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PGandE GEYSERS RETROFIT PROJECT

MILESTONE REPORT NO. 1

RECO Job No. S-79007

June 4, 1979

ROGERS
Engineering • San Francisco

DISCLAIMER

HR

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PGandE GEYSERS RETROFIT PROJECT

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PGandE GEYSERS RETROFIT PROJECT UNITS 1 - 12

MILESTONE REPORT NO. 1

JUNE 4, 1979

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1.0 INTRODUCTION

Rogers Engineering was contracted to determine the technical feasibility and cost/benefit ratios for Pacific Gas and Electric Company to replace the iron-catalyst/peroxide/ caustic systems with surface condensers and Stretford H_2S abatement systems for Units 1 through 12 at the Geysers.

This Milestone #1 Report is a 6 week progress report and will not have the cost benefit analyses which is planned for in the Final Report. This report will focus only on Units 1 and 3, which are thought of as typical to Units 2 and 4 in our contract.

The work performed analyzes the cooling water cycle for both units and determines the turbine operating back pressure as a function of cold water from the existing cooling towers to the new surface condensers. Any power penalty is noted and assessed to the respective turbine-generator with necessary definition for the reason in heat rate deterioration.

The direction of Rogers Engineering Co.'s efforts was the conceptual system analysis for Units 1 and 3. But cooling tower performance differences between Units 1 and 2 influenced the similarity of the cycle thermodynamics and power output at the generator for these two units. We therefore are reporting on Units One and Two. Units Three and Four are identical with some minor location and piping differences.

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2.0 SUMMARY

This Milestone Report No. 1 summary presents technical and cost values for the surface condenser retrofit of Units 1 through 4. The Stretford Process treatment of vent gases and the economic comparison with the present system is to be part of later reports.

2.1 Units 1 and 2

The differences in operating performance between Units 1 and 2 direct contact condenser will extend to the new surface condensers. Differences occurred primarily because of differences in cooling tower operating performance, such as 81°F cold water inlet temperature to Unit 1 condenser and 86°F to Unit 2 condenser for a wet bulb of 65°F at full load. This resulted in differences in the condenser heat balance for each of the two units which impacted on the turbine back pressure and developed a 5.3% power penalty on the gross power output at the generator.

The differences extended into the equipment and installation details because of site configuration.

It appears that there will be space for the additional equipment on the existing property. See Drawings SK-007, SK-008 and SK-009.

The project costs at the time of this Milestone One Report indicate: (See Section 3.4):

GM Estimate Cost Total for Retrofit of Unit #1 = $1,600,000 - Resulting in an additional Energy Charge of 2.89 mills per kWh.

Unit #2 costs for purposes of this report are approximately the same as Unit #1.

2.2 Units 3 and 4

These units are identical with respect to their process flow sheets.

The space location of the main condensers are slightly different. See Drawings SK-002 and SK-010. There is space to install the additional equipment.

The project costs at the time of this Milestone One Report indicate: (See Section 4.4):

GM Estimate Cost Total for Retrofit of Unit #3 = $2,500,000 - Resulting in an additional Energy Charge of 2.41 mills per kWh.

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3.0 UNIT 1 RETROFIT FOR ABATEMENT OF H_2S

Currently the H_2S in the plant geothermal steam supply dissolves in the direct contact heat exchange water system and about 60% of the H_2S enters the cooling tower. The Retrofit program will replace the direct contact heat exchangers with indirect surface type equipment. It is estimated that less than one-twentieth of H_2S will report to the cooling tower via the steam condensate return flow. The remainder will be routed as condenser off-gas through a compressor and pipe gathering network to a Stretford Process Unit which consolidates the off-gas from Units 1 - 6. The H_2S from retrofit Units 1 - 6 will be converted in the Stretford Process to elemental sulfur. This program will enable H_2S abatement of over 90%.

3.1 Equipment Sizing Criteria

3.1.1 Noncondensable Gas Values

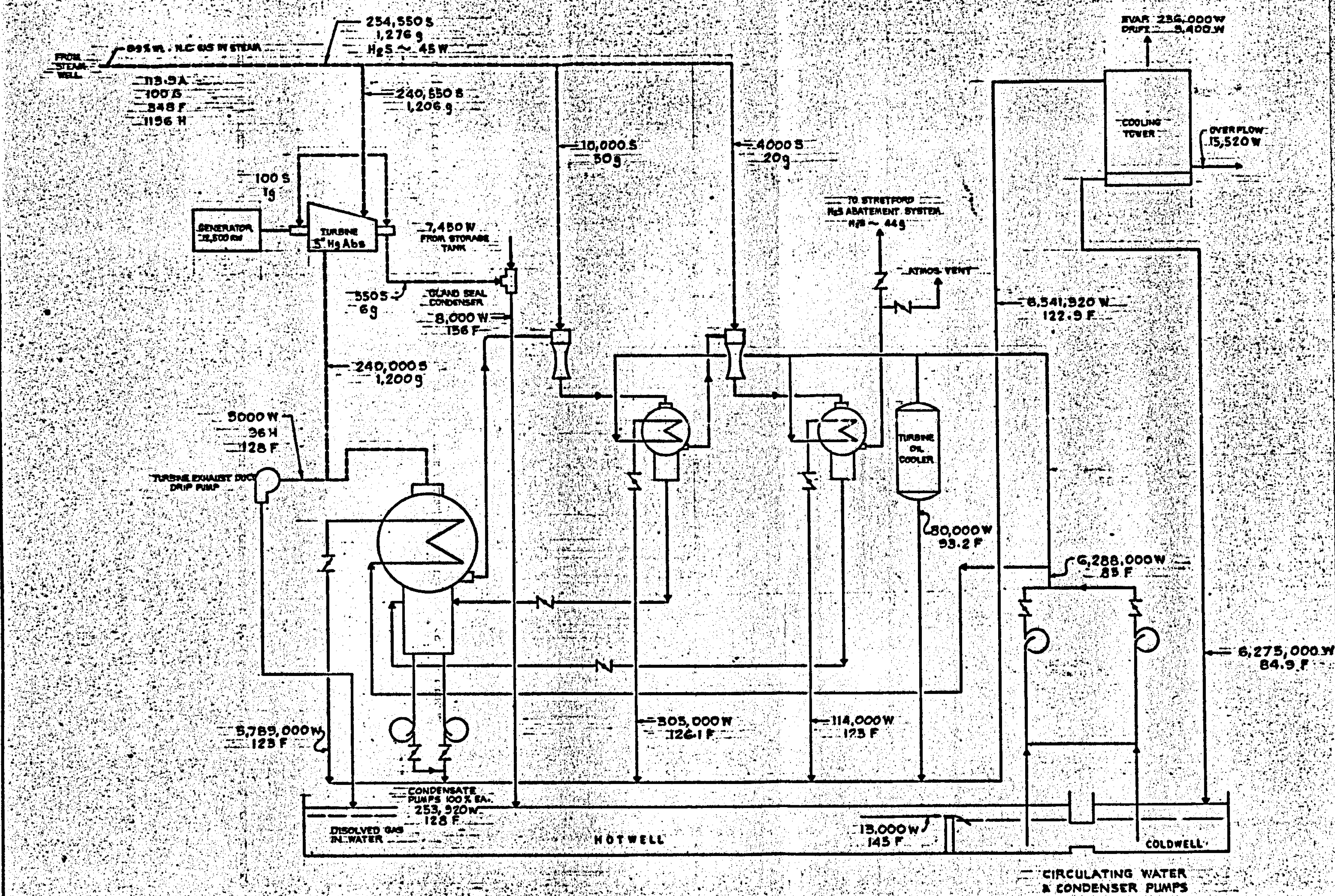
Original base reference design point was 0.75% wt. noncondensable gas in the steam. Based on updated field data which was reported on in PCN #23 and agreed upon by PGandE, the design value was set at 0.5% wt. for Units 1 and 2. The gas composition is shown in detail in Appendix A. The average mol wt. is 30.3.

