{Average \{ for\ Winter}}$ = 33 °F)

Demand for heating for x time : $\frac{12.22 \times 10^6 \times (70 - t_o)}{54}$

This equation does not take solar and internal heat gain into account. To arrive at resonable accurate consumption figures, the $\Delta t_{Average \{ for\ Winter}}$ could be based on 65°F. The example below shows how it is used in the degree-day method to compensate heat gains during daytime.

Example: $t_{Average\ in\ January}$: 36 °F

65 °F : $\Delta t_{AV.}$ = 29 °F

Consumption in January : $\frac{12.22 \times 10^6 \times 29 \times 24 \times 31}{54} = 4.88 \times 10^9$ BTU

Domestic Hot Water: The average demand stays between 50 and 60 % of the design load. Computer analysis simulates actual needs and cannot be replaced by a simplified manual method.

C-34

Project MIUS - ST. CHARLES Structure

For

Average Energy Use Profile (Spring and Fall)

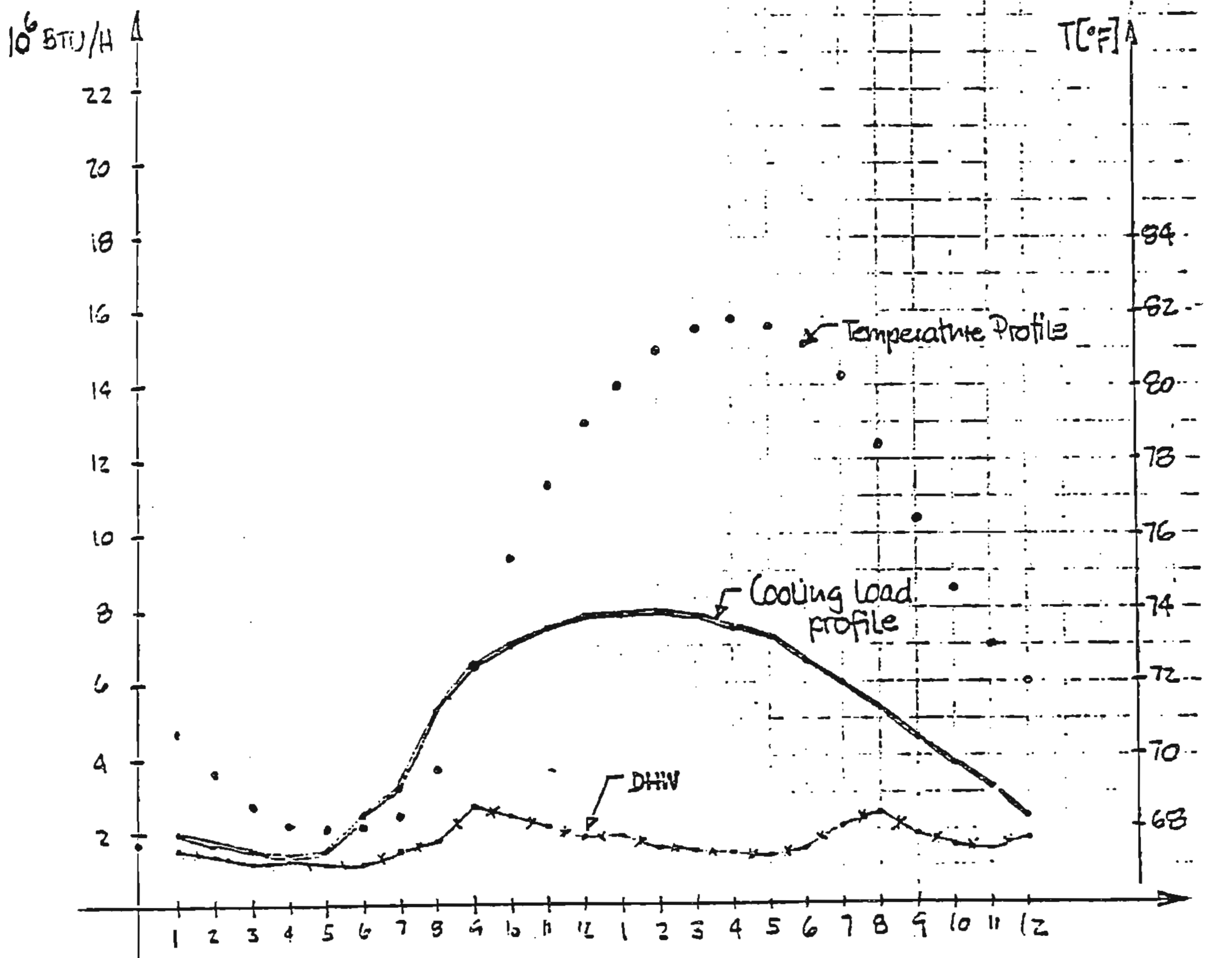
Since there is no design day for the in-between seasons as such, we call the average profile also typical. Depending on the cloud cover, both, demand for chilled water or for heating may occur. The two situations are shown on page C-72, C-73 and C-74.

Project MIUS - ST. CHARLES Structure

For

Average Energy Use Profile* (Summer)

June, July, August, September Average Temperature : 74.64°F
(from "Weather Data for Washington")



* prorated from Figure 3 (p.C-200),
cooling cut off temperature : 55°F
prorated proportional to outdoor temperatures.

C-86

Project: MIUS - ST. CHARLES Structure: ________

For: ________

Assumptions and conclusions

Winter

In winter thermal demand only is used to compute operating time for engine generators.

The incinerator can be operated during the night, when peak heating load occurs, or at any other desired time of a day, because reclaimed energy can be stored in the MTTS*. Both situations are shown on pages C-70 and C-71.

Spring and Fall

In spring and fall both, heating and cooling may be desired during one day (see temp. profile} page C-72)

Assumption: 62°F will be limit for heating cic

Assumption: Between 12 n and 8 p.m there will a demand for cooling capacity of a minimum of 391 TONS C-87

* Medium Temperature Storage Tanks.

Project MIUS - ST. CHARLES Structure

For

Summer

Assumption: 24-Hour demand for a minimum of 351 Tons cooling capacity and a 10-hour demand for a minimum of 742 Tons between 9 a.m. and 7 p.m.

Conclusions

The assumptions described above are conservative for design days. In reality, climatic influence, storage capacity of buildings, decisions by the plant manager and the availability of heat from the storage tanks will determine the mode in which the plant will be operating. In the Monthly Energy Analysis the profiles in this section are used as backgrounds to check daily and hourly capacity needs of chillers, boilers and storage tanks in order to arrive at a reasonably true picture of energy consumptions and fuel requirements in a typical year.

C-88

C.3.3 Monthly Energy Balance

MONTHLY ENERGY BALANCE

1/30/78

4 CATERPILLAR ENGINE GENERATORS
THERMAL TRACKING WITH 5 HOUR PER DAY PEAK SHARING

			JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	
1	DOMESTIC HOT WATER	10^6 BTU	729	661	733	566	583	519	538	536	565	729	710	723	7592	10^6 BTU
2	SPACE HEATING		4624	3544	2602	847	137	15	0	0	92	481	2213	4,349	18,904	
3	TOTAL OF ABOVE		5353	4205	3335	1413	720	534	538	536	657	1210	2923	5072	26496	
4	INCINERATOR HEAT AVAILABLE		1250	1,250	1250	1250	1,250	1250	1250	1250	1250	1,250	1,250	1,250	15,000	
5	DOUBLE EFFECT ABS. HEAT REQ.		0	0	376	921	1250	1250	1250	1250	1040	1040	0	0	8,377	
6	BALANCE 4-5: REST HEAT AVAIL.		1250	1250	874	329	0	0	0	0	210	210	1,250	1250	6,623	
7	ENG/GEN HEAT (FROM 5H/D GEN)		1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	15,360	
8	ENG/GEN HEAT (FROM DEMAND TRACKING)		2823	1,675	1285	12	385	738	1076	928	306	300	393	2542	12463	
9	TOTAL ENG/GEN HEAT AVAILABLE		4103	2955	2,565	1292	1665	2018	2356	2208	1586	1580	1,673	3822	27,823	
10	SINGLE EFFECT ABS. HEAT REQUIRED		0	0	104	208	945	1484	1818	1672	1139	580	0	0	7950	
1	BOILER HEAT REQUIRED	10^6 BTU	0	0	0	0	0	0	0	0	0	0	0	0	0	10^6 BTU
2	TOTAL COOLING REQUIRED	TON-H	0	0	35420	84059	206,551	218,637	307043	290220	212380	114,686	0	0	1,519,000	TON-H
3	DOUBLE EFFECT ABS COOLING		0	0	29420	72059	97,750	97,750	97,750	97,750	81,328	81,328	0	0	655,135	
4	SINGLE EFFECT ABS. COOLING		0	0	6,000	12,000	59,100	85,443	104,646	96,235	65,526	33,358	0	0	457,608	
5	ELECTRIC CHILLER COOLING	TON-H	0	0	0	0	59,400	85,443	104,646	96,235	65,526	0	0	0	406,250	TON-H
6	ELECTRICITY GENERATED (5H/D GEN.)	KWH	312000	312,000	312000	312,000	312,000	312,000	312000	312000	312,000	312000	312,000	312,000	3,744,000	KWH
7	ELECTRICITY GEN'D (DEMAND TRACKING)		688,500	408,500	313,500	2,900	93,900	190,000	262,400	226,300	74,600	73,200	95,800	620,000	3,039,600	
8	TOTAL ELECTRICITY GENERATED		1,000,500	720,500	625,500	314,900	405,900	497,000	574,400	538,300	386,600	385,200	407,800	932,000	6,783,600	
9	ELECTRICITY FOR PLANT USE		146,000	146,000	197,100	197,100	219,000	219,000	219,000	219,000	197,100	197,100	146,000	146,000	2,248,400	
10	ELECTRICITY FOR EL. COOLING		0	0	0	0	39,810	62,525	76,580	70,422	47,950	0	0	0	297,300	
1	ELECTRICITY TO VILLAGE CENTER		207,417	207,417	207,417	207,417	207,417	207,417	207,417	207,417	207,417	207,417	207,417	207,417	2,489,000	
2	TOTAL ELECTRICITY REQUIRED		353,417	353,417	404,517	404,517	466,227	488,942	502,997	496,839	452,467	404,517	353,417	353,417	5,034,700	
3	ELECTRICITY SOLD TO SMECO		647,083	446,650	371,986	205,236	209,120	234,170	261,290	247,900	200,080	242,966	267,150	578,583	3,912,205	
4	ELECTRICITY BOUGHT FROM SMECO		0	79,567	151,003	294,853	261,447	231,112	189,987	206,439	265,947	262,292	212,767	0	2,163,305	
5	FUEL FOR ENGINE GENERATORS	10^3 GAL	79	57	49	25	32	39	45	43	31	30	32	74	536	10^3 GAL
6	FUEL FOR BOILERS		0	0	0	0	0	0	0	0	0	0	0	0	0	
7	FUEL FOR INCINERATOR		3	3	3	3	3	3	3	3	3	3	3	3	36	
8	TOTAL FUEL REQUIRED	10^3 GAL	82	60	52	28	35	42	48	46	34	33	35	77	572	10^3 GAL
9																
10																

NOTE: *Monthly energy consumption totals of the MIUS site in Table 3-5 vary slightly from the figures in this table. All thermal and economic evaluations are based on this table, which was computed prior to Table 3-5. This is also the reason for slight differences in the monthly totals, whereas the yearly totals do coincide.*

Also Electricity Demand Tracking Was Investigated.
Figures Are Shown in the Following Table.

MONTHLY ENERGY ANALYSIS

1/30/78

4 CATS, SELECTIVE COGENERATION
ELECTRICITY DEMAND TRACKING PLUS 5H/D GEN

			JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	
1	DOMESTIC HOT WATER	10^6 BTU	729	661	733	566	583	519	538	536	565	729	710	723	7,592	10^6 BTU
2	SPACE HEATING		4624	3544	2602	847	137	15	0	0	92	481	2213	4349	18904	
3	TOTAL OF ABOVE		5353	4205	3335	1413	720	534	538	536	657	1210	2923	5072	26,496	
4	INCINERATOR HEAT AVAILABLE		1,250	1,250	1250	1,250	1250	1,250	1250	1,250	1,250	1,250	1,250	1,250	15,000	
5	DOUBLE EFFECT ABS. HEAT REQ.		0	0	376	921	1250	1250	1250	1250	1040	1,040	0	0	8,377	
6	BALANCE 4-5: REST HEAT AVAIL.		1,250	1,250	874	329	0	0	0	0	210	210	1,250	1250	6623	
7	ENG/GEN HEAT (FROM 5H/D GEN)		1280	1280	1280	1280	1280	1,280	1280	1,280	1280	1,280	1,280	1280	15360	
8	ENG/GEN HEAT (FROM DEMAND TRACKING)		1040	1040	1250	1214	1,315	1,330	1338	1,334	1244	1,214	1040	1,040	14,399	
9	TOTAL ENG/GEN HEAT AVAILABLE		2320	2,320	2530	2494	2,595	2610	2618	2614	2524	2494	2320	2320	29,759	
10	SINGLE EFFECT ABS. HEAT REQUIRED		0	0	16	31	945	1485	1818	1672	1,139	86	0	0	7192	
11	BOILER HEAT REQUIRED	10^6 BTU	1,783	635	-53	-1,379	-930	-591	-262	-406	-938	-1408	-647	1,502	3920	10^6 BTU
12	TOTAL COOLING REQUIRED	TON-H	0	0	35,420	84059	206551	268637	307043	290220	212,380	114,686	0	0	1,519,000	TON-H
13	DOUBLE EFFECT ABS COOLING		0	0	29,420	72,059	97,750	97,750	97,750	97,750	81,328	81,328	0	0	655,135	
14	SINGLE EFFECT ABS. COOLING		0	0	894	1,788	54,400	85,443	104,646	96,235	65,526	4,973	0	0	413,905	
15	ELECTRIC CHILLER COOLING	TON-H	0	0	5106	10,211	54,400	85,443	104,646	96,235	65,526	28,385	0	0	449,952	TON-H
16	ELECTRICITY GENERATED (5H/D GEN.)	KWH	312,000	312,000	312,000	312,000	312,000	312,000	312,000	312,000	312,000	312,000	312,000	312,000	3,744,000	KWH
17	ELECTRICITY GEN'D (DEMAND TRACKING)		253,750	253,750	304,795	296,181	320,844	324,275	326,414	325,456	303,400	296,154	253,750	253,750	3,512,519	
18	TOTAL ELECTRICITY GENERATED		565,750	565,750	616,795	608,181	632,844	636,275	638,414	637,456	615,400	608,154	565,750	565,750	7,256,519	
19	ELECTRICITY FOR PLANT USE		146,000	146,000	197,100	197,100	219,000	219,000	219,000	219,000	197,100	197,100	146,000	146,000	2,248,400	
20	ELECTRICITY FOR EL. COOLING		0	0	3,736	7,472	39,810	62,525	76,580	70,422	47,950	20,771	0	0	329,266	
21	ELECTRICITY TO VILLAGE CENTER		207,417	207,417	207,417	207,417	207,417	207,417	207,417	207,417	207,417	207,417	207,417	207,417	2,489,004	
22	TOTAL ELECTRICITY REQUIRED		353,417	353,417	408,253	411,989	466,227	488,942	502,997	496,839	452,467	425,288	353,417	353,417	5,066,670	
23	ELECTRICITY SOLD TO SHECO		212,333	212,333	208,542	196,192	166,617	147,333	135,417	140,617	162,933	182,866	212,333	212,333	2,189,849	
24	ELECTRICITY BOUGHT FROM SHECO		0	0	0	0	0	0	0	0	0	0	0	0	0	
25	FUEL FOR ENGINE GENERATORS	10^3 GAL	45	45	49	48	49	50	50	50	49	48	45	45	573	10^3 GAL
26	FUEL FOR BOILERS		3	3	3	3	3	3	3	3	3	3	3	3	36	
27	FUEL FOR INCINERATOR		3	3	3	3	3	3	3	3	3	3	3	3	36	
28	TOTAL FUEL REQUIRED	10^3 GAL	51	51	55	54	55	56	56	56	55	54	51	51	645	10^3 GAL
29																
30																

C.3.4 Incinerator Heat Recovery System

C.3.4 INCINERATOR HEAT RECOVERY SYSTEM

1.0 INCINERATOR

1.1 Design Waste Input Rate

We have estimated the expected quantities of wastes produced by residents of multifamily apartment building based on studies made by Resource Recovery Services, Inc.[1], and by Oak Ridge National Laboratory[2]. Both studies have used 3 lbs per person per day as the projected residential waste production rate. Resource Recovery Services, Inc. determined that the waste generated by the Village Center and peripheral buildings will total 9,275 lbs per day, and that the waste generated by the Stoddert Middle School will total 750 lbs/day. The waste generation is summarized in Table 1.

TABLE 1
WASTE GENERATION SUMMARY

	Pounds Per Day	Days Per Week	Pounds Per Week
Residential	7,575	7	53,025
Village Center and Periphery	9,275	7	64,925
School	750	5	3,750
TOTAL			121,700

On the basis of a 6 day per week incinerator operation, 20,000 pounds per day must be handled. A 10 hours per day burning time has been selected, with a design waste input rate of 2,000 lbs per hour. With a shorter burning period, the design waste input rate will have to be increased and a larger size model will have to be chosen. The Model C1200 of Consumat Systems, Inc. will burn a maximum of 2,000 lb/hr of refuse at the given daily load.

1.2 Range of Constituents and of Heat Content

The waste will consist of a mixture of Type I and Type II. Type II is common to apartment and residential occupancy, and has a heating value of 4300 Btu/lb, the minimum expected. Type I has a heat content of 6500 Btu/lb. The design heat content will therefore be 5400 Btu/lb. Table 2 shows the range of constituents and of heat content.

C.3.4 (Continued)

TABLE 2
SOLID WASTES CONSTITUENTS AND HEAT CONTENT (3)

	Minimum Heat Content	Design Heat Content
Heat Content	4,300 Btu/Lb	5,400 Btu/Lb
Moisture Content	50%	35%
Incombustibles	7%	8%
Combustibles	43%	57%

Cellulose (7500 Btu/Lbs) forms the largest portion of combustibles the other portion consisting of fats, oils, waxes, rubber, proteins, etc. (17,000 Btu/Lbs). The ratio of cellulose to oil and fat is of the order of 7.5 to 2.5. If we fix the moisture content and the content of incombustibles, we more or less fix the heat content which will vary slightly depending on slight variation of the ratio of cellulose to oil and fat. The higher the ratio of fats and oils to cellulose, the higher the heat content.

1.3 Combustion Air and Constituents of Flue Gases

Cellulose burns according to the reaction:

$$C_6 H_{10} O_5 + 6 O_2 \longrightarrow 6 CO_2 + 5 H_2O$$

One pound of cellulose will require 1.185 lbs of O_2 for complete combustion. With 23.15 lbs of O_2 in 100 lbs of air, the stoichiometric air required for the combustion of 1 lb cellulose is 5.12 lbs.

Stoichiometric air for the combustion of the carbon equivalent of oil and fat (78.5% of oil and fat) is determined by the reaction:

$$C + O_2 \longrightarrow CO_2$$

With 2.667 lbs O_2 required for burning 1 lb carbon, 2.095 lbs O_2 will be required per lb of oil and fat, for burning the carbon equivalent of oil and fat.

Stoichiometric air for burning the hydrogen equivalent of oil and fat (10.2% of oil and fat), is determined by the reaction:

$$2 H_2 + O_2 \longrightarrow 2 H_2O$$

C.3.4 (Continued)

With 8 lb O_2 required for burning 1 lb carbon, 0.815 lb O_2 will be required per lb. of oil and fat, for burning the hydrogen equivalent of oil and fat. The stoichiometric air required for the combustion of 1 lb. oil and fat is therefore 12.65 lbs.

The total stoichiometric air is therefore given by:

$$\text{Stoichiometric Air} = \frac{5.12 \times 7.5 + 12.65 \times 2.5}{10} = 7 \text{ lbs air/lb combustibles}$$

The moisture and CO_2 contents of the flue gases are given as follows:

1 lb. moisture/lb. of moisture in refuse

+ 0.65 lbs. moisture/lb. of combustibles

+ 0.013 lbs moisture/lb. of air for combustion

1.96 lb CO_2/lb. of combustibles

Using 150% excess air (Consumat Systems, Inc.), the flue gas constituents in lb/lb of refuse are shown in Table 3 for wastes with minimum heat content and for those with design heat content.

TABLE 3
CONSTITUENTS OF FLUE GASES (150% EXCESS AIR)
(Lb/Lb of Refuse)

	Minimum Heat Content	Design Heat Content
Air	4.52	5.98
Nitrogen	2.30	3.03
CO_2	0.85	1.12
Water Vapor	0.88	0.83
TOTAL	8.55	10.96

C.3.4 (Continued)

1.4 Heat Recovered

The enthalpy changes across the heat exchanger are given as follows(3):

	H (Btu/Lb) 1800°F	H (Btu/Lb) 500°F	H (Btu/Lb)
Air	578	231	347
Nitrogen	597	239	358
CO2	560	189	371
Water Vapor	1110	433	677

The heat recovery rates and the exhaust gas flow rates are shown in Table 4.

TABLE 4
HEAT RECOVERY AND EXHAUST FLOW RATES
(Burning Rate = 2,000 Lb/Hr)

	Minimum Heat Content	Design Heat Content
Heat Content	4300 Btu/Lb	5400 Btu/Lb
Heat Recovered	3301 Btu/Lb	4190 Btu/Lb
Exhaust Gas Flow	17,000 Lb/Hr	22,000 Lb/Hr
Heat Input to Exchanger	6,600,000 Btu/Hr	8,200,000 Btu/Hr

C.3.4 (Continued)

1.5 Sizing of Equipment and Storage Tanks

Calculation of solid waste combustion heat release shows a heat recovery in the range of 8.2 to 6.6 million Btu/H depending on moisture content. These figures are based on 2,000 lbs per hour type II waste and a maximum design temperature of 650^{o}F for the heat transfer fluid. The average heat recovery rate of 7.4 million Btu/H has been used to size the medium temperature storage tanks.

For the energy balance and economic analysis, practical aspects such as warm up period, mechanical failures, repairs, availability of solid waste and heat transfer losses must be taken into consideration. For these reasons a value of 5.0 million Btu/H was arbitrarily chosen for use in the energy analysis, keeping in mind that the WWS and its sludge heater also has a need for high temperature heat.

REFERENCES:

(1) Resource Recovery Services, Inc., "Conceptual Study of the Solid Waste Subsystem for St. Charles, Maryland, MIUS Project" - Appendix A: "Solid Waste Subsystem of the Conceptual Design Report." MIUS Demonstration in St. Charles, Maryland, November 1976.

(2) MIUS Technology Evaluation, Solid Waste Collection and Disposal, Oak Ridge National Laboratory, September 1973.

(3) Source: Comtro Division, Sunbeam Equipment Corporation, Incinerator Manufacturer.

