6.3.5 RAW WATER TREATING-UNIT 44

6.3.5.1 DESIGN BASIS

Purpose of Unit

The Raw Water Treating unit provides for storage and treatment of the influent raw water to a suitable quality for feed to the Boiler Feed Water Treating unit.

Scope of Unit

The Raw Water Treating Unit 44 includes storage for seven days of plant makeup water requirements in the Raw Water Pond, lime softening with attendant additive makeup, sludge dewatering and disposal, clarification, and sand filtration.

General Design Criteria

Unit 44 consists of a single train; the water treating section is designed for a flow of 6428 gpm.

All pumps and mixers have spares; other major equipment is not spared.

The unit design is compatable with an onstream factor of 332 days/year.

The equipment in the unit is designed to operate continuously without a scheduled turnaround.

The unit is designed to operate at 100 percent capacity although a turndown capability of lower than 50 percent is possible.

6.3.5.1 (Continued)

Process Specifications

The Raw Water Treatment unit reduces the total suspended solids (TSS) in the treated water to less than 5 ppm, the total alkalinity to 25 ppm $CaCO_3$ equivalent, and the total hardness to 194 ppm $CaCO_3$ equivalent.

Feed

Feed to the Raw Water Pond is by pipeline from the Bighorn River. The design analysis of this water is as follows:

Component		ppm as $CaCO_3$
Ca		185
Mg		124
Na		190
K		14
	Cation Total	513
HCO_3		164
CO_3		0
OH		0
SO_4		317
Cl		27
NO_3		3
F		2
	Anion Total	513
		ppm as Ions
Fe		0.2
Mn		0.1

6.3.5.1 (Continued)

Component	ppm as Ions
B	0.2
SiO_2	13
CO_2	9
Battery Limit Conditions	
pH	7.6
Turbidity	118 Turbidity Units
TSS	20 ppm
TDS	774 ppm
Temperature	60°F

Additives to the Raw Water Treatment unit include lime, sodium aluminate, sulfuric acid, and polyelectrolytes.

Product

The analysis of the product water is as specified above including changes in other component concentrations as required to reach the product specifications.

The Battery Limit Conditions will be:

pH	6.8
TSS	0-1 ppm
TDS	554 ppm
Temp.	60°F

Utilities Required

Power 1670 kW

6.3.5.2 PROCESS DESCRIPTION

Drawing Number 835704-44-4-101 is the flow diagram for the unit. The unit material balance (Table 6.3.5-1) follows the drawing. Drawing No. 835704-44-4-050 shows the plot plan and Table 6.3.5-2 lists equipment.

Raw water is brought 12 miles to the plant site via a 30 inch pipeline originating at the Bighorn River and terminating at the raw water storage pond. The 775 x 775 x 15 feet deep pond is lined to prevent water loss and has a working capacity of 61.0 million gallons. Approximately 3.6 million gallons in the bottom of the pond is dedicated to firewater.

From the storage pond raw water is pumped to three process units, 54 gpm to Potable Water Treating, 488 gpm to Flue Gas Desulfurization, and the remaining 6221 gpm to Raw Water Treatment.

Raw water treatment includes the following steps:

Temperature Adjustment
Cold Lime Softening
Sludge Dewatering and Disposal
Sand Filtration

The treated water flows to Boiler Feed Water and Condensate Treating Unit 45.

Cold Lime Softening and Sludge Dewatering

A cold lime softening process utilizing gravity sedimentation is provided to achieve:

Suspended Solids Reduction
Precipitation/Sedimentation of Calcium, Magnesium Hardness
Colloidal Silica Reduction

6.3.5.2 (Continued)

The raw water is chlorinated to reduce the organic loading prior to flowing into the clarifier. The intent is to destory the organic material and oxidize any heavy metals that may be present.

Chemicals utilized in the process consist of:

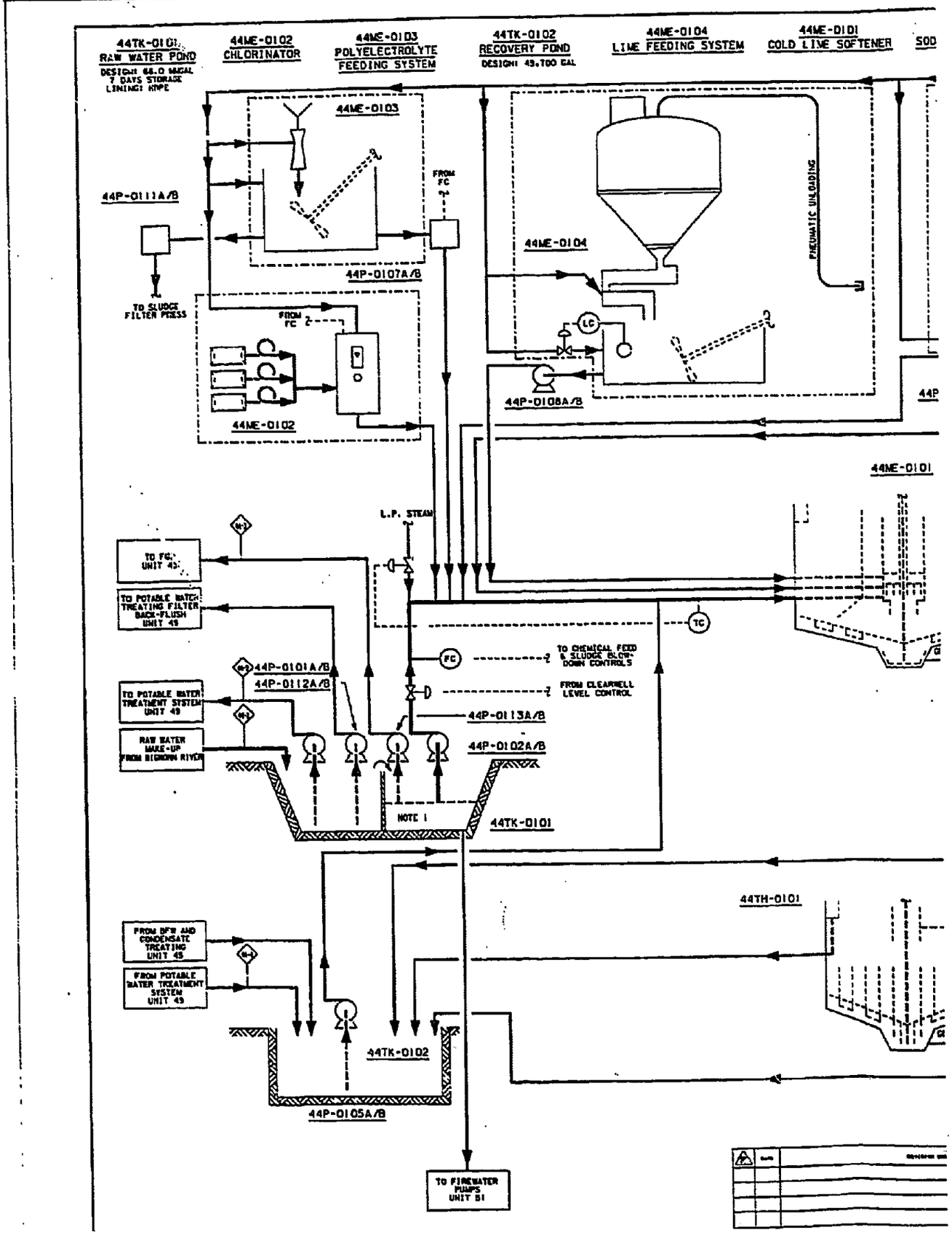
Chlorine as described above
Aluminum sulfate for suspended material coagulation
Polyelectrolyte to enhance settling coagulated materials
Lime/soda ash for alkaline and nonalkaline hardness precipitation
Magnesium hydroxide formed in conjunction with the elevated water temperature results in an appreciable reduction of colloidal silica.

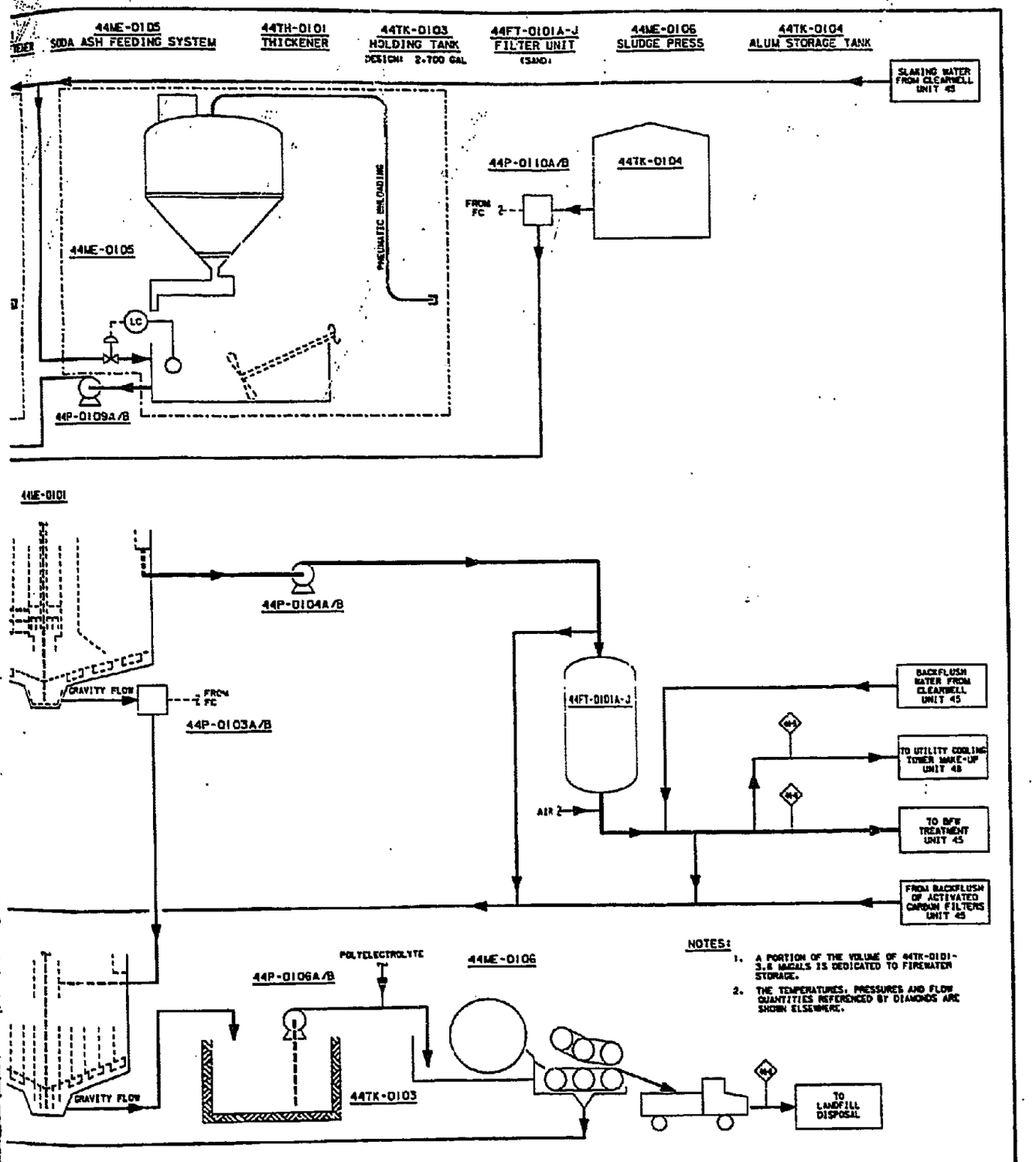
The basic process taking place in the clarifier is an accelerated chemical reaction followed by gravity sedimentation. Chemical reactants are introduced into the central rapid mix/slow mix reaction zone where the precipitate formation occurs. Upflow velocity in the sedimentation zone is low to allow the precipitates to agglomerate and settle out. Rake assemblies are provided to draw the sludge to the central sump for removal.

Thickened cold lime softener sludge is routed to a filter press unit for further dewatering. Sludge cake from this unit is routed offsite to landfill. The clarified water from the sludge dewatering operations is recycled to the softener.

Sand Filtration

Dual-media pressure type sand filters are provided to remove residual turbidity and precipitate carry over from the cold lime softening process. The filters are charged with an anthracite/sand media.


44TK-0101
RAW WATER POND
DESIGN: 68.0 MIGAL
7 DAYS STORAGE
LINING: HYPE
44ME-0102
CHLORINATOR
44ME-0103
POLYELECTROLYTE
FEEDING SYSTEM
44TK-0102
RECOVERY POND
DESIGN: 49,700 BAL
44ME-0104
LIME FEEDING SYSTEM
44ME-0101
COLD LIME SOFTENER
SOD
44ME-0103
44P-0111A/B
FROM FC
44P-0107A/B
TO SLUDGE FILTER PRESS
FROM FC
44ME-0102
44ME-0104
PNEUMATIC UNLOADING
LC
44P-0108A/B
44P
44ME-0101
L.P. STEAM
TO FC UNIT 45
TO POTABLE WATER TREATING FILTER BACK-FLUSH UNIT 49
TC
FC
TO CHEMICAL FEED & SLUDGE BLOW-DOWN CONTROLS
FROM CLEARWELL LEVEL CONTROL
44P-0101A/B
44P-0112A/B
TO POTABLE WATER TREATMENT SYSTEM UNIT 49
RAW WATER MAKE-UP FROM BIGHORN RIVER
44P-0113A/B
44P-0102A/B
NOTE 1
44TK-0101
44TH-0101
FROM DEW AND CONDENSATE TREATING UNIT 45
FROM POTABLE WATER TREATMENT SYSTEM UNIT 49
44TK-0102
44P-0105A/B
TO FIREWATER PUMPS UNIT 51



FLUOR

J. S. RUTTER
G. C. ABATAY
W. O'BELMITO
R. McCARTHY
R. LANG

PROCESS FLOW DIAGRAM
RAW WATER TREATMENT
UNIT 44

CROW TRIBE OF INDIANS — SYNFUELS FEASIBILITY STUDY

NONE | 835704-44-4-101 | 1

003 557441101

TABLE 6.3.5-1

MATERIAL BALANCE

RAW WATER TREATMENT-UNIT 44

Stream Number		44-1	44-2	44-3	44-4
Stream Name		Raw Water Makeup	To Potable Water Treating	To FGD Unit 43	RO Reject From Unit 49
Water	lb/hr (gpm)	3,406,500 (6813)	27,000 (54)	244,000 (488)	1000 (2)
Total	lb/hr	3,406,500	27,000	244,000	1000
Pressure, Psia		13.7	63.7	88.7	300
Temperature, °F		60	60	60	80

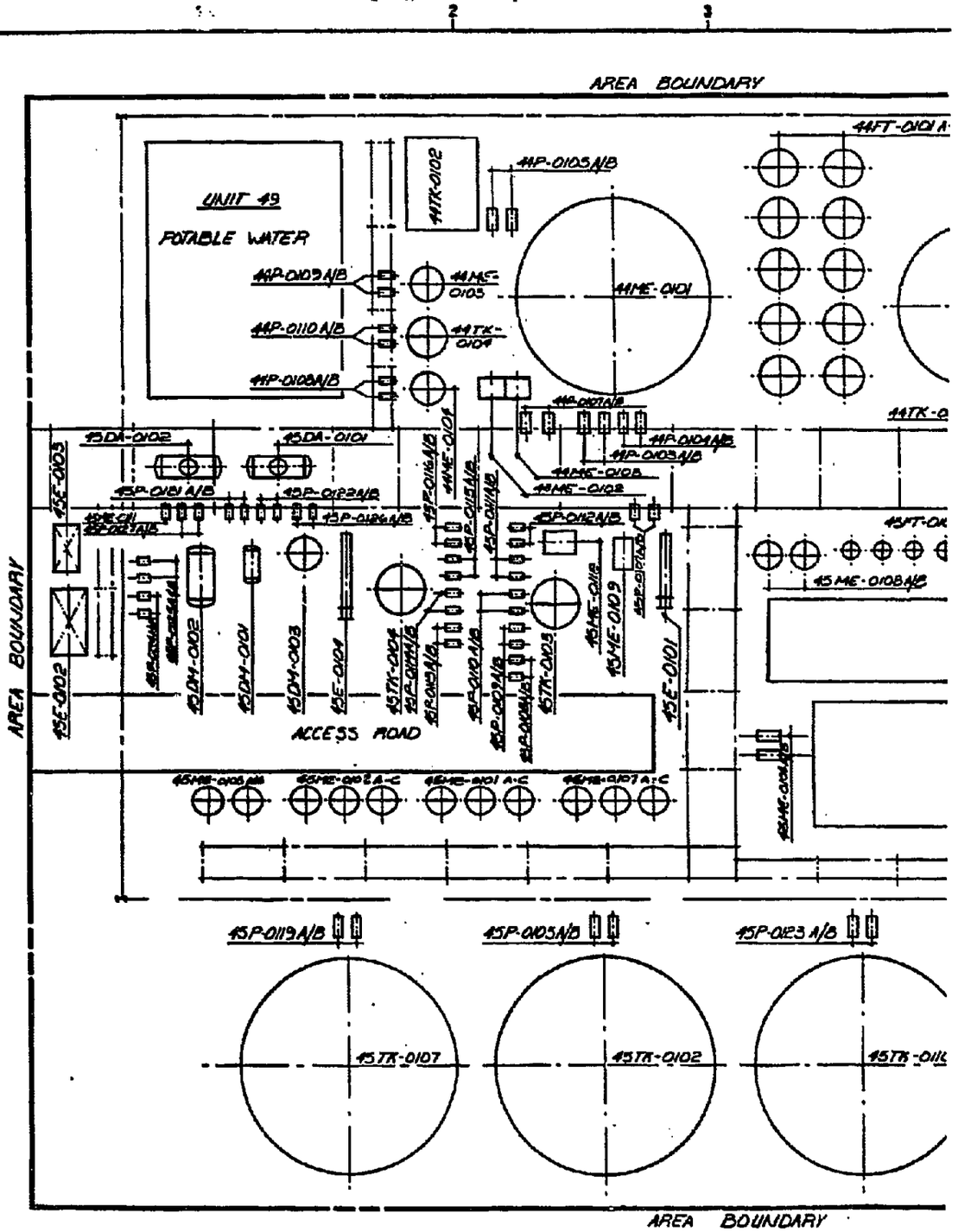
NOTE: Flow quantities, pressures and temperatures shown are for the total unit on a stream-day basis, are to be used solely for process design purposes, and are not necessarily the conditions which will be attained during actual operations.