3.1.2 Field Test Data for Cooling Water Tower

The cooling water tower for Unit 1 was tested when clean on 5 April 1977. At a test condition of 45°F wet bulb, with a circulating water flow of 13,530 gpm and a range of 36.4°F, the approach to wet bulb was 32.6°F. The results of this test indicates that the tower is 4 - 5°F below design rating.

3.1.3 Base Reference Design Point

The Unit 1 Data Book Heat Balance Diagram for 100% Maximum Guaranteed Load is the Base Reference Design Point. The calculated gross power output will be based on essentially the same turbine throttle flow at the retrofit conditions. Net power output will be determined on the basis of the new station auxiliary power requirements. The Unit 1 Process Flow Diagram PD-001 for conversion of the present system shows the expected Unit performance after Retrofit.



PERFORMANCE

THROTTLE FLOW	240,550 #/HR.
GENERATOR ELEC. OUTPUT	11,845 KW(2)
AUXILIARY POWER (ELECTRICAL)	
CIRC. WATER & COND. PUMPS	328 KW
COOLING TOWER FANS	96.2 KW
EXCITER	69.0
OTHER	7.8
TOTAL	501

NET UNIT OUTPUT — 11,344 KW (1)
HEAT INPUT — 297 x 10⁶ BTU/HR
NET HEAT RATE — 26,200 BTU/KWHR
REFERRED TO 60°F

CONDITIONS

GENERATOR POWER FACTOR — 1.0
CONDENSER BACK PRESSURE — 5.0 Hg
DRY BULB AIR TEMPERATURE — 75°F
WET BULB AIR TEMPERATURE — 65°F

GAS SHOWN ENTERING COOLING TOWER IS AIR ABSORBED BY WATER

GASES TO - AND FROM COOLING TOWER DO NOT INCLUDE COOLING AIR BUT ONLY THAT WHICH IS ABSORBED AND DEGASSED.

ANY AIR ABSORBED IN COOLING WATER IN HOTWELL IS NOT INCLUDED

LEGEND

MAIN STEAM LINE
WATER LINES
STEAM LINES
GAS LINES

S	POUNDS PER HOUR STEAM
W	POUNDS PER HOUR WATER
g	POUNDS PER HOUR GASES
F	DEGREES FAHRENHEIT
H	STEAM ENTHALPY
A	PRESSURE PSI ABSOLUTE
G	PRESSURE PSI GAGE

(1) WITHOUT N.C. GAS BLOWER DEBIT.

(2) FOR EXPECTED GROSS OUTPUT, MULTIPLY ACTUAL FIELD OUTPUT OF UNIT BY RETROFIT DERATING FACTOR OF 0.9476.

REFERENCE DRAWINGS

ISSUED FOR REPORT | LO | BF

REVISION

ROGERS ENGINEERING CO., INC.
ENGINEERS • ARCHITECTS

SCALE NONE DATE 5-31-79
DR. G.O. CHK. ENG. BF APPROVED

APPROVALS
DATE
DATE

PG and E RETROFIT PROJECT
UNIT No. 1 CONVERSION
PROCESS FLOW DIAGRAM

JOB NO. 579007

PD-001 | 0

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X

3.2 Specification of Equipment for Conversion from Direct Contact to Surface Type Exchanger - Unit 1

3.2.1 Main Condenser Cooling Water System Limitations

The cooling water tower for Unit 1 by field test is 4 - 5°F below rating. For a set approach in a cooling tower, more water can be circulated as the range is lowered (tower, hot water on temperature is reduced). Increase in turbine output can also be improved. Because a lower exhaust pressure can be specified to maintain a constant terminal termperature difference between the hot water and the incoming steam. However, as the range is lowered the water circulation system piping may need to be larger and/or the pumping power increased, which will reduce the unit net power output. At the base reference design point of 65°F wet bulb the approach must be relaxed from a design of 15.6°F to 20°F and the range dropped from about 40°F to 38°F. A lower range would be desirable to reduce exhaust pressure because the increases in circulating water power requirements and pipe size are near the economic balance point for the Retrofit of Unit 1. This will allow a reduction in turbine exhaust pressure to 5.0 inches Hg Abs.

3.2.1.1 Condensing and Gas Cooling Limitations

The existing direct contact exchange system can achieve temperature approaches of 4°F on the mixed steam-water condensate outlet and about 6°F on the noncondensable gas outlet. For surface type heat exchange the terminal temperature difference might be specified down to 5°F since the increased power produced can recover the increase in exchanger cost in less than a year as shown in Table 3.1. Offsetting this simple economic evaluation is the increase in exchanger size. Therefore for Unit 1 a terminal temperature difference of 7.8°F was used.

It would be desirable on the gas cooling end to achieve low outlet temperatures so as to minimize the motive steam requirements for the 1st stage steam jet ejector. The economic trade-offs are shown in Table 3.2. The main condenser outlet temperature approach has been relaxed to 33°F for Unit 1. The relaxation of this approach was mostly a consideration of consistancy with what surface condenser manufacturers will guarantee using their standard design procedures. The interaction between the cooling water tower approach and range are the major factors in determining turbine exhaust pressure at the base design reference point. This methodology maximizes the power expected after Retrofit.