Project MILLS - ST CHARLES Structure

For STORAGE CAPACITY

Medium Temperature Thermal Storage Tanks

1. Temperatures

Max. Temperature after heat recovery muffler : 260 °F
Min. return temperature to jacket water HX : 180 °F

Max. ΔT for design of storage for winter and cold spring & fall days (Demand of cooling capacity ≤ 351 T)

80 °F

Max. ΔT for hot spring & fall days + summer : 40 °F
(Demand of cooling capacity ≥ 351 TONS)

2. Storage Capacity (see day profiles)

Winter : $\frac{15.5 \times 10^6}{80 \times 1 \times 8.33}$ = 23,300 GAL

Spring & Fall (cold) $\frac{69 \times 10^6}{80 \times 1 \times 8.33}$ = 103,500 GAL

Spring & Fall (hot) $\frac{26.5 \times 10^6}{40 \times 1 \times 8.33}$ = 79,500 GAL

Summer $\frac{22.0 \times 10^6}{40 \times 1 \times 8.33}$ = 66,000 GAL

Average Spring & Fall capacity : 91,500 GAL

Average all year capacity : 60,300 GAL

Design Capacity : 80,000 GAL

C.4 Detail of Plant Burden Estimate

LOAD		JANUARY			FEBRUARY			MARCH			APRIL			MAY			JUNE		I
KEY	HP	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO
PHWP-1	15	11	744	8184	11	672	7392	11	744	8184	11	720	7920	11	744	8184	11	720	7920
PHWP-2	15			STANDBY															
BHWP-1	5			STANDBY															
BHWP-2	5			STANDBY															
AHWP-1	7.5							5.6	20	112	5.6	35	196	5.6	155	868	5.6	245	1372
AHWP-2	7.5			STANDBY															
SHWP-1	20	15	744	11,160	15	672	10,080	15	744	11,160	15	720	10,800	15	744	11,160	15	720	10,800
SHWP-2	20			STANDBY															
TSHWP-1	2	1.5	265	398	1.5	240	360	1.5	265	398	1.5	257	386	1.5	265	398	1.5	257	386
TSHWP-2	7½	5.6	744	4166	5.6	672	3763	5.6	744	4166	5.6	720	4032	5.6	744	4166	5.6	720	4032
HTLP-1	2	1.5	265	398	1.5	240	360	1.5	265	398	1.5	257	386	1.5	265	398	1.5	257	386
HTLP-2	2			STANDBY															
HTLP-3	7½	5.6	265	1484	5.6	240	1344	5.6	265	1484	5.6	257	1439	5.6	265	1484	5.6	257	1439
HTLP-4	7½			STANDBY															
HTLPP-1	4	3.0	27	81	3	27	81	3	27	81	3	27	81	3	27	81	3	27	81
SCHWP-1	125			—				93	80	7440	93	200	18,600	93	270	25,110	93	270	25,110
SCHWP-2	125			STANDBY															
PCHWP-1	10							7.5	80	600	7.5	200	1500	7.5	270	2025	7.5	270	2025
PCHWP-2	7½							5.6	20	112	5.6	35	196	5.6	155	868	5.6	245	1372
PCHWP-3	13													10	82	820	10	130	1300
PCHWP-4	13			STANDBY															
CWP-1	140							104	80	8320	104	196	20384	104	270	28,080	104	270	28,080
CWP-2	140													104	155	16,120	104	245	25,480
OCP-1	10	7.5	155	1,163	7.5	140	1,050	7.5	155	1163	7.5	150	1125	7.5	155	1163	7.5	150	1,125
OCP-2	10			STANDBY															
ACP-1	10	7.5	155	1,163	7.5	140	1050	7.5	155	1163	7.5	150	1125	7.5	155	1163	7.5	150	1125
ACP-2	10			STANDBY															

LOAD KEY	HP	July KW	July HRS	July KWH/MO	August KW	August HRS	August KWH/MO	September KW	September HRS	September KWH/MO	October KW	October HRS	October KWH/MO	November KW	November HRS	November KWH/MO	December KW	December HRS	December KWH/MO
RHWP-1	15	11	744	8184	11	744	8184	11	720	7920	11	744	8184	11	720	7920	11	744	8184
RHWP-2	15	-	-	STANDBY		-	-	-	-	-	-	-	-	-	-		-	-	-
BHWP-1	5																		
BHWP-2	5																		
AHWP-1	7.5	5.6	300	1680	5.6	275	1540	5.6	190	1064	5.6	95	532						
AHWP-2	7.5			STANDBY															
SHWP-1	20	15	744	11,160	15	744	11,160	15	720	10,800	15	744	11,160	15	720	10,800	15	744	11,160
SHWP-2	20			STANDBY															
TSHWP-1	2	1.5	265	398	1.5	265	398	1.5	257	386	1.5	265	398	1.5	257	386	1.5	265	398
TSHWP-2	7½	5.6	744	4166	5.6	744	4166	5.6	720	4032	5.6	744	4166	5.6	720	4032	5.6	744	4166
HTLP-1	2	1.5	265	398	1.5	265	398	1.5	257	386	1.5	265	398	1.5	257	386	1.5	265	398
HTLP-2	2			STANDBY															
HTLP-3	7.5	5.6	265	1484	5.6	265	1484	5.6	257	1439	5.6	265	1484	5.6	257	1439	5.6	265	1484
HTLP-4	7.5			STANDBY															
HTLPP-1	4	3	27	81	3	27	81	3	27	81	3	27	81	3	27	81	3	27	81
SCHWP-1	125	93	300	27,900	93	275	25,575	93	225	20,925	93	225	20,925						
SCHWP-2				STANDBY															
PCHWP-1	10	7.5	270	2025	7.5	266	2025	7.5	225	1688	7.5	225	1688						
PCHWP-2	7.5	5.6	300	1680	5.6	275	1540	5.6	190	1064	5.6	95	532						
PCHWP-3	13	10	155	1550	10	147	1470	10	120	1200									
PCHWP-4	13			STANDBY															
SWP-1	140	104	300	31,200	104	275	28,600	104	225	23,400	104	225	23,400						
SWP-2	140	104	270	28,080	104	270	28,080												
OCA-1	10	7.5	155	1,163	7.5	155	1,163	7.5	150	1,125	7.5	155	1,163	7.5	150	1125	7.5	155	1,163
OCA-2	10			STANDBY															
ACP-1	10	7.5	155	1,163	7.5	155	1163	7.5	150	1125	7.5	155	1163	7.5	150	1125	7.5	155	1,163
ACP-2	10			STANDBY															

Id.

LOAD		JANUARY			FEBRUARY			MARCH			APRIL			MAY			JUNE II		
KEY	HP	KW	HRS	KWH/MO	KW.	HRS	KWH/MO.	KW.	HRS	KWH/MO	KW.	HRS	KWH/MO.	KW.	HRS	KWH/MO.	KW	HRS	KWH/MO
HWP-2	3	2.3	155	357	2.3	140	322	2.3	155	357	2.3	150	345	2.3	155	357	2.3	150	345
HWP-3	3			STANDBY															
HWP-4	15	11	155	1705	11	140	1540	11	155	1705	11	150	1650	11	155	1705	11	150	1650
HWP-5	15			STANDBY															
DOP-1	10	7.5	155	1163	7.5	140	1050	7.5	155	1163	7.5	150	1125	7.5	155	1163	7.5	150	1125
DOP-2	10			STANDBY															
DOP-3	.5	.4	155	62	.4	140	56	.4	155	62	.4	150	60	.4	155	62	.4	150	60
DOP-4	.5			STANDBY															
DOP-5	.5	.4	155	62	.4	140	56	.4	155	62	.4	150	60	.4	155	62	.4	150	60
DOP-6	3	2.3	155	357	2.3	140	322	2.3	155	357	2.3	150	345	2.3	155	357	2.3	150	345
DOP-7	3			STANDBY															
BWPP-1	7½																		
HP-1	12 33																		
LOP-1	1.5	1.1	155	171	1.1	140	154	1.1	155	171	1.1	150	165	1.1	155	171	1.1	150	165
LOP-2	1.5			STANDBY															
E JHWP-1	15	11	155	1705	11	140	1540	11	155	1705	11	150	1650	11	155	1705	11	150	1650
-2	15			STANDBY															
-4	15	11	155	1705	11	140	1540	11	155	1705	11	150	1650	11	155	1705	11	150	1650
-5	15			STANDBY															
-7	15	11	155	1705	11	140	1540	11	155	1705	11	150	1650	11	155	1705	11	150	1650
-8	15			STANDBY															
-10	15	11	155	1705	11	140	1540	11	155	1705	11	150	1650	11	155	1705	11	150	1650
E JHWP-11	15			STANDBY															
E JHWP-3	3/4	.6	155	93	.6	140	84	.6	155	93	.6	150	90	.6	155	93	.6	150	90
-6	3/4	.6	155	93	.6	140	84	.6	155	93	.6	150	90	.6	155	93	.6	150	90
-9	3/4	.6	155	93	.6	140	84	.6	155	93	.6	150	90	.6	155	93	.6	150	90
E JHWP-12	3/4	.6	155	93	.6	140	84	.6	155	93	.6	150	90	.6	155	93	.6	150	90

LOAD		July			August			September			October			November			December		IIId
KEY	HP	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO
HWP-2	3	2.3	155	357	2.3	155	357	2.3	150	345	2.3	155	357	2.3	150	345	2.3	155	357
HWP-3	3			STANDBY															
HWP-4	15	11	155	1705	11	155	1705	11	150	1650	11	155	1705	11	150	1650	11	155	1705
HWP-5	15			STANDBY															
DOP-1	10	7.5	155	1163	7.5	155	1163	7.5	150	1125	7.5	155	1163	7.5	150	1125	7.5	155	1163
DOP-2	10			STANDBY															
DOP-3	.5	.4	155	62	.4	155	62	.4	150	60	.4	155	62	.4	150	60	.4	155	62
DOP-4	.5			STANDBY															
DOP-5	.5	.4	155	62	.4	155	62	.4	150	60	.4	155	62	.4	150	60	.4	155	62
DOP-6	3	2.3	155	357	2.3	155	357	2.3	150	345	2.3	155	357	2.3	150	345	2.3	155	357
DOP-7	3			STANDBY															
BWPP-1	10																		
HP-1	30																		
LOP-1	1.5	1.1	155	171	1.1	155	171	1.1	150	165	1.1	155	171	1.1	150	165	1.1	155	171
LOP-2	1.5			STANDBY															
EJHWP-1	15	11	155	1705	11	155	1705	11	150	1650	11	155	1705	11	150	1650	11	155	1705
-2	15			STANDBY															
-4	15	11	155	1705	11	155	1705	11	150	1650	11	155	1705	11	150	1650	11	155	1705
-5	15			STANDBY															
-7	15	11	155	1705	11	155	1705	11	150	1650	11	155	1705	11	150	1650	11	155	1705
-8	15			STANDBY															
-10	15	11	155	1705	11	155	1705	11	150	1650	11	155	1705	11	150	1650	11	155	1705
EJHWP-11	15			STANDBY															
EJHWP-3	3/4	.6	155	93	.6	155	93	.6	150	90	.6	155	93	.6	150	90	.6	155	93
-6	3/4	.6	155	93	.6	155	93	.6	150	90	.6	155	93	.6	150	90	.6	155	93
-9	3/4	.6	155	93	.6	155	93	.6	150	90	.6	155	93	.6	150	90	.6	155	93
EJHWP-12	3/4	.6	155	93	.6	155	93	.6	150	90	.6	155	93	.6	150	70	.6	155	93

LOAD		JANUARY			FEBRUARY			MARCH			APRIL			MAY			JUNE		
KEY	HP	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO
SWS																			
INCINERATOR	30	23	266	6118	23	240	5520	23	266	6118	23	257	5911	23	266	6118	23	257	5911
INDUCT. FAN	5	3.8	266	1011	3.8	240	912	3.8	266	1011	3.8	257	977	3.8	266	1011	3.8	257	977
PUMPS	4	3	266	798	3	240	720	3	266	798	3	257	771	3	266	798	3	257	771
WMS																			
SP-1	1.5	1.1	744	818	1.1	672	739	1.1	744	818	1.1	720	792	1.1	744	818	1.1	720	792
SP-2	1.5	1.1	372	409	1.1	336	370	1.1	372	409	1.1	360	396	1.1	372	409	1.1	360	396
SP-3	1.5			STANDBY															
ROTO STR-1	.5	.4	744	298	.4	672	269	.4	744	298	.4	720	288	.4	744	298	.4	720	288
ROTO-STR-2	.5			STANDBY															
RDC-1	7.5	5.6	744	4166	5.6	672	3763	5.6	744	4166	5.6	720	4032	5.6	744	4166	5.6	720	4032
RDC-2	7.5			STANDBY															
SED. BASIN-1	3/4	.6	744	446	.6	672	403	.6	744	446	.6	720	432	.6	744	446	.6	720	432
SED BASIN-2	3/4			STANDBY															
FFP-1	10	7.5	744	5580	7.5	672	5040	7.5	744	5580	7.5	720	5400	7.5	744	5580	7.5	720	5400
FFP-2	10			STANDBY															
COMMING B.S.	1/4	.2	744	149	.2	672	134	.2	744	149	.2	720	144	.2	744	149	.2	720	144

LOAD		July			August			September			October			November			December		III a
KEY	HP	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO
SWS																			
Incinerator	30	23	266	6118	23	266	6118	23	257	5911	23	266	6118	23	257	5911	23	266	6118
Induct. Fan	5	3.8	266	1011	3.8	266	1011	3.8	257	977	3.8	266	1011	3.8	257	977	3.8	266	1011
Pumps	4	3	266	798	3	266	798	3	257	771	3	266	798	3	257	771	3	266	798
WMS																			
SP-1	1.5	1.1	744	818	1.1	744	818	1.1	720	792	1.1	744	818	1.1	720	792	1.1	744	818
SP-2	1.5	1.1	372	409	1.1	372	409	1.1	360	396	1.1	372	409	1.1	360	396	1.1	372	409
SP-3	1.5			STANDBY															
Roto. Str-1	.5	.4	744	298	.4	744	298	.4	720	288	.4	744	298	.4	720	288	.4	744	298
Roto. Str-1	.5			STANDBY															
RDC-1	7.5	5.6	744	4166	5.6	744	4166	5.6	720	4032	5.6	744	4166	5.6	720	4032	5.6	744	4166
RDC-2	7.5			STANDBY															
Sed. Basin-1	3/4	.6	744	446	.6	744	446	.6	720	432	.6	744	446	.6	720	432	.6	744	446
Sed. Basin-2	3/4			STANDBY															
EFP-1	10	7.5	744	5580	7.5	744	5580	7.5	720	5400	7.5	744	5580	7.5	720	5400	7.5	744	5580
EFP-2	10			STANDBY															
Commin. & BS	1/4	.2	744	149	.2	744	149	.2	720	144	.2	744	149	.2	720	144	.2	744	149
6																			

LOAD		JANUARY			FEBRUARY			MARCH			APRIL			MAY			JUNE		IV
KEY	HP	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO
HVAC FANS																			
S-1	10	7.5	186	1375	7.5	168	1260	7.5	186	1395	7.5	360	2700	7.5	558	4185	7.5	720	5400
S-2	10	7.5	186	1375	7.5	168	1260	7.5	186	1395	7.5	360	2700	7.5	558	4185	7.5	720	5400
S-3	15	11	186	2046	11	168	1848	11	186	2046	11	360	3960	11	558	6138	11	720	7920
SF-1	7.5	-						5.6	186	1042	5.6	360	2016	5.6	558	3125	5.6	720	4032
SF-2	7.5	-						5.6	186	1042	5.6	360	2016	5.6	558	3125	5.6	720	4032
SF-3	7.5	-						5.6	186	1042	5.6	360	2016	5.6	558	3125	5.6	720	4032
SF-4	7.5	-						5.6	186	1042	5.6	360	2016	5.6	558	3125	5.6	720	4032
SF-5	7.5	-						5.6	186	1042	5.6	360	2016	5.6	558	3125	5.6	720	4032
SF-6	7.5	-						5.6	186	1042	5.6	360	2016	5.6	558	3125	5.6	720	4032
MAU-1	3	2.3	558	1283	2.3	504	1242	2.3	279	642	2.3	140	322	2.3	70	161			
LIGHTING @ 2W/FT²																			
AREA ≅ 23,600 FT²		47	744	34,968	47	672	31,584	47	744	34,968	47	720	33,840	47	744	34,968	47	720	33,840
LUBE OIL TANK HTRS																			
2 @ 7.5 KW		15	744	11,160	15	672	10,080												
L-1																			

LOAD		July			August			September			October			November			December		IV-a
KEY	HP	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO
HVAC FANS																			
S-1	10	7.5	744	5580	7.5	744	5580	7.5	540	4050	7.5	372	2790	7.5	180	1350	7.5	186	1395
S-2	10	7.5	744	5580	7.5	744	5580	7.5	540	4050	7.5	372	2790	7.5	180	1350	7.5	186	1395
S-3	15	11	744	8184	11	744	8184	11	540	5940	11	372	4092	11	180	1980	11	186	2046
SF-1	7.5	5.6	744	4166	5.6	744	4166	5.6	540	3024	5.6	372	5083						
SF-2	7.5	5.6	744	4166	5.6	744	4166	5.6	540	3024	5.6	372	5083						
SF-3	7.5	5.6	744	4166	5.6	744	4166	5.6	540	3024	5.6	372	5083						
SF-4	7.5	5.6	744	4166	5.6	744	4166	5.6	540	3024	5.6	372	5083						
SF-5	7.5	5.6	744	4166	5.6	744	4166	5.6	540	3024	5.6	372	5083						
SF-6	7.5	5.6	744	4166	5.6	744	4166	5.6	540	3024	5.6	372	5083						
MAU-1	3													2.3	540	1242	2.3	558	1283
LIGHTING @ 2 W/FT²																			
AREA ≅ 23,600 FT²		47	744	34,968	47	744	34,968	47	720	33,840	47	744	34,968	47	720	33,840	47	744	34,968
LUBE OIL TANK HEAT																			
2 @ 7.5 KW														15	720	10,800	15	744	11,160
8																			

LOAD		January			February			March			April			May			June		V
KEY	HP	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO	KW	HRS	KWH/MO
Boiler-1	20			Standby															
-2	20			Standby															
Absorp Chillers																			
(DBL) CH-1	7.5							5.6	80	448	5.6	200	1120	5.6	270	1512	5.6	270	1512
CH-2	7.5							5.6	20	112	5.6	35	196	5.6	155	868	5.6	245	1372
Cent Chiller																			
CH-3	–													500	82	41,000	500	130	65000
Air Compressors																			
ACE-1	15	11	186	2046	11	168	1848	11	186	2046	11	180	1980	11	186	2046	11	180	1980
ACE-2	15	11	186	2046	11	168	1848	11	186	2046	11	180	1980	11	186	2046	11	180	1980
NBS Equipment		2	744	1488	2	672	1344	2	744	1488	2	720	1440	2	744	1488	2	720	1440
Master Control Room		24.58	744	18,289	24.58	672	16,519	24.58	744	18,289	24.58	720	17,699	24.58	744	18,287	24.58	720	17,699

LOAD KEY	HP	July KW	July HRS	July KWH/MO	August KW	August HRS	August KWH/MO	September KW	September HRS	September KWH/MO	October KW	October HRS	October KWH/MO	November KW	November HRS	November KWH/MO	December KW	December HRS	December KWH/MO
Boiler-1																			
1-2																			
ABSORB CHILLERS																			
(DBL.) CH-1	7.5	5.6	270	1512	5.6	270	1512	5.6	225	1260	5.6	225	1260						
CH-2	7.5	5.6	300	1680	5.6	275	1540	5.6	190	1064	5.6	95	532						
CENT CHILLER																			
CH-3	=	510	155	77,500	500	147	73,500	290	170	49,300									
AIR COMPRESSORS																			
ACE-1	15	11	186	2046	11	186	2046	11	180	1980	11	186	2046	11	180	1980	11	186	2046
ACE-2	15	11	186	2046	11	186	2046	11	180	1980	11	186	2046	11	180	1980	11	186	2046
NBS Equipment		2	744	1487	2	744	1488	2	720	1440	2	744	1488	2	720	1440	2	744	1488
Master Control Room		24.58	744	18,289	24.58	744	18,289	24.58	720	17,699	24.58	744	18,289	24.58	720	17,699	24.58	744	18,289
10																			

LOAD KEY	HE	JANUARY KW	HRS	KWH/MO	FEBRUARY KW	HRS	KWH/MO	MARCH KW	HRS	KWH/MO	APRIL KW	HRS	KWH/MO	MAY KW	HRS	KWH/MO	JUNE KW	HRS	KWH/MO VI
Monthly Subtotals																			
Chart I		53.2		29,177	53.2		25,980	272.9		42,781	272.9		65,120	327.9		112,083	327.9		112,033
II		71.4		11,069	71.4		7,996	71.4		11,069	71.4		10,710	71.4		11,069	71.4		10,710
III		46.3		19,793	46.3		17,870	46.3		19,293	46.3		19,143	46.3		19,793	46.3		18,143
IV		50.3		52,297	90.3		47,429	108.9		46,698	108.9		55,617	108.9		65,327	108.9		76,752
V		18.6		23,869	18.6		21,559	59.8		24,129	59.8		24,415	560		67,219	560		90,983
Monthly Totals		314.8		135,175	314.8		122,179	560.3		146,170	560.3		178055	1174.5		268581	1171.5		309,621
MIUS Plant Overall Annual Total Consumption			2,545,700 KWH																

LOAD KEY	H.P.	July KW	July HRS	July KWH/MO	August KW	August HRS	August KWH/MO.	September KW	September HRS	September KWH/MO	October KW.	October HRS.	October KWH/MO.	November KW.	November HRS	November KWH/MO	December KW.	December HRS	December KWH/MO
MONTHLY SUBTOTALS																			
CHART # Ia		387.9		122,312	387.9		117,027	233.9		77,135	273.9		25,224	58.2		27,294	58.2		28,177
IIa		71.4		11,069	71.4		11,069	71.4		10,710	71.4		11,069	71.4		10,710	71.4		11,069
IIIa		46.3		11,773	46.3		11,773	46.3		11,143	46.3		11,773	46.3		11,143	46.3		11,773
IVa		109.9		75,303	108.9		22,308	159.9		66,024	105.9		75,138	90.3		50,562	90.3		52,247
Va		559.8		104,561	559.8		100,421	319.8		74,733	59.8		25,661	48.6		23,099	48.6		23,869
MONTHLY TOTALS.		1174.3		337,043	1174.3		327,618	803		247,735	560.3		206,935	314.8		130,808	314.8		135,175

APPENDIX D - FINANCIAL AND MIUS ANALYSIS

D.1 Conventional Utilities and Mius Cost Backup Material

WASTEWATER COLLECTOR SYSTEM OVERCOST - 1978

BUILDINGS	CONVENTIONAL	MIUS	OVERCOST
1. Bannister and Crossland (300,000 sq.ft.)	$ 77,800	$127,800	$ 50,000
2. Wakefield Terrace, Wakefield High Rise, Third Age Center and Eastern Peripherals (500,000 sq.ft.)	$109,600	155,600	$ 46,000
3. Village Center and Western Peripherals (100,000 sq.ft.)	$ 62,600	$ 86,100	$ 23,500
4. Stoddert School	-0-	$ 5,600	$ 5,600
	$250,000	$375,100	$125,100

DISPOSAL SYSTEM

Pumping Station	20,000
13,000 10" Force Main	262,000
$20/Ft.	282,600

CONVENTIONAL UTILITY SYSTEM

WASTEWATER COLLECTOR SYSTEM OVERCOST - 1978 (Continued)

BANNISTER APARTMENTS

8" Sewer	Manholes
90'	14 @ 1,000 = $14,000
235'	
100'	
75'	
50'	
285'	
130'	
235'	
125'	
100'	
240'	
190'	

1,855 Ft. @ $18/Ft. = $33,390 or $33,400

CROSSLAND MANOR

8" Sewer	Manholes
235'	7 @ 1,000 = $7,000
260'	
85'	
120'	
120'	
420'	
60'	

1,300 Ft. @ $18/Ft. = $23,400

MIUS - BANNISTER AND CROSSLAND

1 ejector @ $15,000 = $15,000

300' of 4" Forced Main @ $10/Ft. = $ 3,000

300'
200'
200'
300'

1,000' of Forced Main @ $12/Ft. = $12,000

1 Pumping Station @ $20,000 = $20,000

$50,000 + $77,800 Dist. piping Bannister and Crossland

WASTEWATER COLLECTOR SYSTEM OVERCOST - 1978 (Continued)

THIRD AGE, WAKEFIELD TERRACE AND COMMERCIAL PERIPHERALS

8" Sewer	Manholes	
1,400'	25 @ $1,000 = $25,000	
3,300'		
4,700 Ft. @ $18/Ft. = $84,600		
CONVENTIONAL - $25,000 + 84,600 =		$109,600

MIUS

1 Bypass	=	$ 1,000
Pumping Station	=	$30,000
1,250' of Forced Main @ $12/Ft.	=	$15,000
TOTAL		$46,000
MIUS - $46,000 + $109,600	=	$155,600

COMMERCIAL AND ESTERN PERIPHERALS

8" Sewer	Manholes
770'	14 @ $1,000 = $14,000
1,930'	
2,700 Ft. @ $18/Ft. = $48,600	

MIUS

1,250' of 8" Sewer @ $18/Ft.	=	$22,500
Bypass	=	$ 1,000
TOTAL		$23,500

STODDERT

MIUS

350' of 6" Sewer @ $16/Ft.	=	$ 5,600

Mr. Kenton Drury
Project Manager MIUS
Interstate Land Development Company
336 Post Office Road
St. Charles, Maryland 20601

Re: Cost to Developer for
Electric Service

Dear Kenton:

The following are the costs for the buildings you inquired about:

1. The portion of the Village Center about which you inquired is covered by Public Service Commission of Maryland Order No. 59432, Paragraph 7.1 which states: "The applicant must pay the estimated cost of the underground extension, calculated in accordance with Rule 5, after deducting an allowance of three-fourths (3/4) of the estimated annual revenue, except that for an underground extension to a new multiple-occupancy building Rule 7.1.1 shall apply."

Without knowing the connected load, we cannot determine what the estimated annual revenue would be. However, in general, the revenue from buildings of the type proposed, is such that there is no charge to the applicant for service.

2. Wakefield Terrace and Wakefield Highview are covered by Public Service Commission of Maryland Order No. 59432, Paragraph 7.1.1 which states: "For a new multiple-occupancy building the underground extension on the applicant's owned or leased properties shall be constructed by the utility to the building at no charge to the applicant."

3. The Third Age Center is covered by Public Service Commission of Maryland Order No. 60316, Paragraph 5.2 which states: "The Service connection to the building normally will be at the corner of the building nearest the point at which the underground electric service line enters the property to be served. The charge for such underground electric service line shall be fifty cents (0.50¢) per foot for the shortest distance as measured from

the property line where the underground service line enters the property to be served to the nearest corner of the building. If the applicant specifies a different service connection point at the building, then he must pay the estimated cost of the excess trenching, backfilling and cable."

The design of the distribution system has been completed for The Third Age Center portion of the Wakefield Neighborhood and the preliminary estimate of the cost to the developer is $6864.20. This figure is subject to the field verification of the actual distances involved.

If you require any further information, please contact us.

Very truly yours,

William H. Crouch, Jr.
Engineer--Design/Substation

WHC:ed

CONVENTIONAL CONSTRUCTION

FORM NO. 2328
1810

U. S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
FEDERAL HOUSING ADMINISTRATION

Form Approved
Budget Bureau No. 63-R0827

CONTRACTOR'S and/or MORTGAGOR'S COST BREAKDOWN (SCHEDULES OF VALUES)

Date: 9/16/77
Wakefield Terrace Assoc.
Interstate General Dev., Inc.
Name of Project:
Location:

Project No.: 052-44201-LDI-PAP
Building Identification: 1 thru 6

This form represents the Contractors and/or Mortgagors firm costs and services as a basis for disbursing dollar amounts when insured advances requested. Detailed instructions for completing this form are included on the reverse side.