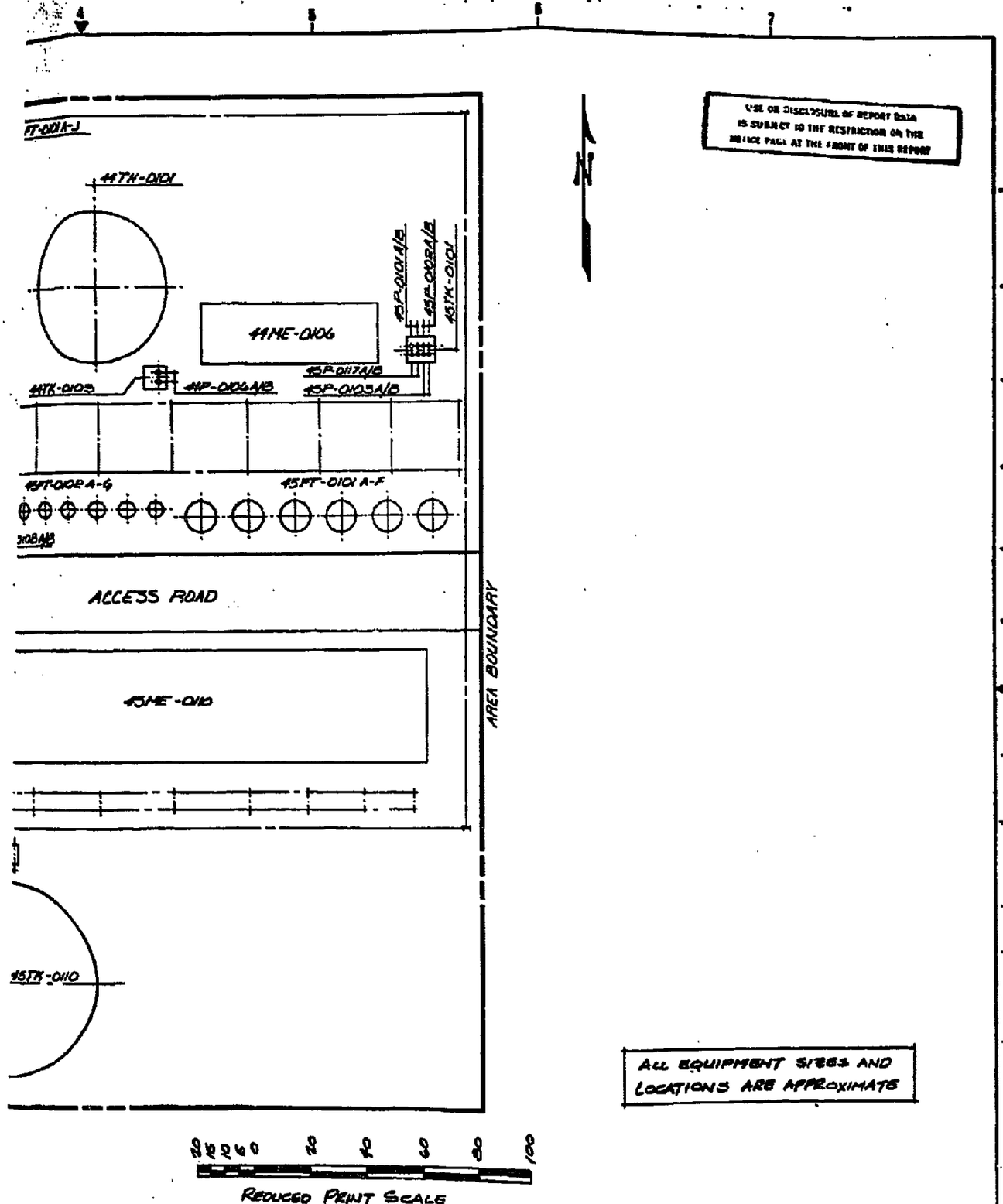
TABLE 6.3.5-1 (Continued)

MATERIAL BALANCE

RAW WATER TREATMENT-UNIT 44

Stream Number		44-5	44-6
Stream Name		To U.C.T. Makeup	To Boiler Feed Water Treatment
Water	lb/hr (gpm)	1,732,500 (3465)	1,435,000 (2870)
Total	lb/hr	1,732,500	1,435,000
Pressure, psia		43.7	33.7
Temperature, °F		80	80


AREA BOUNDARY
UNIT 49
POTABLE WATER
44TK-0102
44P-0105A/B
44ME-0105
44ME-0101
44P-0103A/B
44P-0110A/B
44TK-0104
44P-0108A/B
44P-0107A/B
44P-0104A/B
44P-0103A/B
44ME-0102
44ME-0103
44FT-0101
15DA-0102
15DA-0101
15E-0103
15P-0101A/B
15P-0122A/B
15P-0126A/B
15P-0112A/B
15E-0102
15DM-0102
15DM-0101
15DM-0103
15E-0104
15TK-0104
15P-0119A/B
15P-0105A/B
15P-0102A/B
15TK-0103
15ME-0118
15ME-0109
15E-0101
ACCESS ROAD
15ME-0108A/B
15ME-0106A/B
15ME-0105A/B
15ME-0102A-C
15ME-0101A-C
15ME-0107A-C
15P-0119A/B
15P-0105A/B
15P-0123A/B
15TK-0107
15TK-0102
AREA BOUNDARY
APPROVED FOR STUDY



FLUOR

R MILLER
HUTTON
CHK'D
SHEETS
APPD

PLOT PLAN - UNIT 44, 45 & 49
RAW WATER TREATING, BFW & CONDENSATE TREATING & POTABLE WATER
CROW TRIBE OF INDIANS MONTANA

1"-20'-0" | 835701-44-4-050 | 1

TABLE 6.3.5-2
EQUIPMENT LIST
RAW WATER TREATING-UNIT 44

Item No.	Equipment Name	Number Required	
		Operating	Spares
44TK-0101	Raw Water Pond	1	0
44TK-0102	Recovery Pond	1	0
44TK-0103	Thickener Holding Tank	1	0
44TK-0104	Alum Storage Tank	1	0
44P-0101 A/B	Potable Water Feed Pump	1	1
44P-0102 A/B	Raw Water Treatment Feed Pump	1	1
44P-0103 A/B	Lime Softener Bottoms Pump	1	1
44P-0104 A/B	Softened Water Pump	1	1
44P-0105 A/B	Recovery Pond Pump	1	1
44P-0106 A/B	Thickener Sludge Pump	1	1
44P-0107 A/B	Polyelectrolyte Feed Pump	1	1
44P-0108 A/B	Lime Feed Pump	1	1
44P-0109 A/B	Soda Ash Feed Pump	1	1
44P-0110 A/B	Alum Feed Pump	1	1
44P-0111 A/B	Polyelectrolyte Cleanout Pump	1	1
44P-0112 A/B	Potable Water Treatment Backflush	1	1
44P-0113 A/B	FGD Slaking Water Pump	1	1
44TH-0101	Thickener	1	0
44FT-0101A-J	Sand Filter Unit	9	1
44ME-0101	Cold Lime Softener	1	0
44ME-0102	Chlorinator	1	0
44ME-0103	Polyelectrolyte System	1	0
44ME-0104	Lime Feeding System	1	0
44ME-0105	Soda Ash Feeding System	1	0
44ME-0106	Sludge Press	1	0

6.3.6 BFW AND CONDENSATE TREATING-UNIT 45

6.3.6.1 DESIGN BASIS

Purpose of Unit

The Boiler Feed Water (BFW) and Condensate Treating unit filters and demineralizes treated water makeup to the boilers and purifies returning condensate for reuse in the boilers.

Scope of Unit

BFW and Condensate Treating Unit 45 includes activated carbon and cartridge filtration, reverse osmosis (RO) purification, and ion exchange demineralization for treated raw water makeup. Separate systems of purification equipment are included for treating the returning steam condensate. Cold condensate from the power plant flows through polishing filters and mixed bed demineralizers before being returned to the boiler feed water deaerator. Vacuum condensate from the SNG compressor drivers is combined with process condensate, and pumped through a filter/softener unit into storage where clean low pressure condensate is added. This combined stream feeds the process waste heat boiler deaerator. Potentially oily low pressure condensate flows through the de-oil filter and into the low pressure boiler deaerator. Makeup to the LP deaerator is taken from the RO effluent and softened by a sodium zeolite softener before the flow joins the de-oiled condensate stream.

Also within the scope of the unit are tanks for additive makeup and storage of acid and caustic used for ion exchange resin regeneration.

6.3.6.1 (Continued)

General Design Criteria

Unit 45 consists of a single train. Filtration and demineralization equipment within Unit 45 have at least one component on backflush or regeneration as a spare with the remaining number onstream. All pumps and mixers have spares.

The unit design is compatible with an overall plant onstream factor of 332 days/year.

All equipment are motor driven.

The turndown capability of the unit is to 33 percent or less to provide feed for one of the three plant boilers.

Process Specifications

The BFW and Condensate Treating unit produces 392 gpm of boiler feed water meeting the American Boiler Manufacturers Association specifications for 1500 psig boiler service, 794 gpm of boiler feed water for 600 psig boiler service, 1193 gpm of boiler feed water for 100 psig boiler service and treats 7677 gpm of returning condensate for re-use in the boilers.

Feed

The feed to the demineralization section of the unit is the product of the Raw Water Treatment Unit 44.

Total Hardness	194 ppm ($CaCO_3$ equivalent)
Alkalinity	23 ppm
TSS	0-1 ppm

6.3.6.1 (Continued)

TDS	554 ppm
pH	6.8
Temperature	60°F

The condensate returning to Unit 45 for treatment contains dissolved impurities that are removed.

Products

The boiler feed water product from Unit 45 meets the American Boiler Manufacturers Association Specifications for the respective boilers, as follows:

	Concentration in ppm
Total Solids	0.5
Sodium (as $CaCO_3$)	0.5
OH (as $CaCO_3$)	0.5
Silica (as SiO_2)	0.005
Oxygen	0.005
pH	7 - 8

The water containing the concentrated impurities from back flushing and regeneration within the unit is divided into streams with higher TDS than the RO inlet and those with lower TDS. The low TDS steams are sent to the Utility Cooling Tower. The high TDS streams are routed to Ash Handling Unit 03.

Utility Requirements

Power	15,200 kW

6.3.6.2 PROCESS DESCRIPTION

Drawing Numbers 835704-45-R-101 and 835704-45-R-102 are the flow diagrams for Unit 45. The unit material balance (Table 6.3.6-1) and equipment list (Table 6.3.6-2) follow the drawings.

Demineralization

Treated Raw Water flows from Unit 44 at a rate of 6335 gpm into the clearwell. From there 3465 gpm is pumped to the Utility Cooling tower and small streams are pumped back to Unit 44 as backflush and chemical makeup water. The balance of the feed water, 2870 gpm, is pumped to the BFW purification section where it undergoes the following treatment steps:

Activated Carbon and Micron Cartridge Filtration
pH Adjustment
Reverse Osmosis
Cation Demineralization
Anion Demineralization
Mixed Bed Demineralization

and flows to storage in the demineralized water storage tank. This water is makeup for 1500 and 600 psig boilers.

After the RO unit, 1130 gpm is diverted to sodium zeolite softening. This flows to the medium/low pressure deaerator as makeup.

Pretreated Raw Water Classification

A clearwell is provided to classify raw water and low TDS waste waters for makeup and further treatment processes. Water from sand filtration flows into the first compartment, where water is withdrawn for use as chemical

6.3.6.2 (Continued)

dilution water, and utility cooling tower makeup. Water overflowing the weir is pumped to activated carbon filters for further treatment.

Activated Carbon Filtration

The water exiting the clearwell is routed through activated carbon drums, where remaining organic material and residual free chlorine are removed. The main function of the activated carbon is to protect the downstream reverse osmosis unit membranes.

Boiler Feed Water Demineralization

Pretreated raw water is pumped to demineralization after activated carbon filtration. Upon entering the demineralizer section, the water undergoes a pretreatment phase designed to condition the water for treatment by reverse osmosis. The water is processed as follows:

Micron filtration by cartridge filters to avoid RO membrance fouling,

pH adjustment by acid addition and feed of a phosphate based chemical to prevent membrane scaling,

Temperature adjustment to attain optimum membrane permeability.

The water is boosted to Reverse Osmosis system pressure by in-line pumps.

Reverse Osmosis (RO)

This process forces the water at a high pressure through semi-permeable membrances which produces a product water relatively free of dissolved salts. The permeating water carries a percentage of the dissolved salts

6.3.6.2 (Continued)

through the membrane, while the bulk of the dissolved salts are retained on the inlet side of the membrance. The concentrated brine is collected and discharged to the Utility Cooling Tower Blowdown System for additional recovery. The RO unit is of modular design and will treat 2863 gpm of feed water, based on an 87 percent conversion rate, with a product water production rate of 2491 gpm.

Ion-Exchange Demineralizers

The ion-exchange demineralizers are multiple, parallel operating trains, with each train consisting of a cation unit and an anion unit. A strong acid cation resin operating on the hydrogen cycle is used to carry out the cation exchange. Cation resin is regenerated using 66° Be' sulfuric acid diluted to four percent to shift the equilibrium to the hydrogen ion form. Purity of the decationized water is monitored by a sodium probe at the outlet of each cation exchanger.

The anion units are designed to operate on the hydroxyl cycle using a strong base anion resin. Anion plus dissolved carbon dioxide and silica accumulated on the anion resin sites during the process cycle are removed during regeneration by a four percent solution of sodium hydroxide. High silica concentration and high conductivity probes are provided to signal bed exhaustion.

The regenerate waste disposal is governed by the following:

Waste effluent with a TDS content higher than the Reverse Osmosis system influent is routed to the Ash Handling unit.

Waste effluent with a TDS content at or below the TDS level of the Reverse Osmosis system is collected and, following pH adjustment, injected into the Utility Cooling Tower Blowdown Treatment System.

6.3.6.2 (Continued)

The ion-exchange demineralizer system consists of cation/anion units designed to produce a total of 1316 gpm of product water with two units in operation, one in regeneration standby. The demineralizer system is sized and provided with resin quantities to operate with 100 percent Reverse Osmosis system and treated influent.

Mixed Bed Polishers

The effluent from the cation/anion units contain some leakages of dissolved solids (predominently sodium and silica) when the exchangers are operating near the end of their cycles. Two mixed bed polishing units are provided as a final treatment step to ensure water quality as specified by ABMA. The units contain a homogenous mixture of strong acid cation and strong base anion resin, ope ated in the hydrogen and hydroxyl form similar to the cation and anion units. The "polished" water is essentially pure and flows to the demineralized water storage tank. Regeneration waste is handled in the same manner as the cation/anion train regeneration waste. One polisher is continuously in service, with the remaining one either regenerating or at standby.

Condensate Collection

Influents to this unit also include the condensate return from the boilers and the other plant units. Cold condensate from the power plant is processed in a mixed bed polishing unit and returned to the boilers at a flow rate of 5821 gpm. Vacuum condensate from the SNG compressors is treated in two filter softeners and sent to a storage tank where it is combined with flashed and cooled medium and low pressure condensate. This condensate is used as 600 psig deaerator feed and has a flow rate of 683 gpm. Low pressure condensate that has a potential for contamination with oil is de-oil filtered and sent to the medium/low pressure deaerator with the zeolite softened makeup at a total of 1542 gpm.

6.3.6.2 (Continued)

Process steam condensate is recovered in four collection systems.

Cold Condensate Return

This system collects condensate from surface condensers supporting turbine drivers connected to the turbogenerators in the power plant.

Condensate from this source is pumped into the Cold Condensate Return header and flows through a mixed bed polishing unit and is collected in the condensate storage tank.

Piping design conditions for the Cold Condensate Return header is specified as 150 psig at 175°F outside process unit battery limits.

Vacuum Condensate Return

Vacuum Condensate is collected from surface condensers in Unit 23, SNG Compression. A stream of three gpm is sent to Ash Handling. The remainder flows to a set of filter/sodium softeners within Unit 45 and on to the high pressure deaerator feed storage tank.

HP Condensate Return

This system collects condensate from the HPSAT steam users and header traps in the plant. Condensate from Tar Distillation, Naphtha Hydrotreating and Phenosolvan units is collected in the HP condensate return header. The conden[illegible] is flashed in a centrally located drum to recover LP steam. The co[illegible]nsate from the flash drum is process and returned to the High Pressure Service Deaerator.

Piping design conditions for the HP Condensate Return header are specified at 610 psig and 530°F outside process unit battery limits.

6.3.6.2 (Continued)

MP Condensate Return

Condensate from Rectisol, Phenosolvan, Ammonia Recovery, Tank Farm units as well as Steam Tracing and Ejectors is collected in the MP Condensate Return header. The condensate is flashed in a drum and the vapor condensed by air cooling. The condensate from the flash drum is stored and returned to the high pressure service deaerator.

Piping design conditions for the MP Condensate Return header are specified as 170 psig and 420°F outside process units battery limits.

LP Condensate Return

This system collects condensate from the LP steam users and header traps in the plant.

Condensate from Rectisol, Naphtha Hydrotreating, Phenosolvan, Sulfur Recovery, and Tar Distillation Unit is collected in the LP Condensate Return header. Condensate from these sources is subject to potential oil contamination from the process side of the heat exchanger. As a precautionary measure against contamination, a de-oil filter unit is provided to treat tolerable levels of oil contamination in the condensate before it is returned to the Low Pressure Service Deaerator. Alternately contaminated condensate is sewered.

LP condensate from non-oil contaminating users is collected in a separate header and returned to the Low Pressure Service Deaerator. Sources of clean LP condensate are: Ammonia Recovery, BFW Treatment, and Waste Water Treatment.

Piping design conditions for the LP Condensate Return header are specified as 75 psig and 350°F outside process units battery limits.

6.3.6.2 (Continued)

BFW Deaeration

Deaerated BFW requirement for process steam generation is supplied by high and low pressure service deaerators:

High Pressure Service Deaerator - This deaerator supplies the BFW requirement for steam generation in Coal Gasification, Methanol Synthesis, Methanation, Process Steam Superheating, and Partial Oxidation units. It also provides the desuperheating water needs of steam desuperheater stations.

Water to the High Pressure Deaerator consists of condensate from HP steam condensate flash drum, MP and clean LP Condensate headers and makeup water from the treated water storage tank.

The deaerator is operated at 7 psig and reduces the dissolved oxygen content in BFW to less than 5 ppb.

The deaerator design condition is specified at 75 psig external, full vacuum, and 290°F.

Medium and Low Pressure Service Deaerator - This deaerator supplies the BFW requirement for steam generation in the Coal Gasification, Gas Cooling, Sulfur Recovery, POX and for Rectisol unit wash water.

Water to Low Pressure Service Deaerator consists of potentially oily LP Condensate and makeup water from the zeolite softeners in Unit 45.

The deaerator is normally operated at 7 psig and reduces the dissolved oxygen content in the BFW to Less than 15 ppb.

6.3.6.2 (Continued)

The deaerator design condition is specified at 75 psig external full vacuum, and 290°F.

The high pressure and Low Pressure Service Deaerators are operated at the same temperature. The deaerators are also of equal size and are provided with interconnections to ensure continuous BFW supply to both pressure levels of steam generators when one of the deaerator units is not available.

Condensate Polishing

Cold condensate is collected from the surface condensers in the power plant and pumped to mixed bed ion exchange units followed by activated carbon filtration.

The cold condensate is monitored at each major source for conductivity. At high conductivity levels, the condensate is automatically sewered until the problem is rectified.

Mixed Bed Ion Exchange

Mixed bed ion exchange units are provided to function primarily as guard vessels, ensuring fully demineralized condensate to the 1500 psig boiler feed water system at all times. Inherent in the design of the units is the ability to retain suspended material in the resin bed.

The ion exchange media consists of strong anion and strong cation resins, operating on hydrogen, hydoxyl cycles. External regeneration is provided to facilitate complete regeneration of each resin and thorough flushing of suspended solids. Higher flow rates are allowable in this type of system compared to internally regenerated exchangers, reducing the size of units required.

6.3.6.2 (Continued)

The basic regeneration process consists of sluicing the spent resin into a cation regeneration vessel. The resin is backwashed, causing the anion to migrate to the top portion. Once the resins are segregated, demineralized water is used to sluice the anion resin to the anion vessel for regeneration. Upon completion of the regeneration process, the resins are sluiced to a mixing tank where they are mixed and then sluiced to the polishing units. Air is used to obtain a homogenous mixture in the mixing chamber.

The condensate polishing unit is designed to produce the following water quality:

Dissolved Silica - 0.005 ppm
Total Dissolved Solids - 0.1 ppm

Activated Carbon Filtration

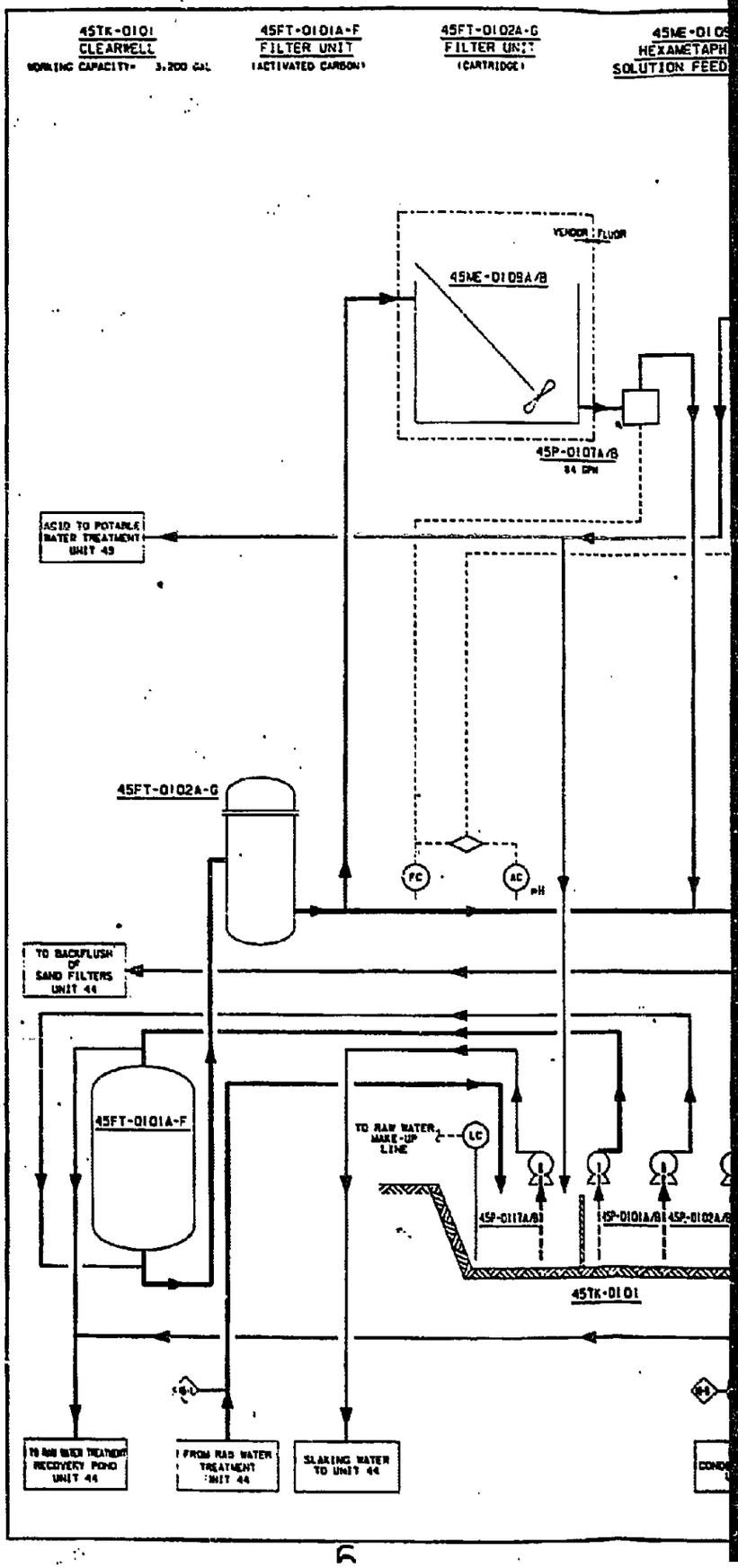
Polished cold condensate is sent through activated carbon filters as a final step prior to being reused as BFW. Pressurized activated carbon filters are provided to guard against organic contamination that could result from cooling water leakage into the condensate.