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3.2.2 Intercondenser

The gas steam mixture is condensed and cooled at a pressure near 5 psia. At this pressure the condensation and cooling design temperatures are not as sensitive to main condenser approach conditions basically because of high steam gas inlet saturation temperatures. With the specified cooling water range and approach the temperature differences specified are 37°F and 25°F respectively at steam gas inlet and outlet.

3.2.3 Aftercondenser

The steam gas mixture is condensed and cooled at 14.1 psia. Similar design conditions as applied to the inter condenser prevail. The temperature differences specified are 77°F and 25°F respectively at the steam gas inlet and outlet. Since it is desirable to hold the after condenser outlet gas steam mixture at a low temperature so as to minimize the steam carry into the Stretford Process no attempt was made to use series flow cooling water, (first into the intercooler and then into the aftercooler).

3.2.4 Steam Jet Ejectors

These units are specified to handle the noncondensable gas and steam vapor carry-over from the main and inter condenser at the pressure and temperature specified for subject equipment.

3.2.5 Cooling Water Pumps

The existing cooling water system is of the "open type" utilizing a cold well and a hot well. Because the condenser supply pump was purchased with just enough differential head to supply the main barometric condenser when it is at design vacuum and 110% of full load, this pump cannot be reused in a "closed" design.
The cooling tower return pump was purchased with just enough differential head to feed the cooling water tower and this pump cannot be used in a "closed" design. It is very desirable to use a "closed" design because all the condenser outlet pressure static head would be lost in an "open" design. For Unit 1 once the cooling water heat balance is specified the system curve can be estimated for the retrofitted "closed" system. The two half-sized pumps required can be arranged in the existing wells by equalizing the hot and cold well compartments as shown on Drawing No. B-02-001. At this time with the direct contact system two sources of warm water enter the hot well. It is proposed to consider this as a "hot bypass". In

the conversion process flow diagram this requirement is met by showing the calculated colder tower off temperature that is required to absorb this heat.

3.2.6 Condensate Pumps

The new main condenser hotwell will collect the condensate from the turbine exhaust and the inter- and aftercondensers. Since the total condensate flow is not large (600 gpm) it is practical to consider a pump that can operate under reduced pressure (full vacuum suction) with a minimum NPSH requirement. Several manufacturers supply pumps which can operate at an NPSH of 6-10 feet without resorting to the "canned" type configuration required for large flows. The total differential head noted in the Data Sheet is based on pumping from the expected condenser operating vacuum into the cooling water tower return header at system design head.

3.2.7 Process Flow Diagram

The Cooling Cycle Conversion Process Flow Diagram PD-001 shows the material balance at the suggested Retrofit conditions. Table 3.3 shows a comparison summary of the original Reference Design Base Point and the Conversion Retrofit.

3.2.8 Equipment Data Sheets

The Equipment Data Sheets associated with the conversion equipment for Unit 1 are included at the end of this section. The Flow/ Thermodynamic Information Sheet is prepared for Unit 1. Exchanger Specification Sheets have been prepared for Unit 1 Main Condenser, Intercondenser, Aftercondenser, as well as the Data Sheets for the Condensate and Main Circulating Water Pumps and Drivers.

3.2.9 Equipment Quotation Requests

Suppliers of the equipment herein were contacted by telephone followed up by transmittal of pertinent equipment data sheets. In the majority of cases, vendors were contacted who have had some experience in the special problems associated with geothermal plants as follows:

3.2.9.1 Surface Condensers and Ejectors

The following vendors have either quoted to PGandE on surface condensers or have been awarded the contract for supply:

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Ecolaire Condenser, Inc., are furnishing surface condensers and ejectors for Units 14 and 15.

DeLaval Turbine, Inc., are furnishing surface condensers and ejectors for Units 16 and 17.

Southwestern Engineering Co., were requested to quote on Units 16 and 17 and declined to bid; however, this supplier did provide a satisfactory quotation for surface condensers for the Union Oil 10 MW Geothermal Plant.

In addition, we included Graham Manufacturing Co., Inc., in our list of potential sources of supply because they have bid to Rogers and were awarded the contract for supplying surface condensers and ejectors for Union Oil's 10 MW plant in Brawley, California.

You will note that, because of space limitations in the Retrofit, we specified 30 ft. limit on lengths of tubing in main condenser, 20 ft. in the inter- and aftercondensers.

On a first pass basis rather than specifying cleanliness factor according to Heat Exchange Institute practice, we specified TEMA fouling factors which are not overly conservative, 0.0001 on shell side and 0.001 on tube side. As a result of PGandE's direction on May 22, cleanliness factors of 70% will be used in the final system concept.

3.2.9.2 Condensate and Cooling Water Circulation Pumps

Similar to the condensers, pump vendors were contacted by phone and supplemental pump data sheets were sent to them. Vendors contacted were:

Byron Jackson
Worthington Pump Corporation
Peerless Pump
Ingersoll Rand

At least two vendors--Byron Jackson and Peerless Pumps--have supplied pumps to the Geysers.

The conditions specified on the pump data sheets as to flow and temperature data were derived from conditions as specified in condenser data sheets. For Pump Summaries See Table 5.

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3.2.9.3 Equipment Costs

Unfortunately, the response from the condenser manufacturers was less than desirable. For example, Southwestern Engineering stated that their work load was so heavy they would have to decline to bid. Graham indicated that they too were extremely overloaded in estimating and engineering and could not give us estimated prices until May 29, which have now been received. The responses from Ecolaire and DeLaval are incomplete in some requested details and are accurate with ± 15 - 20% for pricing. All pricing obtained includes tubed in factory inter- and aftercondensers and ejectors with no data on surface areas of inter- and aftercondensers nor steam rates for ejectors. Neither Ecolaire nor DeLaval included tubes in main condenser, nor costs for installation of same. Graham's pricing includes tubes installed in main condenser.

Ecolaire did obtain some pricing from the factory, the DeLaval information was derived from the local office. DeLaval Engineering would not get involved because of work load.

3.2.9.4 Vendors' Comments

Ecolaire

Ecolaire objected to furnishing main condenser to ASME code as specified. Code only requires ASME stamping if operating pressure is over 15 lbs. If this requirement is insisted upon, and incidentally not usually required by power plant users, the costs are increased for the main condenser accordingly.

Ecolaire further objected to our fouling factors specified which translates from TEMA TO HEI of approximately 60% cleanliness factor. From their previous offerings to PGandE 70% was all that was required. For space requirements Units 1 and 2 Rogers fouling factor would require overall length of 54 feet. If fouling factor is relaxed to 70% overall length would decrease to 46 feet.