Div.	TRADE ITEM	COST	TRADE DESCRIPTION
3	Concrete	179,243	Footings, Slabs, Pan Fill
4	Masonry	526,510	8" & 12" CMU Face Brick
5	Metals	88,346	Misc. Metals, Steel Stair
6	Rough Carpentry	520,441	Labor-Lumber, Trusses, Subflooring, Sheathing, etc.
6	Finish Carpentry	95,824	Base, Closet Shelving, Trim, etc.
7	Waterproofing	9,182	Two-Ply Hot Mopped Felt
7	Insulation	114,780	Rigid & Batt
7	Roofing	49,025	Shingles, Flashing
7	Sheet Metal	8,887	Gutters & Downspouts
8	Doors	286,950	H.M., Prehung Wood Doors, Bifolds, Hardware
8	Windows	68,869	Alum. Windows with insulated glass
8	Glass	—	
9	Lath & Plaster	—	Beads
9	Drywall	246,038	1/2" & 5/8" Thick D/W with Stop Beads & Corner/
9	Tile Work	27,956	Ceramic Tile around tubs
9	Acoustical	9,182	Accoustical Dropped Ceiling
9	Wood Flooring	—	
9	Resilient Flooring	36,843	VAT - Baths & Kitchens & Corridors
9	Painting & Decorating	70,759	One coat primer & one coat finish paint
10	Specialties	16,478	Mailboxes, Fire Ext., Toilet Accessories
11	Special Equipment	34,000	Rough-In Security System
11	Cabinets	62,390	Kitchen Cabinets, Tops
11	Appliances	92,642	Refrigerators, Ranges, Disposals
12	Blinds & Shades, Artwork	13,891	Venetian Blinds at Windows & Drapery Rods
12	Carpets	80,465	Carpet in Living-Dining-Hall-Bedrooms
13	Special Construction	—	
14	Elevators	—	Fixtures
15	Plumbing & Hot Water	258,176	Sprinkler Sys. in Pub. Area, H.W. Heaters & Fixtures
15	Heat & Ventilation	293,176	Includes A/C & Electric Heat Pumps
15	Air Conditioning		
16	Electrical	310,129	Smoke Detectors, Light Fix., Wiring, T.V. System
	SUBTOTAL (Structures)	3,530,181	
	Accessory Structures		
	TOTAL (Lines 32 & 33)	3,530,181	
2	Earth Work	80,200	Cut & Fill, Clear & Grub, etc.
2	Site Utilities	55,637	Water, Storm, Sewer
2	Roads & Walks	106,059	Blacktop, Conc. Walks & Steps, Curb & Gutter
2	Site Improvements	11,960	Tot Lots
2	Lawns & Planting	64,945	Trees & Shrubs & Sod
2	Unusual Site Condition		
	TOTAL LAND IMPRVTS.	318,801	
	TOT. STRUCT. & LAND IMPRVTS.	3,848,982	
1	GENERAL REQUIREMENTS	153,959	
	SUBTOTAL (Lines 41 and 42)	4,002,941	
	BUILDER'S OVERHEAD	80,059	
	BUILDER'S PROFIT	—	
	SUBTOTAL (Lines 44 thru 46)	4,083,000	
	OTHER FEES		
	BOND PREMIUMS		
	TOTAL FOR ALL IMPROVEMENTS	4,083,000	
	Builder's Profit paid by means other than cash		
	TOTAL FOR ALL IMPROVEMENTS LESS LINE 57	4,083,000	

NONRESIDENTIAL AND SPECIAL EXTERIOR LAND IMPROVEMENT (costs included in trade item breakdown)

DESCRIPTION	EST. COST
TOTAL $	

OTHER FEES

DESCRIPTION	EST. COST
TOTAL $	

OFFSITE COSTS (costs not included in trade item breakdown)

DESCRIPTION	EST. COST
TOTAL $	

DEMOLITION (costs not included in trade item breakdown)

DESCRIPTION	EST. COST
TOTAL $	

Mortgagor: Wakefield Terrace Associates By [signature] Date 9/16/77

Contractor: Construction Co., Inc. By [signature] Date 9/16/77

FHA [signature] (Processing Analyst) 9/27/77 (Date) [signature] (Chief, Cost Branch or Cost Analyst) 9/?/77 (Date)

FHA [signature] (Chief Underwriter) Date [illegible]

• CONVENTIONAL CONSTRUCTION

FHA FORM NO. 2328
1/76

U. S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
FEDERAL HOUSING ADMINISTRATION

Form Approved
Budget Bureau No. 63-R0887

CONTRACTOR'S and/or MORTGAGOR'S COST BREAKDOWN
(SCHEDULES OF VALUES)

Revised Nov. 2, 1977

Mortgagor: Wakefield Third Age Associates

Project No.: 052-44202-LDI-WAH-RAP

Building Identification:

Name of Project: Wakefield Third Age

Location: St. Thomas Drive & Wakefield Circle St. Charles Comm, Charles Co., Md.

This form represents the Contractors and/or Mortgagors firm costs and services as a basis for disbursing dollar amounts when insured advances are requested. Detailed instructions for completing this form are included on the reverse side.

Div	Trade Item	Cost	Trade Description
3	Concrete	129,760	Footing, Slabs
4	Masonry	43,953	Block
5	Metals		
6	Rough Carpentry	315,001	Framing, Lumber, Roof Trusses and Labor
6	Finish Carpentry	44,182	Interior, Exterior Millwork & Closet Equipment
7	Waterproofing		
7	Insulation	33,737	3-½" Batt Insulation in wall & 6"insul.in ceilings
7	Roofing	46,092	Asphalt Shingles
7	Sheet Metal	11,448	Gutters and Downspouts
8	Doors	37,443	Interior & Exterior Doors & Bi-fold Doors
8	Windows	18,394	Aluminum Windows
8	Glass		
9	Lath & Plaster		
9	Drywall	100,814	Drywall
9	Tile Work	7,361	Ceramic Tile Around Tubs
9	Acoustical		
9	Wood Flooring		
9	Resilient Flooring	41,753	VAT Floor Throughout
9	Painting & Decorating	25,254	Painting Interior and Exterior Trim
10	Specialties	12,260	Mailboxes
11	Special Equipment	13,000	Rough-in Security System
11	Cabinets	38,017	Kitchen Cabinets with tops & S.S.Sinks & Vanities
11	Appliances	88,796	Refrigerators, Ranges, Range Hoods & Disposals
12	Blinds & Shades, Artwork	5,838	Venetial Blinds and Drapery Rods
12	Carpets		
13	Special Construction		
14	Elevators		
15	Plumbing & Hot Water	137,619	Interior Sewer, Water, Water Heater & Fixtures
15	Heat & Ventilation	157,667	Heating, A/C, Heat Pump System & Vent
15	Air Conditioning		
16	Electrical	125,645	Electrical, T.V. System
	SUBTOTAL (Structures)	1,434,034	
	Accessory Structures		
	TOTAL (lines 32 & 33)		
2	Earth Work	51,235	Clear, Grub, and Excavation
2	Site Utilities	183,643	Storm Sewer, San. Sewer and Water
2	Roads & Walks	97,501	Asphalt Paving, Curb & Gutter and Sidewalks
2	Site Improvements	4,432	Playground
2	Lawns & Planting	41,300	Landscaping
2	Unusual Site Condition		
	TOTAL LAND IMPRVTS.	378,111	
	TOT. STRUCT. & LAND IMPRVTS.	1,812,145	
1	GENERAL REQUIREMENTS	72,486	
	SUBTOTAL (Lines 41 and 42)		
	BUILDER'S OVERHEAD	37,693	
	BUILDER'S PROFIT		
	SUBTOTAL (Lines 44 thru 46)		
	OTHER FEES	148,803	
	BOND PREMIUM	13,046	
	TOTAL FOR ALL IMPROVEMENTS		
	Builder's Profit paid by means other than cash		
	TOTAL FOR ALL IMPROVEMENTS LESS LINE 52	2,084,173	

NONRESIDENTIAL AND SPECIAL EXTERIOR LAND IMPROVEMENT *(costs included in trade item breakdown)*

DESCRIPTION	EST. COST
TOTAL $	

OTHER FEES

DESCRIPTION	EST. COST
S/W Fees	142,620
Building Permit	6,183
TOTAL $	148,803

OFFSITE COSTS *(costs not included in trade item breakdown)*

DESCRIPTION	EST. COST
TOTAL $	

DEMOLITION *(costs not included in trade item breakdown)*

DESCRIPTION	EST. COST
TOTAL $	

Mortgagor: Interstate Gen.Dev., Inc., General Partner, Wakefield Third Age Associates By [signature] Nov. 3, 1977

Contractor: Thomas P. Harkins, Inc. By [signature] Date 11/2/77

FHA ______ (Processing Analyst) ______ (Date) ______ (Chief, Cost Branch or Cost Analyst) ______ (Date)

FHA ______ (Chief Underwriter) ______ Date ______

D.2 Mius and Conventional Construction Cost Backup Material

CAPITAL COSTS (As of 1/13/78)

ITEM OR SYSTEM	CONVENTIONAL		MIUS	
	METHOD	COST $	METHOD	COST $
SMECO's Electric Distribution System	Underground 12 KV	0	Underground 12 KV	0
Electric Wiring Terrace Apts. (204 DU)	All-Electric	310,000	Hydronic Htg/Clg	248,000 (1)
Electric Wiring Third Age (104 DU)	All-Electric	126,000	Hydronic Htg/Clg	95,000 (1)
Electric Wiring High Rise (108 DU)	All-Electric	186,000 (2)	Hydronic Htg/Clg	154,000 (1)
Commercial (100,000 Sq. Ft.) Electric		400,000 (2)	Hydronic Htg/Clg	350,000 (2)
School (Electrical)	Existing	- (3)	No Change	- (3)
HVAC System & Domestic Hot Water				
Terrace	All-Electric	293,000	Hydronic	501,000 (4)
Third Age	All-Electric	158,000	Hydronic	262,000 (5)
High Rise	All-Electric	178,000 (4)	Hydronic Clg/Htg	286,000 (5)
Commercial (100,000 Sq. Ft.)	Hydronic/Elec Htg	500,000 (4)	Hydronic Clg/Htg	375,000 (10)
School	Existing	-	Connect to MIUS	25,000 (6)
Waste Water Treatment System	Existing	0 (8)	Biological Units, Etc.	557,000 (6)
Waste Water Collector System	Existing			
Land for MIUS Plant		0		0 (10)
Effluent Disposal Piping & Sprays	Irrigation	0 (8)	Irrigation	300,000 (9)
Solid Waste Collection	Hauler	0	Special Vehicles	115,000
Solid Waste Subsystem		0	Incinerator	455,000
MIUS Plant Building		0	Dodge Est.	
MIUS Elec/Thermal System		0	See Detail	3,182,440
MIUS Hydronic Distr. & Cond. Water		0		616,000
Parts Inventory		0		20,000
Employee Training & Startup Costs		0	Labor, Fuel & Supplies	50,000
Construction Management		0	Up to Startup	200,000
Construction Process Services		0		25,000
Consulting & Certification		0		100,000
SMECO Requirements for Interface		0		25,000
Permits & Fees (2" Water), Legal, Etc.		0		40,000

NOTES:
1 - Estimated reduction of $300/DU for omission of Elec Bldg. Cap.
2 - Estimated by GKC on basis of other ILD properties
3 - No investment by ILD
4 - Estimated by GKC on basis of type of mech. system
5 - GKC allowed $1000/DU additional piping costs (4 pipe dist)
6 - GKC Estimate
7 - Omit chiller, reduce elec. capacity, add hydronic heating
8 - Sunk costs
9 - ILD had expected the cost to be paid out of Title I Grant.
However, MIUS construction project was terminated before application was acted upon.
10 - 1.5 acres has retail value of $75,000. Under demonstration arrangement ILD planned no charge to program.

DETAILED SUMMARY OF MIUS PLANT COST

1.	Plant Building		$ 587,000
2.	Thermal/Electrical Subsystem		
	Eng/Generators	(4)	$ 386,000
	Chillers	(3)	180,100
	Boilers	(2)	84,000
	Generator Controls		80,000
	Pumps		139,400
	Tanks		154,370
	Heat Exchangers & HR Mufflers		78,150
	Electrical Work (Plus $50,000 for stepup transformers)		800,000
	Piping, Specialties, Misc., Equipment, Insulation & Labor (Thornton Estimate 1/6/78)		1,430,420
			$ 3,219,440
3.	Control, Alarm & Data Log System (Johnson Jc 80)		$ 250,000
4.	Solid Waste Subsystem		
	Incinerator Unit		$ 305,000
	Scrubber & Heat Recovery Unit		35,300
	Erection, Stacks & Misc.		114,700
			$ 455,000
5.	Waste Water Treatment Subsystem		$ 562,000

PLANT EXPANSION - CAPITAL COST

		1978 DOLLARS
1982	1 Electric Chiller 300 Tons	$ 100,000
1983	1 Boiler	$ 60,000
	2 Eng/Gen 720 KW Each	$ 350,000
	1 ABS Chiller 200 Tons	$ 80,000
	Site Hydronic Piping	$ 200,000
1984	None	

WASTEWATER MANAGEMENT SUBSYSTEM CAPITAL COSTS

		UNIT	QUANTITY	UNIT COST	TOTAL COST
1.	Rotating Biological Disk with Covers (Autotrol 651-254)	Each	2	$ 36,000	$ 72,000
2.	Tanks for Biological Units	Each	2	10,500	21,000
3.	Settling Tanks Linkbelt Type L or Clarivac	Each	2	35,000	70,000
4.	Rotostrainers Hydrocyclonics RSA-2524	Each	2	10,000	20,000
5.	Dual Media Pressure Filters 84 GPM Permutit Type G	Each	3	25,000	75,000
6.	Hypochlorite Chlorinator Sanilee Model 20	Each	1	10,000	10,000
7.	Idrex Sludge Handling System	Each	1	25,000	25,000
8.	Equalization Chamber (20' x 20' x 20') includes Excavation and Backfill	Each	1	21,000	21,000
9.	70 GPM Pumps - Equal. Chamber	Each	3	1,800	5,400
10.	Equal. Chamber Aeration Unit	Each	1	25,000	25,000
11.	Clearwell	Each	1	4,000	4,000
12.	6,000 Gal. Storage and C12	Each	2	6.000	12,000
13.	2,000 Gal. Tanks	Each	3	25,000	7,500
14.	Heat Exchangers	Each	2	1,000	2,000
15.	Instrumentation and Control (On line only)	LS	1	4,000	4,000
16.	Pumps, Piping and Valving	LS	1	60,000	60,000
	CAPITAL COSTS				$433,000
	INSTALLATION COSTS				80,000
	CONTRACTORS OVERHEAD AND PROFIT				22,000
	CONTINGENCIES				22,000
	TOTAL COST				$557,900

NOTES: Costs do not include building electrical and mechanical.
Instrumentation and control includes only on-line equipment and hookup. (No main panel costs.)
Installation costs can vary considerably depending on manufacturer. For example, some rotating biological disks come preassembled while others may be assembled on site.
Capital costs include shipping costs which also may vary with manufacturer's location.

THERMAL METER - 1980

WAKEFIELD TERRACE

6 Bldgs - 3 Master Panels @ $1,100 ea.	=	$ 3,300
204 Apts @ $55		$11,220
2 Btu Meter - 4 inch @ $1,000 ea.		$ 2,000
TOTAL		$17,820

WAKEFIELD HIGH RISE

1 Bldg. - 3 Master Panels @ $1,100 ea.	=	$ 2,200
108 Apts. @ $55	=	$ 5,940
2 Btu Meter - 4 inch @ $1,000 ea.	=	$ 2,000
TOTAL		$ 7,040

THIRD AGE

26 Bldg. - 2 Master Panels @ $1,100 ea.	=	$ 2,200
104 Apts @ $55	=	$ 5,720
2 Btu Meter - 4 inch @ $1,000 ea.	=	$ 2,000
TOTAL		$34,320

STODDERT

2 Btu Meter @ $1,000 ea.	=	$ 2,000

SMALLWOOD V.C.

1 Master Panel	=	$ 1,100
20 Tenants @ $55	=	$ 1,100
2 Btu Meter @ $1,000 ea.	=	$ 2,000
Total Equipment Costs		$42,780

THERMAL METER - 1980 (Continued)

Installation Cost (5%)	$ 6,417
Shipping Cost and Ctg. (5%)	$ 2,139
TOTAL	$51,336

ELECTRIC METERS

Demand/Consumption Meter	$ 1,000
20 Electric Meters (Consumption @ $100)	$ 2,000
	$ 3,000
Installation (15%)	$ 450
	$ 3,450
TOTAL	$54,786

MEMORANDUM

TO: MIUS FILES

FROM: K. DRURY HKD

DATE: JANUARY 24, 1978

SUBJ: MIUS OVERCOST/PERMITS AND FEES

The following overcosts have been projected for review and tap fees and construction permits:

Wakefield Terrace	$241,125
Third Age Center	$148,802
Wakefield Hi-Rise	$148,828

The fees and permits do not concern electrical utilities.

Based on the above data the average cost for permits and fees on a square footage basis is $1.14/sq.ft. This unit value was used to estimate the following permit and fee costs for the commercial area and the MIUS plant:

	ESTIMATED PERMIT & FEES COST
Commercial (100,000 sq.ft.)	$114,000
MIUS Plant (20,000 sq.ft.)	$ 22,800

	CONVENTIONAL	MIUS
Permit and Fee Overcost	$652,755	$675,555
Difference	$ 22,800	

nr

Mr. Bill Reeves
Interstate Land Development Corporation
360 P. O. Road
Waldorf, Maryland 20601

Dear Bill:

The following are the estimated installed costs for the equipment we will use to serve the MIUS Project:

750 MCM AL 15KV URD CABLE	$10,611.24
Termination Equipment	· 3,662.45
Metering Equipment	5,373.76
Engineering	5,600.00
Total	$25,247.45

If you need any further information, give us a call.

Yours Truly,

William H. Crouch
Associate Engineer

WHC:ed

MEMORANDUM

TO: MIUS FILES 5000/K5

FROM: K. DRURY AKD

DATE: JANUARY 24, 1978

SUBJ: SOLID WASTE CONTAINERS

I spoke with Banks Hudson of Dempster Dumpster Systems about a drop bottom container which is compatible with conventional front load equipment. Mr. Hudson says that Dempster makes a combination container which is lighter in weight and less expensive than the Standard Universal container. The maximum 8 cubic yard container would cost about $800.

nr

JANUARY 18, 1978 ANALYSIS NO. 164

DESCRIPTION	LABOR	MATERIAL	TOTAL	SQ FT
FOUNDATIONS	28,921	22,170	51,091	2.36
FLOORS ON GRADE	19,371	27,129	46,500	2.15
SUPERSTRUCTURE	24,341	111,786	136,127	6.30
ROOFING	10,038	13,425	23,463	1.09
EXTERIOR WALLS	146,153	115,115	261,268	12.08
PARTITIONS	2,439	4,375	6,814	0.32
WALL FINISHES	5,186	1,806	6,992	0.32
TOTAL	236,449	295,806	532,255	24.62

ABOVE COST IS BASED ON CURRENT WAGES
AND PRICES FOR THE ZIP CODE AREA 20601

FOR FOUNDATIONS & MEZZANINE ADD $ 55,000

537,255

HVAC PLUMBING & ELEC IS INCLUDED IN
THORNTON & FOLLEY ESTIMATES

Project MIUS - ST. CHARLES Structure MAJOR EQUIPMENT

For CONTRACTOR PRICES

KEY	ITEM	UNIT SPECIFICATIONS	MANUFACTURER & MODEL No.	PRICE EACH, $	TOTAL COST $
B-1,2	WATER BOILER	16,740 MBH INPUT, 400 HP, #1 RINGEL, 13,390 MBH OUTPUT, 75 psig W.P. ASME STAMPED, 245°F MAX WATER TEMP, WITH 20 HP, 480V, 3Ø, 60~ BLOWER	CLEAVER-BROOKS CB-400	42,000	84,000
H-1	HIGH TEMP ABSORPTION CHILLER	391 TONS CAPACITY CHILLED WATER: 667 GPM, 56°F→42°F CONDENSER WATER: 1390 GPM, 80°F→94°F CONCENT.: 552 GPM, 400°F→361°F	TRANE MODEL ABTD-03J	71,700	71,700
H-2	ABSORPTION CHILLER	351 TONS CAPACITY CHILLED WATER: 600 GPM, 56°F→42°F CONDENSER WATER: 1250 GPM, 80°F→94°F HOT WATER: 945 GPM, 220°F→207°F	TRANE MODEL ABSC-03F	45,400	45,400 ✓
1-3	CENTRIFUGAL CHILLER	1111 TONS CAPACITY CHILLED WATER: 1900 GPM, 56°F→42°F CONDENSER WATER: 2350 GPM, 80°F→94°F	TRANE MODEL CVHA-055	63,000	63,000
-1,2,3,4	ENGINE GENERATOR	1115 BHP @ 1100 RPM, 800 KW OUT. JACKET WATER: 356 GPM MAX. HEAT RECOVERY: 2,952,000 BTU/HR.	CATERPILLAR D-399 TA	96,500	386,000

Project MIUS - ST. CHARLES Structure MAJOR EQUIPMENT

For CONTRACTOR PRICES

KEY	ITEM	UNIT SPECIFICATIONS	MANUFACTURER & MODEL NO.	PRICE EACH, $	TOTAL COST $
HRM-1,2,3,4	HEAT RECOVERY MUFFLER	NOISE POWER EMISSION LEVEL: 10.1 BEL EXH. SILENCER SIZE: 12" WEIGHTED SOUND LEVEL: 89 dB (SEMI-RESID.) HEAT RECOVERY ≥ 350 MBH	RILEY-BEAIRD MAXIM MET 410-10	4,500	18,000
ACE-1,2	AIR COMPRESSOR	CAPACITY: 51 CFM @ 250 PSIG 2-STAGE, INTERCOOLED, WITH WATER-COOLED AFTERCOOLER	QUINCY MODEL D-5105	4,100	8200
	INCINERATOR	PYROLYTIC INCINERATOR W/EXHAUST GAS HEAT RECOVERY, LOADING RAM, AUTO. ASH REMOVAL. FUEL: #21 DIESEL FUEL WASTE: COMB. OF TYPES #1 & 2, AND 25 GPH OF SLUDGE	CONSUMAT C-1200	305,000	305,000
	SCRUBBER	MULTIPLE-CHAMBERED VENTURI-TYPE GAS SCRUBBER WATER USED = 50 GPM MAX GAS FLOW = 6,500 SCFM	SLY DYNAVENT #2 VENTURY SCRUBBER	10,300	10,30
	INCINERATOR STACK GAS HEAT EXCH.	SHELL SIDE: 5,000 CFM EXHAUST GAS 1800°F INLET TEMP 500°F OUTLET TEMP TUBE SIDE: 125 GPM DOWTHERM A 450°F INLET TEMP 650°F OUTLET TEMP	SUNROD	25,000	25,000

Project: MIUS - ST. CHARLES Structure: PUMPS

For:

KEY	GPM	HEAD (FT.)	MOTOR HP	RPM	MFR. & MODEL No.	PRICE EACH, $	TOTAL COST $
PHWP-1,2	1700	25	15	1150	B&G VSC 8X8X10½	2,750	5,500
HWP-1,2	200	15	5	1150	B&G VSC 6X6X9¾	1,700	3,400
HWP-1,2	1000	20	7½	1150	B&G VSC 8X8X10½	2,300	4,600
HWP-1,2	750	80	20	1750	B&G VSC 6X6X12	2,400	4,800
SHWP-1	143	25	2	1750	GOULD 3736 HPI	2800	2,800
TLP-1,2	180	20	2	1750	GOULD 3735 HPI	4,400	8,800
TLP-3,4	810	25	7½	1750	GOULD 3735 HPI	7,000	14,000
TLPP-1	475	20	4	1750	GOULD 3736 HPI	4,100	4,100
SHWP-2	850	25	7½	1150	GOULD 3236 HPI	5,400	5,400
HWP-1,2	3000	120	125	1750	B&G VSC 10X10X[illegible]	5,750	11,500
HWP-4	680	20	10	1750	B&G SER 80 4X4X9½	1,000	1,000

Project: MIUS - ST. CHARLES Structure: PUMPS

For:

KEY	GPM	HEAD (FT.)	MOTOR HP	RPM	MFR. & MODEL NO.	PRICE EACH, $	TOTAL COST $
PCHWP-2	600	20	7½	3500	B&G SER. 80 4X4X9½	1,000	1,000
PCHWP-3,4	2000	20	15	1150	B&G VSCS 10X12X11	3200	6,400
CWP-1,2	3000	150	200	1750	LANE & BOWLER 19GM	14,750	29,50?
OCP-1,2	320	60	10	1750	B&G SER. 80 3X3X9½	900	1,800
ACP-1,2	320	60	10	1750	B&G SER 80 3X3X9½	900	1,800
HWP-1	120	15	1	1750	B&G SER 80 3X3X7	500	500
HWP-2,3	350	15	3	1750	B&G SER 80 4X4X7	600	1,200
HWP-4,5	450	20	15	1750	B&G SER 80 4X4X9½	1,200	2,400
DOP-1,2	66	120	10	1200	TUTHILL MODEL 7C-*	1,400	2,800
DOP-3,4	3.3	250	½	600	TUTHILL MODEL 2CG*	400	800
DOP-5	1	120	½	1800	TUTHILL* MODEL OLA	200	200

Project MIUS - ST. CHARLES Structure PUMPS

For

KEY	GPM	HEAD (FT.)	MOTOR HP	RPM	MFR. & MODEL NO.	PRICE EACH, $	TOTAL COST $
LOP-1,2	20	120	1½	1200	TUTHILL MODEL 4CE*	400	800
BWPP-1	50	220	7½	3500	B&G SER 80 1½x1½x7	600	600
HP-1	600	120	(2) 30	3500	B&G ZOM 4A3DE	11,100	11,100
DOP-6,7	27	120	3	1200	TUTHILL MODEL 5CG*	700	1,400
ETHWP-1, 2,4,5,7,8,10,11	350	75	15	1750	B&G SER 80 4x4x9½	1,200	9,600
ETHWP-3,6, 9,12	60	10	¾	1750	B&G SER 80 1½x1½x7	400	1,600

* = MODELS RECOMMENDED BY MFR BASED ON OUR SPECIFICATIONS; NOT ALWAYS THE EXACT MODEL NO. SPEC'D. IN MECH. EQPT. SCHEDULE

Project: MIUS - ST. CHARLES Structure: TANKS

For: CONTRACTOR'S COST

KEY	CAPACITY	DIAMETER	HEIGHT (H)/ LENGTH (L)	WORK. PRESS (ASME STAMPED)	REMARKS	$ EACH	TOTAL $
AT-1,2 (AIR TANKS)	51 cu ft	36"	8'0" H	250 psig	Adamson Co. F-96 3" INLET & DISCH 1¼" SAFETY VA.	1025	2050
MTTS-1,2,3,4 (MED. TEMP. THERMAL STOR.)	20,000 gal.	14'0"	17'6" H	150 psig @ 300°F	Adamson Co. VERT. TANK w/ MANHOLE 7/8" thick	24,000	96,000
HTTS-1,2 (HIGH TEMP. THERMAL ST.)	20,000 gal.	7'0"	10'0" H	100 psig @ 650°F	Adamson Co. VERT. TANK w/ MANHOLE	3600	7,200
OST-1 (LUBE OIL TANK)	4000 gal.	7'11"	13'10"	—	OWENS-CORN. FIBERGLASS UNDERGR. 22" MANHOLE	3,350	3,350
OSWT-1 (LUBE OIL STOR. WASTE TANK)	4000 gal.	7'11"	13'10"	—	SAME	3,350	3,35
OST-1,2	25,000 gal.	126"	38'-7" L	—	Adamson Co. 24" MANHOLE UNDERGR. UL Label	9,000	18,00

Project: MHAS – St. Charles   Structure: Tanks

For:

Key	Capacity	Diameter	Height (H) / Length (L)	Work. Press. (ASME Standard)	Remarks	$ Each	$ Total
DOSDT-1,2 (Diesel Oil Stor. Day Tank)	1500 gal	64"	9'-0" L	—	Adamson Co U.L. Label	2750	5500
DOSDT-3,4	1000 gal	64"	6'-0" L	—	Adamson Co. U.L. Label	1,750	3,500
DOCT-1 (Diesel Oil Charge Tank)	1500 gal	64"	9'0" L	—	Adamson Co. U.L. Label	2750	2,750
GFT-1,2 (Glycol Fill Tank)	24 gal	13"	49" L	125 psig	B&G Model 24	120	1210
ET-1 (Expansion Tank)	1200 gal	48"	14'-0" L	125 psig	Adamson Co. w/ Penberthy X-546 Gauge	1800	1800
ET-2,6	470	36"	10'0" L	125 psig	Adamson Co w/ Pen. X-526 Gauge	700	1,400
ET-3,9,11,12	270	30"	8'0" L	125 psig	B&G w/ Liquid Level Gauge	500	2,000

Total
5,500
3,900
2,750
1210
1800
1400
2000

Project: MMS – ST. CHARLES   Structure: TANKS

For:

KEY	CAPACITY	DIAMETER	HEIGHT (H) / LENGTH (L)	WORK. PRESS. (ASME STAMPED)	REMARKS	# EACH	# TOTAL
ET-4,5	1600 gal	60"	12'-0" L	150 psig @ 500°F	Adamson Co. w/ Liq. Level Ga.	2300	4,600
ET-8	860 gal	48"	10'-0" L	125 psig	Adamson Co. w/ Liq. Level Ga.	1450	1,450
ET-10	600 gal	36"	12'0" L	125 psig	Adamson Co. w/ Penberthy X-526 Liq. Level Ga.	900	900

J-M Piping Estimate (as per Jack Martine, 12/21/77) for a double run, temp-tite throughout, the total pipe cost.