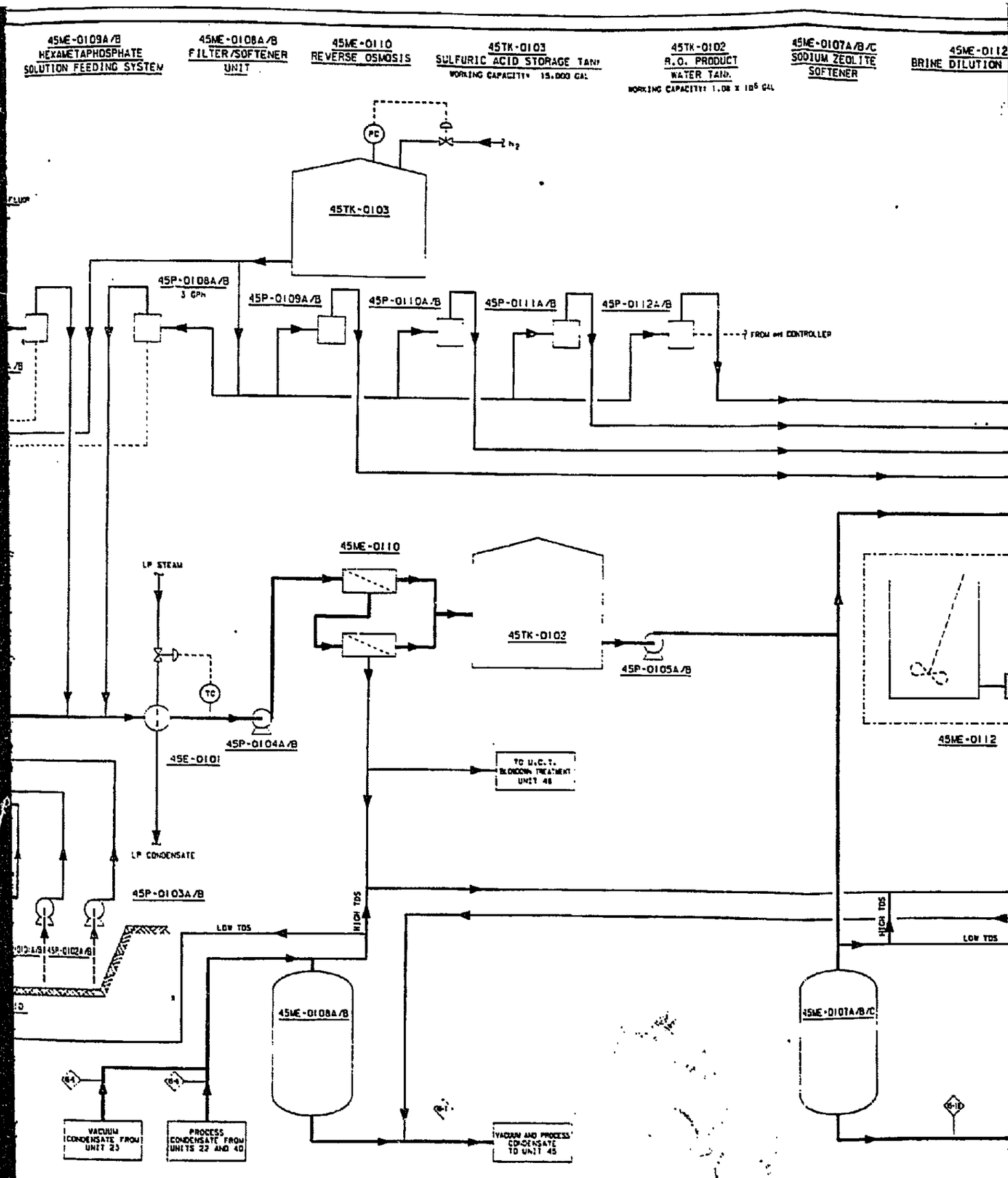
The carbon drums act as filters for suspended material as well as removing dissolved organics. The units are periodically backwashed to remove suspended material. In-situ steam regeneration cycle is not provided for the activated carbon due to the low organic loading that is anticipated.

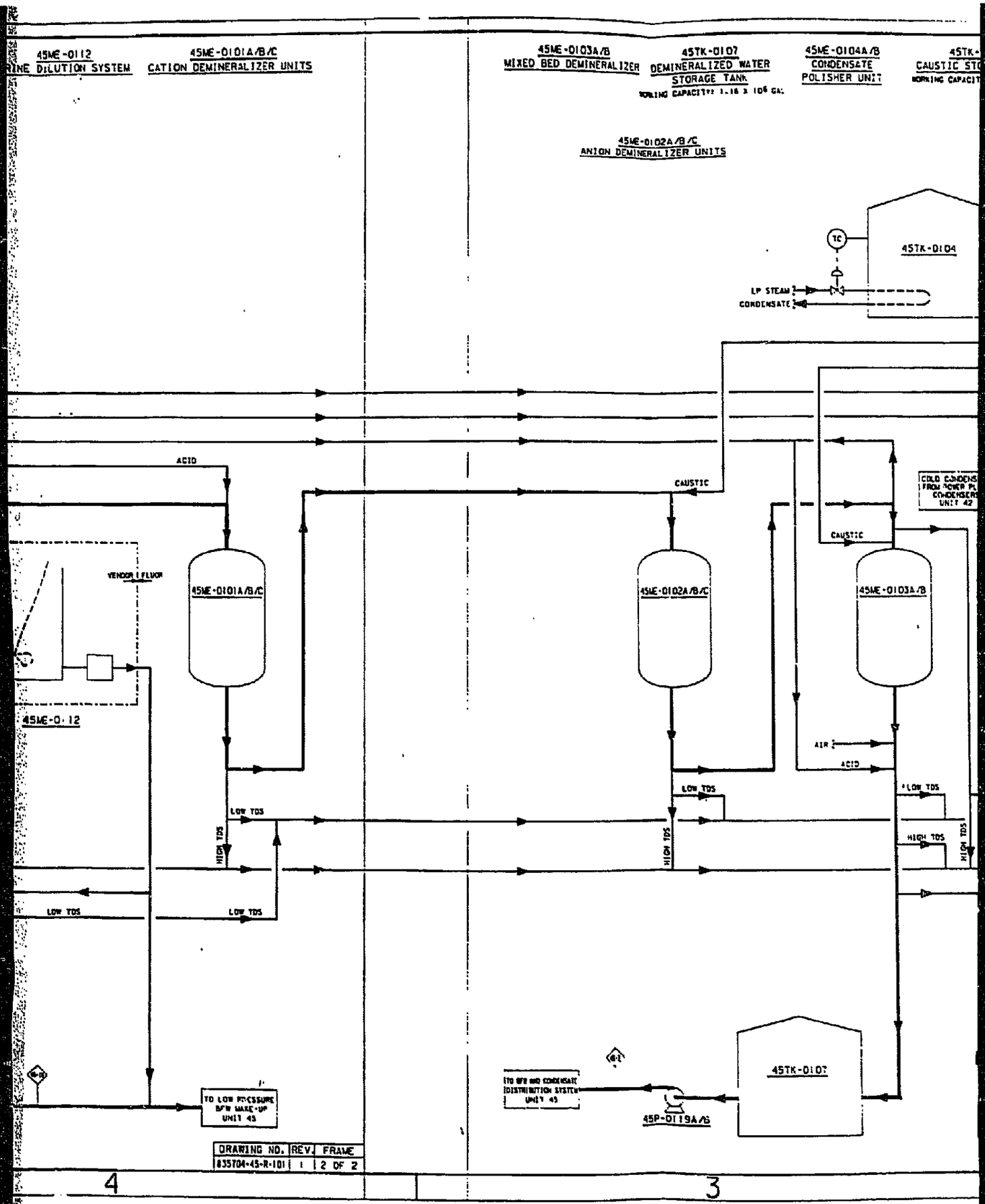
6.3.6.2 (Continued)

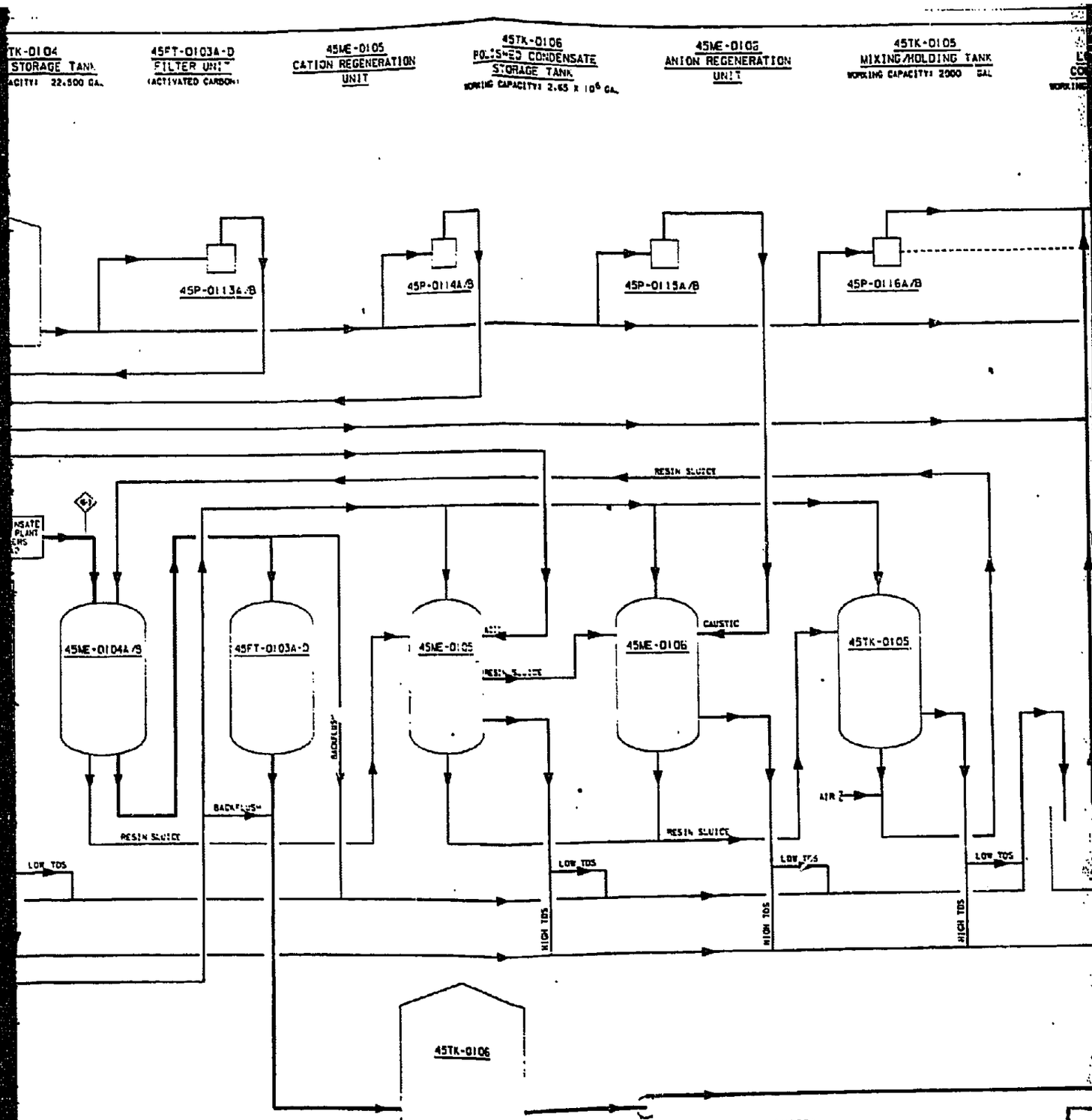
Waste Water Disposal

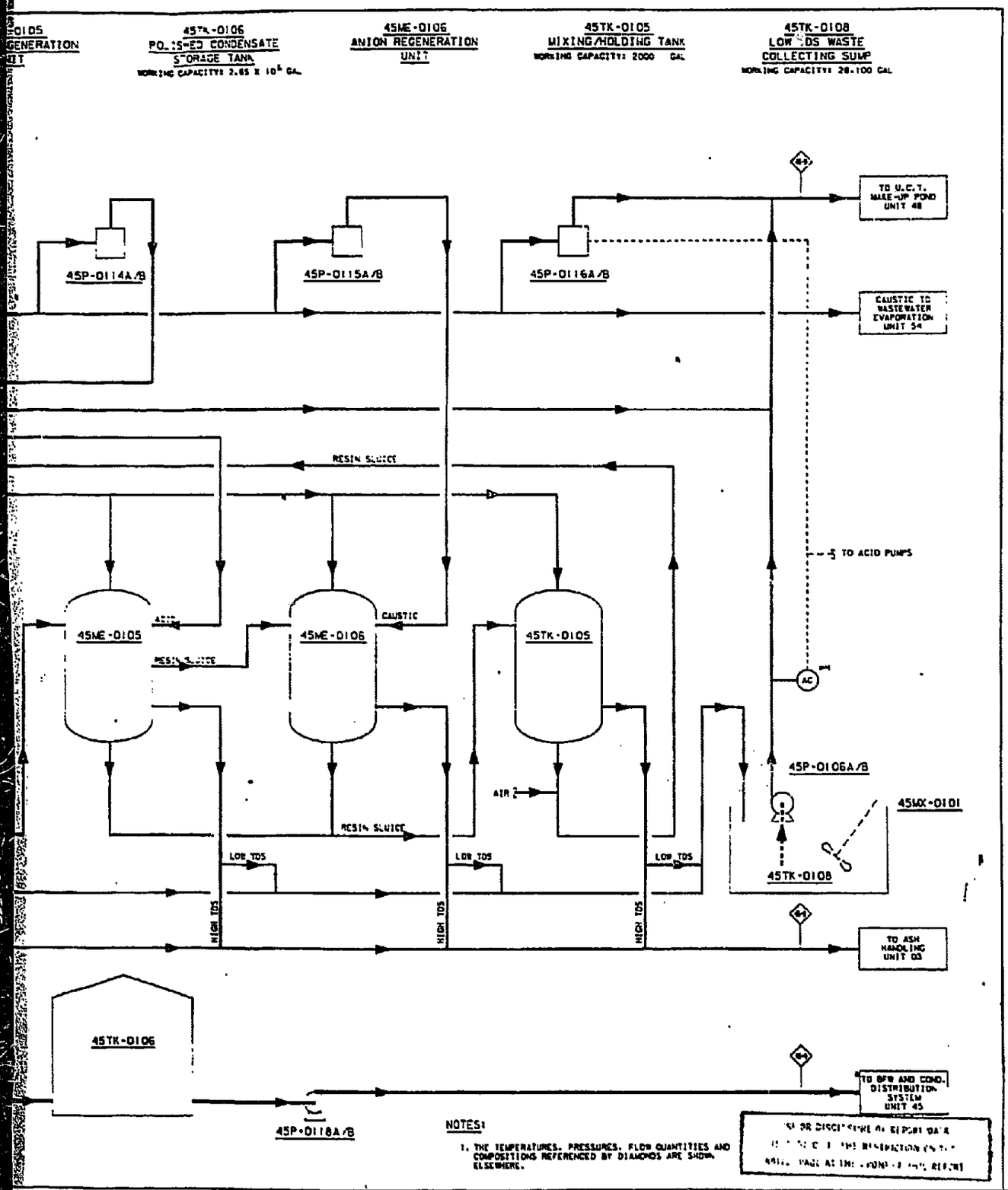
Backwash and regeneration wastes from the condensate polishing units and the activated carbon filters are classified into high TDS and low TDS streams. The high TDS stream is collected as feed to the Ash Handling System, while the low TDS stream is collected in the raw water recovery sump and recycled to the Raw Water Treating System.


45TK-0101
CLEARWELL
WORKING CAPACITY= 3,200 GAL
45FT-0101A-F
FILTER UNIT
(ACTIVATED CARBON)
45FT-0102A-G
FILTER UNIT
(CARTRIDGE)
45ME-0109
HEXAMETAPH
SOLUTION FEED
VENDOR: FLUOR
45ME-0109A/B
45P-0107A/B
84 GPM
ACID TO POTABLE WATER TREATMENT UNIT 49
45FT-0102A-G
FC
AC
pH
TO BACKFLUSH OF SAND FILTERS UNIT 44
45FT-0101A-F
TO RAW WATER MAKE-UP LINE
LC
45P-0117A/B
45P-0101A/B
45P-0102A/B
45TK-0101
TO RAW WATER TREATMENT RECOVERY POND UNIT 44
FROM RAW WATER TREATMENT UNIT 44
SLAKING WATER TO UNIT 44


45ME-0109A/B
HEXAMETAPHOSPHATE
SOLUTION FEEDING SYSTEM
45ME-0108A/B
FILTER/SOFTENER
UNIT
45ME-0110
REVERSE OSMOSIS
45TK-0103
SULFURIC ACID STORAGE TANK
WORKING CAPACITY: 15,000 GAL
45TK-0102
R.O. PRODUCT
WATER TANK
WORKING CAPACITY: 1.08 X 10⁶ GAL
45ME-0107A/B/C
SODIUM ZEOLITE
SOFTENER
45ME-0112
BRINE DILUTION
45TK-0103
45P-0108A/B
3 GPM
45P-0109A/B
45P-0110A/B
45P-0111A/B
45P-0112A/B
FROM pH CONTROLLER
45ME-0110
LP STEAM
45TK-0102
45P-0105A/B
45P-0104A/B
45E-0101
45ME-0112
TO U.C.T. BLOWDOWN TREATMENT UNIT 48
LP CONDENSATE
45P-0103A/B
HIGH TDS
LOW TDS
45ME-0108A/B
45ME-0107A/B/C
VACUUM CONDENSATE FROM UNIT 23
PROCESS CONDENSATE FROM UNITS 22 AND 40
VACUUM AND PROCESS CONDENSATE TO UNIT 45


45ME-0112
NE DILUTION SYSTEM
45ME-0101A/B/C
CATION DEMINERALIZER UNITS
45ME-0103A/B
MIXED BED DEMINERALIZER
45TK-0107
DEMINERALIZED WATER
STORAGE TANK
45ME-0104A/B
CONDENSATE
POLISHER UNIT
45TK-
CAUSTIC ST
45ME-0102A/B/C
ANION DEMINERALIZER UNITS
45TK-0104
TC
LP STEAM
CONDENSATE
ACID
CAUSTIC
VENDOR FLUOR
45ME-0101A/B/C
45ME-0102A/B/C
45ME-0103A/B
45ME-0112
AIR
ACID
LOW TDS
HIGH TDS
TO LOW PRESSURE
BFW MAKE-UP
UNIT 45
45TK-0107
45P-0119A/S
DRAWING NO.
835704-45-R-101
REV.
1
FRAME
2 OF 2
4
3


TK-0104
STORAGE TANK
ACITY: 22,500 GAL
45FT-0103A-D
FILTER UNIT
(ACTIVATED CARBON)
45ME-0105
CATION REGENERATION
UNIT
45TK-0106
POLISHED CONDENSATE
STORAGE TANK
WORKING CAPACITY: 2.65 X 10⁶ GAL
45ME-0106
ANION REGENERATION
UNIT
45TK-0105
MIXING/HOLDING TANK
WORKING CAPACITY: 2000 GAL
45P-0113A/B
45P-0114A/B
45P-0115A/B
45P-0116A/B
RESIN SLUICE
45ME-0104A/B
45FT-0103A-D
45ME-0105
45ME-0106
45TK-0105
CAUSTIC
BACKFLUSH
AIR
LOW TDS
HIGH TDS
45TK-0106
45P-0118A/B
NOTES:
1. THE TEMPERATURES, PRESSURES, FLOW QUANTITIES AND COMPOSITIONS REFERENCED BY DIAMONDS ARE SHOWN ELSEWHERE.
FLUOR
R. WHITE
K. K. ABATAY
R. McCARTHY
R. LANG
NONE
2
1