Ecolaire also commented on our requirement to cool the noncondensable gas to 95°F. Their standard design would cool the gas to 115°F. We agreed that the allowable drop of 0.3# psi on the shell side would probably be required to get down to the 95°F specified. Ecolaire stated that their shell side drop is 0.1 to 0.15 psi, which allows a lower turbine back pressure than in our design, but a greater motive steam requirement for the 1st stage ejector because of the higher gas exit temperature and its resultant equilibrium carry-over of more steam in the gas seen by the ejector.

They quoted a price of approximately $400,000 for a condenser to meet our design, $330,000 if we permit them to furnish their design (70% cleanliness factor, 115°F outlet gas temperature). In both cases to this price must be added cost of tubes and their field installation costs.

Because our cooling water load is fixed, for ~ $400,000 they would furnish their design outlet temperature (115°F and our cleanliness factor) with the benefit of a lower turbine back pressure. No data was received on ejector performance at this time.

DeLaval Turbine Inc.

To our specifications DeLaval quoted a price of $370,000 less tubes for the main condenser. They estimate bare cost of tubes is approximately $50,000, which seems low based on some prices obtained locally. Installation cost of tubes will be covered elsewhere in the installation costs.

For summary of vendors' quotations and specifications see Table 6.

Because most vendors have pump designs to fit most any case, and selection of materials is readily available for pricing, obtaining quotations on pumps was considerably less difficult than on condensers.

The condensate pump data sheet specifies an all stainless vertical in line full capacity pump in lieu of a vertical can pump as being more economical from previous experience on other projects.

The cooling water circulation pump was specified to be a 60% capacity pump with two alternatives: a) All stainless steel construction; b) Cast iron case with carbon steel internals.

Equipment summary sheets are as shown in the following Tables.

3.2.9.5 Evaluated Equipment Cost - Unit 1 and 2

The condenser and gas ejection system was bid to specification by Graham, the low bidder. To this offer in the cost estimate 15% has been added for contingency.

Changes in the specification would have the following estimated cost changes at the factory:

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From TEMA (Tube .001; Shell .0001) to HEI 70% CF---Reduce by 15%
N. C. gas cooling from 95°F to 110°F---Reduce by 15%

NOTE: The steam jet ejection flows have not been given by the Suppliers.

The main C. W. pumps as bid to specification varied from a low of \$52,775 (Byron Jackson) to a high of \$126,000 (Worthington). A figure of \$85,000 was used in the cost estimate to cover the increase in pumping from 7,063 to 7,565 gpm and a contingency. These pumps are rated at 60% system capacity.

The condensate pumps as bid to specification varied from \$8,200 (Worthington) to \$12,610 (Byron Jackson). The cost estimate is based on a figure of \$12,000.

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TABLE 3.1

ECONOMIC ANALYSIS

MAIN CONDENSER - UNIT 1

STEAM END APPROACH (TTD)

Study Case Item	A	B
TTD °F	7.8	5
Difference in Heat Exch. Cost (1)		$376,800
Calc. Power Output Difference	0	190 kWh
Steam Input Difference	0	0
ECONOMIC EVALUATION		
Difference in Capital (2)	0	$ 54,700
Difference in Energy (3)	0	$ 86,500

(1) Capital Installed
(2) Annualized Capital Installed per Year Value
(3) System Level Annualized Power per Year Value

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TABLE 3.2

ECONOMIC ANALYSIS

MAIN CONDENSER - UNIT 1

NONCONDENSABLE GAS END APPROACH

Study Case Item	A	B	C	D
Noncondensable Gas Outlet °F	95	105	115	119
Difference in Heat Exch. Cost (1)	$ 17,700	9,300	2,700	0
Power Penalty (2)	$115,300	83,400	19,100	0
Steam to Jet Difference (3)	0	$ 14,400	47,200	67,500
TOTAL DIFFERENCES (4)	$133,000	107,100	69,000	67,500

(1) Annualize Capital Installed
(2) System Level Annualized Power Value
(3) Steam Fuel Level Annualized Value
(4) Annualized Basis

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TABLE 3.3

COMPARATIVE SUMMARY

UNIT 1

	Base Reference Design Point	Conversion Retrofit
Throttle Flow lb./hr.	240,550	240,550
Noncondensable Gas % Wt.	0.75	0.5
General Electric Output kW	12,500	*11,845
Auxiliary Power (Electric) kW		
Cooling Tower Fans	96.2	96.2
Exciter	69.0	69.0
Miscellaneous	7.8	7.8
Circ. Water & Cond. Pumps	229.0	328.0
Noncondensable Gas Blower		(Later)
Net Unit Output kW	12,098	11,344 (1)
Heat Input Btu/Hr. (Ref. to 60°F)	293×20^6	297.3×10^6
Net Heat Rate Btu/kWh	24,215	26,200
Turbine Exh. Inch Hg Abs	4	5
Wet Bulb	65.0	65.0
C. W. T. Range/Approach °F	40/15	38/19.9

(1) Without Noncondensable Gas Blower Debit

*Derated by note on Process Flow Diagram, PD-001

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TABLE 5

PUMP SUMMARY

UNITS 1 AND 2

Specifications	Vendors' I. R. Models 6x15W**	Alt. 6x4x10 VOC	Peerless	Byron Jackson	Worthington
Condensate Pump					
Materials: All 316SS	Yes	Yes	N. Q.	Yes	Yes
Vertical In Line	Yes	Yes	N. Q.	Horizontal	Yes
NPSH Min. Required: 6 ft.	7'6"	8'	N. Q.	No	Yes
Flow Inducer: Required			N. Q.	No	Yes
Efficiency %:			N. Q.	79	Not Stated
Motor HP	20-TEFC	20-TEFC	N. Q.		
Price $:	$19,700.	$4,250.	N. Q.	12,610	8,200
	Engineered	Standard			
	1200 rpm	1800 rpm			
C. W. Circulation Pump					
Material: All S. S.	N. Q.		Yes	Yes	Yes
Alt. C. I. w/C. S. Trim	N. Q.		*	Yes	Yes
Type Vertical	N. Q.		Yes	Yes	Yes
Pit Pump	N. Q.				
Efficiency	N. Q.		Not Stated	Not Stated	Not Stated
Motor HP	N. Q.		250	250	
Price $: 316 SS	N. Q.		73,700	52,775	126,000
Alt. C. I. w/C. S. Trim	N. Q.		*34,200	20,155	55,000