$383,540 for all CHWS&Rand HWS&R (est. by Jack)
Contractor Package Price

18" condensing water ($13.68/ft) pipe for class 100 (T35)
$41,040 estimate for 3000 ft. For class 150, add $2/ft.

Total - 41040 & 383,540

		Elbows	Tee	Adaptor
12"	$25.05/ft	$148.22	$238.34	$115.16
10	19.30	113.49	188.97	88.09
8	15.80	78.81	115.42	67.17
6	10.40	55.32	80.20	48.52
4	9.30	39.82	57.30	44.22
3	7.50	37.64	53.08	41.48
1 1/4	5.92			
1	5.52			

If we drop to 16" Class 100, price is $8.75/ft
Class 150, " 10.78/ft

Total for all pipe (as per Jack), including 3000 ft run of condenser pipe $383,540 + 41,040 = $424,580

Jack's Total Figures for all Liner, S&R:

12"	1120 ft X $/ft
10	1920 ft
8	5860 ft
6	2920 ft
4	10,920 ft
3	10,060 ft
1 1/4	1920 ft
1	1920 ft

Broken down into chilled water S&R, hot water S&R, and condenser piping:

CHWS&R	=	$209,326	≃	$209,300
HWS&R	=	174,214	≃	174,200
3000' Condenser Pipe	=	41,040	≃	41,000

If we use our estimate of ≃ 2500 ft for condenser S&R piping we get [2500 ft] X [13.68/ft] = $34,200.

Our total for these is: 383,540 + 34,200 = $417,740

Man hours for Pipe-Laying (based on JM letter of 9/3/76 by R.N. Barton)

Pipe Size	Man-hour/ft	# of feet	Man-hours
12"	.35	1120	392
10"	.37	1920	614
8"	.26	5860	1,524
6"	.21	2920	613
4"	.15	10,920	1,638
3"	.15	10,060	1,509
1 1/4	.10	1,920	192
1"	.10	1,920	192
	TOTAL MAN-HOURS		6,674

Total cost of Man-hours @ $10.00/hour cost
6674 ($10.00) = $66,740 for labor

Pipe Size (in)	O.D. (in)	S&R Approximate Trench Width, W
12	18	54"
10	15	48"
8	14	42"
6	10	42"
4	9	36"
3	7	36"
1 1/4	4	24"
1	4	24"

* Multiplier: $V = LWH$;h = 2ft

$\frac{V}{C} = WH$, since length varies

$$\frac{V}{L} = \frac{\text{"W" Trench Width(in)}}{1} \left(\frac{1\text{ft}}{12\text{ in}}\right) \left(\frac{2\text{ft}}{1}\right) \frac{1\text{yd}^3}{27\text{ft}^3} = \frac{\text{yd}^3}{\text{ft}}$$

$\frac{V}{L} = [.006]\ [W(\text{in.})]\ \frac{\text{yd}^3}{\text{ft}}$ and $W = W_1 + W_2 = \Sigma W$

$V = (.006)(W)(\text{length})$

Note: These trench widths are added because the slope of the trench is correctly accounted for by assuming that each trench will carry four pipes. However, industrial contractors trench very differently, so these figures cannot be taken too literally

Condenser Water Piping

Pond to Bend: 800ft

Bend to MIUS Plant: 320 ft

Total: 1120 ft/run = Call 1250 ft/run

1250X2 = 2500 ft. of 18" for CWS&R

2 bends @ 90°

2500ft (\$13.68/ft) = \$34,200

TOTAL PIPING COST FOR CONDENSER WATER PIPING

Piping for condenser water is class 100 transite with an 18" inside diameter.

1) Excavation and Backfill
   - a) Trench width for S&R pipes: 12+18+6+18+12=66"
   - b) Length of run = 1250 ft.
   - c) Excavated and Backfilled Volume:

     (.006)(66")(1250) = 495yd
   - d) Cost of E&B = (495)($2.50/yd^3) = $1237.50 ≈ $<u>1200</u>

2) Man-Hours of Labor and Labor Cost
   - a) assume same labor man-hr/ft for class 100 as for class 150
   - b) 18" Class 150 = .51 man-hrs/ft of pipe
   - c) Labor cost is $10.00/man-hr.
   - d) Man-hours: (2500 ft. of pipe) X (15 man-hr/ft) = 1275 man-hr.
   - e) Labor Cost: (1275 man-hr) ($10/man-hr) = $12,750 ≈ 12,800

PIPING COSTS FOR THE 1983 and 1984 MIUS Expansions

The piping is to be sized for the 300 units of Huntington Apartments to be added in 1982 and for the added 300 units of Huntington to be built in 1983. Both will have one common main, with branch feeders for each building.

A) <u>Pipe Sizing</u>

1) Heating Load + DHW for 1983-84 buildings
   - a) <u>for 1983</u>) 300 units, like Wake Terrace in design

     Scale up the Wake Terrace loads

$$[(3.46 + 2.04) \text{ X } 10^6] \frac{300 \text{ units}}{204 \text{ units}} = 809 \text{ X } 10^6 \text{ Btu/h}$$

b) for 1984) 300 units like Wake HiRise in design

Scale up Hi Rise loads:

$$[(2.00 + 1.06) \times 10^6] \frac{300}{156} = 8.66 \times 10^6 \text{ BtuH}$$

c) Total Heat Load: $(8.09 + 8.66) \times 10^6 = \underline{16.75 \times 10^6 \text{BtuH}}$

Total Heat Load is <u>16,750 MBH</u> The pipe size gives the following results for $\Delta T = 40^{\circ}F$

Total GPM =850

Main Pipe Size: 8" for HWS&R

1983 Piping : 410 GPM = 6" pipe HWS&R for 1983

1984 Piping : 440 GPM = 6" pipe HWS&R for 1984

2) Cooling Load

a) 1983: 288 tons $(\frac{300}{204}) = 424$ tons $= 5.08 \times 10^6$ Btu

b) 1984: 193 tons $(\frac{300}{106}) = 541$ tons $= 6.55 \times 10^6$ BtuH

c) $(5.08 + 6.55) \times 10^6 = 11.63 \times 10^6$ BtuH

Total Cooling Load is 11.63×10^6 BtuH, or 970 tons

For 11,637 MBH we need, for a $14^{\circ}F$ ΔT, the following:

Total GPM = 1700

Main Pipe Size = 10" CWS&R

1983 Piping : 750 GPM = 6" pipe CWS&R

1984 Piping : 950 GPM = 8" pipe CWS&R

1983 PIPING COSTS

a) Main Line

b) Feeder to low rise apartments

a) Main Line

Run Length - 2X(800+450+365) =2x(1615)= 3230ft

8" HWS&R = 3230 ($15.80) = 51,034 ∿ 51,000

10" CWS&R = 3230 ($19.30) = $62,339 ∿ 62,300

tuH

TOTAL MAIN PIPES COST

b) 1983 Branch 2(330+270) = 2(600) = 1200ft

6" HWS&R: 1200 ($10.40/ft) = 12,480 =12,500

6" CWS&R = 1200($10.40/ft) = 12480 = 12,500

1983 Total Pipe Cost

HWS&R: 51,000 + 12,500 = 63,500

CWS&R: 62,300 + 12,500 = 74,800

Total Overall 138,300

1984 Pipe Cost: 1000 ft

6" HWS&R: 1000ft ($10.40/ft) = $10,400

8" CWS&R: 1000ft ($15.80/ft) = 15,800

Total 1984 Pipe Cost: $26,200

II. EXCAVATION AND BACKFILL

A) Main: 8" HWS&R, 10" CWS&R = Trench = 48+42=90

Length = 1615 ft

Volume: (90") (.006)(1615) = 8721 yd^3

Cost: 872.1 ($2.50/yd) = $2180

B) 1983 Branch: 6" HWS&R, 6" CWS&R = Trench = 2x42=84

Length: 1200ft

Volume: (84")(.006)(1200ft) = 604.8 yd^3

Cost: ($2.50)(605) = $1510

C) Total Cost: 2150 + 1510 = $3690 = 3700

II. (cont'd)

1984: 6" HWS&R, 8" CWS&R = Trench = 42" + 42" = 84"

Length =1000ft

Volume = (84")(.006)(1000) = 504 yd^3

Cost = $2.50 (504) = $1260 ≃ $1300

III. LABOR COSTS

1983) Size	Total Length		MH ft	ΣMH	Cost
10"	3230	3230ft	.32	1034	10,336
8"	3230	3230ft	.26	840	8,398
6"	1200+1200	2400ft	.21	504	5,040
					23,774
		Call			$ 23,800

1984 Labor Cost

8"	1000 ft. (.26 M-H/ft) = 260 MH	$2600
6"	1000 ft (.21 ") = 210 MH	2100
	Total	$4700

All are based on $10/hr cost

Piping cost for 1983-1984 MIUS Additions

	1983	1984
Piping	$138,300	$26,200
Labor	23,800	4,700
Excavation & Backfill	3,700	1,300
	$165,800	$32,200

Cost

10,336

8,398

5,040

23,774

23,800

Gamze, Korobkin & Calozer
205 Wacker Suite 2201
Chicago, IL 60606

Attention: Mr. Nicholas Malik

Dear Mr. Malik:

Attached is a copy of FCC Tech. Report #66 which will be of value to you in your work. All underground heat distribution systems must now be qualified per this report for acceptance by the Federal Government because of the serious problems that have plagued most underground systems over the years. These problems, stemming from corrosion of the outer casing, leaky casing joints, and wet insulation, have caused untold losses including not infrequent replacement of systems, as outlined in the attached FCC Tech Report #47. There is a lot of other material published on these continuing problems.

Also attached, are computer printouts for two pipe systems. The first, marked "TT", is for Temp-Tite run on 6", 12" and 18" sizes with water temperatures of 210°F in the supply and 150°F in the return. The second, marked "STT" is for Super Temp-Tite, 3", 6" and 12" sizes with water temperatures of 350°F supply and 250°F return. These will show the heat loss interaction of the two pipes.

The computation system is an iterative process to reach a balance between the "k" value of the insulation and the temperature of the insulation since "k" varies with temperature and the temperature gradient varies with "k" The printout does not show the final "k" value but does show the temperature of the gradient at various points or "junctions" through the insulations, as follows in the STT.

Junction 1 - Steel - Calcium silicate interface
Junction 2 - Calcium silicate - Foam interface
Junction 3 - Foam - Casing interface

Cost of installation of pipe materials is difficult to give because of the wide variety of conditions experienced from one job to another. These varying conditions include contractor preference, crew size, local wage scales, etc. Let's first indicate manhours per lineal foot of pipe required to install Class 150 Transite (asbestos cement) pressure pipe including machine handling and pipe installation, but not including digging and backfill. These figures are from "National Mechanical Estimator" by Ottaviano Technical Services. Assuming a wage scale of $8.50 per hour (and this may be higher or lower, depending on location and union, if any) the installation cost per foot of pipe is shown.

Pipe Sizes	Man Hours Per Foot	Cost Per Foot
3 (My Estimate)	.15	1.28
4	.15	1.28
6	.21	1.79
8	.26	2.21
10	.32	2.72
12	.35	2.98
14	.42	3.57
16	.47	4.00
18	.51	4.34
20	.53	4.51
24	.60	5.10
30 (My Estimate)	.65	5.53
36 (My Estimate)	.67	5.53

To determine the manhours required to install the pre-insulated piping materials, multiply the above manhours by the following multipliers, or use the manhour per foot figure shown.

Product	Multiplier	Man Hr/Ft
Temp-Tite	1.0	
Copper Temp-Tite		.10
Kool Kore		.15
Heat-Tite	1.3	
Super Temp-Tite	1.5	
Chemtite	1.5	

A comparison of many jobs indicates that most contractors estimate the installation costs of Super Temp-Tite at only about 25% - 50% of the installation costs of the drainable, dryable, air gap systems such as Ric-Wil or Perma Pipe sell. An occasional contractor will go higher and on one job the contractor put our installation costs only 10% of the cost of installting Ric-Wil.

I hope this information will be of value. Please contact me if you need any more. Thank you.

Most sincerely yours,

R. N. Barton
Market Manager
CHAC & A/C Electrical & Telephone Duct

bh

Attachments

BCC: E. Stoltz
R. Smith

EST. NO. Foley Estimate

SHEET NO. 1

ELECTRICAL

FINAL RECAP SHEET

JOB NAME

DATE

SHEET NO.	ITEM	MATERIAL ($)	LABOR (HOURS)
	TOTAL FROM COMPUTER PRINTOUT	95,394.00	10,094.00
3	TOTAL FROM LISTING SHEET	----------------	----------------
	MATERIAL AND LABOR ADJUSTMENT	----------------	----------------
4	TOTAL FROM EQUIPMENT SHEET	447,600.00	X X X X X X X X X X
5	TOTAL FROM SYSTEMS SHEET	79,800.00	X X X X X X X X X X
7	TOTAL FROM FIXTURES SHEET	9,600.00	X X X X X X X X X X
7	ADD NON-PRODUCTIVE LABOR	X X X X X X X X X X	----------------
	TOTAL MATERIAL AND LABOR	632,394.00	10,094.00
		LABOR RATE PER HOUR	X $ 11.70
		LABOR COST	$ 118,100.00
		MATERIAL COST	632,394.00
		ADD JOB EXPENSES	186,132.00
		TOTAL PRIME COST	936,626.00
		10% Fee	93,663.00
			~~1,030,289.00~~

reduced to $800,000* by GKC

PRICE QUOTED

* includes step up transformer

D-44

EST. NO.

SHEET NO. 2

ELECTRICAL

JOB EXPENSES

ITEM	AMOUNT ($)
BID BOND	------------
PAYMENT & PERFORMANCE BONDS	------------
INSURANCE & TAXES 25.0 % OF LABOR $ 118,100.00	29,525.00
SPECIAL ADDITIONAL INSURANCE	------------
LICENSES	2,000.00
PERMIT & INSPECTION FEES	2,000.00
ASSOCIATION FEES % OF LABOR $	------------
N.E.B.F. % OF LABOR $	Included
WATCHMAN	------------
TELEPHONE	3,500.00
SALES TAX 4 % OF MATERIAL $ 632,394.00	25,296.00
DRAWINGS & ENGINEERING	90,000.00
STORAGE & OFFICE	5,000.00
TRAVEL ALLOWANCE $ PER MAN-DAY	------------
EQUIPMENT (Crane & Operator)*	2,500.00
SMALL TOOLS 2 % OF LABOR $	2,362.00
FREIGHT EXPRESS & CARTAGE	------------
TRAVEL EXPENSES	------------
OFFICE SUPPLIES-WATER-HEAT-ELECTRICITY	3,000.00
LABOR FRINGES $ 1.58 PER HOUR X 10,094 HOURS	15,949.00
PARKING $ PER HOUR X HOURS	------------
Temporary Power & Light for Construction	5,000.00

TOTAL	186,132.00

* includes step up transformer

EST. NO.

ELECTRICAL

SHEET NO. 4

EQUIPMENT

SYSTEM NUMBER	SYSTEM TITLE	AMOUNT ($)
101	SWITCHGEAR 15 KV	~~204,000.00~~ out GKC
103	SWITCHGEAR 5 KV	----------------
105	UNIT SUBSTATIONS	----------------
106	LOAD CENTERS	----------------
107-108	POWER TRANSFORMERS & GROUND RESISTORS	48,000.00
109	NETWORK TRANSFORMERS & PROTECTORS	----------------
123	LOW VOLTAGE SWITCHGEAR	----------------
124	SWITCHBOARDS	----------------
140	4160 V CONTROL CENTERS	----------------
142	MOTOR CONTROL CENTERS	72,000.00
154	FEEDER BUS DUCT	108,000.00
156	PLUG-IN BUS DUCT	----------------
157	TROLLEY BUS DUCT	----------------
170	DRY TYPE TRANSFORMERS	10,800.00
175-179	PANELS	4,800.00
181	MOTOR STARTER PANELS	----------------

	TOTAL	447,600.00

EST. NO.
ELECTRICAL

SYSTEMS

SHEET NO. 5

SYSTEM NUMBER	SYSTEM TITLE	QUOTED BY	AMOUNT ($)
120	Emergency Generator		~~72,000.00~~
410	Devices & Dimmers		1,800.00
470	Fire Alarm		6,000.00
		TOTAL	79,800.00

out AKD

EST. NO.
ELECTRICAL

SHEET NO. 6

LIGHTING FIXTURES

SYSTEM NUMBER	SYSTEM TITLE	AMOUNT ($)
340	OUTSIDE LIGHTING	---------------
349	LIGHTING FIXTURES	9,600.00

	TOTAL	9,600.00

January 6, 1977

Gamze, Korobkin, Caloger, Inc. (312) 641-5988
205 W. Wacker Dr.
Chicago, Illinois 60606
Attn: Mr. D. M. Caloger
Interstate Land Development, Inc.
336 Post Office Rd.
St. Charles, Md. 20601
(301) 645-4440
(202) 343-8600
Attn: Mr. William R. Reeves

Re: MIUS - St. Charles, Md.
Equipment Room
Mechanical Work

Mechanical Engineer:
Gamze-Korobkin-Caloger, Inc.
Plan Date 9/22/77 Specs. None
Addendum: Notes and meeting of 6/1/77 with you and Mr. Luther Wichmann, (312) 641-5988

Gentlemen:

We propose to furnish necessary labor and materials to install piping and pipe covering in the above project for the sum of:

Budget price (not firm)	$1,344,420.00
Add: Plumbing Allowance	60,000.00
Painting & labelling allowance	40,000.00
TOTAL	$1,444,420.00
Option: Piping for HP 9 in lieu of dry cooler (Plan M-3 & Column A) Deduct	$ 13,332.00

The following is included: Piping, fans, steel for hanging, pipe covering, pipe connections to equipment, rigging and setting mechanical equipment, expansion tanks, stacks, ductwork, unit heater.

The following has been omitted: boilers, all tanks (other than expansion), pumps, heat exchangers, mufflers, dry coolers, chillers, H & V units, coils, foundations, starters, all pumps, piping, etc. at pond, vibration isolation, controls, wiring, control valves, oil tank switch over valves, sprinkler, waste water treatment plant, ventilation of waste treatment plant, engines and generators, excavation, concrete, all work outside MIUS equipment room, mezzanines, stairs, catwalks, ladders, incinerator, stack for incinerator. financing, retention, motor control centers, pumping, Dowtherm, turbine flow meters, freight and sales tax on equipment for which you are getting prices.

Very truly yours,
R. M. Thornton, Inc.

Frank M. Reaves,
President

DATE 1/7/78 JOB NAME MIUS - STOUFFER'S ENG. 640 1/7/78

	5/10/77 BUDGET NO. 2	6/1/77 BUDGET NO. 3	A. PRIMARY H.W. M-3	B. AFTER COOLER FLOW-M-11	C. DIESEL FUEL M5	D. AIR SYSTEM M-8	E. OIL COOLER M-4	F. CONDEN. WATER M	G. CHILLED WATER M-7	H. LUBE OIL M-6	1/7/78
PERMITS	10,000.	3,000.	2,600	200	500						3,200
BOILERS W/OIL BURNERS, CLEANING, BOXES	66,000.	75,000.									
OIL TANK, PUMPS, PIPING, BURNERS, DAY TANK	7,700.	7,700.									
CIRCULATING PUMPS, HEAT EXCHANGERS	100,620.	87,000.									
CONDENSATE PUMPS, GOULD	4,000.	—									
SPECIALTIES, EXPANSION JOINTS MUFFLERS	32,000.	57,000.									
PRESSURE REDUCING & POP VALVES, SWITCHES	10,000.	10,000.			420 -	150 -		275 -			945 -
TRITHILL OIL PUMP	700.	700.									
FLEXIBLE CONNECTIONS (ALLOWANCE)	15,000.	2,000.	4,750 -	750 -							
EXPANSION & CONDENSATE TANKS	227,650.	143,000.						760 -	250 -		7,020 -
HEAT EXCHANGERS & CONVERTERS "R ALSTRAN	616.	616.									10,[illegible]
COOLING TOWER & EVAP. CONDENSER BAHU, RECYCLE	27,500.	27,500.									
REFRIGERATION MACHINE W/STARTERS TRANE	202,000.	107,583.									
HIGH PRESSURE A-C UNITS FREON	1,000.	—									
A.C. UNITS STACKS, ALLOWANCE	50,000.	25,000.	27,000 -								
H. & V. UNITS TRANE	7300.	7300.									27,[illegible]
COILS HTG. & CLG. TRANE	8,700.	8,700.									
INDUCTION OR FAN-COIL UNITS PUMPS, FMC	1,000.	—									
CONVECTORS, FIN TUBE & RADIATORS	1,000.	—									
UNIT HEATERS	8,500.	8,500.									8,500 -
FILTERS	500.	—									500 -
FANS PENN ALLOWANCE	26,842.	26,842.									5,000 -
POWER ROOF VENTILATORS AIR COMP.	7,000.	7,000.				5,700 -					5,[illegible]
REGISTERS & DIFFUSERS - ALLOWANCE	6,000.	5,000.									5,020 -
STARTERS / MOTOR CONTROL CENTERS OTHERS	10,000.	—									OTHERS
VIBRATION & SOUND CONTROL NONE	8,000.	—									NONE
MISCELLANEOUS HANGERS & SUPPORTS ALLOWANCE	25,000.	15,0[illegible]	7,000 -	6,102 -	750	500 -	2,2[illegible]	1,330	2,250 -	100 -	15,000 -
SLEEVES	1,000.	600.									[illegible]
ACCESS DOORS	300.	200.	200 -								200 -
VALVE CHARTS & TAGS	3,000.	2,000.									2,400 -
FOUNDATION BASES	10,000.	—									OTHERS
THERMOMETERS & GAGES	6,500	3,500.									SEE SPEC[illegible]
STRAINERS TAILS, FITTINGS IN TANKS	5,000.	2,000.									2,000 -
HI-FLO-DUTY VALVES	14,000.	—									[illegible]
DUCTWORK, BREECHING, LOUVERS ALLOWANCE	75,000.	50,000.									50,[illegible] -
INSULATION ALLOWANCE	400,000.	150,000.									136,220 -
TEMPERATURE CONTROLS	—	—									OTHERS
ELECTRIC WIRING	—	—									OTHERS
SPRINKLER SYSTEM	—	—									OTHERS
WATER TREATMENT	10,000.	5,000.									5,000 -
SPECIALTIES	—	—	5,075 -		4,352 -	1,800 -	1,726	12[illegible]		1,618 -	15,216 -
WELDING, SOLDERING, JOINT MATERIAL	—	—									
ROUGH MATERIAL	420,000.	300,000.	176,423 -	29,685	8,694 -	5,825	47,975	53,416	47,206	2,691 -	375,7[illegible] -
RIGGING	50,000.	40,000.	11,200 -	4,640 -	2,22[illegible] -	4,480 -	1,000 -	1,240	3,480		32,220 -
SALES TAX 5% OF MATERIAL & EQUIP.	61,946.	53,000.									17,[illegible] -
FITTER LABOR, PIPE MAN, TINSMITH	480,000.	330,000.	184,401 -	22,647 -	12,472 -	9,912 -	29,940 -	21,179	49,056	6,911 -	240,18[illegible] -
20% PAYROLL INSURANCE & TAXES	120,000.	80,000.									95,345 -
12% TRUCK, EQUIP., RENTAL, EXPENDED MISC. TRAILERS	60,000.	44,000.									45,[illegible] -
TOTAL COST	2,579,374.	1,733,041.									1,194,420 -
MARKUP Allowance	250,000.	160,000.									150,000 -
BID	2,829,274.	1,893,041.									1,344,420 +

* 2,829,400. * 1,893,000.