FLUOR

PROCESS FLOW DIAGRAM
BFW AND CONDENSATE TREATMENT
SOFTENING AND DEMINERALIZATION SECTION
UNIT 45

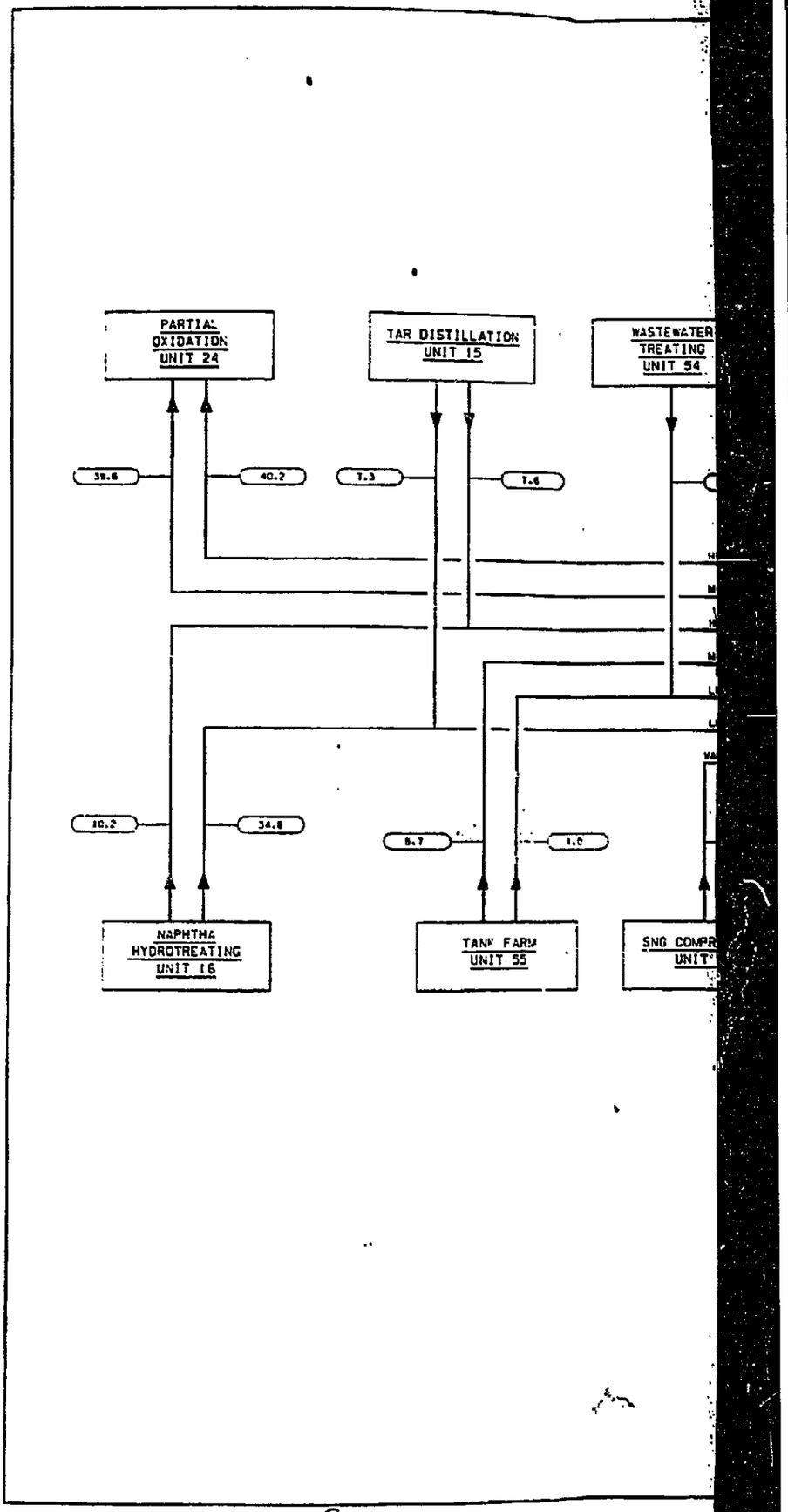
SYNFUELS FEASIBILITY STUDY

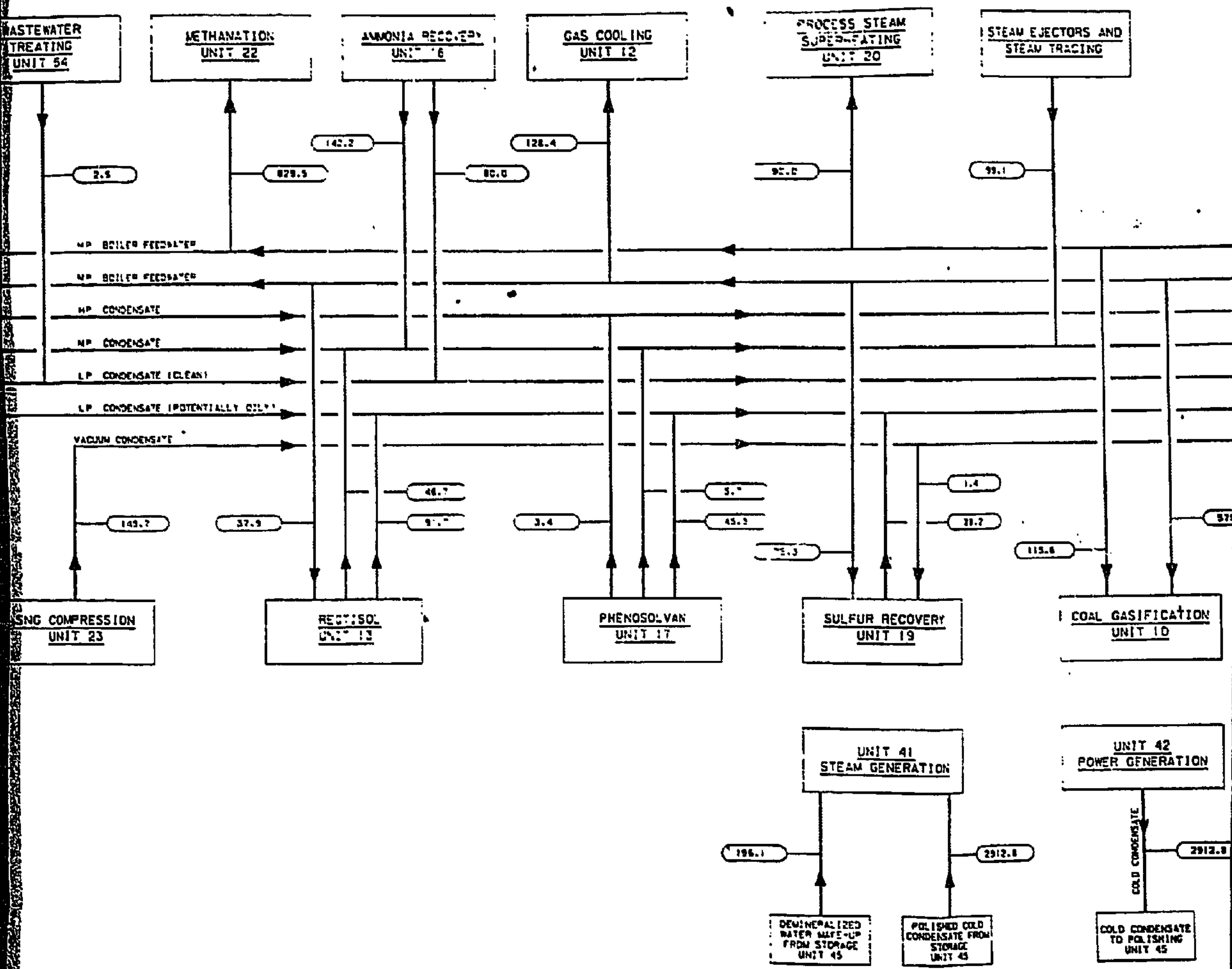
835704-45-R-101

NONE

MICROFILM FRAME NO. 1 OF 2

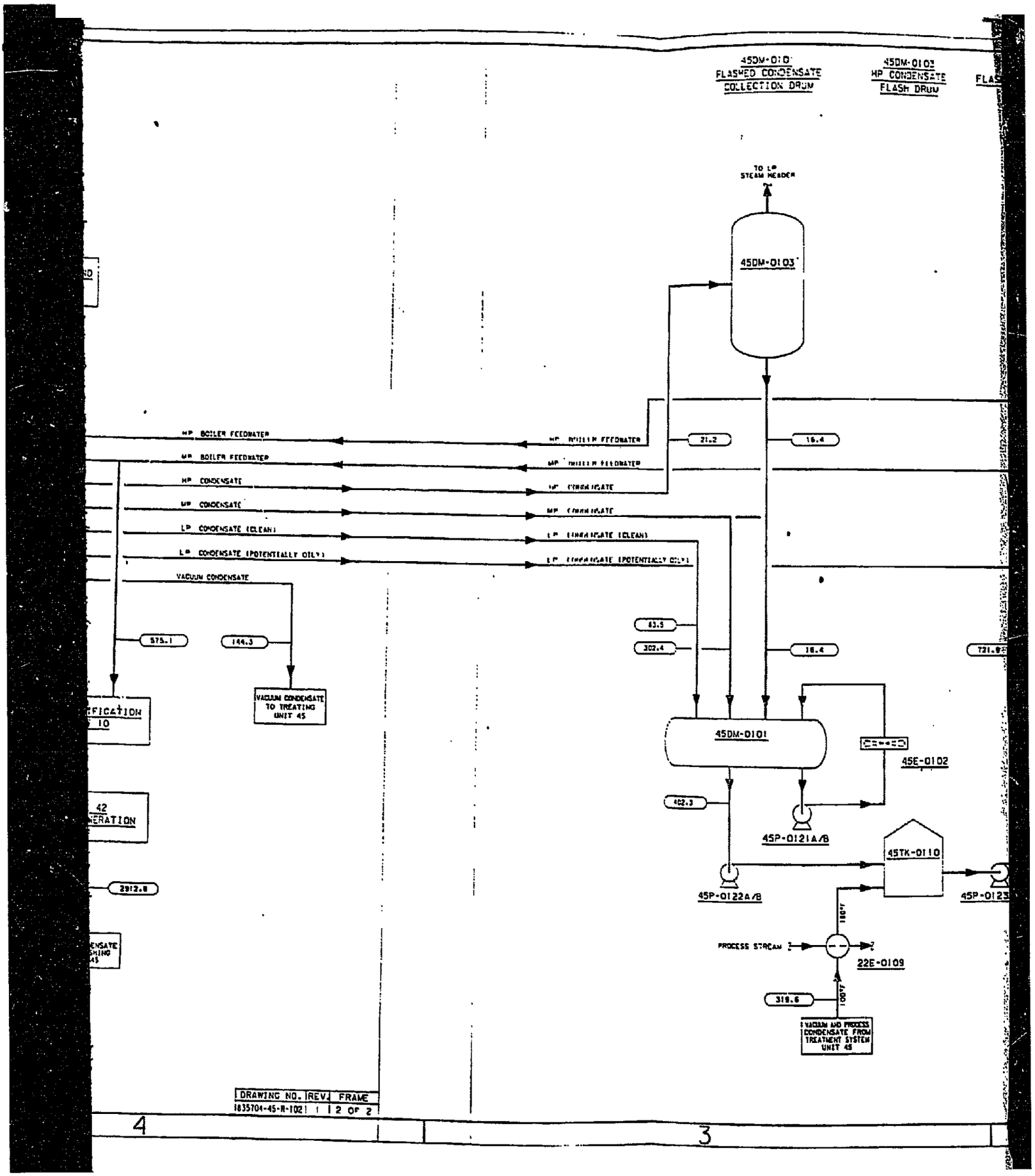
2

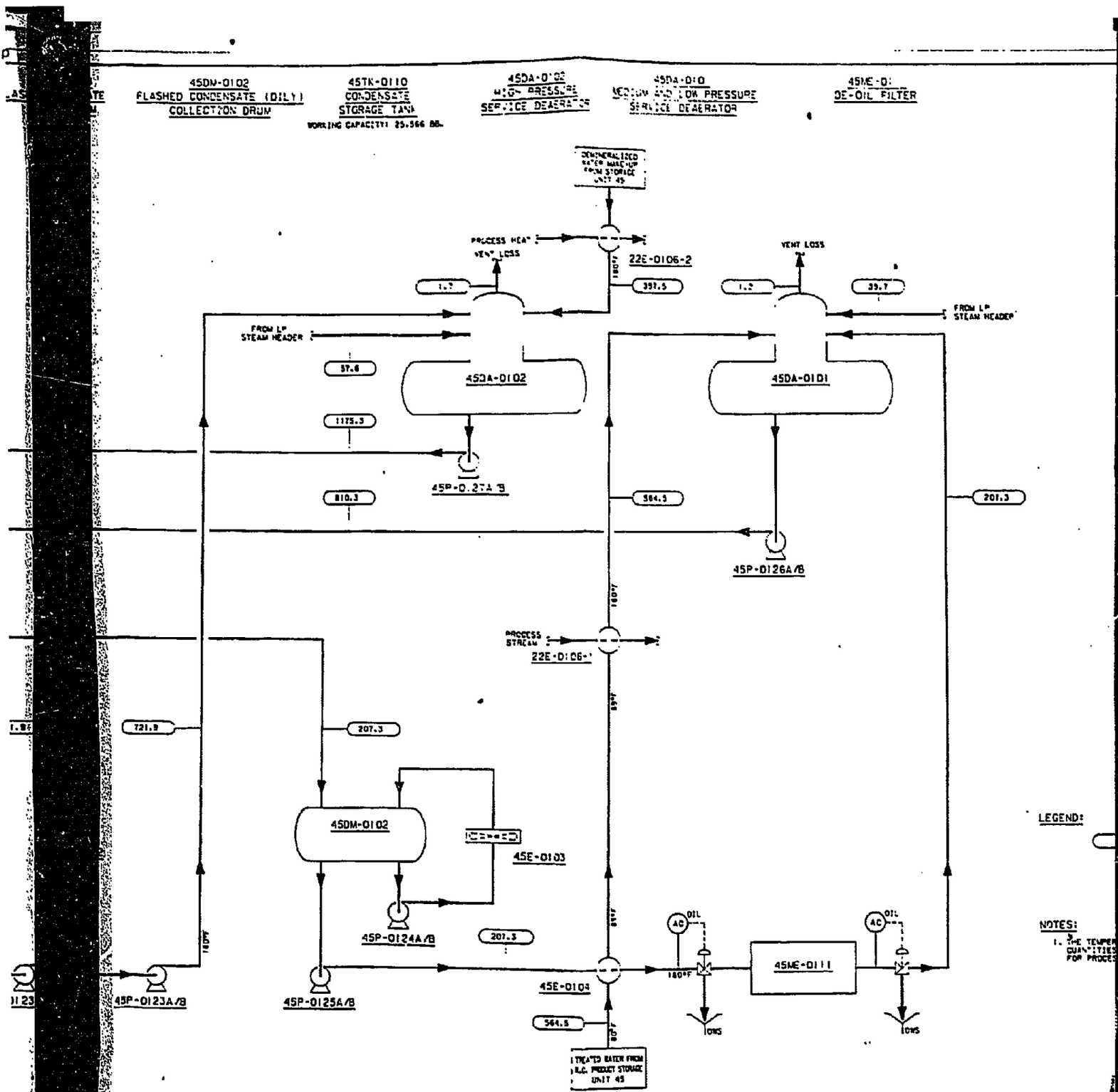

PARTIAL OXIDATION UNIT 24
TAR DISTILLATION UNIT 15
WASTEWATER TREATING UNIT 54
39.6
40.2
7.3
7.6
10.2
34.8
8.7
1.0
NAPHTHA HYDROTREATING UNIT 16
TANK FARM UNIT 55



WASTEWATER TREATING UNIT 54
METHANATION UNIT 22
AMMONIA RECOVERY
GAS COOLING UNIT 12
PROCESS STEAM
STEAM EJECTORS AND STEAM TRACING
2.5
829.5
142.2
80.0
128.4
92.0
99.1
HP BOILER FEEDWATER
MP BOILER FEEDWATER
HP CONDENSATE
MP CONDENSATE
LP CONDENSATE (CLEAN)
VACUUM CONDENSATE
143.7
37.9
46.7
3.4
45.3
1.4
31.2
115.6
SNG COMPRESSION UNIT 23
PHENOSOLVAN UNIT 17
SULFUR RECOVERY UNIT 19
COAL GASIFICATION UNIT 10
UNIT 41 STEAM GENERATION
UNIT 42 POWER GENERATION
196.1
2912.8
COLD CONDENSATE
POLISHED COLD CONDENSATE FROM STORAGE UNIT 45
COLD CONDENSATE TO POLISHING UNIT 45

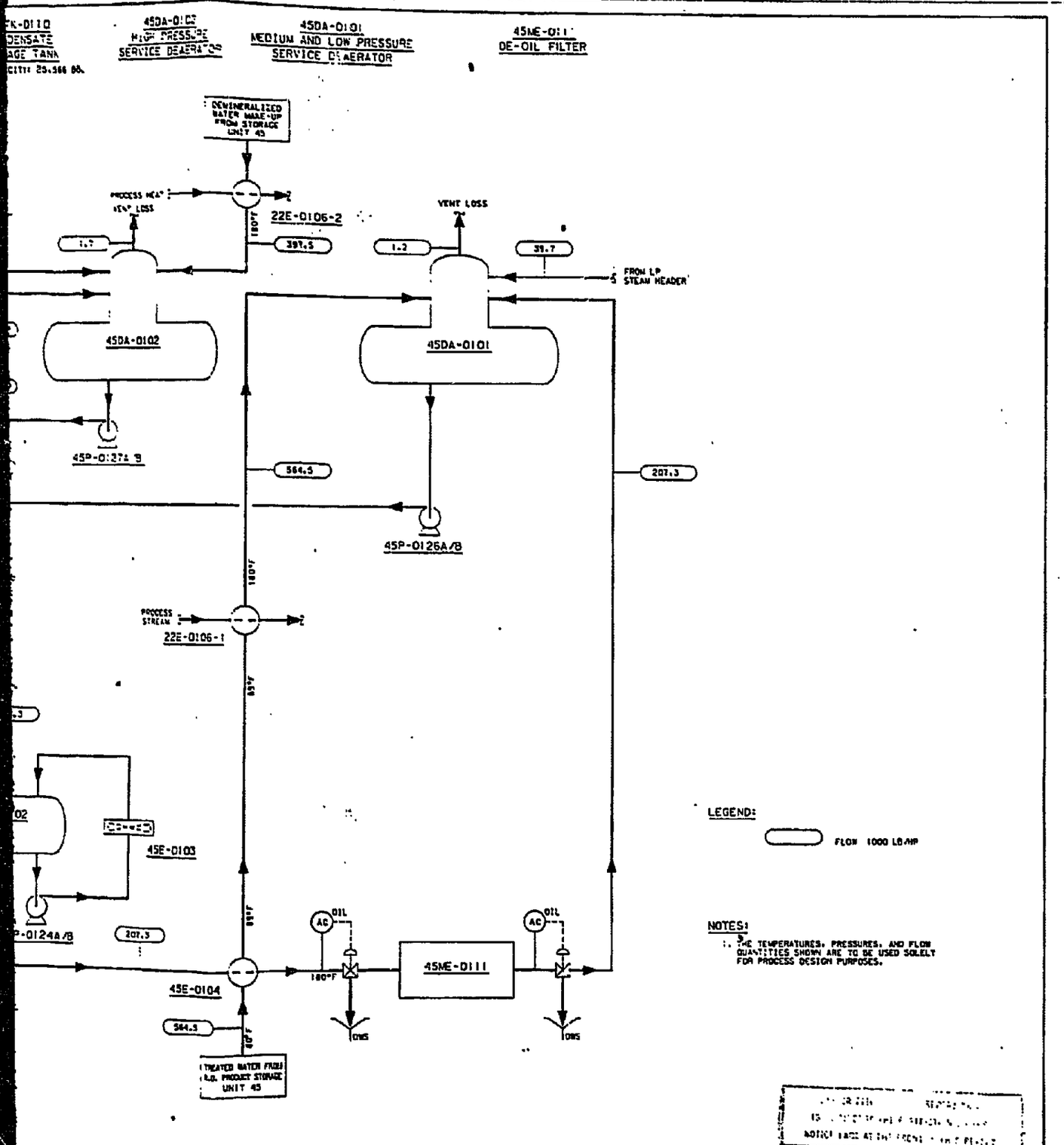
5


45DM-0102
FLASHED CONDENSATE
COLLECTION DRUM
45DM-0103
HP CONDENSATE
FLASH DRUM
TO LP
STEAM HEADER
45DM-0103
HP BOILER FEEDWATER
HP BOILER FEEDWATER
HP CONDENSATE
HP CONDENSATE
LP CONDENSATE (CLEAN)
LP CONDENSATE (POTENTIALLY OILY)
VACUUM CONDENSATE
21.2
16.4
575.1
144.3
43.5
302.4
16.4
721.9
VACUUM CONDENSATE
TO TREATING
UNIT 45
45DM-0101
45E-0102
462.3
45P-0121A/B
45TK-0110
45P-0122A/B
45P-0123
2912.8
PROCESS STREAM
22E-0109
318.6
VACUUM AND PROCESS
CONDENSATE FROM
TREATMENT SYSTEM
UNIT 45
DRAWING NO. | REV. | FRAME
1835704-45-R-102 | | 2 OF 2



FLUOR

R. WHITE
C. C. ARATAY
R. O'BELMETO
R. McCARTHY
R. LANG
BFW AND
NONE



FLUOR

R. WHITE	PROCESS FLOW DIAGRAM	
C.C. ABATAY	BFW AND CONDENSATE DISTRIBUTION SYSTEM	
R.D. BELMITO	UNIT 45	
R. McCARTHY	CROW TRIBE OF INDIANS	SYNFUELS FEASIBILITY STUDY
R. LAND	NONE	835704-45-R-102
		MICROFILM FRAME NO. 1 OF 2

003 55574102

TABLE 6.3.6-1

MATERIAL BALANCE

BOILER FEED WATER AND CONDENSATE TREATMENT-UNIT 45

Stream Number		45-1	45-2	45-3	45-4	45-5
Stream Name		BFW Feed From Unit 44	Demin. Water To Distr.	Cold Cond. For Polishing	Polished Cold Cond.	Vacuum Cond. From Unit 23
Water	lb/hr	1,435,000	658,000	2,912,800	2,912,800	144,300
	(gpm)	(2870)	(1316)	(5821)	(5821)	(288)
Total	lb/hr	1,435,000	658,000	2,912,800	2,912,800	144,300
Pressure, psia		33.7	88.7	40	88.7	40
Temperature °F			80	100	285	100 285

NOTE: Flow quantities, pressures and temperatures shown are for the total unit on a stream-day basis, are to be used solely for process design purposes, and are not necessarily the conditions which will be attained during actual operations.