*C. I. Bronze Construction
**Not Good Selection From Pump Curve

TABLE 6

Units 1 and 2 Equipment Summary Sheets

SURFACE CONDENSER SUMMARY
UNITS 1 AND 2

Specification Main Condenser	Ecolaire (Note 2-	DeLaval (Note 2)	Graham	Southwestern
		VENDOR		
Fouling Factor Tube 0.001	~ 60% C. F.*	To Specs	To Specs	No Quote
Shell 0.0001	- 70% C. F. (alt.)			
Shell Side Δp allow. 0.3 psi	Yes	Yes	Yes	No Quote
Shell Side (alt. 2) Δ psi:	0.1 to 0.15	Not Stated	Not Stated	No Quote
Cooling H_2O Flow gpm: 11,040	11,040	11,040	11,040	No Quote
Tube Length Max. Ft.: 30 ft.	48' approx.	Not Stated	34'	No Quote
Number of Passes: As Required	2	Not Stated	4	No Quote
Tube Length (alt. 2)	40' (70% C. F.)	Not Stated	Not Stated	No Quote
Surface Area: As Required To Spec Sq. Ft.	26,000	23,000	28,000	No Quote
Alt. 1 Spec Fouling 115°F Gas Outlet	26,000	-	-	No Quote
Alt. 2 70° C. F. 115°F Gas Outlet	21,550	-	-	No Quote
Cost of Tubes		Not Included est.	Included	No Quote
@ $1.19 per ft. (Local Quotation)				
For 304L Welded, 3/4" 22 ga., 40' Long				
Spec, Alt. 1	154,700 (Approx.)	$50,000 (Note 1)		
Alt. 2	128,000			
Temperature Outlet Gas °F 95	To Specs	To Specs	To Specs	No Quote
	115° (alt.)	-		
Condensate Outlet °F 131	To Specs	To Specs	To Specs	No Quote
	(Alt. 1 & 2) Not Stated	-		
Dimensions: As Required (Overall)	8' Dia. x 54' L Spec	Not Stated	9'-2" W x 40'L	No Quote
	8' Dia. x 46' L	Not Stated	x 14'-6"H	
	(70% C. F.) Alt. 2			
Inter- and Aftercondenser:				
& Ejectors Required	Included	Included	Included	No Quote
Purchase Price $: Spec	$554,700	$420,000	$380,000	No Quote
Alt. 1	$554,700		-	No Quote
Alt. 2	$458,222			
Delivery	42 Weeks	Not Stated	32-36 Weeks	No Quote

*C. F. Cleanliness Factor as defined by H. E. I.

Note 1 - Estimated by Vendor
Note 2 - Neither Ecolaire nor DeLaval include cost of tube installation in field in their quotation

EXCHANGER SPECIFICATION SHEET

3.2.8.1

No.				
1	PROJECT GEYSERS RETROFIT		EXCHANGER MFR.	
2	PLANT UNIT 1		REQ. NO.	
3	EXCHANGER NO.		ITEM NO.	
4	SERVICE OF UNIT MAIN STEAM CONDENSER			
5	SIZE	TYPE	CONNECTED IN	SERIES PARALLEL
6	SURFACE PER UNIT	EFF. GR. SHELLS PER UNIT	SURFACE PER SHELL	EFF. GR.

PERFORMANCE OF ONE UNIT

No.		SHELL SIDE		TUBE SIDE	
7	FLUID CIRCULATED	STEAM + NONCONDENSABLES		COOLING WATER	
8	TOTAL FLUID ENTERING LBS/HR	241,270		5,789,000	
9	VAPOR				
10	LIQUID			(11,578 gpm)	
11	STEAM				
12	NON-CONDENSIBLES	AIR 70 + N.C. GAS 1200 (MOL WT 30.3)			
13	FLUID VAPORIZED OR CONDENSED				
14	STEAM CONDENSED	237,610			
15	GRAVITY-LIQUID			1.0	
16	VISCOSITY-LIQUID				
17	MOLECULAR WEIGHT-VAPORS				
18	SPECIFIC HEAT-LIQUIDS	1.0	B.T.U./#	1.0	B.T.U./#
19	LATENT HEAT-VAPORS	924.7	B.T.U./#		B.T.U./#
20	TEMPERATURE IN		°F	85	°F
21	TEMPERATURE OUT	NOTE 1 & 2	°F	123	°F
22	OPERATING PRESSURE	@ INLET 2.29 PSIA			
23	NUMBER OF PASSES per Shell	ONE			
24	VELOCITY		FT/SEC.	7	FT/SEC
25	PRESSURE DROP ALLOW/CALC.	0.25/	#/SQ.IN.	15/	#/SQ.IN.
26	FOULING ~~RESISTANCE~~	HEI CLEANLINESS 70% →			
27					
28	HEAT EXCHANGED-B.T.U./HR. 220 X10⁶		M.T.D. (CORRECTED)		
29	TRANSFER RATE-SERVICE	CLEAN	ACTUAL FOULING FACTOR		

CONSTRUCTION

No.		SHELL SIDE		TUBE SIDE	
30	DESIGN PRESSURE	FULL VAC & 14.6	#/SQ.IN.	75	#/SQ.IN.
31	TEST PRESSURE		#/SQ.IN.	113	#/SQ.IN.
32	DESIGN TEMPERATURE	150	°F	150	°F
33	TUBES 304L SS	NO. O.D. BWG.	AVG. MIN.	LENGTH	PITCH △ ◁ □ ◇
34	SHELL 304L SS	I.D. O.D.		THICKNESS	
35	SHELL COVER			FLOATING HEAD COVER	
36	CHANNEL			CHANNEL COVER C.S. (COAL TAR EPOXY LINED	
37	TUBE SHEETS-STATIONARY 304LSS			FLOATING	
38	BAFFLES - CROSS	TYPE		THICKNESS	
39	BAFFLE - LONG 304L SS	TYPE		THICKNESS	
40	TUBE SUPPORTS 304L SS			THICKNESS	
41	GASKETS				
42	CONNECTIONS - SHELL - IN	OUT		RATING	
43	-CHANNEL-IN	OUT		RATING	
44	CORROSION ALLOWANCE-SHELL SIDE NONE			TUBE SIDE NONE	
45	CODE REQUIREMENTS ASME TUBE SIDE ONLY, HEI	TEMA CLASS "C"		SPEC.	
46	WEIGHTS - EACH SHELL	BUNDLE		FULL OF WATER	
47	NOTE. INDICATE AFTER EACH PART WHETHER STRESS RELIEVED (S.R.) AND WHETHER RADIOGRAPHED (X-R)				
48	REMARKS: -				
49	NOTE 1. N.C. GAS + STEAM VAPOR SHALL BE COOLED TO 118°F				
50	2. CONDENSATE SHALL BE COOLED TO 128°F				
51	3. CONDENSATE HOT WELL SHALL HAVE A MINIMUM HOLD UP OF 135 CU.FT.				