F.S., office overhead + profit ~~15%~~

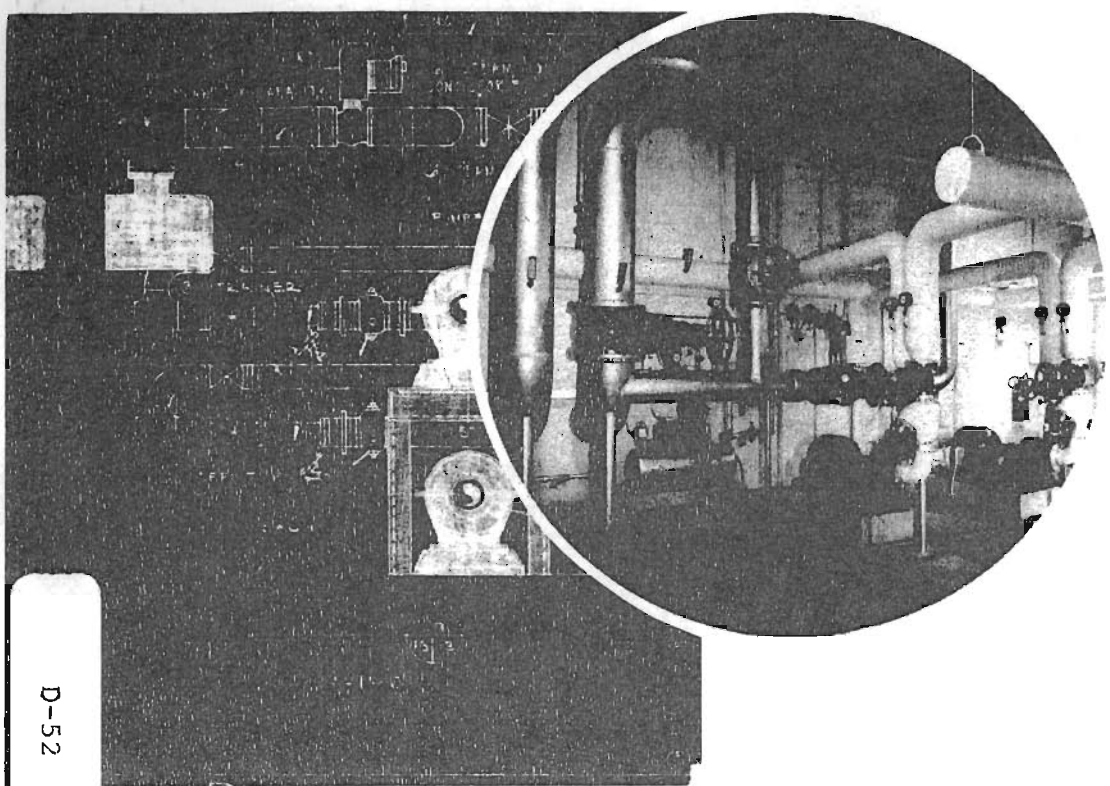
(circled) PRICES BEING OBTAINED BY YOU.

DATE 1/7/78 JOB NAME MI[illegible]

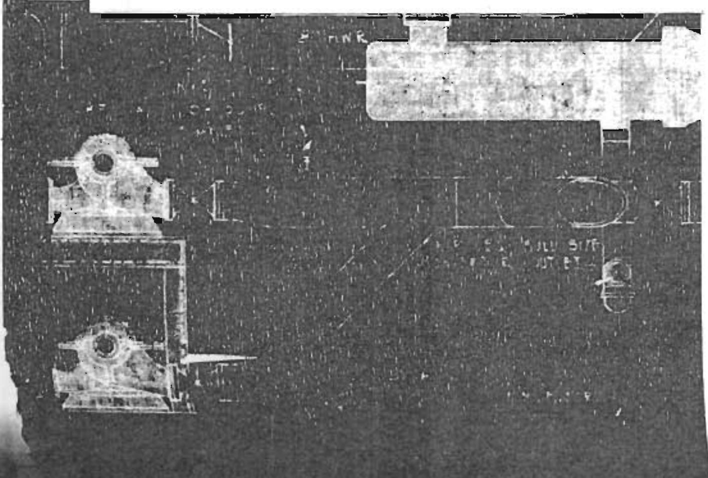
PERMITS	
BOILERS W/OIL BURNERS, CLEANING, BOXES	3%
OIL TANK, PUMPS, PIPING, BURNERS, DAY TANK	
CIRCULATING PUMPS, HEAT EXCHANGERS	
CONDENSATE PUMPS, GOULD	
SPECIALTIES, EXPANSION JOINTS MUFFLERS	
PRESSURE REDUCING & POP VALVES, SWITCHES	
TRITHILL OIL PUMP	
FLEXIBLE CONNECTIONS (ALLOWANCE)	
EXPANSION & CONDENSATE TANKS	
HEAT EXCHANGERS & CONVERTERS "R ALSTRAN	
COOLING TOWER & EVAP. CONDENSER BAHU, RECYCLE	
REFRIGERATION MACHINE W/STARTERS TRANE	
HIGH PRESSURE A-C UNITS FREON	
A.C. UNITS STACKS, ALLOWANCE	
H. & V. UNITS TRANE	
COILS HTG. & CLG. TRANE	
INDUCTION OR FAN-COIL UNITS PUMPS, FMC	
CONVECTORS, FIN TUBE & RADIATORS	
UNIT HEATERS	
FILTERS	
FANS PENN ALLOWANCE	
POWER ROOF VENTILATORS AIR COMP.	2
REGISTERS & DIFFUSERS - ALLOWANCE	
STARTERS / MOTOR CONTROL CENTERS OTHERS	
VIBRATION & SOUND CONTROL NONE	
MISCELLANEOUS HANGERS & SUPPORTS ALLOWANCE	
SLEEVES	
ACCESS DOORS	
VALVE CHARTS & TAGS	
FOUNDATION BASES	
THERMOMETERS & GAGES	
STRAINERS TAILS, FITTINGS IN TANKS	
HI-FLO-DUTY VALVES	
DUCTWORK, BREECHING, LOUVERS ALLOWANCE	
INSULATION ALLOWANCE	
TEMPERATURE CONTROLS	
ELECTRIC WIRING OT	
SPRINKLER SYSTEM	
WATER TREATMENT	
SPECIALTIES	
WELDING, SOLDERING, JOINT MATERIAL	
ROUGH MATERIAL	
RIGGING	
SALES TAX 5% MATERIAL AND EQUIP.	
FITTER LABOR, PIPE MAN, TINSMITH	
PAYROLL INSURANCE & TAXES	25%
TRUCK, EQUIP., RENTAL, EXPENDED MISC. TRAILERS	12%
TOTAL COST	
MARKUP	
BID	

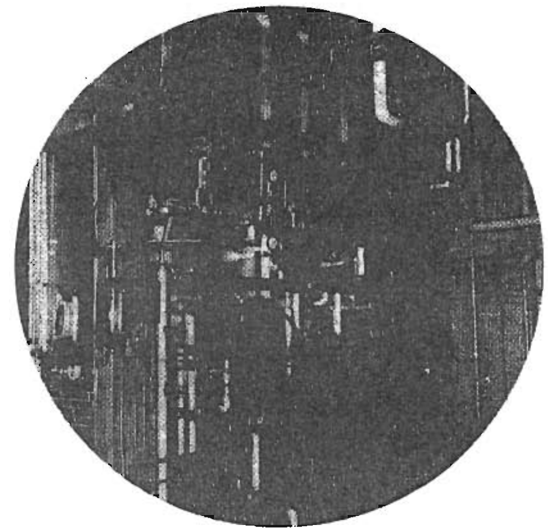
F.S., office overhead + profit

D-52



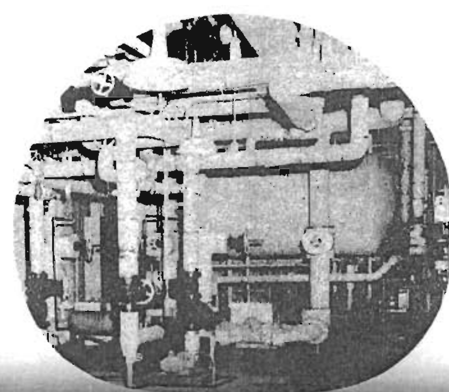
Mechanical Contractors

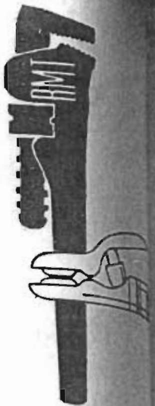


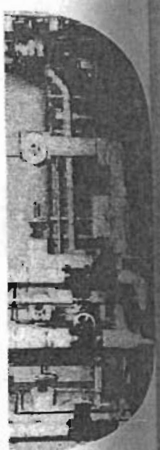


Installing: Air Conditioning • Heating • Piping • Plumbing

1354 FLORIDA AVENUE, N.E.
WASHINGTON, D. C. 20002
phone 399-2000
area code 202
cable: THORNTON







Mechanical Contractors founded in 1932 by Russell M. Thornton, emphasizes the following factors in successful achievements relative to its operations, customers and projects:

- Ability
- Responsibility
- Independence (To perform in the best interest of the customer)
- Cooperation
- Financial Resources
- Integrity
- Diversity
- Project Manager System

R. M. Thornton has proven itself on all types of projects. A partial list of customers is as follows:

OWNERS

- Alexandria Hospital
- American Broadcasting Co.
- Chesapeake and Patomac Telephone Co.
- Columbia Hospital
- District of Columbia Government
- Doctors Hospital
- Hecht Co.
- International Monetary Fund
- Kass-Berger Realty Co.
- Kodak Processing Laboratory
- Montgomery Ward & Co.
- National Coal Association
- National Wildlife Association
- Prince Georges General Hospital
- Rock Creek Ginger Ale Co.
- Safeway Dairy
- Sears Roebuck and Co.
- Sheraton Corporation
- Steuart Petroleum Co.
- Washington Daily News
- Washington Gas Light Co.
- Washington Hospital Center
- Woodward & Lothrop Co.
- U.S. Army Corps of Engineers
- U.S. General Services Administration
- U.S. Navy, Bureau of Yards & Docks

ENGINEERS

- Brown, William A.
- Cotton & Harris
- Dollar Blitz & Associates
- General Engineering Associates
- Kluckhuhn & McDavid Co.
- Love, Nash M. & Associates
- Redmile, H. Walton Assoc.
- Silver, Schwartz & Assoc.
- Smith and Lee-Thorp
- Weller and Gooch
- Wilberding Company, Inc.
- Worsley, Geo. Ira, Jr.
- Wyble, J.B.
- Youssef and Associates

BUILDERS

- American Construction Co., Inc.
- Austin Company
- Beauchamp, Victor R. & Associates
- Corning Construction Corp.
- Davis Wick Rosengarten Co., Inc.
- Eisen-Magers Construction Co., Inc.
- Fuller, Geo. A. Co.
- H.R.H. Construction Corp.
- Humphreys & Harding, Inc.
- Irons & Reynolds, Inc.
- Jordan Construction Co., Inc.
- Lipscomb, Wm. P. Co., Inc.
- Martin, Geo. C., Inc.
- Prescott Construction Co., Inc.

ARCHITECTS

- Abbott-Merkt
- Ballinger Co.
- Chatelain Gauger and Nolan
- Chloethiel Woodward Smith, & Associates
- Clas and Riggs
- Dreyfuss, Edmund
- Eggers and Higgins
- Faulkner, Kingsbury & Stenhouse
- Francisco and Jacobus
- Giuliani & Associates
- Greeley and Hanson
- Hayes Seay Mattern and Mattern
- Kea, Paul H.
- Keyes, Lethbridge and Condon
- Koubek, Valastimil
- Kockman, Alan
- May & Ruppert
- Mills, Petticord & Mills
- Porter, Irwin S. & Sons
- Saunders & Pearson

Dear Ion:

This is to confirm our earlier conversations with respect to the lengthily discussed Mius (Modular Integrated Utility System), a segment of the total energy plant in the new community of St. Charles, Maryland.

We have been discussing this project for well over a year, and have reached a point where some budgets have to be established for the basic central plant itself.

This is in contrast to earlier discussions, which included the Satellite Buildings and capabilities for remote readout through telemetry and leased telephone lines.

In order to provide ongoing system analysis, record keeping and close systems surveillance, the JC/80 automated system was selected as the optimal type for this project, and the essential components of the JC/80 would include the following: A central processing unit, A cathode ray tube for dynamic system display with dedicated keyboard, A high speed line printer, A slide projector and the miscellaneous loop remotes, a quantity to be determined upon the final selection of number of points and system memory capacity. These loop remotes would act as the system or gathering point for several sub-systems and provide the interface between the terminal sensors or pick-up points and the looped coaxial cable which provides the intelligence and railroad track for digital information for the computerized control system.

Insofar as capacity is concerned, we have talked about a 64K core memory for this project in its present state of development, which would, of course, be far above and beyond the requirements of the current central plant, and this is no accident, since the intention is to include the system capability insofar as memory is concerned and system capability for the future Satellite Buildings when they are provided under future contracts.

Our understanding of the system based upon our previous discussions would provide for graphic display, trend logging, individual point logging, alarm and operational summaries, and input/output of the various control modes and status for some approximate 120 points which would include both binary (on-off-digital), and analog (variable) points, whether these be of temperature, pressure, humidity or such comporable functions that would be determined by standard control system devices as are used in the industry.

The basic plant would include three (3) chillers, two (2) boilers, one (1) incinerator, BTU totalizing equipment for six (6) circuits; three (3) air handling units, five (5) reheat coils, three (3) exhaust fans, one (1) wing make up heater, a high capacity duplex air compressor installation, a cooling pond (in lieu of cooling tower), a package cooling unit for the engineer's office, a multiplicity of hot water convertors, and a multiplicity of pumps both for hot water, chill water, condenser water, etc. In addition, there would be four (4) thermal storage tanks and sub-systems such as condenser water bypass, differential pressure bypass, etc.

In an attempt to establish a budget for the project at this point, we must bear in mind the projected labor rates; the number of total points and types of terminal sensor/pickup points, physical location of equipment and number of programs which would be required for system generation for ongoing analysis and evaluation during the operational cycle of the system.

Based on the above, we would estimate that the budget for the central plant only to be $341,000.00. This is based upon current labor rates, and is not meant to be a firm price since we do not know at what point in time the project would start nor the duration of it which would greatly affect labor rates and, of course, total labor cost nor do we know the physical layout of the plant which would determine quantities and conduit/piping runs which also affect costs.

However, based upon our discussions, we feel that the budget established at $341,000.00 is realistic and something with which the entire project can be approached reasonably and intelligently from the standpoint of budgeting.

Very truly yours,

JOHNSON CONTROLS, INC.

Mike Berngard
Sales Engineer

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D-57

Dear Mr. Reeves:

Your letter of December 12th, 1977, to Hersey Products, Inc. of Spartanburg, South Carolina, has been referred to us as we are their representatives for this area.

We are enclosing bulletin on the NIAGARA BTU Meters and are pleased to quote the following prices:

<u>For chilled water service:</u>

1" size	$548.00 each.	
1-1/4" size	606.00 "	NOTE:- For Hot water
1-1/2" size	640.00 "	service - ADD $10.00
2" size	818.00 "	to each meter price.

F.O.B. factory - Spartanburg, South Carolina.

Prices quoted are subject to change without notice and are void in 30 days.

If we can be of further service, please advise.

Very truly yours,

HERSEY PRODUCTS,INC.,
Industrial Measurement Division

Wm. L. Becker,
Controlled Equipment Co., rep.

WLB:amc
encl.

Niagara BTU Meters assure accurate, equitable billing ■ Promote energy conservation and economy ■ Provide accurate data for internal energy control and auditing.

Typical Uses

Niagara BTU Meters are used in many installations: airports, offices and industrial complexes, apartments and condominiums, colleges, and shopping centers.

Major Features

The all-mechanical operation of these meters obviate external power sources. In addition to energy consumed, readouts also display temp differential and water flow. A high degree of accuracy is maintained over the entire measurement range.

Register may be rotated to any angle — for ease of reading. Temp probes are small — for easy installation.

Remote Indication. The BTU odometer can be constructed with a pulse transmitter for remote display of BTU reading.

How It Works

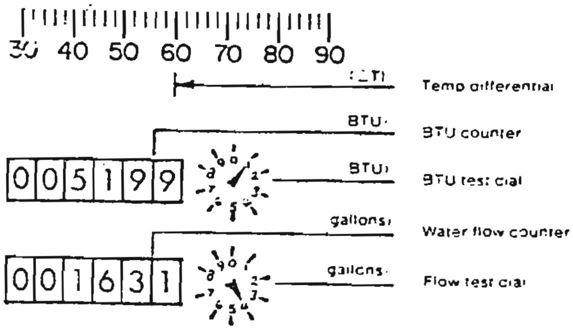
The Niagara BTU Meter consists of a temp differential sensing system and display, a water flow meter and display, and a BTU computing mechanism and display.

Temp differential sensing system. Two probes — one in the water supply line and one in the return — sense and transmit the water temp through capillary tubes. Each capillary tube is connected to a separate Bourdon spring which contracts or expands according to the water temp. An interconnecting mechanism between the two springs activates the temp indicator which displays the temp differential of the supply and return water. The major function of the springs, however, is to activate cams in the computing mechanism.

Water meter. Normally located on the water return line for heating and the inlet line for cooling, the water meter may be either a disc type or a turbine type. The meter is connected to an odometer which displays total water flow in gallons. The meter is also connected to dual cam rollers in the computing mechanism. For detailed operating characteristics of these meters, refer to appropriate Niagara Water Meter bulletins.

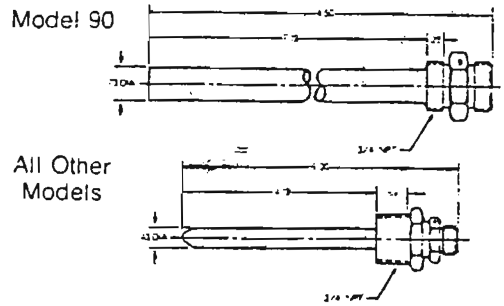
BTU computing mechanism. This mechanism receives inputs from the water meter and the temp differential sensing system. Each Bourdon spring in the sensing system activates a separate, concentrically profiled cam. Together, the two cams form a recess which varies in angular size according to the temp differential of the water. Dual cam rollers driven by the water meter rotate continuously around the cams. As the rollers pass over and into the recess generated by the cams, two cam levers attached to the rollers engage the serrated circumference of a drive wheel. The levers disengage the drive wheel when the rollers pass out of the recess. The resulting intermittent rotation of the drive wheel is directly proportional to the energy consumed, and the odometer connected to the drive wheel displays total energy consumed in BTU's

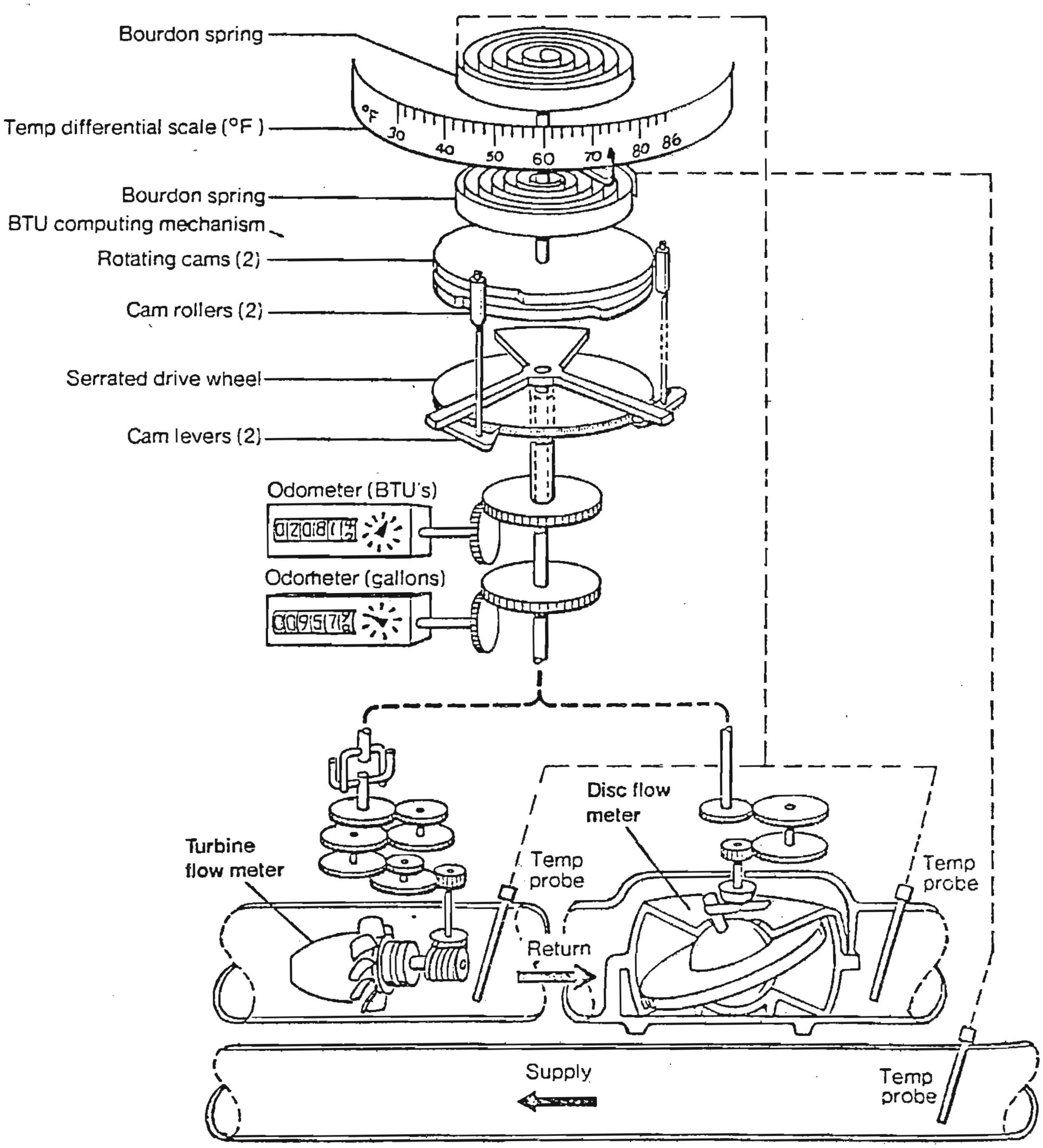
Register Readouts



Thermowell Dimensions (In.)

Large Threaded (Steel)





Register Specifications for Niagara BTU Meters

Note: The following specifications are for the registers only For flow meter specifications, refer to appropriate Niagara Water Meter bulletins.

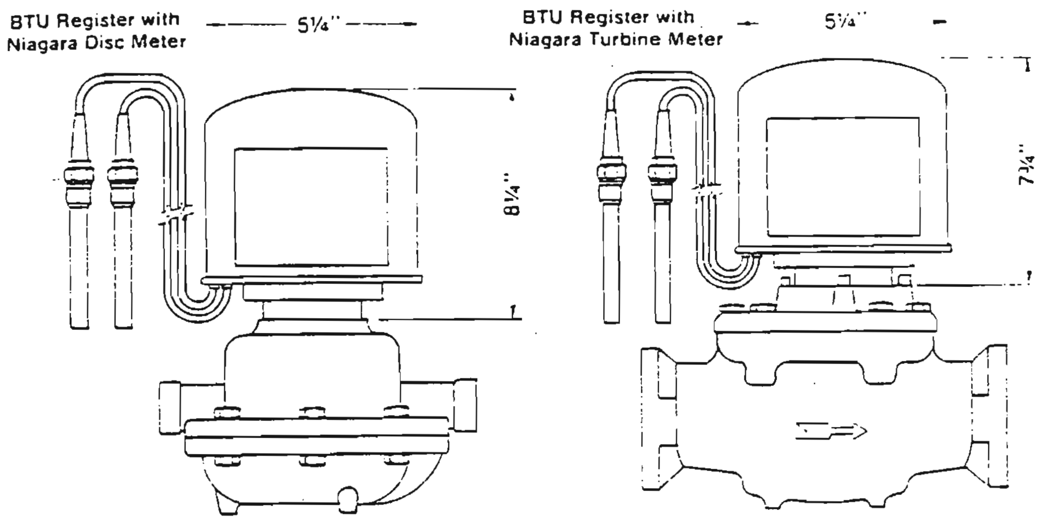
Temperature Characteristics

MODEL NUMBER	TEMP RANGE RETURN	SUPPLY	TEMP DIFFERENTIAL MIN.	MAX.
90	90°F	30°F	5°F	25°F
185	90°F	185°F	9°F	45°F
195	85°F	195°F	20°F	100°F
266	104°F	266°F	30°F	160°F
356	140°F	356°F	40°F	215°F

Register Accuracy: ± 1.5% @ > 50% rated ΔT

Register Dimensions

Note: for flow meter dimensions, refer to appropriate Niagara Water Meter bulletin.



Capillary Tube Length:

Standard length is 6.5 feet. Length of 31 feet is available on special order.

The Hersey representative in your area is:

Dear Mr Reeves

Thank you for your letter of April 22 and the attached presentation of your project MIUS.

We are pleased to confirm that our various models of metering equipment for mains-connection can be designed for operation at 60 Hz if a reasonable number of items are required.

It appears from your MIUS presentation that our heat meters can be used for the registration of heating and cooling energy for a large but so far undefined number of building complexes and houses. Following this assumption and bearing in mind that the components of our meters can be freely combined to meet wide varieties of measuring conditions, we would like to present some examples of prices for heat meters of common standard as presented in our brochure "Products and systems for the measurement of heat and water".

Heat Meter SVMU-60-52-040-3, as presented on page 6, with hot water meter bore 40 mm and for continous load 5.0 m3/h	$ 615,-
Heat Meter SVMU-60-52-100-3 with hot water meter bore 100 mm and for continuos load 50 m3/h	$ 965,-
Heat Meter SVMU-65-01-020, as presented on page 7, with hot water meter bore 20 mm and for continous load .4 m3/h	$ 380,-

Further to these examples we would like to point out that the load of water circulated is imperative information for the design of a heat meter and that the size of the hot water meter affects the price considerably. Particular combinations of our Integration Units, Resistance Thermometers, Contact Units and Hot ~~Water~~ Meters are available at slightly higher prices.