TABLE 6.3.6-1 (Continued)

MATERIAL BALANCE

BOILER FEED WATER AND CONDENSATE TREATMENT-UNIT 45

Stream Number		45-6	45-7	45-8	45-9	45-10
Stream Name		Process Cond. From Unit 22	Softened Vac. and Process Cond.	High TDS to Ash Handling	Low TDS to UCT Makeup LP	Softened Water to Deaerator
Water	" hr (gpm)	175,000 (350)	319,000 (638)	13,500 (27)	10,000 (20)	564,500 (1128)
Total	lb/hr	175,000	319,600	13,500	10,000	564,500
Pressure, psia		88.7	78.7	63.7	63.7	88.7
Temperature °F			100	100	100	100 100

TABLE 6.3.6-2

EQUIPMENT LIST

BOILER FEED WASTE & CONDENSATE TREATING-UNIT 45

Item No.	Equipment Name	Number Required	
		Operating	Spares
45TK-0101	Clearwell	1	0
45TK-0102	RO Product Storage Tank	1	0
45TK-0103	Sulfuric Acid Storage Tank	1	0
45TK-0104	Caustic Storage Tank	1	0
45TK-0105	Mixing/Holding Tank	1	0
45TK-0106	Polished Condensate Storage Tank	1	0
45TK-0107	Demineralized Water Storage Tank	1	0
45TK-0108	Low TDS Waste Collection Sump	1	0
45TK-0110	Vacuum and Process Cond. Storage Tank	1	0
45DM-0101	LP Condensate Flash Drum	1	0
45DM-0102	Oily Condensate Flash Drum	1	0
45DM-0103	Medium Pressure Flash Drum	1	0
45E-0101	RO Stream Preheater	1	0
45E-0102	Flashed Condensate	1	0
45E-0103	Flashed Oily Condensate Cooler	1	0
45E-0104	Medium Pressure Makeup Preheater	1	0
45P-0101 A/B	BFW Treatment Feed Pump	1	1
45P-0102 A/B	Activated Carbon Filter Backflush	1	1
45P-0103 A/B	Sand Filters Backflush	1	1
45P-0104 A/B	RO Feed Pump	1	1
45P-0105 A/B	Demineralizer Feed Pump	1	1
45P-0106 A/B	Low TDS Sump Pump	1	1
45P-0107 A/B	Hexametaphosphate Feed Pump	1	1
45P-0108 A/B	Sulfuric Acid Injection Pump	1	1
45P-0109 A/B	Sulfuric Acid Injection Pump	1	1

TABLE 6.3.6-2 (Continued)

EQUIPMENT LIST

BOILER FEED WASTE & CONDENSATE TREATING-UNIT 45

Item No.	Equipment Name	Number Required	
		Operating	Spares
45P-0110 A/B	Sulfuric Acid Injection Pump	1	1
45P-0111 A/B	Sulfuric Acid Injection Pump	1	1
45P-0112 A/B	Sulfuric Acid Injection Pump	1	1
45P-0113 A/B	Caustic Injection Pump	1	1
45P-0114 A/B	Caustic Injection Pump	1	1
45P-0115 A/B	Caustic Injection Pump	1	1
45P-0116 A/B	Caustic Injection Pump	1	1
45P-0117 A/B	Raw Water Treatment Slaking Water	1	1
45P-0118 A/B	Polished Condensate Return Pump	1	1
45P-0119 A/B	Demineralized BFW Feed Pump	1	1
45P-0121 A/B	Flashed Cond. Cooler Pump	1	1
45P-0122 A/B	LP Condensate Pump	1	1
45P-0123 A/B	MP Deaerator Feed Pump	1	1
45P-0124 A/B	Oily Condensate Cooler Pump	1	1
45P-0125 A/B	LP Deaerator Feed Pump	1	1
45P-0126 A/B	LP BFW Pump	1	1
45P-0127 A/B	MP BFW Pump	1	1
45DA-0101	Low Pressure Service Deaerator	1	0
45DA-0102	Medium Pressure Service Deaerator	1	0
45MX-0101 A/B	Low TDS Waste Sump Mixer	1	1
45FT-0101 A-F	Activated Carbon Filter	5	1
45FT-0102 A-G	Cartridge Filter	6	1
45FT-0103 A-D	Activated Carbon Filter	3	1

TABLE 6.3.6-2 (Continued)

EQUIPMENT LIST

BOILER FEED WASTE & CONDENSATE TREATING-UNIT 45

Item No.	Equipment Name	Number Required	
		Operating	Spares
45ME-0101 A/B/C	Cation Demineralizer	2	1
45ME-0102 A/B/C	Anion Demineralizer	2	1
45ME-0103 A/B	Mixed Bed Demineralizer	1	1
45ME-0104 A/B	Condensate Polisher	1	1
45ME-0105	Cation Regeneration Unit	1	0
45ME-0106	Anion Regeneration Unit	1	0
45ME-0107 A/B/C	Sodium Zeolite Softener	2	1
45ME-0108 A/B/C	Filter/Softener	2	1
45ME-0109	Hexametaphosphate System	1	0
45ME-0110	Reverse Osmosis (RO)	1	0
45ME-0111	De-Oiling Filter	1	0
45ME-0112	Salt Regeneration Dilution	1	0

6.3.7 AIR AND NITROGEN SYSTEMS-UNIT 46

6.3.7.1 DESIGN BASIS

Purpose of Unit

The Air and Nitrogen Systems unit provides compressed plant air for maintenance and plant uses, dry compressed air for pneumatic instrumentation, and a high purity nitrogen for purging of tanks, lines, and process vessels handling flammable materials.

Scope of Unit

The scope of the Air and Nitrogen System unit includes compressors and receivers for the plant and instrument air system, dryers for the plant air, and distribution networks throughout the plant for the plant air, instrument air, and nitrogen.

General Design Criteria

The compressors for plant and instrument air each have two 100 percent units. The plant air driers are designed for one onstream and the other on regeneration or standby.

The design onstream factor is for continuous operation of the unit without shutdown and is compatible with the overall plant onstream factor of 332 days/year.

The compressors are motor driven.

The turndown capability of Unit 46 is controlled by compressor controls and/or purge rates.

6.3.7.1 (Continued)

Process Specifications

The plant and instrument air are delivered at the following conditions:

Pressure	100 psig
Dew Point	-40°F min.

The nitrogen is delivered at a purity of 99.9 percent at 35 psig with a maximum oxygen content of 100 ppm.

Feed

Feed streams to the nitrogen and instrument air sections of the Air and Nitrogen Supply unit are from the Air Separation Unit 40. Plant air is directly compressed from the atmosphere.

	Nitrogen	Instrument Air	Plant Air
Nitrogen	99.9%	-	-
Pressure	50	50	atm
Dew Point	-	-100	65
Design Rate	15.0 MM SCFD	5.0 MM SCFD	15.0 MM SCFD
Operating Rate	12.9 MM SCFD	4.4 MM SCFD	13.8 MM SCFD

Products

The plant and instrument air are compressed and dried to the specifications presented in the Process Specifications Section. Unit usages are presented in Table 6.3.7-1, 6.3.7-2, and 6.3.7-3 for plant air, instrument air, and nitrogen respectively.

6.3.7.1 (Continued)

Utility Requirements

Power	3400 kW
Cooling Water	433 gpm

6.3.7.2 PROCESS DESCRIPTION

Drawing Number 835704-46-R-101 is the flow diagram for Unit 46. The unit material balance (Table 6.3.7-4) and equipment list (Table 6.3.7-5) follow the drawing.

Plant Air

Plant air is supplied to the Unit 46 battery limits at a pressure of 120 psig and is available to plant users at 100 psig minimum.

Two package centrifugal compressors are provided for plant air compression. These compressors take suction from the atmosphere through filters. Each compressor is designed to supply 4800 scfm of air. Sizing flow rate is based upon supporting maintenance operations during a major plant turnaround with both compressors operating.

The plant air compressors also provide back-up support to the instrument air systems during initial startup when instrument air is not available from the Oxygen Production unit. A plant air receiver is provided for water/oil knockout for the plant air.

Instrument Air

The Oxygen Production Unit 40 supplies instrument air to Unit 46 at a pressure of 50 psig and with a dew point of -100°F at 55 psig. The instrument air booster compressor(s) boost the pressure to 125 psig for

6.3.7.2 (Continued)

delivery to the Unit 46 battery limits. An instrument air receiving drum is the provided surge capacity. Instrument air is distributed to plant user battery limits at a minimum pressure of 90 psig.

Two instrument air booster compressors are provided; each has a capacity of 3650 scfm. Each compressor is sized to provide 1.20 times the total consumption quantity indicated on Table 6.3.7-2. Excess capacity accommodates undefined needs and emergency operating conditions. The second compressor increases the reliability of the system and provides additional contingency.

As stated above, the plant air system can provide makeup to the instrument air system. Compressed plant air passes through desiccant driers and after-filters before entering the instrument air system, assuring that only dry air is utilized in the instrument air system.

Nitrogen

Low pressure nitrogen is available from the Oxygen Plant at an expected pressure of 60 psig at the Unit 40 battery limits. This nitrogen is available to the most distant user plant battery limit at a minimum expected pressure of 40 psig.

TABLE 6.3.7-1
PLANT AIR REQUIREMENTS

Unit		Consumption (M SCFD)
02	Coal Preparation	167.8
10	Coal Gasification	175.4
11	CO Shift	3864.9 (2)
14	Gas Liquor Separation	566.1
16	Naphtha Hydrogenation	501.1
19	Sulfur Recovery	1026.6
22	Methanation	3152.2 (2)
	Buildings and Maintenance	7632.0
	TOTAL	13,933.9 (1)

NOTE: Other units' usages are intermittent at utility stations only.

(1) If the plant air requirement is exceeded, makeup can be supplied by the instrument air system.

(2) Intermittent use for catalyst regeneration. The plant air system is designed to produce the constant usage plus the single largest intermittent use, Unit 11.

TABLE 6.3.7-2
INSTRUMENT AIR REQUIREMENTS

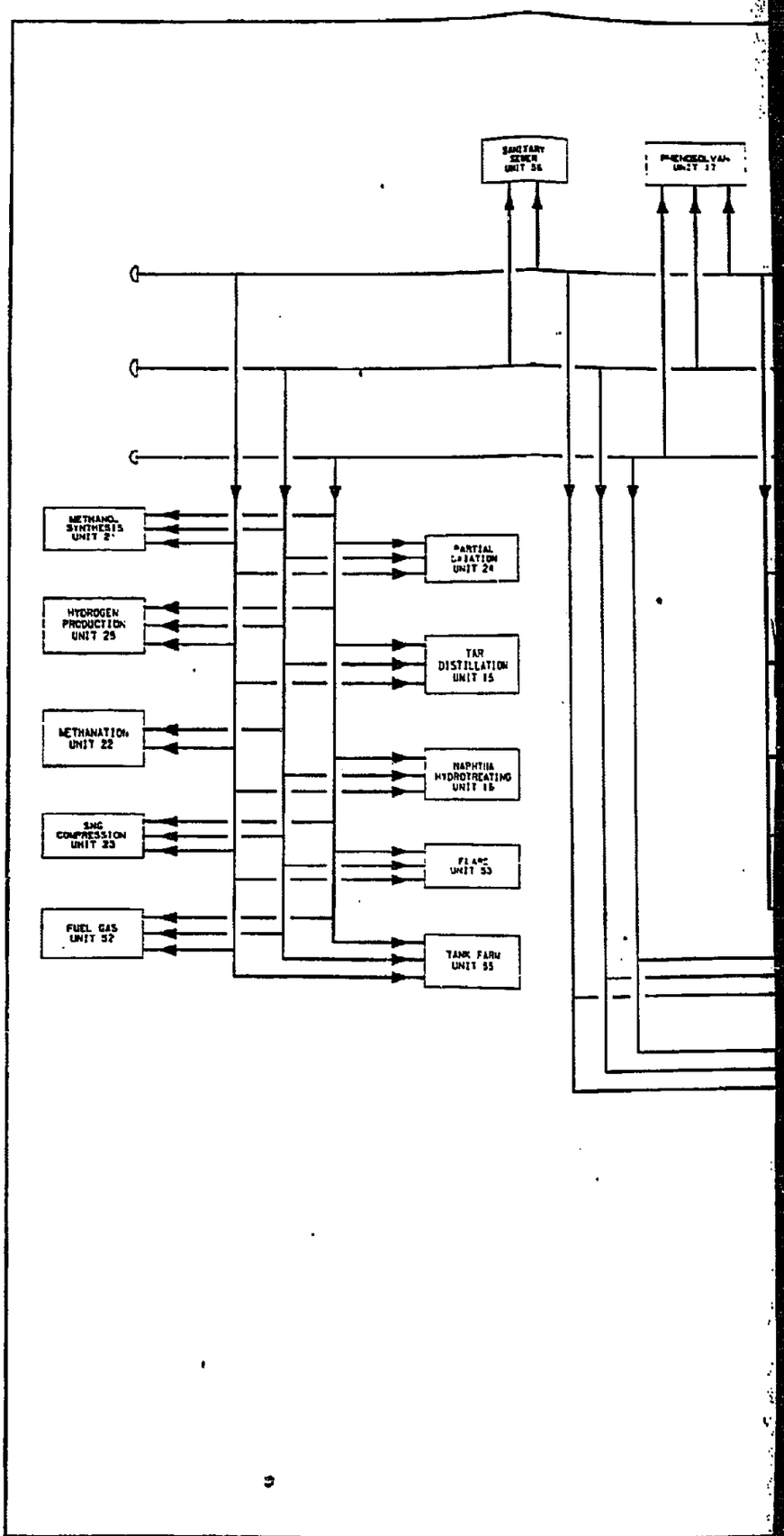
Unit		Consumption (M SCFD)
02	Coal Distribution	20
10	Coal Gasification	467
11	CO Shift	250
12	Raw Gas Cooling	15
13	Rectisol	310
14	Gas Liquor Separation	30
15	Tar Distillation	33
16	Naphtha Hydrotreating	25
17	Phenosolvan	95
18	Ammonia Recovery	80
19	Sulfur Recovery	103
20	Process Steam Superheating	31
21	Methanol Synthesis	389
22	Methanation	250
24	POX	500
40	Oxygen Production	372
41	Steam Generation	300
42	Power generation	300
43	FGD	38
44, 45, & 49	Water Treating	20
46	Air & Nitrogen Supply	40
47	Process Cooling Water	25
48	Utility Cooling Water	10
50 & 51	Utility and Firewater	30
52	Fuel Gas	30
53	Flare	10
54	Waste Water Treating	30

TABLE 6.3.7-2 (Continued)
INSTRUMENT AIR REQUIREMENTS

Unit		Consumption (M SCFD)
55	Tank Farm & Dispatch	165
56	Sanitary Sewer	4
	Cable Purge	405
	TOTAL	4,377