REV.	DATE				JOB NO.	DRWG. NO.	REV.
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△	6/1/79	ISSUED FOR REPORT NO.1	BF	409	5-79007-10	DS-12-010	0

EXCHANGER SPECIFICATION SHEET

3.2.8.2

No.				
1	PROJECT	GEYSERS RETROFIT	EXCHANGER MFR.	
2	PLANT	UNIT 1	REQ. NO.	
3	EXCHANGER NO.		ITEM NO.	
4	SERVICE OF UNIT	INTERCONDENSER		
5	SIZE	TYPE	CONNECTED IN	SERIES / PARALLEL
6	SURFACE PER UNIT	EFF. GR.	SHELLS PER UNIT	SURFACE PER SHELL EFF. GR.

PERFORMANCE OF ONE UNIT

No.		SHELL SIDE	TUBE SIDE
7	FLUID CIRCULATED		
8	TOTAL FLUID ENTERING LBS/HR	13,710	305,000
9	VAPOR		
10	LIQUID		(610 gpm)
11	STEAM		
12	NON-CONDENSIBLES	AIR 70 + N.C. GAS 1250 (MOL WT 30.3)	
13	FLUID VAPORIZED OR CONDENSED		
14	STEAM CONDENSED	12,150	
15	GRAVITY-LIQUID		1.0
16	VISCOSITY-LIQUID		
17	MOLECULAR WEIGHT-VAPORS		
18	SPECIFIC HEAT-LIQUIDS	1.0 B.T.U./#	1.0 B.T.U./#
19	LATENT HEAT-VAPORS	~1033 B.T.U./#	B.T.U./#
20	TEMPERATURE IN	~162 °F	85 °F
21	TEMPERATURE OUT	NOTE 1 & 2 °F	126.1 °F
22	OPERATING PRESSURE	@ INLET 5.5 PSIA	
23	NUMBER OF PASSES per Shell	ONE	
24	VELOCITY	FT./SEC.	7 FT./SEC.
25	PRESSURE DROP ALLOW/CALC.	0.1/ #/SQ.IN.	15/ #/SQ.IN.
26	FOULING RESISTANCE MIN.	0.0001	0.001
27			
28	HEAT EXCHANGED-BTU./HR.	12.6×10^6 BTU/HR	M.T.D. (CORRECTED)
29	TRANSFER RATE-SERVICE	CLEAN	ACTUAL FOULING FACTOR

CONSTRUCTION

No.		SHELL SIDE	TUBE SIDE
30	DESIGN PRESSURE	FULL VAC + 60 #/SQ.IN.	75 #/SQ.IN.
31	TEST PRESSURE	90 #/SQ.IN.	113 #/SQ.IN.
32	DESIGN TEMPERATURE	210 °F	150 °F
33	TUBES 304L SS NO.	O.D. 3/4" BWG. 22 AVG. MIN.	LENGTH PITCH ⊙◁□◇
34	SHELL 304L SS	I.D. O.D.	THICKNESS
35	SHELL COVER		FLOATING HEAD COVER
36	CHANNEL		CHANNEL COVER C.S. (COALTAR EPOXY LINED
37	TUBE SHEETS-STATIONARY 304 LSS		FLOATING
38	BAFFLES-CROSS	TYPE	THICKNESS
39	BAFFLE-LONG 304LSS	TYPE	THICKNESS
40	TUBE SUPPORTS 304LSS		THICKNESS
41	GASKETS		
42	CONNECTIONS-SHELL-IN	OUT	RATING
43	-CHANNEL-IN	OUT	RATING
44	CORROSION ALLOWANCE-SHELL SIDE NONE		TUBE SIDE NONE
45	CODE REQUIREMENTS ASME	TEMA CLASS "C"	SPEC.
46	WEIGHTS-EACH SHELL	BUNDLE	FULL OF WATER

47 NOTE INDICATE AFTER EACH PART WHETHER STRESS RELIEVED (S.R.) AND WHETHER RADIOGRAPHED (X-R)

48 REMARKS: –

49 NOTE 1. N.C. GAS + STEAM VAPOR SHALL BE COOLED TO 110°F

50 2. CONDENSATE SHALL BE COOLED TO 120°F

51 3. CONDENSATE HOT WELL SHALL HAVE A MINIMUM HOLD UP OF 27 CU. FT.

REV.	DATE				JOB NO.	DWG. NO.	REV.
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△	6/1/79	ISSUED FOR REPORT NO. 1	BF	[illegible]	5-79007-10	DS-12-022	0

EQ 304

EXCHANGER SPECIFICATION SHEET

3.2.8.3

No.				
1	PROJECT	GEYSERS RETROFIT	EXCHANGER MFR.	
2	PLANT	UNIT 1	REQ. NO.	
3	EXCHANGER NO.		ITEM NO.	
4	SERVICE OF UNIT	AFTER CONDENSER		
5	SIZE	TYPE	CONNECTED IN	SERIES / PARALLEL
6	SURFACE PER UNIT	EFF. GR. / SHELLS PER UNIT	SURFACE PER SHELL	EFF. GR.

PERFORMANCE OF ONE UNIT

No.		SHELL SIDE	TUBE SIDE
7	FLUID CIRCULATED	STEAM + NONCONDENSABLES	114,000
8	TOTAL FLUID ENTERING LBS/HR	5,580	
9	VAPOR		
10	LIQUID		(228 gpm)
11	STEAM		
12	NON-CONDENSIBLES	AIR 70 + N.C. GAS 1270 (MOL Wt 30.3)	
13	FLUID VAPORIZED OR CONDENSED		
14	STEAM CONDENSED	4,160	
15	GRAVITY-LIQUID		1.0
16	VISCOSITY-LIQUID		
17	MOLECULAR WEIGHT-VAPORS		
18	SPECIFIC HEAT-LIQUIDS	1.0 B.T.U./#	1.0 B.T.U./#
19	LATENT HEAT-VAPORS	~1042 B.T.U./#	B.T.U./#
20	TEMPERATURE IN	~202 °F	85 °F
21	TEMPERATURE OUT	NOTE 1 & 2 °F	123 °F
22	OPERATING PRESSURE	@ INLET 14.1 PSIA	
23	NUMBER OF PASSES		
24	VELOCITY	FT./SEC.	7 FT./SEC.
25	PRESSURE DROP ALLOW/CALC.	0.1/ #/SQ.IN.	15/ #/SQ.IN.
26	FOLLING RESISTANCE MIN.	0.0001	0.001
27			

No.			
28	HEAT EXCHANGED - B.T.U./HR. 4.3 X 10^6		M.T.D. (CORRECTED)
29	TRANSFER RATE - SERVICE	CLEAN	ACTUAL FOULING FACTOR