Our Power Demand Meter SVMS-3-32, presented on page 15, is by many suppliers of hydronic heating energy an important metering unit for the continous supervision of load of energy. The price is $ 1,800,-

It seems to us as SMALLWOOD VILLAGE CENTER can use our heat meters for large tenants and Central Heat Meter SVMC-70 for the small tenants. We believe that this part of the project is of particular interest with regard to the expected savings of energy and domestic hot water when individual metering is applied.

Central Heat Meter SVMC-70, presented on page 18, is sold in Sweden and other parts of Europe in the following manner of pricing:

Measure Centre $ 1,100,- and per No. of counters $ 55,- incl. one resistance thermometer per apartment.

The reason for this is that SVMC-70 is tailored with regard to the number of tenants or measuring points to be attached. This may turn out impractical for your demand and circumstances, and we would very much appreciate your comments in this respect.

Incidentally, may we also ask for your opinion about metering the heating and cooling energy in MWh, with consequent fair and easy comparison with the kWh used for electricity.

Please bear in mind that following conditions must be considered for correct design of meters for heating or cooling energy:

- maximum demand of energy
- expected drop of temperature at maximum load
- temperature range
- continous flow of water
- pressure drop at continous water flow
- operating pressure

all in order to secure highest measuring accuracy for the quantities in question.

It is our hope that this information shall be of assistance to you in your work with the MIUS project, and we will be pleased to provide you with a firm quotation when your demand and the technical conditions are known.

Sincerely,

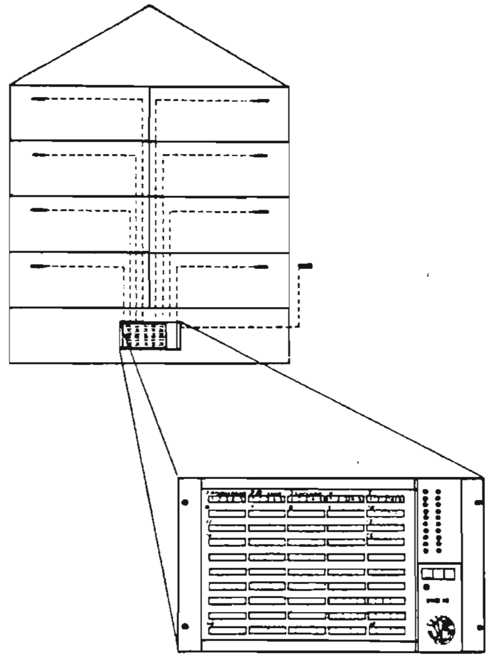
AB SVENSK VÄRMEMÄTNING
SVM

L. Knutsson

The SVMC-70 Central Heat Meter

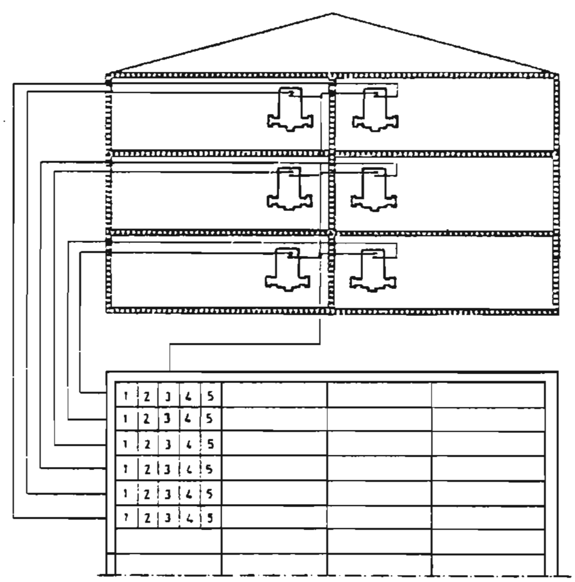
has been developed for measuring heat in blocks of flats. It measures the room temperature inside each flat as well as the outdoor temperature with a very high degree of precision. In the meter centre the time integral of the measured difference in temperature is recorded as the number of degree-days ($^{o}C \times 24$ h) on the counter reserved for the particular flat in question.

Hot Water Meter SVMV-4-1-4-1 complete with contact unit can also be connected to the SVMC-70. This combination is practical and allows complete frequency measurements to be made of both heat and hot water.



The SVMC-4-1-4-1 Hot Water Meter

measures hot and cold water in flats and various types of houses. It can be equipped with a contact unit for connection to an SVMC-10-32 Central Remote Reading Unit, containing at the most 32 counters, or to an SVMC-70 Central Heat Meter. Readings from two water meters can be added together on one and the same counter so that each counter registers the total amount of hot or cold water consumed by each particular flat or property where measurements are taken.



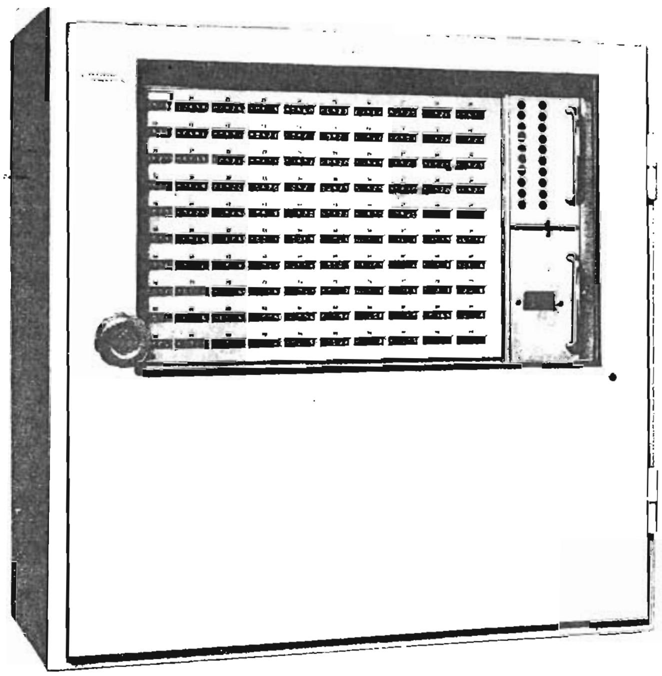
Central Heat Meter SVMC-70

The SVMC-70 ~~Heat~~ Meter is an electronic temperature meter with an integral function. In the case of a block of flats, for example, it registers centrally the number of degree-days per flat on separate counters. The values obtained provide a good basis for dividing up the fuel costs.

The temperature of each flat is measured and compared to the outdoor temperature at intervals of about once every 8 minutes by the meter successively coupling in the inside thermometer for each flat and the outdoor thermometer. The results are then digitized and stored in a counter (one for each flat). The final results are registered on a separate counter where each unit represents one degree-day.

The SVMC-70 Central Heat Meter is equipped with a panel containing a measuring point indicator and an electronic digital counter which shows the actual difference in temperature at each particular reading.

Hot Water Meter SVMV-4-1-4-1 can also be connected to this centre.



Thermometers

Ni 100 resistance thermometers in accordance with DIN 43760. The indoor temperature is measured with one or more resistance thermometers which are placed inside each flat at representative spots from the point of view of temperature.

SVMT-1-11-0-0 for mounting on wall
SVMT-1-02-1-0 for return pipe mounting

The outdoor temperature is measured by resistance thermometers mounted on the shaded side of the building.

SVMT-1-20-0-0 for outdoor installation

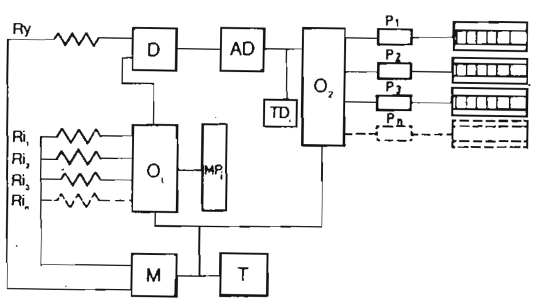
Technical Data

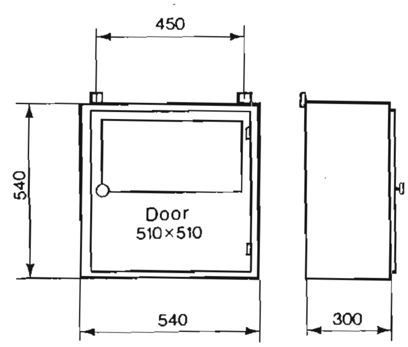
Line voltage: 220 V 50 Hz
Power consumption: 15 W
Permissible fluctuation in voltage ±15 %
Ambient temperature: 0—50 °C
Outgoing voltage: 24 V DC
Maximum permissible line resistance: 8 ohms
A common return line can be used

Central Unit

Enamelled sheet-metal cabinet containing 100 counters for registering the number of degree-days in the respective flats and/or for the remote reading of a hot water meter. The cabinet is fully enclosed ready for installation in the instrument space. Flush-mounting design is available on request.

Function





Resistance thermometers Ri_1, Ri_2, Ri_3 ... Ri_n are each successively connected to differential D via change-over unit 0, at fixed periods of time which are determined by timing device T. Resistance thermometer Ry is directly connected to differential D. At each change-over measuring pulse generator M emits 2 exactly identical and, from the point of view of time, well-defined but reverse surge pulses to Ry and to the temporarily connected Ri thermometers. The divergence pulse flow thereby created is a function of the difference in temperature between Ry and Ri and is transformed by analogue to digital converter AD into a pulse train whose frequency is proportional to the difference in temperature and whose length is the same as that of the measuring pulse. With the aid of change-over device O_2, which functions in step with O_1, the pulse train is fed into the respective electronic counter (P_1, P_2, P_3 ... P_n) for the particular flat in question and is then transmitted to the relevant counter in the measuring centre. Measuring point indicator MPi and temperature difference indicator TDI show the respective difference in temperature for each measurement taken.

Ordering Key

Central Heat Meter SVMC-70-bb-cc

00* = No. of counters, heat measurement
00 = No. of. counters, water measurement
*00 = 100 when purely heat measurement; the combined no. of counters for heat and water quantities is max. 100

Example
1 Central Heat Meter SVMC-70-42-42

D.3 Revenue Support Data

REVENUE SUPPORT DATA

Electric Energy

Rate = $0.0218/KWH

$0.00398/KWH*
0.016913/KWH** Fuel Adjustment

$0.020211/KWH 1979; inflate to 1980

1.08 ($0.020211) = $0.0218/KWH 1980 Energy Revenue

* SMECO-Pepco Contract dated June 1977
** $0.0145/KWH Present Fuel Adjustment Inflated at 8%/year to 1979

Electric Demand

Rate = $4.36/KW

$4.48/KW* (1979) Inflate to 1980 at 8% = $4.84/KW

ILD receipt (0.9) $4.84 = $4.36/KW

* SMECO-Pepco Contract dated 1977

Heating

Rate = $\$8.20/10^6$ BTU

Support - $3.21¢/KWH \frac{(5)}{(12)} + 2.15¢/KWH \frac{(7)}{(12)} = 2.59¢/KWH$

* Pepco rate schedule last step January 5, 1977, MD-R
Assumption - SMECO residential rate will be similar

2.59¢
1.12c Fuel adjustment charge (Memo from K. Drury dated April 11, 1977)

Inflate to 1980 at 8% per year

(1.26) (3.71c/KWH) = 4.67¢/KWH in 1980

Heat pump equivalent, heating c.o.p. = 1.5 (source Pepco)

$\frac{\$0.0467/KWH\ (10^6)}{3413\ BTU/KWH\ (1.5)}$ = $9.12 less 10% $\$8.20/10^6$ BTU

Wastewater

Rate = $0.68/1000 gallons

Support - Letter to Murray Levy from William R. Reeves, dated May 3, 1977.

(1.26) ($0.54/1000) = $o.68/1000 in 1980

Cooling

Rate = 7.4¢/Ton Hr.

Support - Same Electric Charge derived in Heat Rate

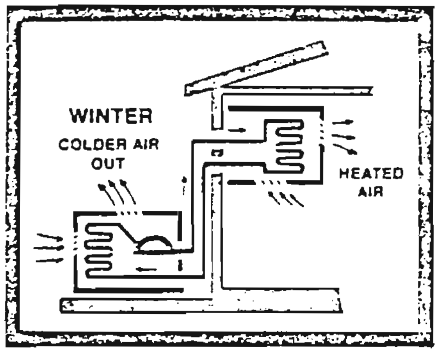
c.o.p. = 2.0 (cooling)

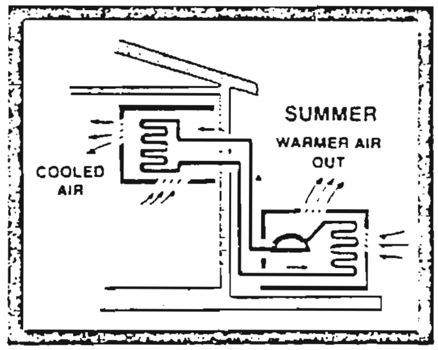
$$\frac{\text{12,000 BTU Cool (4.67c/KWH)}}{\text{Ton Hr (2.0) 3413 BTU/KWH}} = \text{8.21 Ton Hr.}$$

Less 10% 7.4c/Ton Hr.

3000/N 2

Understanding the Heat Pump





or

How to heat and cool your home with one very efficient system.

The heating system that air conditions, too. Instead of using electricity to create heat, in cold weather the heat pump uses electricity to capture free outdoor heat. It then transfers that heat to the indoor air. No matter how cold the outdoor air may seem, it always contains heat that can be removed, concentrated and transferred inside the home.

Even on the very coldest days, the heat pump system is able to supply heat to make a home comfortable. When temperatures are very low, supplemental electric resistance heaters, installed as part of the heat pump system, automatically provide any additional heat needed.

In the summer, the heat pump works like a conventional electric air conditioner. The unit automatically reverses the heat transfer process, taking heat away from indoor air, and transferring it outdoors. The diagrams above show how the heat pump functions in summer and winter.

How does the heat pump compare to available alternatives? Very favorably. In winter, it costs about the same to operate as an oil heating system and about 2/3 of the cost to operate an electric furnace. In summer the system costs the same to operate as a conventional central air conditioning system.

The heat pump system may cost a little more to purchase than separate heating and cooling systems, but this expense is offset by operating savings. No exhaust flue is needed, so the total cost of construction may be less than for a home with an oil furnace.

The heat pump is exceptionally clean and quiet. It needs no fuel tank and no outdoor air for combustion. It takes up little floor space. Because it runs on electricity, which PEPCO produces mainly with coal, the heat pump helps conserve oil supplies and is not dependent on a single energy source.

After forty years of refinement, the heat pump's time has come. Engineers have been improving the heat pump since the 1930's. With today's technology the heat pump is a reliable, energy-efficient heating and cooling system. Builders of more than a dozen subdivisions in PEPCO's service area already install heat pumps as standard equipment. That's good news as energy conservation becomes more and more important to us all.

No matter how you heat and cool, think insulation. There are many different types of thermal insulation—for walls, ceilings, floors, windows and doors. All serve to slow the natural flow of heat from areas of greater concentration to areas of lesser concentration, so you need less energy, and spend less money, to maintain a comfortable indoor temperature.

For more detailed information about heat pumps, and about home insulation, please phone our Energy Services Department at 872-2465, or write PEPCO, Room 525, 1900 Pennsylvania Avenue, N.W., Washington, D. C. 20068.

pepco
Potomac Electric Power Company

ESTIMATED REVENUE FROM VILLAGE CENTER MALL

Large Tenants

Demand - 300 KW/Mo
Consumption - 100000 KWH/Mo

Consumption

4000 x 0.223 =	$ 89.20
6000 x 0.0179 =	107.40
90000 x 0.0112 =	1,008.00
	$1,204.60/Mo
Less 5%	$1,144.37/Mo*

* SMECO L-9 Schedule.
Average cost/KWH = $0.0114/KWH

Pepco charge to SMECO = $0.0051/KWH
(Old Contract)

SMECO Mark-Up = $0.0063/KWH

1979 Charge

$0.0033/KWH Base Rate
0.0063/KWH Mark-Up
0.0164/KWH Fuel Adjustment
$0.0260/KWH (1.08) = $0.0281/KWH (1980)

Demand

40	(1.67) =	$ 66.80
760	(1.45) =	377.00
		$443.80
	Less 5%	421.61

Average Demand = $\frac{421.61}{300}$ = $1.41/KW

Pepco to SMECO = $1.03/KW
(Old Contract)

SMECO Mark-Up = $0.38/KW

1979

$4.48/KW Base Price
0.38/KW Mark-Up

$4.86/KW (1.08) = $5.25/KW (1980)

Small Tenants

Demand = $325/Mo

Consumption 107,400 KWH/Mo.

	30 x 0.614	=	1.84
(325-15)100	+60 x 0.480	=	1,490.88
	150 x 0.0257	=	3.86
	2,260 x 0.0201	=	45.43
	104,900 x 0.0167	=	1,751.83
			$3,293.84/Mo

Average Charge = $0.0307/KWH

Pepco to SMECO	=	107,400 (0.00512)	=	549.89
		325 (1.03)	=	334.75
				884.64 / 107,400
	=	$0.0087/KWH		

Mark-Up = $0.0225

$0.0033/KWH Base
0.0225/KWH Mark-Up
0.0164/KWH Fuel Adj.

$0.0422/KWH (1.08) = $0.0456/KWH (1980)

Project UIL'S - ST. CHARLES Structure

For

(D.3. cont'd) ENERGY FOR SALE TO THE UTILITY

(IN THE 5-HOUR PEAK SHAVING PERIOD)

Project MIUS - ST CHARLES Structure
For

(D-3 CONT'D) ENERGY FOR SALE TO THE UTILITY (IN THE 5-HOUR PEAK SHAVING PIRIOD)

TABLE D-32 AVAILABLE POWER FOR SALE TO SMECO (IN THE 5-HOUR PEAK SHARING PERIOD)

POWER USER/GENERATOR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT.	NOV	DEC	YEARLY AVERAGE
PLANT BURDEN	296	296	541	541	655	655	655	655	541	541	296	296	497
CHILLER	-	-	-	300	500	500	500	500	300	-	-	-	217
COMMERCIAL CENTER	635	635	635	635	635	635	635	635	635	635	635	635	635
D TOTAL	931	931	1176	1476	1790	1790	1790	1790	1476	1176	931	931	1349
POWER GENERATION	2880	2880	2880	2880	2880	2880	2880	2880	2880	2880	2880	2880	2880
EXCESS POWER TO SELL TO SMECO	1949	1949	1704	1404	1090	1090	1090	1090	1404	1704	1949	1949	1531

TABLE 7-23 AVAILABLE POWER FOR SALE TO SMECO (IN THE 5-HOUR PEAK SHARING PERIOD)

TABLE 7-23 AVAILABLE POWER FOR SALE TO SMECO (IN THE 5-HOUR PEAK SHARING PERIOD)
(EXPANDED SITE AND PLANT OF 1981 AND 1982)

POWER USER/GENERATOR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEARLY AVERAGE
	[illegible]	~~355~~	~~355~~	~~650~~	~~650~~	~~787~~	~~787~~	~~787~~	~~787~~	~~650~~	~~650~~	~~355~~	~~355~~	~~597~~
PLANT BURDEN	1981	415	415	758	758	918	918	918	918	758	758	415	415	697
	1982	474	474	866	866	1049	1049	1049	1049	866	866	474	474	796
	[illegible]	~~-~~	~~-~~	~~-~~	~~400~~	~~660~~	~~660~~	~~660~~	~~660~~	~~400~~	~~-~~	~~-~~	~~-~~	~~287~~
CHILLER	1981	-	-	-	520	860	860	860	860	520	-	-	-	373
	1982	-	-	-	640	1070	1070	1070	1070	640	-	-	-	463
COMMERCIAL CENTER		1270	1270	1270	1270	1270	1270	1270	1270	1270	1270	1270	1270	1270
	[illegible]	~~1625~~	~~1625~~	~~1920~~	~~2320~~	~~2717~~	~~2717~~	~~2717~~	~~2717~~	~~2320~~	~~1920~~	~~1625~~	~~1625~~	~~2154~~
TOTAL	1981	1685	1685	2028	2548	3048	3048	3048	3048	2548	2028	1685	1685	2340
	1982	1744	1744	2136	2776	3389	3389	3389	3389	2776	2136	1744	1744	2530
	[illegible]	~~2880~~	~~2880~~	~~2880~~	~~2880~~	~~2880~~	~~2880~~	~~2880~~	~~2880~~	~~2880~~	~~2880~~	~~2880~~	~~2880~~	~~2880~~
POWER GENERATION	1981	4320	4320	4320	4320	4320	4320	4320	4320	4320	4320	4320	4320	4320
	1982	4320	4320	4320	4320	4320	4320	4320	4320	4320	4320	4320	4320	4320
	[illegible]	~~1255~~	~~1255~~	~~960~~	~~560~~	~~163~~	~~163~~	~~163~~	~~163~~	~~560~~	~~960~~	~~1255~~	~~1255~~	~~726~~
EXCESS POWER TO SELL TO SMECO	1981	2635	2635	2292	1772	1272	1272	1272	1272	1772	2292	2635	2635	1980
	1982	2576	2576	2184	1544	931	931	931	931	1544	2184	2576	2576	1790

SMECO/PEPCO ENERGY RATES INFORMATION

MEMORANDUM

TO: MIUS FILES

FROM: W. REEVES

DATE: JUNE 28, 1977

SUBJ: SMECO CONTRACT WITH PEPCO

On June 24th, I met with Dick McCoy and Bill Crouch of SMECO to discuss their proposed agreement with PEPCO.

McCoy allowed me to look at the contract, but said that he had been instructed not to release copies until after the FTC decision has been rendered. Here are the essential numbers in the contract:

YEAR*	MONTHLY DEMAND CHARGE	ENERGY CHARGE**
1977	$1.55/KW	.3298¢/KWH
1978	$2.81/KW	.3298¢/KWH
1979	$4.48/KW	.3298¢/KWH

* Upon FTC approval, rates will be retroactive to March 1, 1977.

** Exclusive of fuel cost adjustment; fuel adjustment is to be made on a basis different from that applied to the existing contract. Under the new formula SMECO has tracked fuel adjustment charges for calendar year 1977 in the range of 1.33857¢/KWH to 1.48522¢/KWH.

No provision is made for extension of rates beyond 1979. Of interest, SMECO specifically is allowed to purchase power from a "5 megawatt plant ..... to be constructed within its franchised area ......". No "ratchet" clauses appear in the new contract.

SCHEDULE L-9

Large Light and Power Service

AVAILABILITY

Available to commercial and industrial consumers throughout the area served by the Cooperative for all uses, subject to the established rules and regulations of the Cooperative. Also available to farm and residential consumers and schools, churches and community halls to which the Rate Schedule G-9 is not available.

TYPE OF SERVICE

Single-phase or three-phase where facilities are available, 60 cycles, at standard voltages of the Cooperative.

RATE

Demand Charges of:

$1.67 per month per kilowatt of billing demand for the first 40 kilowatts.
$1.45 per month per kilowatt of billing demand for all remaining kilowatts.

Plus Energy Charges of:

2.23¢	per KWH for the first	4,000	KWH per month.
1.79¢	per KWH for the next	6,000	KWH per month.
1.12¢	per KWH for the next	90,000	KWH per month.
1.00¢	per KWH for all over	100,000	KWH per month.

except for KWH over 100,000 KWH or 400 KWH per KW of demand, whichever is greater, will be billed at 0.89¢ per KWH.

DETERMINATION OF BILLING DEMAND

The highest 15 minute integrated kilowatt demand occurring during the billing month or 50 percent of the highest 15 minute integrated kilowatt demand occurring in any of the preceding eleven months, whichever is greater, shall be used for billing purposes, except that the billing demand shall not in any case be less than 50 percent of the maximum kilowatt capacity contracted for not less than 20 kilowatts.

The consumer agrees to maintain unity power factor as nearly as practicable. The Cooperative reserves the right to measure the power factor. Should such measurements indicate that the average power factor is less than 85 percent, the demand for billing purposes shall be the demand as indicated or recorded by the demand meter multiplied by 85 percent and divided by the percent power factor. [illegible]h corrections to measured demand shall be made until subsequent tests indicate an improvement [illegible] power factor. Tests shall be made at the request of the consumer upon completion of remedial measures.

MINIMUM MONTHLY BILL

The demand charge as determined above shall be the minimum charge in any month during the term of the contract.

SCHEDULE H-9

Commercial and Small Power Service

AVAILABILITY

Available to commercial and industrial consumers throughout the area served by the Cooperative for all uses, subject to the established rules and regulations of the Cooperative. Also available to farms and residential consumers and schools, churches and community halls to which Rate Schedule G-9 is not available.

Consumers having their homes on the same premises with their business establishments may include service to both on the same meter, in which case all services will be billed under this schedule, using the rate set out below. If the consumer prefers, he may make provision for two meters, in which case his usage for residential service will be billed under Schedule G-9, and his usage for business purposes will be billed under this schedule and rate.

TYPE OF SERVICE

Single-phase and three-phase where available, 60 cycles, at standard secondary voltages of the Cooperative.

RATE

First	30 KWH per month at 6.14¢ per KWH
*Next	60 KWH per month at 4.80¢ per KWH
Next	150 KWH per month at 2.57¢ per KWH
Next	2260 KWH per month at 2.01¢ per KWH
Over	2500 KWH per month at 1.67¢ per KWH

*Provided, however, that the number of KWH billed at 4.80¢ shall be increased by 100 KWH for each kilowatt of billing demand in excess of 15 kilowatts.

MINIMUM MONTHLY CHARGE

The minimum monthly charge under the above rate shall be $2.23 for single-phase service and $11.16 for three-phase service.

DETERMINATION OF DEMAND

The billing demand shall be the maximum 15 minute kilowatt demand occurring during the month for which the bill is rendered, as indicated by a demand meter.