TABLE 6.3.7-3
NITROGEN REQUIREMENTS

Unit		Consumption (M SCFD)
10	Gasification	470.9
11	Shift	370.1
12	Cooling	149.8
13	Rectisol	2836.8
14	Gas Liquor Separation	623.1
15	Tar Distillation	40.3
16	Naphtha Hydrotreating	331.2
17	Phenosolvan	407.5
19	Sulfur Recovery	373.0
22	Methanation	718.6
24	POX	720.0
41	Steam Generation	61.9
43	Power Generation	67.7
45 & 54	Water Treatment	214.6
53	Flare	259.2
55	Tank Farm	6850.1
	TOTAL	14,494.8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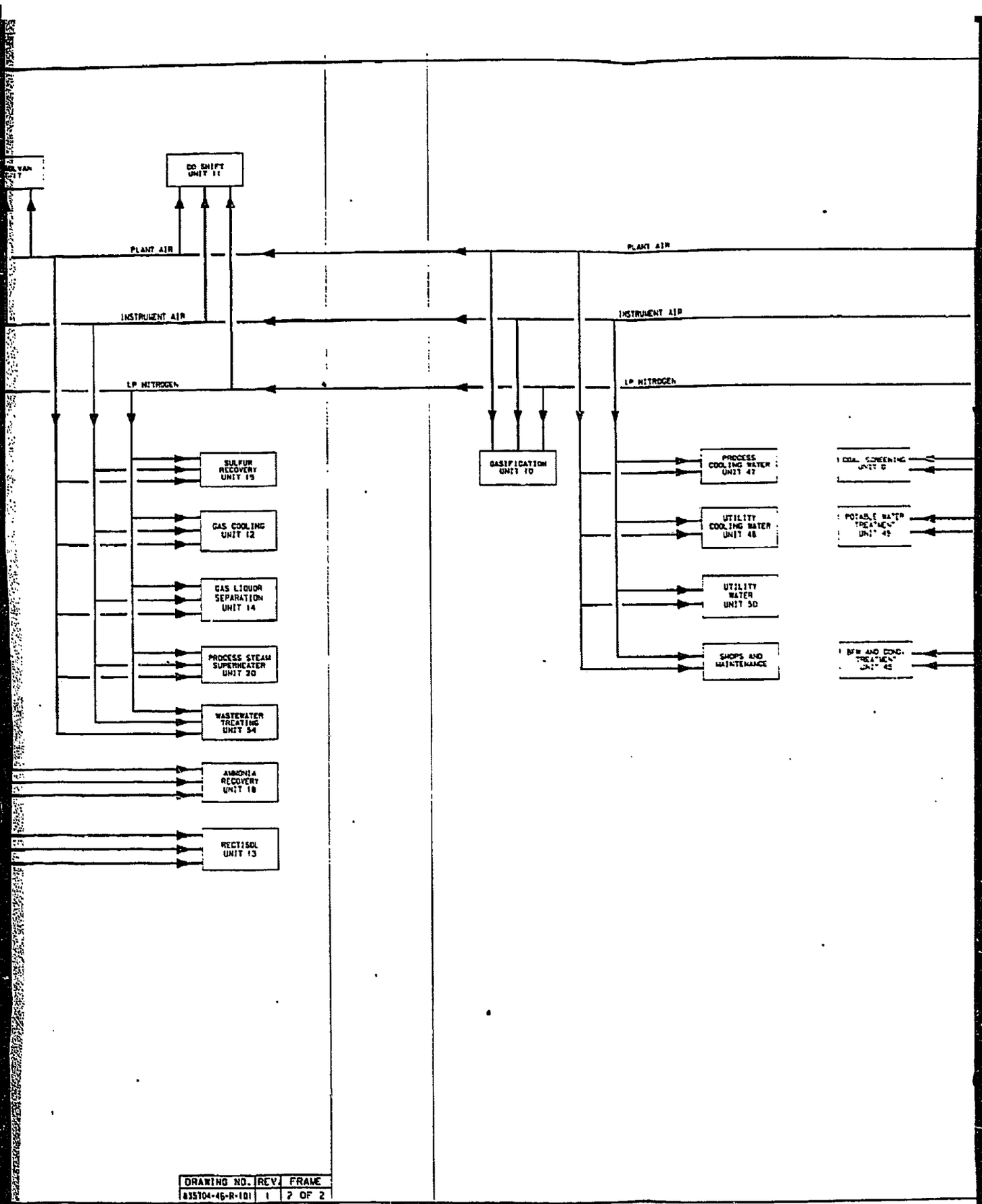
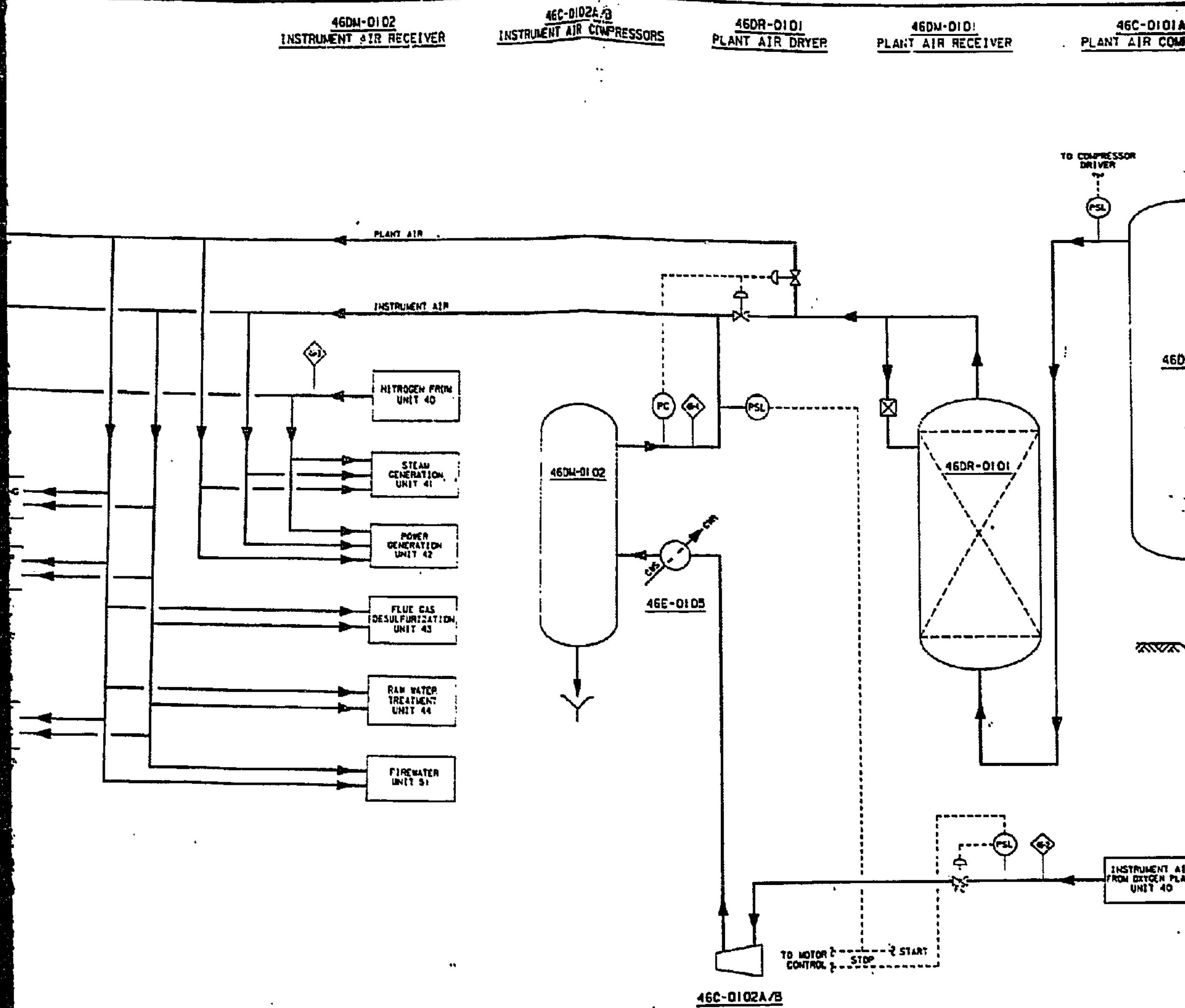
METHANOL SYNTHESIS UNIT 21
HYDROGEN PRODUCTION UNIT 25
METHANATION UNIT 22
SNG COMPRESSION UNIT 23
FUEL GAS UNIT 52
PARTIAL OXIDATION UNIT 24
TAR DISTILLATION UNIT 15
NAPHTHA HYDROTREATING UNIT 16
FLARE UNIT 53
TANK FARM UNIT 55



DRAWING NO.	REV.	FRAME
835704-46-R-101	1	2 OF 2

4 3



NOTES:

1. TEMPERATURES, PRESSURES AND FLOW ... ARE SHOWN ELSEWHERE.
2. INTERMITTENT FLOWS OF NITROGEN ARE ... THE OXYGEN PLANT PRODUCES LOW PRES...
3. THE CAPACITY OF THE INSTRUMENT AIR ... ADDITIONAL INSTRUMENT AIR WILL BE ...
4. IT IS ASSUMED THAT THE LARGEST OF ... FLOWS IS ADDITIVE TO THE CONTINUOU... AIR SYSTEM IS 9.676 SCFM.
5. REFER TO PROCESS DESCRIPTION FOR I...

FLUOR

R. WHITE

C.C. ABATAY

CROW TRIBE OF

NONE

2

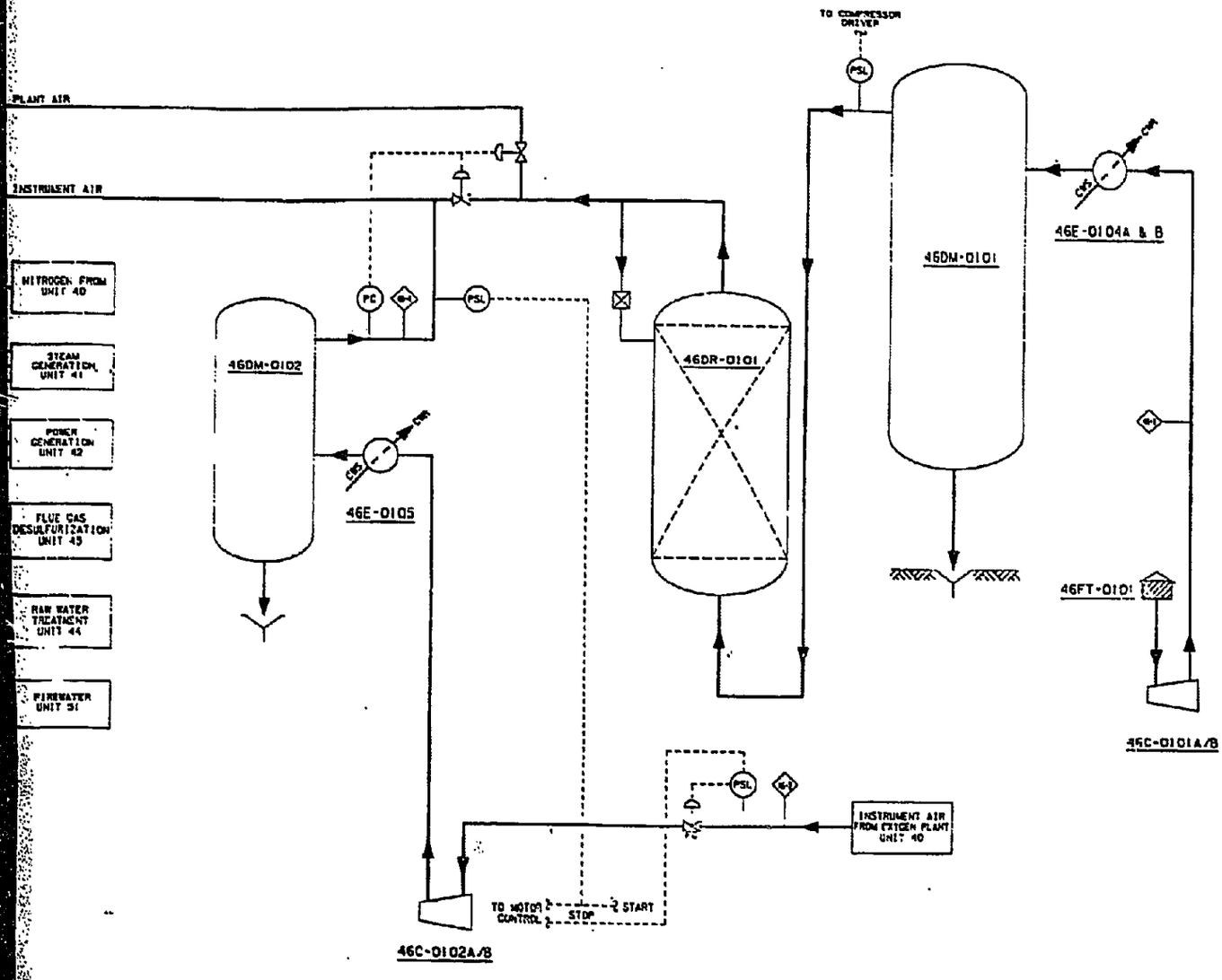
46C-0102A/B
INSTRUMENT AIR COMPRESSORS

46DR-0101
PLANT AIR DRYER

46DM-0101
PLANT AIR RECEIVER

46C-0101A/B
PLANT AIR COMPRESSOR

46FT-0101
PLANT AIR FILTER



NOTES:

1. TEMPERATURES, PRESSURES AND FLOW QUANTITIES REFERENCED BY DIAMONDS ARE SHOWN ELSEWHERE.
2. INTERMITTENT FLOWS OF NITROGEN ARE NOT ADDITIVE TO THE DESIGN TOTAL. THE OXIGEN PLANT PRODUCES LOW PRESSURE NITROGEN AS REQUIRED.
3. THE CAPACITY OF THE INSTRUMENT AIR COMPRESSORS IS 3,040 SCFM EACH. ADDITIONAL INSTRUMENT AIR WILL BE PROVIDED BY THE PLANT AIR SYSTEM.
4. IT IS ASSUMED THAT THE LARGEST OF THE INTERMITTENT PLANT AIR DESIGN FLOWS IS ADDITIVE TO THE CONTINUOUS LOAD. THE CAPACITY OF THE PLANT AIR SYSTEM IS 9,676 SCFM.
5. REFER TO PROCESS DESCRIPTION FOR INTERMITTENT FLOW QUANTITIES TO USERS.

FLUOR

R. WHITE
C.C. ABATAY
R. ST. MARTIN
J. McCARTHY

PROCESS FLOW DIAGRAM
AIR AND NITROGEN SYSTEMS
UNIT 46

CROW TRIBE OF INDIANS — SYNFUELS FEASIBILITY STUDY

NONE

835704-46-R-101

MICROFILM FRAME NO. 1 OF 2

1

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TABLE 6.3.7-4
MATERIAL BALANCE
AIR AND NITROGEN SYSTEM-UNIT 46

ALL CASES

Stream Number	46-1		46-2		46-3		46-4	
Stream Name	Plant Air		Instrument Air From Unit 40		Nitrogen From Unit 40		Instrument Air	
Component	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%	lb-mol/hr	Mol%
Air	1477.6	100.0	480.5	100.0			480.5	100.0
Nitrogen					1592.1	100.0		
Total Dry Gas	1477.6	100.0	480.5	100.0	1592.1	100.0	480.5	100.0
H_2O	33.8							
Total Wet Gas	1511.4							
Dry Gas lb/hr	42,555		13,920		44,604		13,920	
Water lb/hr	608							
Total lb/hr	43,163		13,920		44,604		13,920	
Pressure, psia	125		63		63		125	
Temperature, °F	80		75		75		80	

NOTE: Flow quantities, pressures and temperatures shown are for the total unit on a stream-day basis, are to be used solely for process design purposes, and are not necessarily the conditions which will be attained during actual operations.

TABLE 6.3.7-5
EQUIPMENT LIST
AIR AND NITROGEN SYSTEMS-UNIT 46

Item No.	Equipment Name	Number Required	
		Operating	Spares
46DM-0101	Plant Air Receiver	1	0
46DM-0102	Instrument Air Receiver	1	0
46C-0101 A/B	Plant Air Compressor	1	1
46C-0102 A/B	Instrument Air Compressor	1	1
46DR-0101	Plant Air Drier	1	0
46E-0104	Plant Air Aftercooler	1	0
46E-0105	Instrument Air Aftercooler	1	0

6.3.8 PROCESS COOLING WATER - UNIT 47

6.3.8.1 DESIGN BASIS

Purpose of Unit

The Process Cooling Water System provides heat rejection for the cooling water used by the plant process units using induced draft cooling towers.

Scope of Unit

Unit 47 includes the distribution and collection piping network necessary for cooling water service to and from the power generation and process units of the plant and the cooling towers and peripherals to reject the process heat picked up by the water. Also included are a side stream treating system to remove suspended solids from the cooling water and a cooling water makeup treating system consisting of filtration, sodium zeolite softening, and Reverse Osmosis to upgrade the waste treatment effluent to process cooling water.

General Design Criteria

The Process Cooling Water unit consists of four subsystems of one train each: Cooling towers, cooling water distribution, chemical treatment, and side stream treatment.

The cooling water pumps are designed with a minimum of one spare per tower.

The equipment design is compatible with the overall plant stream factor of 332 days/year operation.

The cooling tower fans and cooling water pumps are motor driven.

6.3.8.1 (Continued)

The system is designed for continuous operation without a major turnaround.

The turndown capability is designed as needed.

Process Specifications

The Process Cooling Water Unit is designed to circulate 168,000 gpm based on 110 percent capacity. The total process cooling water heat removal is 2279×10^6 Btu/hr. This duty is rejected from the Process Cooling Towers which are designed for a 17°F approach to design wet bulb temperature based on the five percent corresponding summer dry bulb temperature.

The feed water to the cooling tower consists of cooling water from process heat exchangers in the following units:

Unit		Flow (gpm)
10	Gasification	551
12	Gas Cooling	609
13	Rectisol	13,613
14	Gas Liquor Separation	5,548
15	Tar Distillation	240
16	Naphtha Hydrotreating	206
17	Phenosolvan	779
18	Ammonia Recovery	8,165
19	Sulfur Recovery	2,900
21	Methanol Synthesis	80
22	Methanation	293
23	SNG Compression	10,200
24	Partial Oxidation	465
25	H_2 Production	25
24	Partial Oxidation	465

6.3.8.1 (Continued)

Unit		Flow (gpm)
42	Power Generation	108,200
55	Tank Farm	100

Inlet Temperature to the Tower is 110°F

Makeup water flow to the cooling towers is 4617 gpm. The treated effluent from the wastewater treatment unit is recycled into the makeup stream. Additives to the makeup treatment include sulfuric acid pH control and hexametaphosphate for the RO unit. Additives to the process cooling water include dispersant chemicals, pH control, biocides and corrosion inhibitors.

The outputs of Cooling Towers I and II are 108,200 gpm and 44,674 gpm respectively of 80°F water. The cooling water pumps discharge at 75 psig for distribution to the process units.

Utility Requirements

Power	9,600 kW
Treated Water Makeup	4,617 gpm

6.3.8.2 PROCESS DESCRIPTION

Drawing No. 835704-47-R-101, 835704-47-4-102, and 835704-47-4-103 are the flow diagrams for Unit 47. The unit material balance and equipment list (Tables 6.3.8-1 and 6.3.8-2) follow the drawings. Drawing No. 835704-47-4-050 shows the plot plan.

6.3.8.2 (Continued)

Cooling Towers

The Process Cooling Water System has two induced draft cooling towers. The first tower is situated near the Steam and Power Generation Unit to service two of the three power turbine surface condensers. The second tower is situated near the process units to provide cooling to the rest of the process units.

Makeup water to the two towers is pumped at 4617 gpm from the Process Cooling Water Pond. The cooling water makeup from waste water treating undergoes the following treatment steps within Unit 47:

Activated Carbon Filtration
Sodium Zeolite Softening
Micron Cartridge Filtration, pH Adjustment, Reverse Osmosis

Side stream treatment for both towers includes filtration and solids handling.

Cooling towers are designed to evaporate the total amount of waste water produced throughout the year. During cold weather operation, the ability of the ambient air to absorb water at saturation is substantially reduced. Maintenance of the cold water temperature and waste water evaporation is by computer control, which supervises fan operation, hot water bypass and cooling cell isolation.

Protection of the towers against fire is an important consideration. The design incorporates a deluge system in compliance with NFPA standards and firestops to prevent propagation of fire between cells, thereby minimizing the amount of fire water required.

6.3.8.2 (Continued)

Reversible fans are provided to allow air circulation to be reversed to prevent freeze-up during winter.

Cooling Water Distribution

Centralized cooling water distribution piping is provided to supply process units throughout the plant. Selection of a central system versus individual units is based on cost and operating considerations.

Circulation of cooling water is provided by vertical mixed flow impeller pumps. Three 54,000 gpm capacity and three 22,000 gpm capacity pumps are provided, each rated at 75 psig discharge. Normally, two of each of the motor driven pumps operate. The standby pumps are motor driven. The philosophy in driver selection is based upon having sufficient cooling water available to shutdown the plant in a safe and orderly fashion in the event of plant-generated power failure.

The pumps are arranged in a pit which receives, by gravity flow, cold water from the cooling tower basins. Each pump pit is equipped with trash racks and screens which are periodically manually cleaned.

Due to the large cooling water circulation, consideration was given to dynamic changes in the piping system as a result of pump tripout, etc. To accommodate sudden surges, the pumps are equipped with hydraulically operated auto-closing valves on each discharge. The valve is designed to close in two stages upon pump failure to prevent excessive pressure from developing in the distribution system as a result of sudden shutoff. The first stage is a rapid closure to approximately 75 percent of travel with the second stage set at a lower rate to achieve complete closure.

6.3.8.2 (Continued)

Chemical Treatment

The use of biologically upgraded process waste waters as cooling water makeup has the inherent problems associated with conventional systems. Without extensive testing, it is impossible to predict the impact of the upgraded waste water in the circulation system with respect to scaling, corrosion, and biological fouling. However, approximations can be made on the water quality and the tendency it has to scale, etc. The following chemical addition systems are considered essential to provide the flexibility required to develop a successful cooling water treatment program and are included in the process cooling tower design:

Dispersant chemical injection
pH control
Biocide injection
Corrosion inhibitor

The makeup waste water is processed through a section of five activated carbon filters and four sodium zeolite softeners followed by micron cartridge filtration and reverse osmosis. Acid and anti-scale agents are added to the makeup prior to temperature adjustment and feed to the RO unit.

The treated makeup flows to the Process Cooling Water Makeup Pond and is pumped to the two cooling tower basins. The reject stream flows to the Waste Water Evaporator in Unit 54.

6.3.8.2 (Continued)

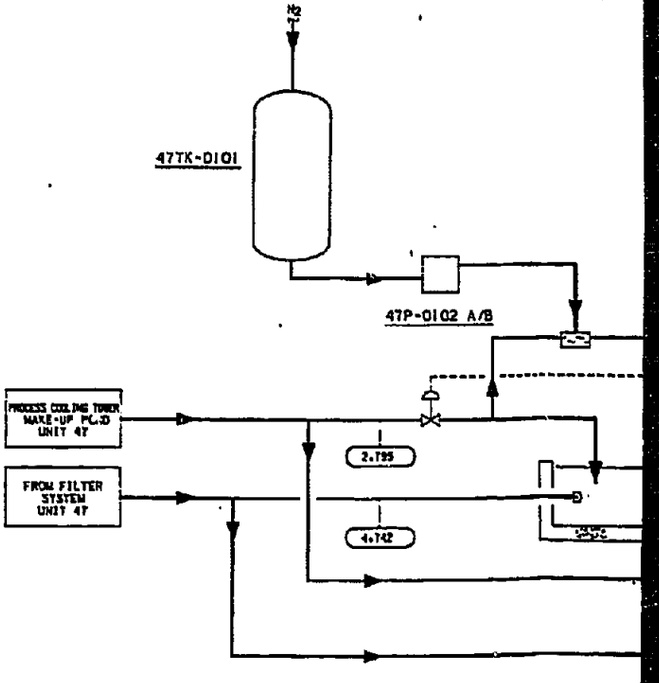
Side Stream Treating

To control the buildup of suspended solids in the cooling water a flow of 8137 gpm total from both towers is diverted to eight gravity filters and returned. The solids from these filters are flushed into a clarifier and combined with the blowdown from both towers. The overflow of the clarifier is sent to the Waste Water Evaporator in Unit 54 while the sludge is dewatered and sent offplot to disposal as landfill.