CONSTRUCTION

No.		SHELL SIDE	TUBE SIDE
30	DESIGN PRESSURE	FULL VAC + 60 #/SQ.IN.	75 #/SQ.IN.
31	TEST PRESSURE	90 #/SQ.IN.	113 #/SQ.IN.
32	DESIGN TEMPERATURE	210 °F	150 °F

No.			
33	TUBES 304L SS NO.	O.D. 3/4" BWG. 22 AVG. MIN.	LENGTH / PITCH ○ ◁ □ ◇
34	SHELL 304L SS	I.D. O.D.	THICKNESS
35	SHELL COVER		FLOATING HEAD COVER
36	CHANNEL		CHANNEL COVER C.S. (COAL TAR EPOXY LINED)
37	TUBE SHEETS - STATIONARY 304L SS		FLOATING
38	BAFFLES - CROSS	TYPE	THICKNESS
39	BAFFLE - LONG 304L SS	TYPE	THICKNESS
40	TUBE SUPPORTS 304L SS		THICKNESS
41	GASKETS		
42	CONNECTIONS - SHELL - IN	OUT	RATING
43	- CHANNEL - IN	OUT	RATING
44	CORROSION ALLOWANCE - SHELL SIDE NONE		TUBE SIDE NONE
45	CODE REQUIREMENTS ASME	TEMA CLASS "C"	SPEC.
46	WEIGHTS - EACH SHELL	BUNDLE	FULL OF WATER
47	NOTE INDICATE AFTER EACH PART WHETHER STRESS RELIEVED (S.R.) AND WHETHER RADIOGRAPHED (X-R)		
48	REMARKS: -		
49	NOTE 1. NC GAS + STEAM VAPOR SHALL BE COOLED TO 110°F		
50	2. CONDENSATE SHALL BE COOLED TO 136 °F		
51	3. CONDENSATE HOT WELL SHALL HAVE MINIMUM HOLD UP OF 27 CU. FT.		

REV.	DATE				JOB NO.	DRWG. NO.	REV.
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△	6/1/79	ISSUED FOR REPORT NO. 1	BF	[illegible]	S-79007-10	DS-12-011	0

EQ 304

PLANT: UNIT NO. 1

	1st Jet	2nd Jet
A. INLET CONDITIONS		
1. MOTIVE STEAM		
Enthalpy (BTU/lb.) @ 113.9 psia	1196	1196
Available Pressure @ Jet psia	103	103
Flow Required (lb./hr.):		
Preliminary Eng. Calc.	~10,000	~4,000
Manufacturer Calc. *		
2. INLET GASES		
Air leakage (lb./hr.)	70	70
N. C. Gas (Mol. wt. 30.3) (lb./hr.)	1200	1250
Steam Vapor (lb./hr.)	2,390	240
Temperature (°F)	118	110
Pressure (psia)	1.94	5.3
B. DISCHARGE CONDITIONS		
Temperature (°F) *		
Pressure (psia)	5.5	14.1

C. SITE CONDITIONS

Temperature (°F) 65°F WET BULB

Pressure (psia) 13.9

*To be specified by Supplier

No.	Date	Description		Ck.	R.App	C.App
0	6/1/79	ISSUED FOR REPORT NO. 1	BF		[illegible]	

ROGERS ENGINEERING CO., INC. 111 PINE STREET SAN FRANCISCO, CALIF. 94111	Geysers Retrofit Project Flow/Thermodynamic Information Sheet	DRAWING NO DS-12-023	REV. 0
JOB NO. S-79007-10	Client PGandE Date	SHEET OF	

DS-022

DATA SHEET FOR CENTRIFUGAL PUMPS

FOR PG&E Retrofit Project NO. 3.2.8.5

ITEM NO.

SITE Geysers UNIT 1

SERVICE Condensate Pump MOTOR DRIVE ✓ TURBINE DRIVE

PUMP MFR SIZE AND TYPE NO. REQ'D. 2

API STD. 610 APPLIES: YES NO X

OPERATING CONDITIONS		RATED	
LIQUID Water containing dissolved H_2S.	U.S. gpm at 128	514.0	
	DISCH PRESS., ~~psig~~	39.7	psia
°F 128	SUCT PRESS., ~~psig~~	7.2	psia
SP GR at 128°F 0.99	DIFF PRESS., psi	32.5	
VAP PRESS at 128 psia 2.11	DIFF HEAD, ft	75	
VIS at SSU	NPSH AVAIL., ft	6	
CORR/EROS caused by dissolved H_2S			

PERFORMANCE

PROPOSAL CURVE NO

NPSH REQ'D (WATER), ft

NO. OF STAGES RPM

DES EFF. BHP

MAX BHP RATED IMP.

MAX HEAD RATED IMP, ft

MIN CONTINUOUS, gpm (BY MFR)

ROTATION FACING COUPLING END

WATER COOLING

BEARINGS

STUFF. BOX

PEDESTAL

GLAND

TOTAL WATER REQ'D, gpm

PACKING COOLING

FLUSHING

AUX PIPING

CONSTRUCTION AND MATERIALS

CASING-MOUNTING (CENTERLINE) (FOOT) (BRACKET) (VERTICAL X)

SPLIT (AXIAL) (RADIAL)

TYPE (SINGLE VOLUTE) (DOUBLE VOLUTE) (DIFFUSER X)

TAPPED OPENINGS (VENT) (DRAIN) (GAGE CONNS.)

NOZZLES	SIZE	ASA RATING	FACING	POSITION
SUCTION				
DISCHARGE				

IMPELLER DIAM RATED MIN MAX TYPE

MFR'S BEARING NO. RADIAL THRUST

LUBRICATION LUBRICATOR TYPE & SIZE

COUPLING TYPE OR MAKE SIZE BASE PLATE

CPL'G GUARD, MEETING Cal. OSHA SAFETY REQNTS.

PACKING

MECH SEAL ✓ CLASS CODE MFR

Crane preferred.