"Willie Wiredhand" Says —

(Over)

PRIMARY SERVICE

A discount of 5 percent (5%) of the total bill excluding adjustment for cost of fuel will be allowed when the service is metered and delivered at primary voltage and the consumer owns, installs and maintains all transforming and protective equipment.

FUEL CLAUSE

The rate above is based upon an average cost of fuel to the Potomac Electric Power Company of 30.4 cents per million BTU as burned in the Company's power plants. The monthly energy charge shall be increased or decreased .0010 cents per KWH for each one-tenth cent increase or decrease above or below 30.4 cents per million BTU. The adjustment shall be based upon the average cost of fuel during the second month preceding that of the billing month.

TERM OF CONTRACT

Not less than one (1) year. Where special investment is made to serve a consumer a contract for more than one (1) year may be required.

AUXILIARY SERVICE

Auxiliary, breakdown emergency or a standby service will be rendered under this schedule at 1½ times the demand charges herein provided. The minimum charge per month shall be the demand charge based on the maximum kilowatt capacity contracted for.

SEASONAL SERVICE

Service may be rendered hereunder to "Seasonal Consumers" for periods of less than one (1) year but not less than three (3) consecutive months during any year.

For such consumers, the demand charge shall be $1.67 per kilowatt of billing demand per month, but not less than 20 KW. The minimum bill for each of the first three months of seasonal service shall not be less than $3.35 per kilowatt of billing demand, but in no case less than $66.94 per month. During the remaining months of the "season," there shall be no minimum monthly charge.

CONDITIONS OF SERVICE

The rated capacity of single-phase motors shall not be in excess of five horsepower (5 hp). Motors having a rated capacity in excess of five horsepower (5 hp) shall be three-phase.

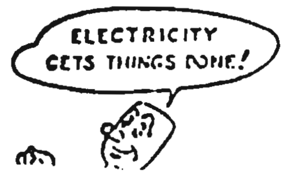
TERMS OF PAYMENT

The above rates are net, the gross rates being five percent (5%) higher. In event the current monthly bill is not paid within fifteen (15) days after the rendition of the bill, the gross rate shall apply.

ISSUED: April 16, 1975

EFFECTIVE WITH METER READINGS OF May 1, 1975 AND THEREAFTER

"Willie Wiredhand" Says —



(Over)

FUEL CLAUSE

The rate above is based upon an average cost of fuel to the Potomac Electric Power Company of 30.4 cents per million BTU as burned in the Company's power plants. The monthly energy charge shall be increased or decreased .0010 cents per KWH for each one-tenth cent increase or decrease above or below 30.4 cents per million BTU. The adjustment shall be based upon the average cost of fuel during the second month preceding that of the billing month.

TEMPORARY SERVICE

Temporary service shall be supplied in accordance with the foregoing rate except that there shall be an additional charge of $2.231 for each kilowatt, or fraction thereof, of connected load for each month, or fraction thereof, that service is connected. Bills will not be prorated for fractional part of a month.

The consumer shall in addition, pay the total cost of connecting and disconnecting service less the value of materials returned to stock. The Cooperative may require a deposit, in advance, of the full amount of the estimated bill for service including the cost of connection and disconnection.

CONDITIONS OF SERVICE

The rated capacity of single-phase motors shall not be in excess of five horsepower (5 hp). Motors having a rated capacity in excess of five horsepower (5 hp) shall be three-phase.

TERMS OF PAYMENT

All of the above rates are net, the gross rates being five percent (5%) higher. In the event the current monthly bill is not paid within fifteen (15) days after the rendition of the bill, the gross rates shall apply.

ISSUED: April 16, 1975

EFFECTIVE WITH METER READINGS OF
May 1, 1975 AND THEREAFTER

D.4 Operating Cost Support Data

OPERATING COST SUPPORT DATA

Electricity Purchase

Rate = $0.022 B/KWH

$0.0218/KWH*
0.0010/KWH**

$0.0228/KWH

* Electrical sell calculation
** SMECO letter from Dick McCoy to Bill Reeves dated April 5, 1977

Fuel (#2)

Rate = $0.0467/gallon

Support - Letter from L. T. Via of Steuart Petro Co. to Bill Reeves dated November 22, 1976 (end of year prices) inflate to end of 1979, early 1980.

(1.26) ($0.3709) = $0.467/gal. #2

Mr. William R. Reeves
Director of Industrial Development
Interstate Land Development Company, Inc.
336 Post Office Road
St. Charles, Maryland 20601

Dear Mr. Reeves:

Our discussion was most interesting and we look forward to serving the fuel oil requirements of St. Charles City one of these days. If your requirements (apparently one to two million gallons) existed today, the prices quoted to you for the various grades discussed would be as follows:

NO. 2 OIL: delivered by Truck Transport from our Washington terminal to 25,000 fuel oil storage tanks at St. Charles City would be $.3709 per gallon to escalate on Steuart Petroleum Company's posted Truck Transport price in Washington, D. C. which today is $.4107 per gallon.

NO. 4 OIL: delivered by Truck Transport from our Washington terminal to 25,000 fuel oil storage tanks at St. Charles City would be $.3485 per gallon to escalate on Steuart Petroleum Company's posted Truck Transport price in Washington, D. C. which today is $.3485 per gallon.

NO. 6 OIL: 1% Sulfur: delivered by Truck Transport from our Washington terminal to 25,000 fuel oil storage tanks at St. Charles City would be $.3254 per gallon to escalate on Steuart Petroleum Company's posted Truck Transport price in Washington, D. C. which today is $.3348 per gallon.

NO. 6 OIL: 2% Sulfur: delivered by Truck Transport from our Piney Point terminal to 25,000 fuel oil storage tanks at St. Charles City would be $.3122 per gallon to escalate on Steuart Petroleum Company's posted Truck Transport price in Piney Point, Maryland which today is $.3122 per gallon.

I am enclosing test results on 1% sulfur No. 6 oil, No. 4 oil, and No. 2 oil.

We will stop down and visit you one of these days in passing through and look forward to keeping in touch with you so that as you approach your actual time of requirement we will be able to serve your needs.

Very truly yours,

STEUART PETROLEUM COMPANY

L. T. Via
Sales Manager

LTV:jk

WASTEWATER SUBSYSTEM OPERATION DESCRIPTION

1. Plans currently show the sludge holding tank to be aerated to extend the holding time.

2. Sludge pasteurization has been included to condition the sludge for more effective dewatering and permit storing for longer periods than permitted with fresh sludge.

3. Both Items (1) and (2) provide an effective means to control offensive odors.

4. During low flow periods it was intended to circulate sludge back into the system prior to the rotary disc contractor to reduce intrification and further reduce the sludge solids volume.

Equipment as manufactured by Nichols is for the purpose of identifying the type of process and equipment available to perform the tasks described above. At the present time the system would have to be custom built to match the low capacities required.

The reduction of sludge volume through decanting reduces the amount of fuel used in maintaining incinerator combustion and according to some incinerator equipment manufacturers reduces the amount of corrosive by-products within the combustion and stack sections of the incinerator.

When the incinerator is inoperative sludge will be held in storage and removed as necessary by contract septic haulers. Recirculating larger volumes of sludge would also tend to increase the time it would take to fill the sludge holding tank.

Pasteurized sludge could also be spread on previously selected fields.

WASTEWATER SUBSYSTEM OPERATION COST

Annual operating costs in addition to labor costs are:

Biological Units	$ 3,500
Settling Tank (clarifiers)	1,000
Dual Media Filters	1,500
Chlorinators	1,100
Pumping	600
Sludge Handling	
Pumping	300
Holding Tank	350
Decanting Tank, Incinerator Feed	1,500
Laboratory	400
	$10,250

Industrial Financing

Long term, low interest financing for new and expanding industries is available in Maryland from several sources. A brochure entitled *Industrial Financing in Maryland* describes fully these sources and is available from the Maryland Department of Economic and Community Development. (See page 1 for address and telephone number.)

Income

Effective Buying Income — 1975[5]			
Distribution	Percent Households		
	Charles County	Maryland	U.S.
$ 0 - $ 2,999	7.1	8.0	10.9
3,000 - 4,999	5.1	5.5	7.8
5,000 - 7,999	7.8	9.5	11.2
8,000 - 9,999	6.4	7.7	8.0
10,000 - 14,999	21.0	22.1	21.4
15,000 - 24,999	36.1	31.6	28.5
25,000 - 49,999	15.7	14.1	10.8
50,000 and over	0.8	1.5	1.4
Per Capita	$ 4,653	$ 5,321	$ 5,003
Median Household	15,545	14,384	12,824
Average Household	16,788	16,341	14,797
Total (Millions)	278.7	22,003.2	1,073,292.8

Effective Buying Income — A classification exclusively developed by Sales & Marketing Management. It is personal income less personal tax and nontax payments. The resultant figure is commonly known as "disposable personal income."

Transportation

Highways (Interstate and/or U.S.): U.S. 301.

Rail: Consolidated Rail Corporation (ConRail).

Truck: 11 motor freight lines authorized to serve the County.

Water: Served by the Port of Baltimore, 42' channel, 4th largest foreign tonnage port in U.S. Excellent containership facilities.

Air: Served by Washington National Airport and Dulles International Airport near Washington, D.C., and Baltimore-Washington International Airport (BWI) near Baltimore.

Utilities

Electricity: Southern Maryland Electric Cooperative, Inc.

Gas: The Washington Gas Light Company serves the northern area of the County. (Inquiries as to the availability of natural gas service should be directed to the company.) Elsewhere, bottled gas is available from local distributors.

Water: The Charles County Sanitary District provides water for St. Charles Communities and Waldorf. Glymont, Indian Head, and La Plata have municipal water systems.

Sewer: Municipal systems in Indian Head, La Plata, Potomac Heights, St. Charles Communities and Waldorf.

Government and Taxes

Type of Government — Three commissioners elected for four year terms.

Taxes — Fiscal 1977		
	Charles County	Maryland
Tax Rate Per $100 Assessed Value	$2.52*	$.23
Assessment Ratio For New Manufacturers		
Real property	50%	50%
Machinery, tools, and equipment	Exempt	Exempt
Manufacturers inventories	Exempt	Exempt**
Warehousing inventories	Exempt	Exempt**

*Includes 10¢ County-wide levy for fire protection.

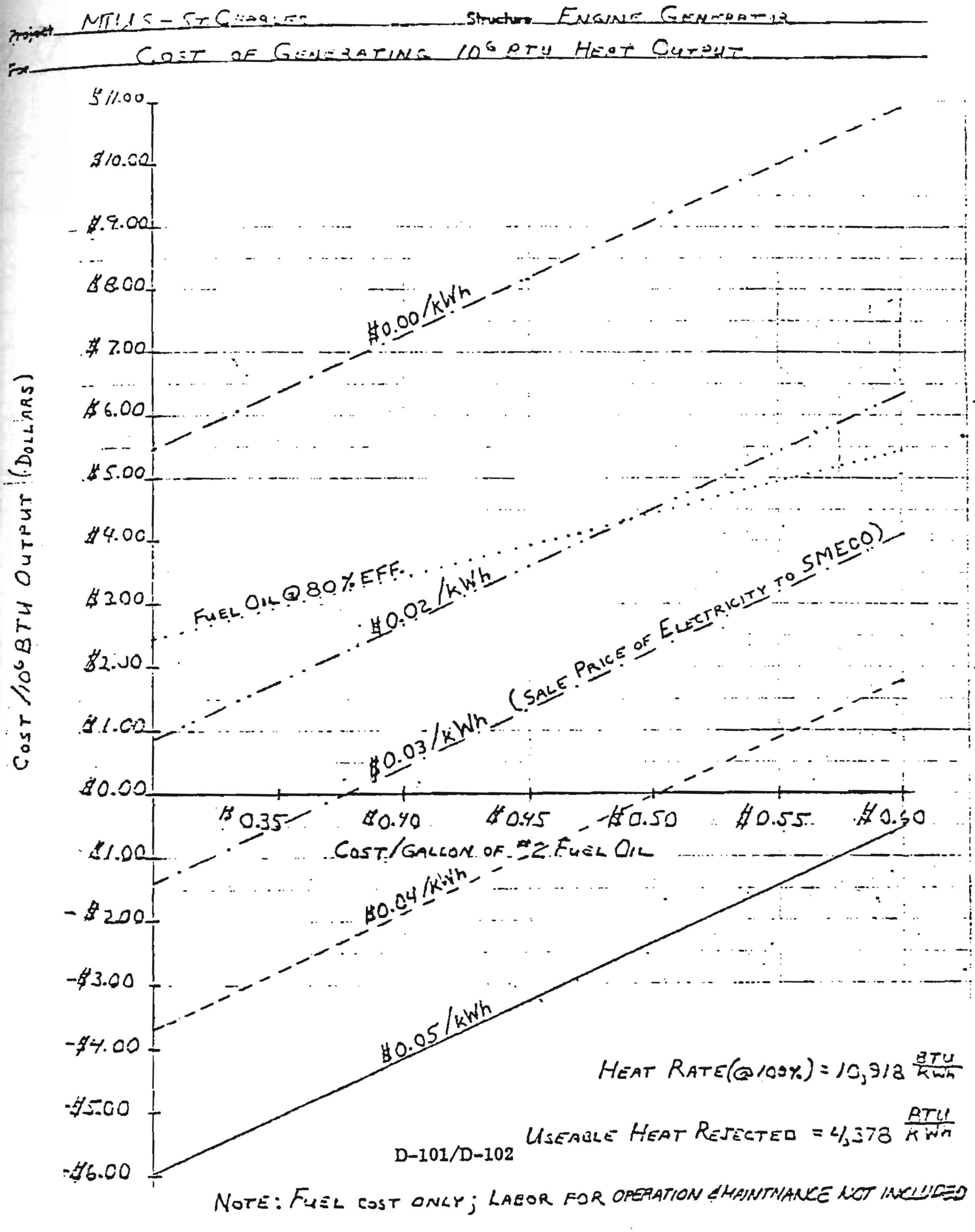
**Inventories are actually assessed at 100% and taxed by the State, but tax is deductible from State corporation income tax. If necessary, cash rebate is given.

For detailed tax information, the Maryland Department of Economic and Community Development will provide, upon request, a copy of the *Digest of Maryland Taxes and Fees*. (See page 1 for address and telephone number.)

5 — 1976 Survey of Buying Power Data Service; further reproduction is forbidden by Sales & Marketing Management.

D.5 Cost of Generating 10^6 Btu Heat Output Graph

D.5 COST OF GENERATING 10^6 BTU HEAT OUTPUT GRAPH



D.6 Cost of Heat Generated by Incineration

Project MIUS - ST. CHARLES Structure

For

D.10 Cost of Heat Generated by Incineration

D.6.1 Burning rate per day : 10 tons per day : 20,000 lbs/day

Average heat recovered : 3700 BTU/lb. 7.4×10^7 BTU/day

(Auxiliary fuel heat included)

Auxiliary fuel : 695 BTU/lb waste × 20,000 lb = 13,900,000 BTU/day

Fuel use : $\frac{13,900,000}{137,000 \times 1.0}$ = 101.46 GAL/day

Cost of 1000 BTU : $\frac{101.46 \times 0.467 \text{ GAL day \$}}{74,000 \text{ day BTU GAL}}$ = 0.064 ¢/1000 BTU

D.6.2 Extras :

Wages : Operator : 1 @ $ 18K

Pick up/Clean up : 1 @ $ 10K

28,000 ÷ 300 $ 93.33 per day

El. energy : 9 KW × 10 h/day × 0.0388* $/KWH = $ 3.49 per day

$ 96.82 per day

Extras per 1000 BTU : $\frac{96.82}{74,000}$ = 0.131 ¢/1000 BTU

* generated by eng/gen (no revenue)

Project HIUS – ST. CHARLES Structure

For

D. 6.3 Total Cost of Heat Generation

- Only manpower allocated exclusively to solid waste subsystem has been taken into account (wages)
- Fuel cost for hauling has been neglected
- Maintenance is done by SWS personel

Fuel cost:	\$	0.64 /10^6 BTU
Extras :	\$	1.31 /10^6 BTU
TOTAL	\$	1.95 /10^6 BTU

D.7 High Temperature Absorption Chiller Economic Evaluation

Project MIUS - ST. CHARLES Structure

For

D. 7 HIGH TEMPERATURE ABSORPTION CHILLER ECONOMIC EVALUATION

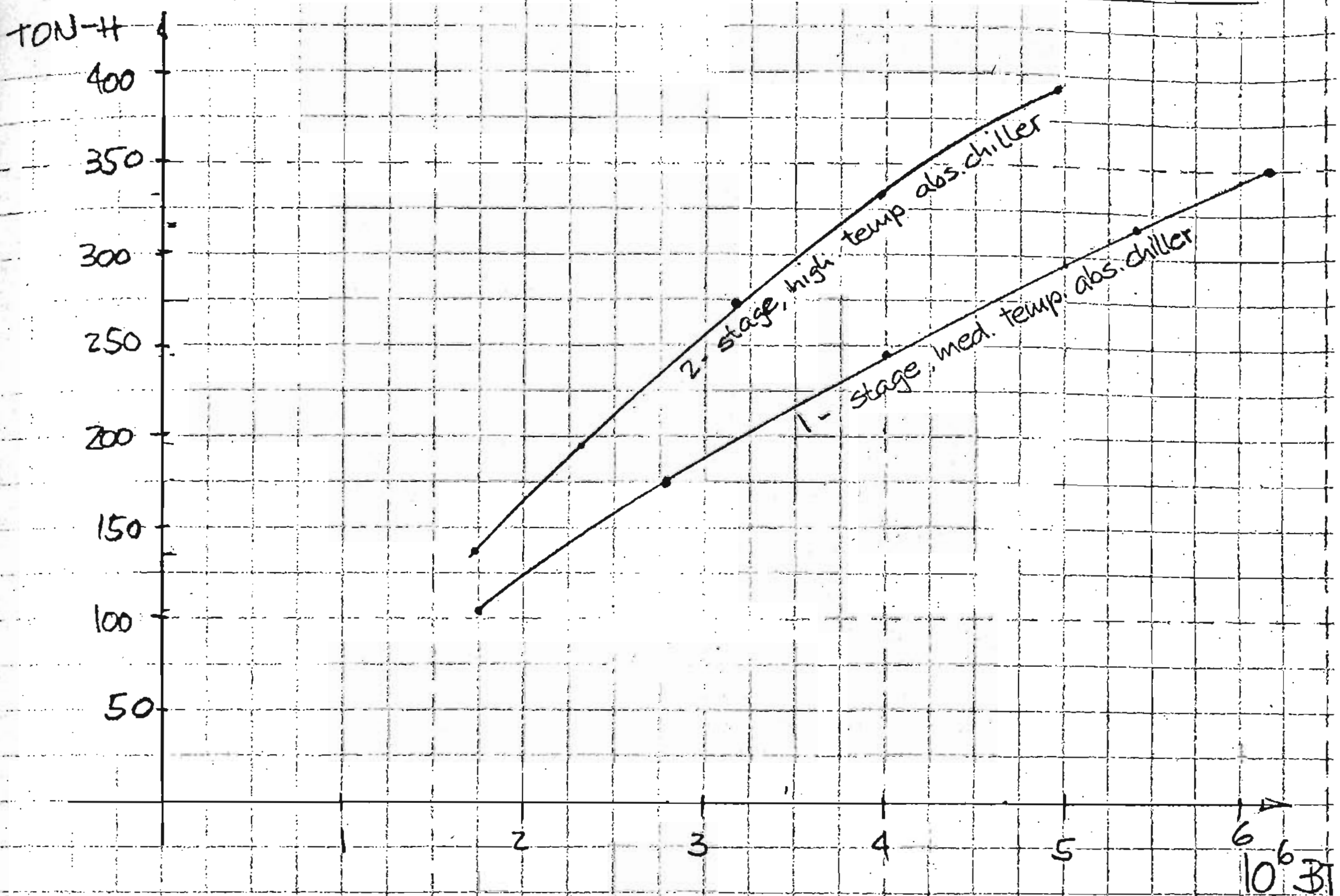
There is a maximum of 7.4×10^6 BTU/H heat available from the incinerator which is the only heat source for the double stage absorption chiller. Simultanously there is a need of high temperature heat for sludge heating in the WWS.

The double stage absorption chiller is sized a continuous availability of heat which will be about 5.0×10^6 BTU/H. Two possible chillers were concidered with demands of 6.0×10^6 BTU/H and 4.84×10^6 BTU/H, respectively. The smaller chiller was choosen, because it can operate most of the time at full capacity and optimal performance.

Project MIUS - ST. CHARLES Structure

For EVERGY - ANALYSIS

2 - STAGE AGAINST 1 - STAGE ABSORPTION CHILLER



Example : Available heat : 5.0×10^6 BTU/H

Output 1-stage chiller : 295 TONS

Output 2-stage chiller : 391 TONS

savings : 96 TONS el. chilling

0.9 KW/TON* : 96 × 0.9 KW : 87 KW

* Average performance for low load

D.7 (Continued)

Assuming 1980 Hours of Full Operation Per Year:

Savings Per Year	172,000 KWH
Cost @ 2¢/KWH:	$ 3,440

1.	Nominal cooling capacity required	1784 tons
	Maximum load for chillers: 1784 x 0.85 (0.85 is the diversity factor)	1516 tons
	Load taken by L.T. Abs. Chiller instead of H. T. Abs. Chiller	295 tons
	Load met by Electric Chiller	1221 tons
2.	Maximum load for chillers	1516 tons
	Load taken by H. T. Abs. chiller instead of L. T. Abs Chiller	391 tons
	Load met by electric chiller	1125 tons
	Additional capacity required under Option 1	96 tons

Economic Evaluation

	Option 1	Option 2
Equipment Cost Electric Chiller	122,100.00	112,500.00
Equipment Cost Absorption Chiller	32,450.00	62,560.00
Total	$154,550.00	$175,060.00
Balance	$ 20,510.00	

Return of Investment: (No interest or escalation) $\frac{20,510}{3,440}$ = 6 years

APPENDIX E - ECONOMIC ANALYSES

E.1 Economic Analyses – Computer Program Documentation

COMPUTER CASES 48-51

EXPANDED MIUS - Fuel Escalation Sensitivity Study

1. Total investment made by the developer during construction, i.e., no loan or interest.

2. Maryland State Tax at 7% of positive net margin.

3. Investment tax credits of 10%.

4. Internal Rate of Return is the discount rate which makes the sum of present value of net cash flow zero.

$$\sum_{N=1978}^{2004} \frac{(\text{net cash flow})_N}{(1+i)\ \exp\ (N-1978)}$$

   where i is the discount rate determined by an iterative routine.

5. General escalation is at 8% per year on all elements except fuel.

6. Fuel escalation:

Case	48	49	50	51
Fuel Escalation	8.0	6.0	9.0	10
IRR (%)	8.0	10.6	5.6	(neg)

COMPUTER CASES 52-55

INITIAL MIUS - Fuel Escalation Sensitivity Study

1. Total investment made by the developer during construction, i.e., no loan or interest.

2. Maryland State Tax at 7% of positive net margin.

3. Investment tax credits of 10%.

4. Internal Rate of Return is the discount rate which makes the sum of present value of net cash flow equal zero.

$$\sum_{N=1978}^{2004} \frac{(\text{net cash flow})_N}{(1+i)\ \exp\ (N-1978)} = 0$$

   where i is the discount rate determined by an iterative routine.