47TK-0101
ACID DAY TANK

47CT-0101
PROCESS COOLING TOWER

INHIB

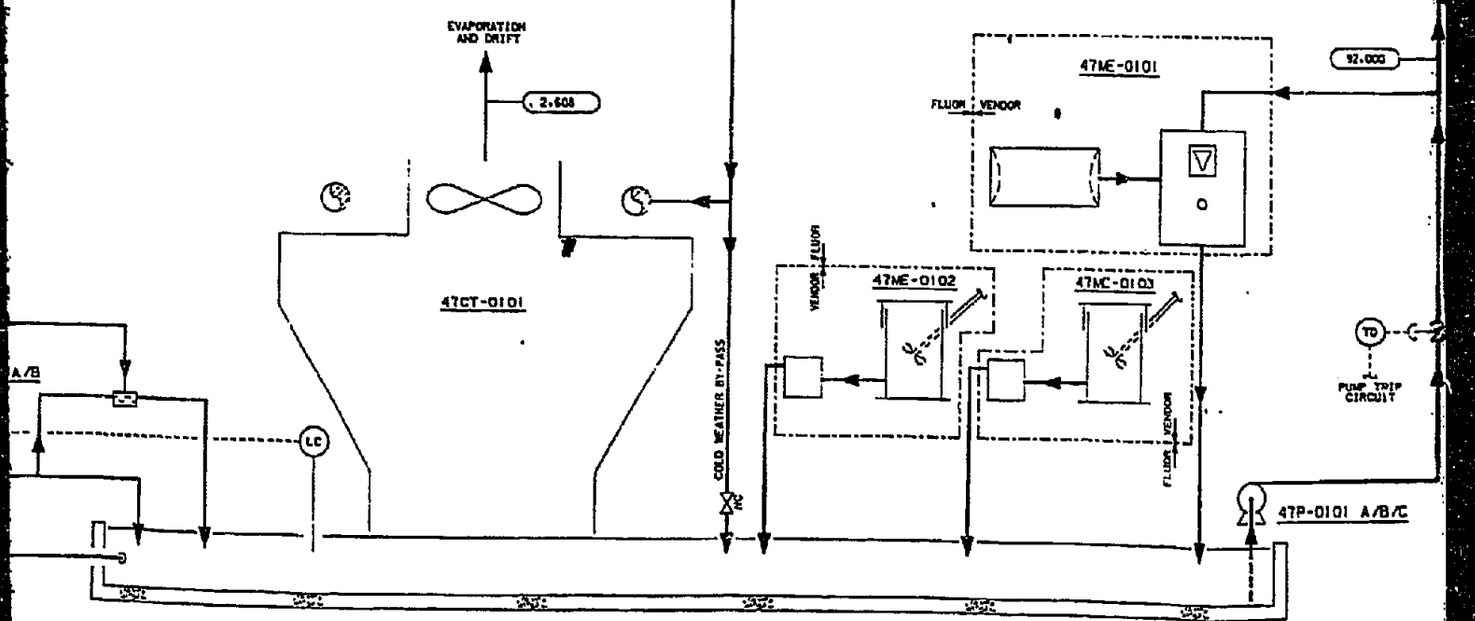


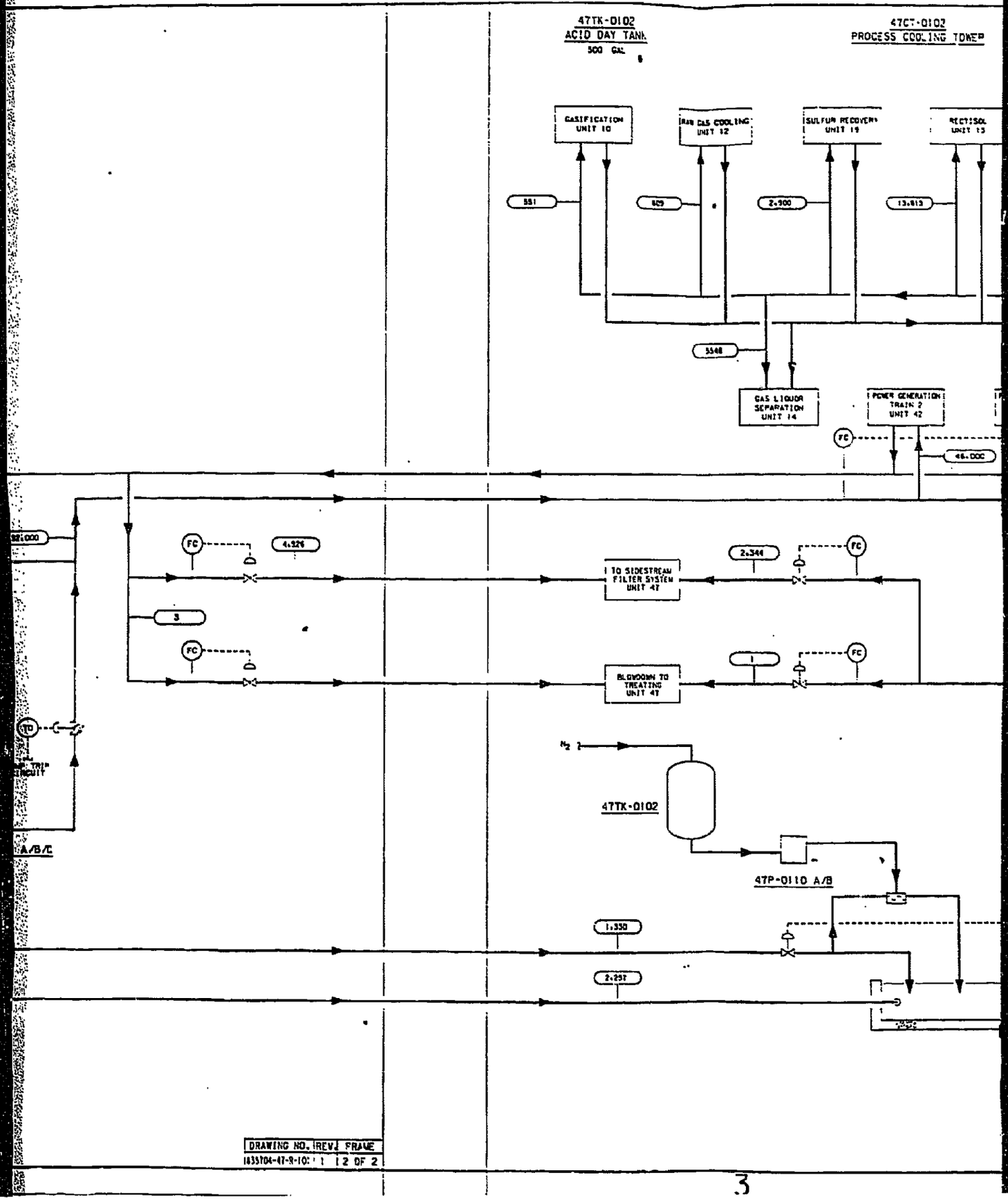
47CT-0101
S COOLING TOWER

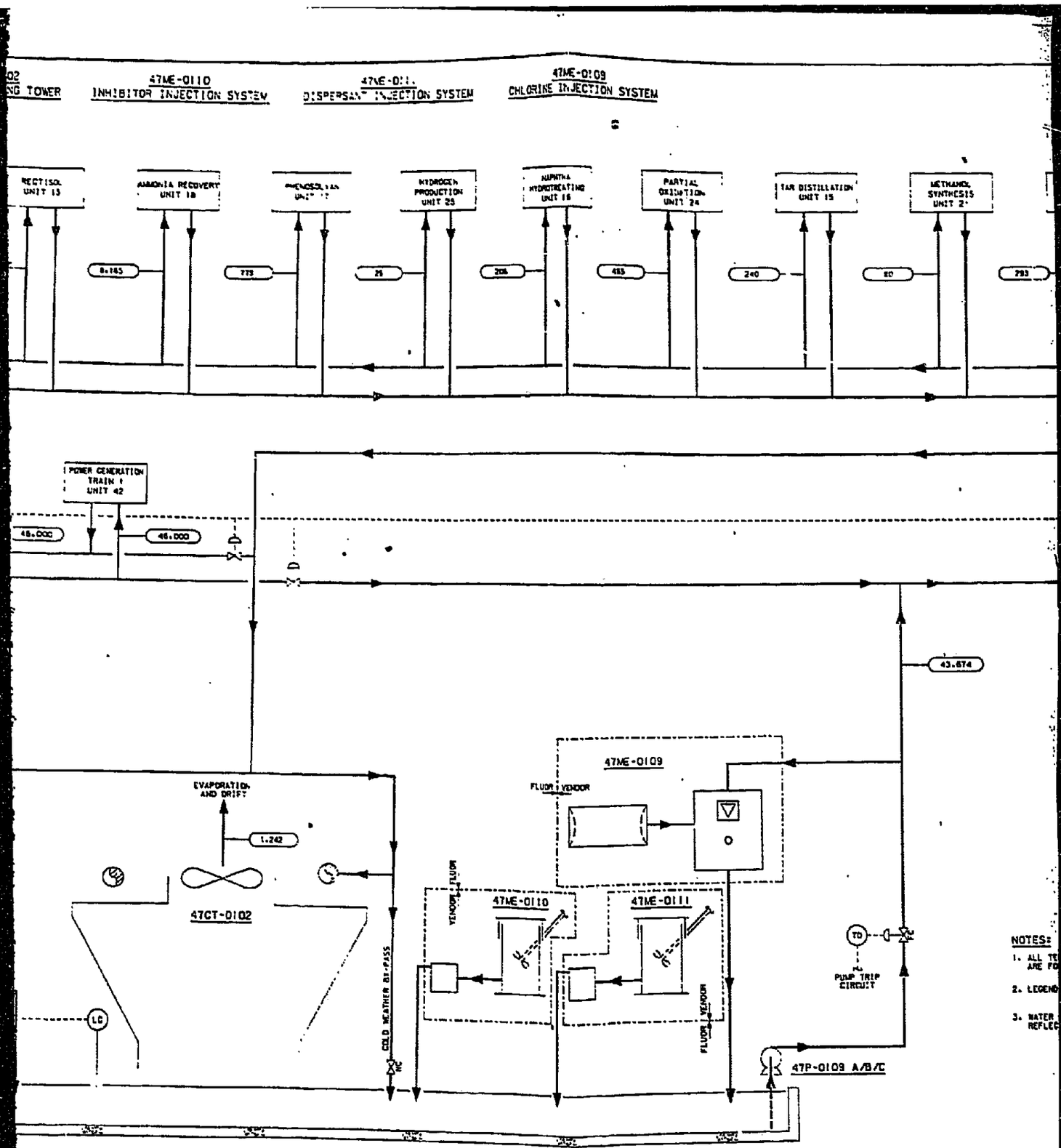
47ME-0102
INHIBITOR INJECTION SYSTEM

47ME-0103
DISPERSANT INJECTION SYSTEM

47ME-0101
CHLORINE INJECTION SYSTEM

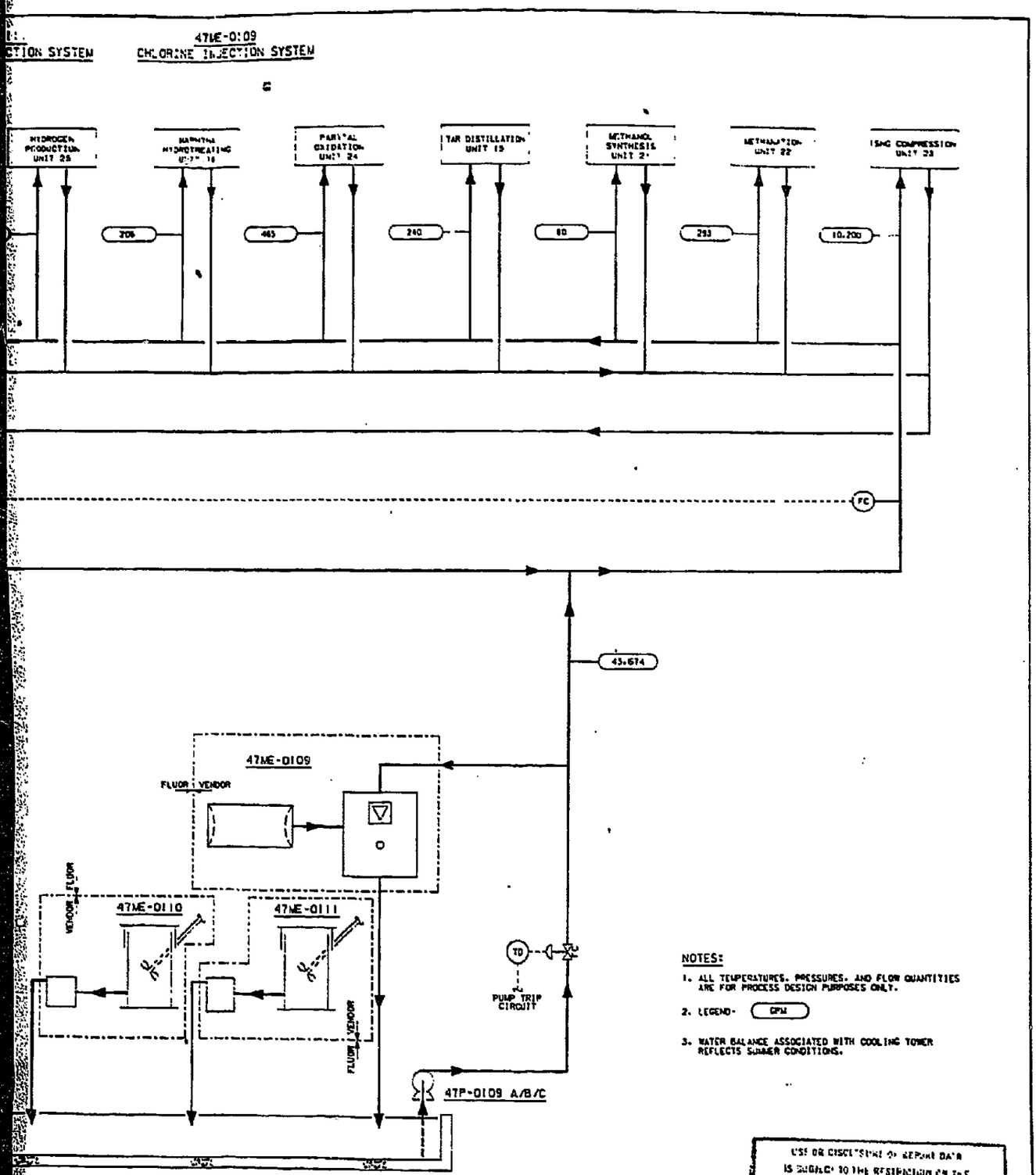



47TK-0102
ACID DAY TANK
500 GAL
47CT-0102
PROCESS COOLING TOWER
GASIFICATION UNIT 10
RAW GAS COOLING UNIT 12
SULFUR RECOVERY UNIT 19
RECTISOL UNIT 13
551
609
2,900
13,813
5548
GAS LIQUOR SEPARATION UNIT 14
POWER GENERATION TRAIN 2 UNIT 42
FC
46,000
4,926
TO SIDESTREAM FILTER SYSTEM UNIT 47
2,344
3
1
BLOWDOWN TO TREATING UNIT 47
TO
A/B/C
N2
47TK-0102
47P-0110 A/B
1,330
2,257
DRAWING NO. REV. FRAME
1835704-47-9-10 1 2 OF 2



FLUOR

R. WHITE
P.C. ABATAY
W.D'BELMIO
R. McCARTHY
R. I. ENG



FLUOR

PROCESS FLOW DIAGRAM
PROCESS COOLING WATER SYSTEM
UNIT 47

CROW TRIBE OF INDIANS — STNFUELS FEASIBILITY STUDY

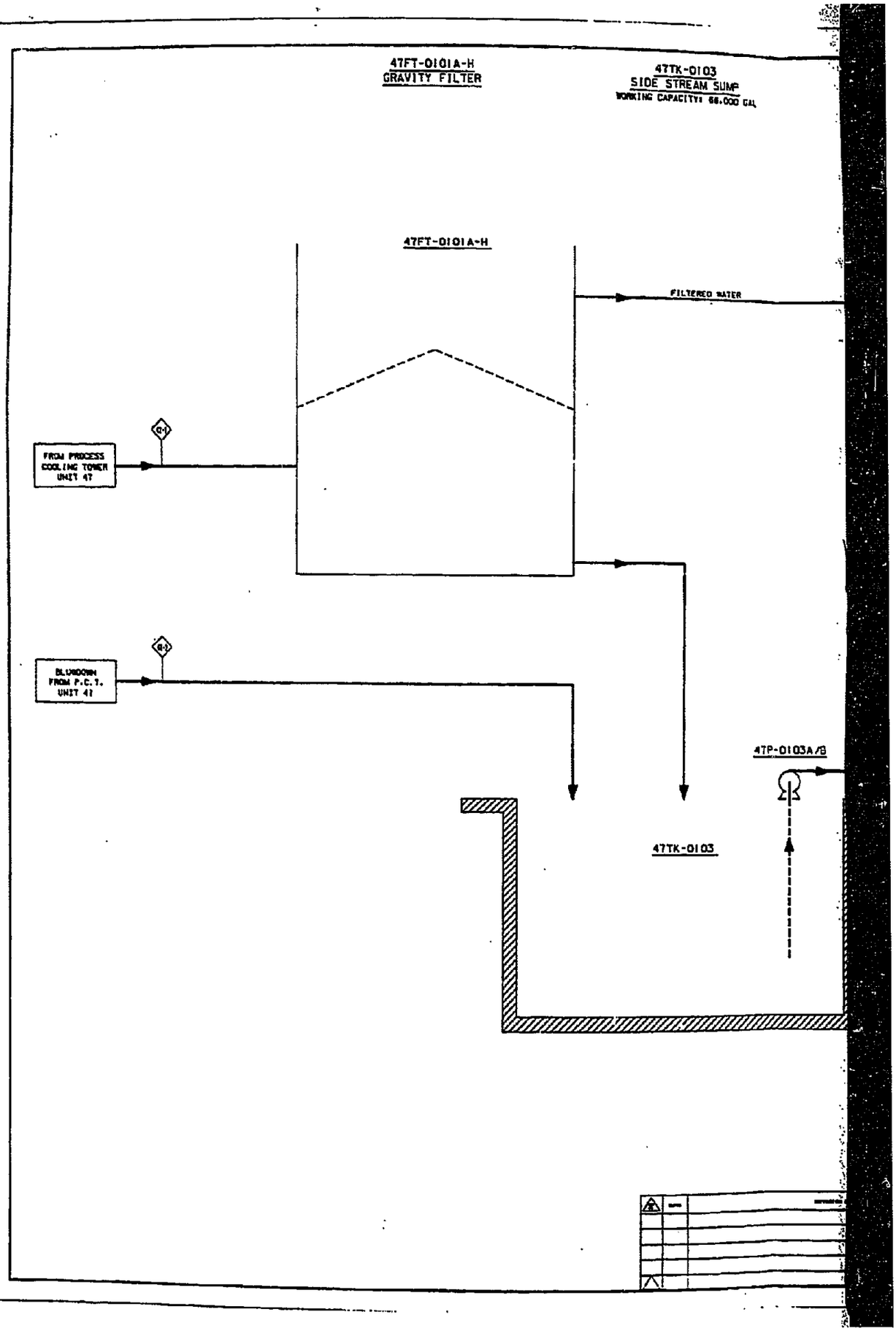
NONE

835704-47-R-101

MICROFILM FRAME NO. 1 OF 2

1

003 | 35747101


47FT-0101A-H
GRAVITY FILTER
47TK-0103
SIDE STREAM SUMP
WORKING CAPACITY: 66,000 GAL
47FT-0101A-H
FILTERED WATER
FROM PROCESS COOLING TOWER UNIT 47
BLOWDOWN FROM P.C.T. UNIT 41
47P-0103A/B
47TK-0103

47ME-0104
CLARIFIER CHEMICALS
FEED PACKAGE

47CA-0101
CLARIFIER

TO PROCESS COOLING TOWER UNIT 47

FROM CHEMICAL DRUMS

47ME-0104
(NOTE 2)

VENDOR FLUOR

47P-0103A/B

47P-0105A/B

TO WASTE TREATMENT EVAPORATION UNIT UNIT 54

47CA-0101

47P-0104A/B

TO WASTE TREATMENT THICKENER UNIT 54

NOTES:
1. THE TEMPERATURES, PRESSURES AND FLOW QUANTITIES REFERENCED BY DIAMONDS ARE SHOWN ELSEWHERE.
2. SUPPLIED AS VENDOR PACKAGE.