5. General escalation is at 8% per year on all elements except fuel.

6. Fuel escalation:

Case	52	53	54	55
Fuel ESC (%)	8.0	6.0	9.0	10.0
IRR (%)	1.2	3.8	(neg)	(neg)

E.2 Computer Printouts

CASE 52

INITIAL MIUS 2/24/78 0.% INT 100.% INV 8.% ESC CASE 52
MIUS, ST CHARLES 10.% TAX CR 8.% FL ESC
GENERATORS = 4 MEGAWATT CAPACITY = 2.880 HOURS PER DAY = 24.0 DAYS PER YEAR = 365.
EQUIPMENT LIFE = 25 YEARS TOT INVEST = 7053200.0

OUTPUT TABLES - CASH FLOW ANALYSIS ($1000)

YEAR :	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
REVENUES :												
RETAIL ELECTRIC	0.0	0.0	58.8	63.5	68.6	74.0	80.0	86.4	93.3	100.7	108.8	117.5
WHOLESALE ELECT	0.0	0.0	85.3	92.1	99.5	107.4	116.0	125.3	135.3	146.2	157.8	170.5
LIQUID WASTE	0.0	0.0	49.6	53.6	57.9	62.5	67.5	72.9	78.8	85.1	91.9	99.2
HEAT	53.5	124.2	217.3	234.7	253.5	273.7	295.6	319.3	344.8	372.4	402.2	434.4
SOLID WASTE	0.0	0.0	45.1	48.7	52.6	56.8	61.4	66.3	71.6	77.3	83.5	90.2
AIR CONDITIONING	20.0	60.2	111.6	120.5	130.2	140.6	151.8	164.0	177.1	191.3	206.6	223.1
AHU SERVICE	7.2	20.2	45.8	49.9	53.9	58.3	62.9	68.0	73.4	79.3	85.6	92.5
DEM CHG SHECO	0.0	0.0	80.0	86.5	93.4	100.8	108.9	117.6	127.0	137.2	148.2	160.0
DEM CHG LG TEN	0.0	0.0	18.9	20.4	22.0	23.8	25.7	27.8	30.0	32.4	35.0	37.8
RET ELEC LG TEN	0.0	0.0	33.7	36.4	39.3	42.5	45.9	49.5	53.5	57.8	62.4	67.4
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL REVENUES :	80.7	204.6	746.2	806.4	870.9	940.5	1015.8	1097.0	1184.8	1279.6	1381.9	1492.5
EXPENSES :												
WHOLESALE ELECT	0.0	0.0	49.3	53.3	57.5	62.1	67.1	72.5	78.3	84.5	91.3	98.6
BOILER FUEL	29.6	68.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DIESEL FUEL	0.0	0.0	250.3	270.3	292.0	315.3	340.5	367.8	397.2	429.0	463.3	500.4
INCINERATOR FUEL	0.0	0.0	16.8	18.2	19.6	21.2	22.9	24.7	26.7	28.8	31.1	33.6
OPERATORS	0.0	0.0	140.0	151.2	163.3	176.4	190.5	205.7	222.2	239.9	259.1	279.9
EXPENDABLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MAINTENANCE	1.0	2.0	82.5	89.1	96.2	103.9	112.2	121.2	130.9	141.4	152.7	164.9
RET ELEC	63.1	196.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INSURANCE+TAXES	2.2	50.0	96.0	103.7	112.0	120.9	130.6	141.1	152.4	164.5	177.7	191.9
DEPRECIATION	0.0	94.0	282.1	282.1	282.1	282.1	282.1	282.1	282.1	282.1	282.1	282.1
INTEREST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL EXPENSES :	96.0	411.6	917.1	967.9	1022.7	1082.0	1146.0	1215.1	1289.7	1370.3	1457.4	1551.4
CASH FLOW :												
NET MARGIN	-15.3	-207.0	-170.9	-161.5	-151.9	-141.5	-130.2	-118.0	-104.9	-90.7	-75.4	-58.9
REV AFTER FD TAX	-15.3	-207.0	-170.9	-161.5	-151.9	-141.5	-130.2	-118.0	-104.9	-90.7	-75.4	-58.9
CREDITS	423.1	282.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DEPRECIATION	0.0	94.0	282.1	282.1	282.1	282.1	282.1	282.1	282.1	282.1	282.1	282.1
TOTAL INFLOW	407.8	169.1	111.2	120.6	130.3	140.7	151.9	164.1	177.2	191.4	206.7	223.2
INVESTMENT	4231.9	2821.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NET CASH FLOW	-3824.1	-2652.1	111.2	120.6	130.3	140.7	151.9	164.1	177.2	191.4	206.7	223.2
CUM CASH FLOW	-3824.1	-6476.2	-6364.9	-6244.3	-6114.1	-5973.4	-5821.5	-5657.4	-5480.2	-5288.8	-5082.1	-4858.9

RETURN ON INVESTMENT BY DISCOUNTED CASH FLOW:
IS 1.2 PERCENT IN 27. YEARS FROM 1978

MAX NEG CUM CASH FLOW IS $ -6476.2 IN 1979

FIRST YEAR OF POSITIVE CUMULATIVE CASH FLOW IN 2002

INITIAL MWS 2/24/78 0.% INT 100.% INV 8.% ESC CASE 52
MWS, ST CHARLES 10.% TAX CR 8.% FL ESC
GENERATORS = 4 MEGAWATT CAPACITY = 2.800 HOURS PER DAY = 24.0 DAYS PER YEAR = 365.
EQUIPMENT LIFE = 25 YEARS TOT INVEST = 7053200.0

OUTPUT TABLES - CASH FLOW ANALYSIS ($1000)

YEAR :	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
REVENUES :												
RETAIL ELECTRIC	126.9	137.0	148.0	159.9	172.6	186.5	201.4	217.5	234.9	253.7	274.0	295.9
WHOLESALE ELECT	184.1	198.8	214.8	231.9	250.5	270.5	292.2	315.5	340.8	368.0	397.5	429.3
LIQUID WASTE	107.2	115.7	125.0	135.0	145.8	157.5	170.1	183.7	198.4	214.2	231.4	249.9
HEAT	469.2	506.7	547.2	591.0	638.3	689.3	744.5	804.0	868.4	937.8	1012.9	1093.9
SOLID WASTE	97.4	105.2	113.6	122.7	132.5	143.1	154.5	166.9	180.2	194.6	210.2	227.0
AIR CONDITIONING	240.9	260.2	281.0	303.5	327.8	354.0	382.3	412.9	445.9	481.6	520.1	561.7
AUX SERVICE	99.8	107.8	116.5	125.8	135.8	146.7	158.4	171.1	184.8	199.6	215.6	232.8
DEM CHG SMECO	172.8	186.6	201.6	217.7	235.1	253.9	274.2	296.2	319.9	345.5	373.1	403.0
DEM CHG LG TEN	40.8	44.1	47.6	51.4	55.5	60.0	64.7	69.9	75.5	81.6	88.1	95.1
RET ELEC LG TEN	72.8	78.6	84.9	91.7	99.0	107.0	115.5	124.8	134.7	145.5	157.2	169.7
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL REVENUES :	1611.9	1740.8	1880.1	2030.5	2193.0	2368.4	2557.9	2762.5	2983.5	3222.2	3480.0	3758.3
EXPENSES :												
WHOLESALE ELECT	106.5	115.0	124.2	134.1	144.9	156.4	169.0	182.5	197.1	212.8	229.9	248.2
BOILER FUEL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DIESEL FUEL	540.4	583.6	630.3	680.8	735.2	794.0	857.6	926.2	1000.2	1080.3	1166.7	1260.0
INCINERATOR FUEL	36.3	39.2	42.3	45.7	49.4	53.3	57.6	62.2	67.2	72.6	78.4	84.6
OPERATORS	302.2	326.4	352.5	380.7	411.2	444.1	479.6	518.0	559.4	604.2	652.5	704.7
EXPENDABLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MAINTENANCE	178.1	192.4	207.7	224.4	242.3	261.7	282.6	305.2	329.7	356.0	384.5	415.3
RET ELEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INSURANCE+TAXES	207.3	223.9	241.8	261.1	282.0	304.6	328.9	355.2	383.7	414.4	447.5	483.3
DEPRECIATION	282.1	282.1	282.1	282.1	282.1	282.1	282.1	282.1	282.1	282.1	282.1	282.1
INTEREST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL EXPENSES :	1652.9	1762.6	1881.0	2008.9	2147.1	2296.3	2457.4	2631.4	2819.4	3022.4	3241.6	3478.3
CASH FLOW :												
NET MARGIN	-41.0	-21.8	-0.9	21.6	45.9	72.1	100.4	131.1	164.1	199.8	238.4	280.0
REV AFTER IN TAX	-41.0	-21.8	-0.9	20.1	42.7	67.1	93.4	121.9	152.6	185.8	221.7	260.4
CREDITS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DEPRECIATION	282.1	282.1	282.1	282.1	282.1	282.1	282.1	282.1	282.1	282.1	282.1	282.1
TOTAL INFLOW	241.1	260.4	281.2	302.2	324.8	349.2	375.5	404.0	434.7	467.9	503.8	542.5
INVESTMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NET CASH FLOW	241.1	260.4	281.2	302.2	324.8	349.2	375.5	404.0	434.7	467.9	503.8	542.5
CUM CASH FLOW	-4617.8	-4357.4	-4076.2	-3774.0	-3449.3	-3100.1	-2724.5	-2320.5	-1885.8	-1417.8	-914.0	-371.5

RETURN ON INVESTMENT BY DISCOUNTED CASH FLOW:
IS 1.2 PERCENT IN 27. YEARS FROM 1978

MAX NEG CUM CASH FLOW IS $ -6476.2 IN 1979

FIRST YEAR OF POSITIVE CUMULATIVE CASH FLOW IN 2002

INITIAL MIUS 2/24/78 0.% INT 100.% INV 8.% ESC CASE 52
MIUS, ST CHARLES 10.% TAX CR 8.% FL ESC
GENERATORS = 4 MEGAWATT CAPACITY = 2.880 HOURS PER DAY = 24.0 DAYS PER YEAR = 365.
EQUIPMENT LIFE = 25 YEARS TOT INVEST = 7053200.0

OUTPUT TABLES - CASH FLOW ANALYSIS ($1000)

YEAR :	2002	2003	2004
REVENUES :			
RETAIL ELECTRIC	319.5	345.1	372.7
WHOLESALE ELECT	463.6	500.7	540.8
LIQUID WASTE	269.9	291.5	314.8
HEAT	1181.4	1275.9	1378.0
SOLID WASTE	245.2	264.8	286.0
AIR CONDITIONING	606.7	655.2	707.6
AHU SERVICE	251.4	271.5	293.3
DEM CHG SHECO	435.2	470.0	507.6
DEM CHG LG TEN	102.7	111.0	119.8
RET ELEC LG TEN	183.3	198.0	213.8
	0.0	0.0	0.0
TOTAL REVENUES :	4059.0	4383.7	4734.4
EXPENSES :			
WHOLESALE ELECT	268.1	289.6	312.7
BOILER FUEL	0.0	0.0	0.0
DIESEL FUEL	1360.8	1469.7	1587.3
INCINERATOR FUEL	91.4	98.7	106.6
OPERATORS	761.1	822.0	887.8
EXPENDABLES	0.0	0.0	0.0
MAINTENANCE	448.5	484.4	523.1
RET ELEC	0.0	0.0	0.0
	0.0	0.0	0.0
	0.0	0.0	0.0
	0.0	0.0	0.0
INSURANCE+TAXES	522.0	563.7	608.8
DEPRECIATION	282.1	282.1	188.1
INTEREST	0.0	0.0	0.0
TOTAL EXPENSES :	3734.0	4010.2	4214.4
CASH FLOW :			
NET MARGIN	325.0	373.5	520.0
REV AFTER NO TAX	302.2	347.4	483.6
CREDITS	0.0	0.0	0.0
DEPRECIATION	282.1	282.1	188.1
TOTAL INFLOW	584.3	629.5	671.7
INVESTMENT	0.0	0.0	0.0
NET CASH FLOW	584.3	629.5	671.7
CUM CASH FLOW	212.9	842.4	1514.1

RETURN ON INVESTMENT BY DISCOUNTED CASH FLOW:
IS 1.2 PERCENT IN 27. YEARS FROM 1978

MAX NEG CUM CASH FLOW IS $ -6476.2 IN 1979

FIRST YEAR OF POSITIVE CUMULATIVE CASH FLOW IN 2002

INITIAL MIUS 2/24/78 0.% INT 100.% INV 8.% ESC CASE 52
MIUS, ST CHARLES 10.% TAX CR 8.% FL ESC
GENERATORS = 4 MEGAWATT CAPACITY = 2.880 HOURS PER DAY = 24.0 DAYS PER YEAR = 365.
EQUIPMENT LIFE = 25 YEARS TOT INVEST = 7053200.0

ANNUAL PAYMENTS ON LOAN PRINCIPAL

YEAR	PAYMENT
1978	0.
1979	0.
1980	0.
1981	0.
1982	0.
1983	0.
1984	0.
1985	0.
1986	0.
1987	0.
1988	0.
1989	0.
1990	0.
1991	0.
1992	0.
1993	0.
1994	0.
1995	0.
1996	0.
1997	0.
1998	0.
1999	0.
2000	0.
2001	0.
2002	0.
2003	0.
2004	0.
2005	0.
2006	0.
2007	0.
2008	0.
2009	0.

CASE 62

GROWTH MIUS 2/24/78 12.% INT 50.% DWN 8.% ESC CASE 62
MIUS, ST CHARLES 20.% TAX CR TAP FEES
GENERATORS = 6 MEGAWATT CAPACITY = 4.320 HOURS PER DAY = 24.0 DAYS PER YEAR = 365.
EQUIPMENT LIFE = 25 YEARS TOT INVEST = 8367200.0

OUTPUT TABLES - CASH FLOW ANALYSIS ($1000)

YEAR :	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
REVENUES :												
RETAIL ELECTRIC	0.0	0.0	58.8	127.0	137.1	148.1	159.9	172.7	186.5	201.5	217.6	235.0
WHOLESALE ELECT	0.0	0.0	85.3	163.1	302.8	327.1	353.2	381.5	412.0	445.0	480.5	519.0
LIQUID WASTE	0.0	0.0	49.6	53.6	57.9	62.5	67.5	72.9	78.8	85.1	91.9	99.2
HEAT	53.5	124.2	217.3	389.4	566.0	611.3	660.2	713.0	770.0	831.6	898.2	970.0
SOLID WASTE	0.0	0.0	45.1	48.7	52.6	56.8	61.4	66.3	71.6	77.3	83.5	90.2
AIR CONDITIONING	20.0	60.2	111.6	208.3	278.2	300.5	324.5	350.5	378.5	408.8	441.5	476.8
AHW SERVICE	7.2	20.2	45.8	77.8	101.3	109.4	118.1	127.6	137.8	148.8	160.7	173.6
DEM CHG SHECO	0.0	0.0	80.0	111.5	108.9	117.6	127.0	137.2	148.1	160.0	172.8	186.6
DEM CHG LG TEN	0.0	0.0	18.9	40.8	44.1	47.6	51.4	55.5	60.0	64.8	70.0	75.6
RET ELEC LG TEN	0.0	0.0	33.7	72.8	78.7	85.0	91.8	99.1	107.0	115.6	124.8	134.8
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL REVENUES :	80.7	204.6	746.2	1293.0	1727.6	1865.8	2015.1	2176.3	2350.4	2538.4	2741.5	2960.8
EXPENSES :												
WHOLESALE ELECT	0.0	0.0	49.3	26.6	26.7	28.9	31.2	33.7	36.4	39.3	42.4	45.8
BOILER FUEL	29.6	68.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DIESEL FUEL	0.0	0.0	250.3	577.4	866.2	935.5	1010.4	1091.2	1178.5	1272.8	1374.6	1484.6
INCINERATOR FUEL	0.0	0.0	16.8	18.2	19.6	21.2	22.9	24.7	26.7	28.8	31.1	33.6
OPERATORS	0.0	0.0	140.0	151.2	163.3	176.4	190.5	205.7	222.2	239.9	259.1	279.9
EXPENDABLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MAINTENANCE	1.0	2.0	82.5	89.1	96.2	103.9	112.2	121.2	130.9	141.4	152.7	164.9
RET ELEC	63.1	196.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INSURANCE+TAXES	2.2	50.0	96.0	115.2	124.4	134.4	145.1	156.7	169.3	182.8	197.5	213.3
DEPRECIATION	0.0	111.5	334.6	334.6	334.6	334.6	334.6	334.6	334.6	334.6	334.6	334.6
INTEREST	137.5	345.6	452.3	485.7	492.2	487.3	481.8	475.6	468.6	460.7	451.8	441.8
TOTAL EXPENSES :	233.5	774.7	1421.9	1798.0	2123.3	2222.2	2328.7	2443.4	2567.1	2700.3	2843.8	2998.4
CASH FLOW :												
NET MARGIN	-152.8	-570.1	-675.7	-505.1	-395.7	-356.3	-313.6	-267.1	-216.7	-161.9	-102.3	-37.6
REV AFTER NO TAX	-152.8	-570.1	-675.7	-505.1	-395.7	-356.3	-313.6	-267.1	-216.7	-161.9	-102.3	-37.6
CREDITS	1079.9	819.5	268.3	376.5	295.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0

GROWTH MIUS 2/24/78 12.% INT 50.% O&M 8.% ESC CASE 62
MIUS, ST CHARLES 20.% TAX CR TAP FEES
GENERATORS = 6 MEGAWATT CAPACITY = 4.320 HOURS PER DAY = 24.0 DAYS PER YEAR = 365.
EQUIPMENT LIFE = 25 YEARS TOT INVEST = 8367200.0

OUTPUT TABLES - CASH FLOW ANALYSIS ($1000)

YEAR :	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
REVENUES :												
RETAIL ELECTRIC	253.8	274.1	296.0	319.7	345.3	372.9	402.7	435.0	469.8	507.3	547.9	591.8
WHOLESALE ELECT	560.5	605.4	653.8	706.1	762.6	823.6	889.5	960.6	1037.5	1120.5	1210.1	1306.9
LIQUID WASTE	107.2	115.7	125.0	135.0	145.8	157.5	170.1	183.7	198.4	214.2	231.4	249.9
HEAT	1047.6	1131.4	1221.9	1319.7	1425.3	1539.3	1662.4	1795.4	1939.1	2094.2	2261.7	2442.7
SOLID WASTE	97.4	105.2	113.6	122.7	132.5	143.1	154.5	166.9	180.2	194.6	210.2	227.0
AIR CONDITIONING	515.0	556.2	600.7	648.7	700.6	756.7	817.2	882.6	953.2	1029.5	1111.8	1200.8
AHW SERVICE	187.5	202.5	218.7	236.2	255.1	275.5	297.5	321.3	347.0	374.8	404.8	437.1
DEM CHG SMECO	201.5	217.7	235.1	253.9	274.2	296.1	319.8	345.4	373.0	402.9	435.1	469.9
DEM CHG LG TEN	81.6	88.1	95.2	102.8	111.0	119.9	129.5	139.9	151.0	163.1	176.2	190.3
NET ELEC LG TEN	145.6	157.2	169.8	183.4	198.1	213.9	231.0	249.5	269.5	291.0	314.3	339.5
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL REVENUES :	3197.7	3453.5	3729.8	4028.1	4350.4	4698.4	5074.3	5480.2	5918.7	6392.2	6903.5	7455.8
EXPENSES :												
WHOLESALE ELECT	49.5	53.5	57.7	62.4	67.4	72.7	78.6	84.8	91.6	99.0	106.9	115.4
BOILER FUEL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DIESEL FUEL	1603.3	1731.6	1870.1	2019.7	2181.3	2355.8	2544.3	2747.8	2967.6	3205.0	3461.4	3738.4
INCINERATOR FUEL	36.3	39.2	42.3	45.7	49.4	53.3	57.6	62.2	67.2	72.6	78.4	84.6
OPERATORS	302.2	326.4	352.5	380.7	411.2	444.1	479.6	518.0	559.4	604.2	652.5	704.7
EXPENDABLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MAINTENANCE	178.1	192.4	207.7	224.4	242.3	261.7	282.6	305.2	329.7	356.0	384.5	415.3
NET ELEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INSURANCE+TAXES	230.3	248.7	268.6	290.1	313.3	338.4	365.5	394.7	426.3	460.4	497.2	537.0
DEPRECTATION	334.6	334.6	334.6	334.6	334.6	334.6	334.6	334.6	334.6	334.6	334.6	334.6
INTEREST	430.5	417.7	403.4	387.3	369.0	348.5	325.4	299.4	270.0	237.0	199.7	157.7
TOTAL EXPENSES :	3164.9	3344.1	3537.1	3744.9	3968.5	4209.2	4468.2	4746.8	5046.5	5368.8	5715.3	6087.8
CASH FLOW :												
NET MARGIN	32.8	109.4	192.6	283.3	381.9	489.2	606.1	733.5	872.2	1023.4	1188.3	1368.0
REV AFTER IN TAX	30.5	101.7	179.2	263.4	355.1	455.0	563.7	682.1	811.1	951.8	1105.1	1272.3
CREDITS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

GROWTH MIUS 2/24/78 12.% INT 50.% OWN 8.% ESC CASE 62
MIUS, ST CHARLES 20.% TAX CR TAP FEES
GENERATORS = 6 MEGAWATT CAPACITY = 4.320 HOURS PER DAY = 24.0 DAYS PER YEAR = 365.
EQUIPMENT LIFE = 25 YEARS TOT INVEST = 8367200.0

OUTPUT TABLES - CASH FLOW ANALYSIS ($1000)

YEAR :	2002	2003	2004
REVENUES :			
RETAIL ELECTRIC	639.1	690.2	745.4
WHOLESALE ELECT	1411.5	1524.4	1646.3
LIQUID WASTE	269.9	291.5	314.8
HEAT	2638.1	2849.1	3077.1
SOLID WASTE	245.2	264.8	286.0
AIR CONDITIONING	1296.8	1400.6	1512.6
AHU SERVICE	472.1	509.9	550.7
DEM CHG SMECO	507.5	548.1	591.9
DEM CHG LG TEN	205.5	221.9	239.7
RET ELEC LG TEN	366.6	396.0	427.6
	0.0	0.0	0.0
TOTAL REVENUES :	8052.3	8696.5	9392.2
EXPENSES :			
WHOLESALE ELECT	124.7	134.6	145.4
BOILER FUEL	0.0	0.0	0.0
DIESEL FUEL	4037.4	4360.4	4709.2
INCINERATOR FUEL	91.4	98.7	106.6
OPERATORS	761.1	822.0	887.8
EXPENDABLES	0.0	0.0	0.0
MAINTENANCE	448.5	484.4	523.1
RET ELEC	0.0	0.0	0.0
	0.0	0.0	0.0
	0.0	0.0	0.0
	0.0	0.0	0.0
INSURANCE+TAXES	580.0	626.4	676.5
DEPRECTATION	334.6	334.6	223.1
INTEREST	110.4	57.1	6.5
TOTAL EXPENSES :	6488.1	6918.2	7278.2
CASH FLOW :			
NET MARGIN	1564.2	1778.2	2114.0
REV AFTER ND TAX	1454.7	1653.8	1966.0
CREDITS	0.0	0.0	0.0

GROWTH MUS 2224270 12.% INT 50.% DHM 0.% ESC CASE 62
MUS, ST CHARLES 20.% TAX CR TAP FEES
GENERATORS = 6 MEGAWATT CAPACITY = 4.320 HOURS PER DAY = 24.0 DAYS PER YEAR = 365.
EQUIPMENT LIFE = 25 YEARS TOT INVEST = 8367200.0

ANNUAL PAYMENTS ON LOAN PRINCIPAL

YEAR	PAYMENT
1978	0.
1979	0.
1980	29324.
1981	32483.
1982	38606.
1983	43502.
1984	49018.
1985	55234.
1986	62238.
1987	70131.
1988	79024.
1989	89044.
1990	100336.
1991	113059.
1992	127396.
1993	143550.
1994	161754.
1995	182265.
1996	205378.
1997	231421.
1998	260767.
1999	293834.
2000	331094.
2001	373079.
2002	420388.
2003	473697.
2004	214685.
2005	0.
2006	0.
2007	0.
2008	0.
2009	0.

E.3 Tap Fee Credits

SEWER TAP FEES

Apartments

$750.00	Per unit (sewer connection charge)
16.00	Inspection Fee
200.00	Mattawoman Fee (sewage treatment plant)
$966.00/Unit	

Commercial

3 Out Parcels	(7,500-10,000 Sq.Ft.) 1" Meter
$2,900.00	Sewer Connection Charge (1" Meter)
16.00	Inspection Fee
200.00	Mattawoman Fee
$3,116.00/Building	

Stoddert School

$17,400	Sewer Connection Charge (4" Meter)
16	Inspection Fee
200	Mattawoman Fee
$17,616	

SCHEDULE OF WATER AND SEWER CHARGES - RESIDENTIAL*

Water Connection Charges and Fees

3/4" connection with 5/8" meter	$ 400.00
3/4" connection with 3/4" meter	430.00
1" connection with 1" meter	505.00

(Additional charge applies to water service on streets with right-of-way over 50')

Inspection Fee	$ 10.00

Sewer Connection Charge and Fees

Normal House Connection	$1,100.00
Inspection Fee	16.00

Procedure to obtain water and sewer house connections:

1. There must be water or sewer mains available. You can check this by calling the Commission's office at 645-3632.
2. If these facilities are available, you must apply for them on forms which may be obtained at the Commission's office.
3. The application must be filled out and signed by both the property owner and registered master plumber.
4. A check payable to the Charles County Sanitary Commission covering the connection charge and inspection fee must accompany application.
5. The Commission will build the connection from the mains in the street to your property line. The registered master plumber must extend the connection from the property line to your house.

Water and Sewer Usage Charge

Water- Minimum bill for up to 12,000 gallons .... $ 11.25
Over 12,000 gallons $ .90 per thousand

Sewer- The sewer usage charge is 100% of the quarterly water bill. Bills are mailed quarterly for water consumed as recorded on the water meter.

Front Foot Benefit Assessment

Under the Sanitary District Law, the Commission is required to charge a front foot benefit assessment against property abutting the water or sewer line. At present time the uniform is 30¢ an assessable foot for water and 75¢ and assessable foot for sewer. These are billed on an annual basis by the Commission.

*Add $200 Mattawoman fee to Water, Sewer and Inspection fees.

SCHEDULE OF WATER AND SEWER CHARGES - COMMERCIAL*

Water Connection Charges and Fees

3/4" connection with 5/8" meter ..	$445.	1-1/2" connection with 1-1/2" meter	$770.
3/4" connection with 3/4" meter ..	470.	2" connection with 2" meter	935.
1" connection with 1" meter ..	545.		

(Additional charge applies to water service on streets with right-of -way over 50 feet)

Inspection Fee	$ 10.00
Apartments	350.00 per unit, plus meters
Mobile Homes......................	350.00
Motels	300.00

Sewer connection Charges (based on size of water meter)

5/8" meter... $1,960.	1" meter... $2,900.	2" meter ... $4,350.	4" meter $17,400.
3/4" meter... 2,175.	1-1/2" meter 3,480.	3" meter ... 11,600.	

(Call for fees on larger sizes)

Mobile Trailer...	$750.00	Apartment Unit ... $750.00 per unit
Motel Unit.......	500.00 per each unit	
Inspection Fee...	16.00	

Commercial buildings with two or more distinct businesses within the same building or buildings will be charged the base charge plus $300.00 additional for each business over one.

Procedure to obtain water and sewer service:

1. There must be water or sewer lines available. You can check this by calling the Commission's office at 645-3632.
2. If these facilities are available, you must apply for them on forms which may be obtained at the Commission's office.
3. The application must be filled out and signed by both the property owner and registered master plumber.
4. A check payable to the Charles County Sanitary Commission covering the connection charge and inspection fee must accompany application.
5. The Commission will build the connection from the mains in the street to your property line. You then must employ a registered master plumber to extend the connection from the property line to your house.

Water and Sewer Usage Charge

Water- Minimum bill for up to 12,000 gallons..... $11.25
Over 12,000 gallons........................ .90 per thousand

Sewer- The sewer usage charge is 100% of the quarterly water bill. Bills are mailed quarterly for water consumed as recorded on the water meter.

Front Foot Benefit Assessment

Under the Sanitary District Law, the Commission is required to charge a front foot benefit assessment against property abutting the water or sewer line. At the present time the uniform rate is 50¢ an assessable foot for water and $1.25 an assessable foot for sewer. Trailers, apartment units and motel rooms are considered at 22' per unit for front foot assessment purposes. The present uniform rate for Mobile Homes, Apartment Units and Motel rooms is 30¢ an assessable foot for water and 75¢ an assessable foot for sewer. Front Foot Assessments are billed on an annual basis by the Commission.

* Add $200 Minimum fee to Water, Sewer, and Inspection fees.

May 1979
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