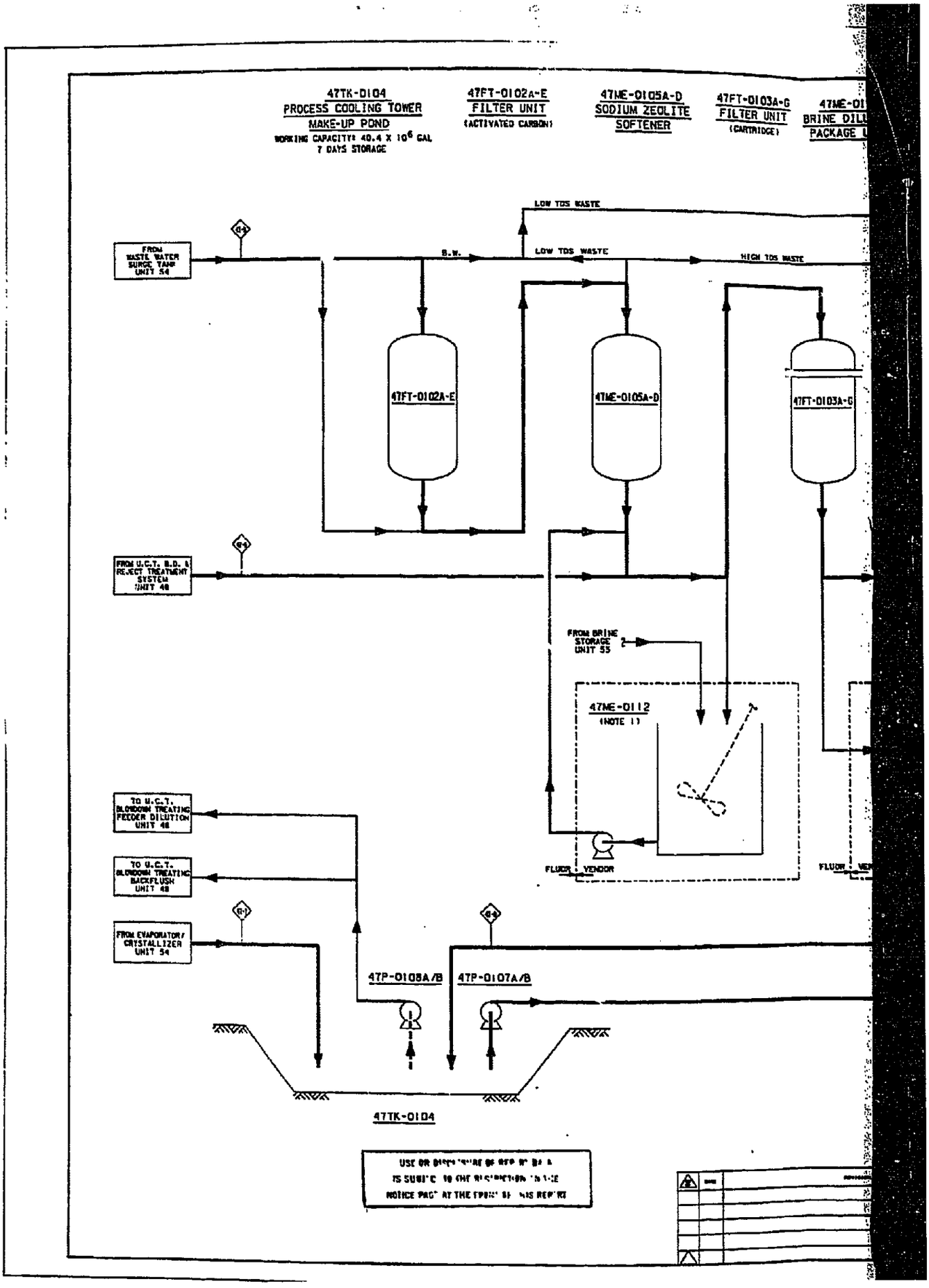
FLUOR

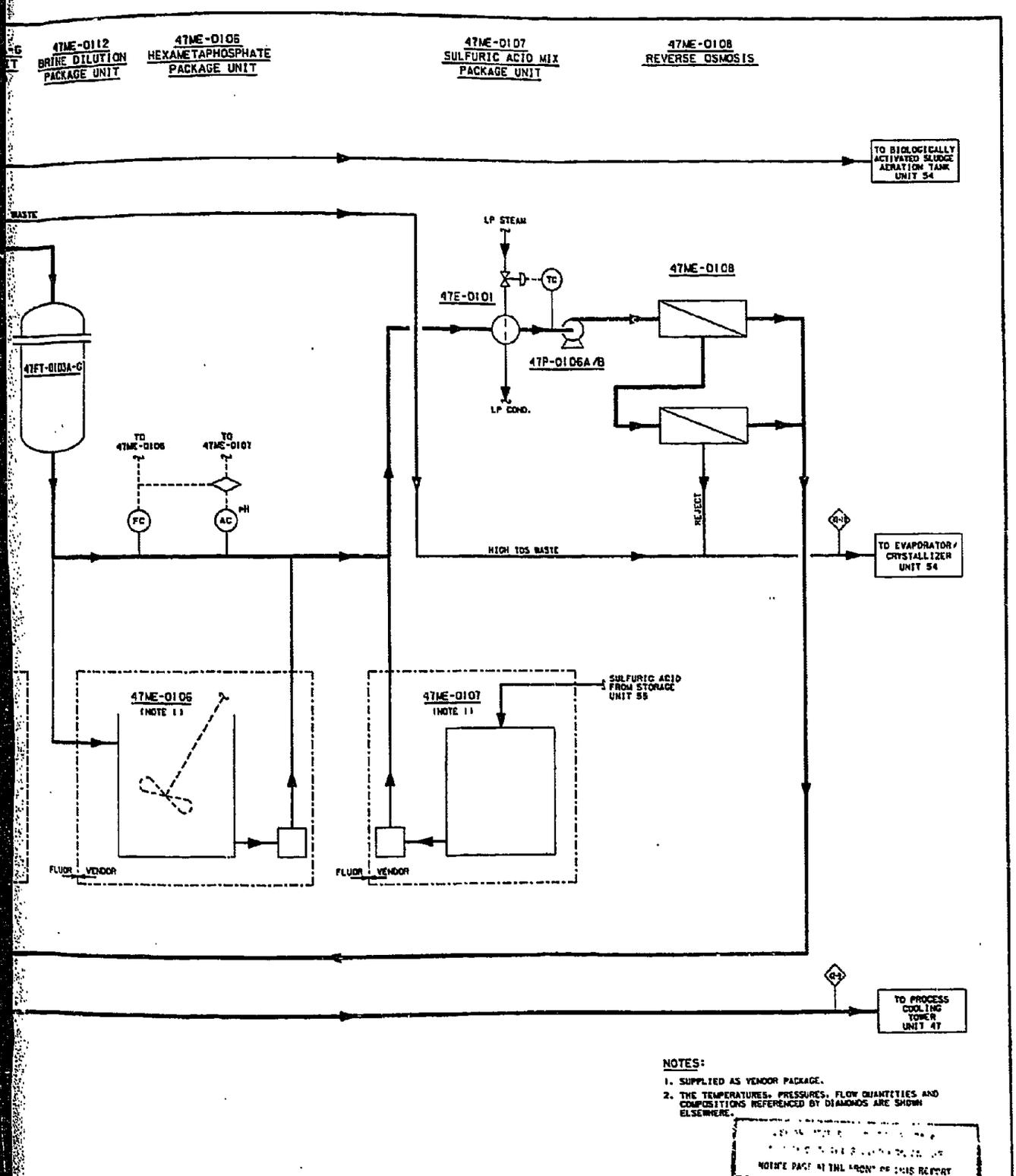
R. WHITE
C.C. AGATAY
W.O'BELMITO
R. McCARTHY
R. LANG

PROCESS FLOW DIAGRAM
PROCESS COOLING WATER - SIDE STREAM FILTRATION
UNIT 47
CROW TRIBE OF INDIANS — SYNFUELS FEASIBILITY STUDY

NONE | 835704-47-4-102 | 1

003 35741102


47TK-0104
PROCESS COOLING TOWER
MAKE-UP POND
WORKING CAPACITY: 40.4 X 10⁶ GAL
7 DAYS STORAGE
47FT-0102A-E
FILTER UNIT
(ACTIVATED CARBON)
47ME-0105A-D
SODIUM ZEOLITE
SOFTENER
47FT-0103A-G
FILTER UNIT
(CARTRIDGE)
47ME-01
BRINE DILU
PACKAGE U
LOW TDS WASTE
B.W.
LOW TDS WASTE
HIGH TDS WASTE
FROM WASTE WATER SURGE TANK UNIT 54
47FT-0102A-E
47ME-0105A-D
47FT-0103A-G
FROM U.C.T. B.D. & REJECT TREATMENT SYSTEM UNIT 48
FROM BRINE STORAGE UNIT 55
47ME-0112
(NOTE 1)
FLUOR VENDOR
TO U.C.T. BLOWDOWN TREATING FEEDER DILUTION UNIT 48
TO U.C.T. BLOWDOWN TREATING BACKFLUSH UNIT 48
FROM EVAPORATOR/ CRYSTALLIZER UNIT 54
47P-0108A/B
47P-0107A/B
47TK-0104



NOTES:

1. SUPPLIED AS VENDOR PACKAGE.
2. THE TEMPERATURES, PRESSURES, FLOW QUANTITIES AND COMPOSITIONS REFERENCED BY DIAMONDS ARE SHOWN ELSEWHERE.

NOTICE PAGE AT THE FRONT OF THIS REPORT

		FLUOR	D.P.HALVERSON	PROCESS FLOW DIAGRAM		3574103
			C.C.ABATAY	P.C.T. MAKE-UP WATER TREATMENT SYSTEM		
			R.D'DELMITO	UNIT 47		
			R.McCARTHY	CROW TRIBE OF INDIANS	SYNFUELS FEASIBILITY STUDY	
			R.LANG	NONE	835704-47-4-103	1

PROCES

Stream Number		47-1	47-2	47-3	
Stream Name		PCT To Side Stream Filter	Process Cooling Tower Blowdown	Side Stream Filtration to PCT	Hi Ef Ev
H_2O	lb/hr	4,068,500	2,000	3,917,000	
	(gpm)	(8137)	(4)	(7834)	
Total	lb/hr	4,068,500	2,000	3,917,000	
Pressure, psia		13.7	13.7	13.7	
Temperature, °F		110	110	80	

NOTE: Flow quantities, pressures and temperatures shown are
purposes, and are not necessarily the conditions which

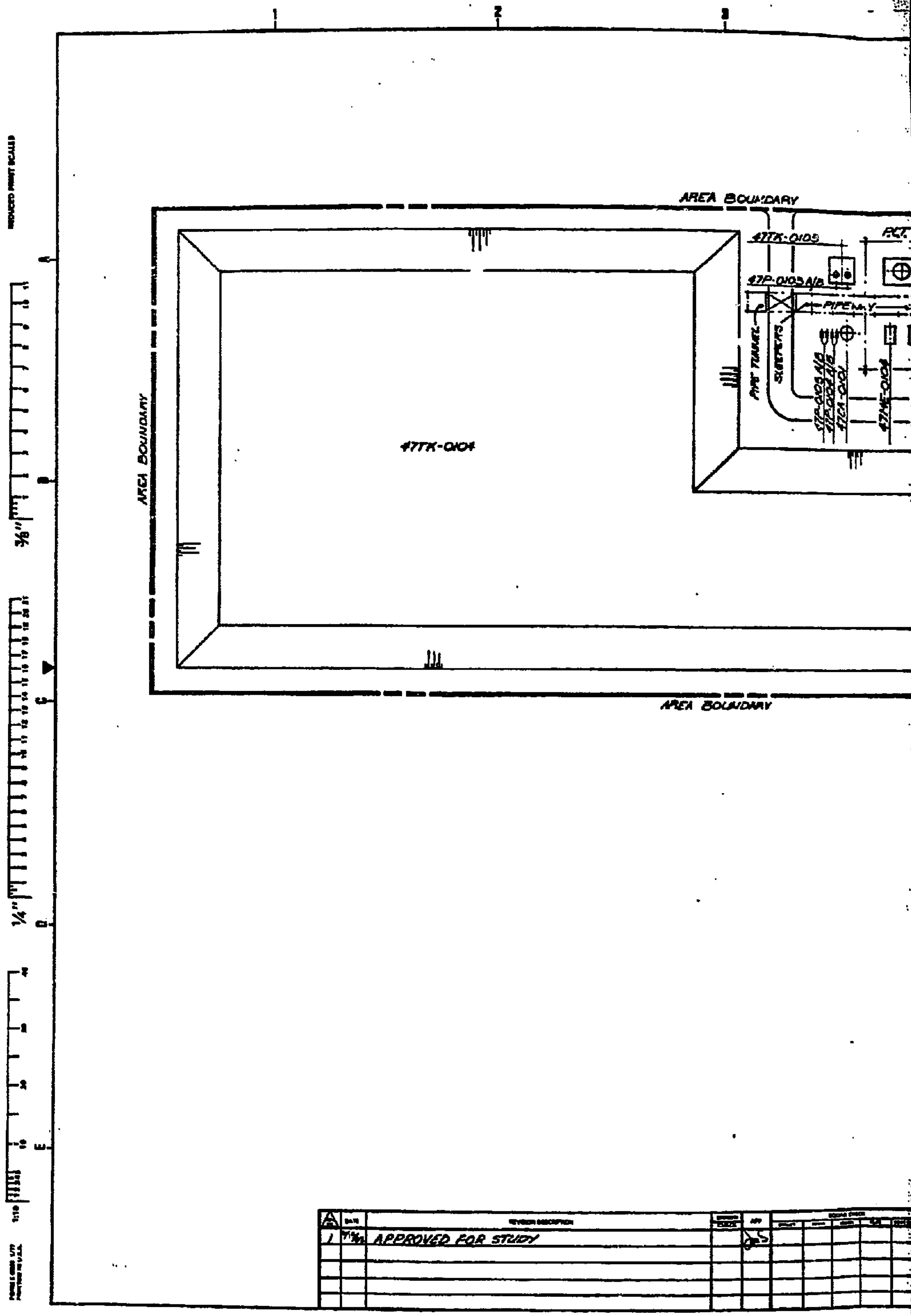
TABLE 6.3.8-1

MATERIAL BALANCE

PROCESS COOLING WATER - UNIT 47

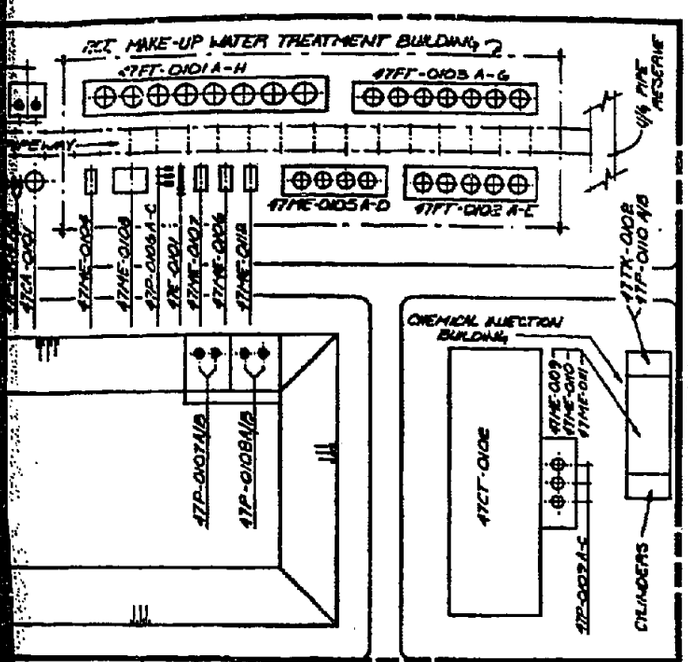
	47-4	47-5	47-6	47-7	47-8	47-9	47-10
ream on	High TDS Effluent to Evaporation	Treated Waste Water to PCT Makeup	From UCT Blowdown Treatment	From Evaporator	From PCT Makeup Water Treatment	To PCT	To Evaporator
00	140,000	1,185,500	992,000	415,000	884,500	2,291,500	295,000
)	(280)	(2371)	(1984)	(830)	(1769)	(4583)	(590)
00	140,000	1,185,500	992,000	415,000	884,500	2,291,500	295,000
7	63.7	63.7	43.7	13.7	13.7	20.7	63.7
0	100	65	80	100	65	80	85

own are for the total unit on a stream-day basis, are to be used solely for process design
s which will be attained during actual operations.



AREA BOUNDARY
47TK-0105
PCT
47P-0105A/B
PIPEWAY
PIPE TUNNEL
SLEEPERS
47TK-0104
AREA BOUNDARY
AREA BOUNDARY
3/8"
1/4"
1 APPROVED FOR STUDY

USE OR DISCLOSURE OF REPORT DATA IS SUBJECT TO THE RESTRICTION ON THE SOURCE PAGE AT THE FRONT OF THIS REPORT



REDUCED PRINT SCALE

ALL EQUIPMENT SIZES AND LOCATIONS ARE APPROXIMATE

FLUOR

R. MILLER
B. MOSETL
COUNTS
SHEETS
R. LAING

PLOT PLAN - UNIT 47
PROCESS COOLING WATER
CROW TRIBE OF INDIANS MONTANA

1"=40'-0" 835704-47-4-050 1

TABLE 6.3.8-2

EQUIPMENT LIST

PROCESS COOLING WATER - UNIT 47

Item No.	Equipment Name	Number Required	
		Operating	Spare
47TK-0101	Acid Day Tank	1	0
47TK-0102	Acid Day Tank	1	0
47TK-0103	Side Stream Sump	1	0
47TK-0104	Process C.W. Makeup Pond	1	0
47E-0101	RO Preheater	1	0
47P-0101 A/B/C	Cooling Water Pumps	2	1
47P-0102 A/B	Acid Pump	1	1
47P-0103 A/B	Side Stream Sump Pump	1	1
47P-0104 A/B	Clarifier Sludge Pump	1	1
47P-0105 A/B	High TDS Clarifier Pump	1	1
47P-0106 A/B	RO Feed Pump	1	1
47P-0107 A/B	P.C.W. Makeup Pump	1	1
47P-0108 A/B	Unit 48 Backflush Pump	1	1
47P-0109 A/B/C	Cooling Water Pump	2	1
47FT-0101 A-H	Side Stream Gravity Filter	7	1
47FT-0102 A-E	Filter Unit (Activated Charcoal)	4	1
47FT-0103 A-G	Filter Unit (Cartridge)	6	1
47CT-0101	Process Cooling Tower (Power)	1	0
47CT-0102	Process Cooling Tower (Process)	1	0

TABLE 6.3.8-2 (Continued)

EQUIPMENT LIST

PROCESS COOLING WATER - UNIT 47

Item No.	Equipment Name	Number Required Operating	Spare
47ME-0101	Chlorine Injection System	1	0
47ME-0102	Inhibitor Injection System	1	0
47ME-0103	Dispersent Injection System	1	0
47ME-0104	Clarifier Chemicals Injection System	1	0
47ME-0105 A-D	Sodium Zeolite Softener	1	0
47ME-0106	Hexa-Metaphosphate Package Unit	1	0
47ME-0107	Sulfuric Acid Package Unit	1	0
47ME-0108	Reverse Osmosis	1	0
47ME-0109	Chlorine Injection System	1	0
47ME-0110	Inhibitor Injection System	1	0
47ME-0111	Dispersant Injection System	1	0
47ME-0112	NaCl Dillution Package	1	0
47CA-0101	Side Stream Clarifier	1	0

6.3.9 UTILITY COOLING WATER - UNIT 48

6.3.9.1 DESIGN BASIS

Purpose of Unit

The Utility Cooling Water System provides heat rejection for the cooling water used in the Oxygen Production, Air and Nitrogen Systems, and Power Generation units using an induced draft cooling tower.

Scope of Unit

Unit 48 includes the distribution and collection grids necessary for cooling water circulation for the units mentioned above. Also included are the cooling tower and peripherals to reject the heat absorbed by the water.

A cooling tower blowdown treatment system is included in this unit to upgrade the water for use elsewhere in the plant. The blowdown treatment consists of chlorination, lime softening, filtration, and sodium zeolite softening. A sludge thickening and disposal system is necessary to process the waste from the softeners.

General Design Criteria

The Utility Cooling Water unit consists of a single train.

The Utility Cooling Water pumps are designed with one spare.

The system design is compatible with an overall plant onstream factor of 332 days/year.

The Cooling Water pumps are motor driven.