MATERIAL CODE—EXTERNAL CASING SS INTERNAL PARTS

MATERIAL CODE	INTERNALS CODE	I	B	S	C	X
I - CAST IRON	IMPELLER	~~I~~	~~B~~	~~S~~	~~C~~	SS 316
B - BRONZE	INNER CASE PARTS	~~I~~	~~I~~	~~S~~	~~C~~	SS 316
S - STEEL	SLEEVE (PACKED)	Ch	Ch	Af	Af	SS 316
C - 11-13% CHROME	SLEEVE (SEAL)	C	C	C	C	SS 316
A - ALLOY	WEAR PARTS	I	B	Ch	Ch	
h - HARDENED	SHAFT	S	S	S	S	SS 316
f - FACED						
X - AS NOTED						

SHOP TESTS	REQUIRED	WITNESSED
RUNNING PERF		
NPSH		
HYDROSTATIC PSIG		

MAX ALLOW. WP PSIG F

WEIGHTS: PUMP BASE

MOTOR TURBINE

MOTOR DRIVER BY

ITEM NO. MTD BY

HP RPM FRAME

MFR

TYPE TEFC INSUL

ENC. TEMP RISE C

VOLTS/PHASE/CYCLES 460/3/60

BEARINGS LUBE

FULL LOAD AMPS

TURBINE DRIVER BY

ITEM NO. MTD BY

HP RPM MAT'L

MFR and TYPE

INLET STEAM psig TEMP F

EXHAUST

STEAM RATE, FL lb/BHP/HR

BEARINGS LUBE

NOZZLES	SIZE	ASA RATING	FACING	POSITION
INLET				
EXHAUST				

MFR FINAL DATA (AS BUILT)

ACTUAL IMPELLER DIAM

TEST CURVE NO.

OUTLINE DWG. NO.

PUMP SECT. DWG. NO.

SEAL DIM. DWG. NO.

PUMP SERIAL NO.

Notes: 1) The selected pump casing and impellers shall be sized to allow for an increase of at least 5% in head at design flow by a change of impeller diameter.

2) The selected pump shall include a flow inducer.

						JOB NO.	DRAWING NO.	REV.
						5-79007	14-001-A &	
0	5/29/79	Issued for Milestone Report No. 1	EJ	[illegible]	[illegible]	-10	14-001-B	0
NO.	DATE							

PR 252

VERTICAL CENTRIFUGAL PUMP DATA SHEET

POWER ______ VOLTS ______
CYCLES ______ PHASES ______
STEAM ______ PSIG ______ °F
EXHAUST PRESS ______

MANUFACTURER ______
SPECIFICATION NO. ______ REQ. NO. 3.2.8.6

INSTRUCTIONS TO BIDDERS– FILL IN EVERY SPACE FOR EACH PUMP TO MAKE BID COMPLETE

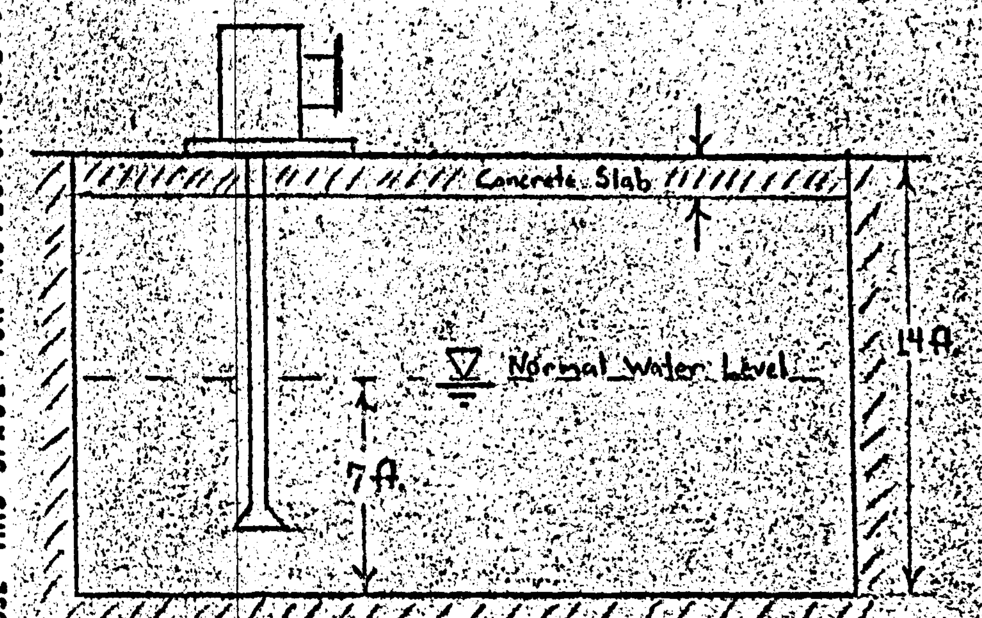
PUMP NUMBER	Unit No. 1		
A. SERVICE Cooling water circ pumps (2 required)			
TYPE OF INSTALLATION (WELL, PIT, SUMP, DOUBLE CASE)	Sump		
B. LIQUID CHARACTERISTICS			
LIQUID PUMPED	Water		
SPECIFIC GRAVITY AT FLOW TEMP	1.0		
FLOW TEMP ______ F	84.9		
VISCOSITY AT FLOW TEMP ______ (CENTISTOKES) (SSU)			
VAPOR PRESSURE AT FLOW TEMP ______ PSIA	0.596		
C. CAPACITY AND PRESSURES			
GPM AT FLOW TEMP	7565		
SUCTION AT PUMP (IF NOT OPEN SUCTION) ______ PSIA	15.4		
DIFFERENTIAL (INCL. LIFT FROM INLET) ______ PSI	41.2		
DISCHARGE (AT DISCH. CONN.) ______ PSIA	56.6		
DIFFERENTIAL HEAD (TOTAL, NOT INCL. VEL. HEAD) ______ FT	102		
NPSH A) REQ'D & B) AVAILABLE ft.	32		
SUBMERGENCE A) REQ'D & B) AVAILABLE ft.	3.5		
ENTRANCE VEL. AT IMPELLER EYE AT RATING ______ FT/SEC.			
IMPELLER EYE AREA ______ SQ. IN.			
MAX CASE WORKING PRESSURE ______ PSIG			
D. MANUFACTURER'S SIZE & TYPE PUMP			
TYPE PUMP			
NUMBER OF STAGES			
SERIAL NUMBER (ON FINAL DATA SHEET)			
E. OPERATION			
RPM			
EFFICIENCY AT RATING ______ %			
BHP AT RATING			
MAX BHP FOR BID IMPELLER DIAMETER			
DRIVER HORSEPOWER			
IMPELLER DIAMETER, MAXIMUM/MINIMUM ______ IN.			
IMPELLER DIAMETER FOR RATING ______ IN.			
ROTATION (CW) (CCW) VIEWED FROM TOP			
DRIVE: (MOTOR) (TURBINE) (RT ANGLE GEAR)			
DRIVER TO BE FURNISHED BY			
MOTOR OR TURBINE DATA SHEET NO.			
MOTOR TYPE (TEFC) (WEATHERPROOF) (EXPL PRF)			
NEMA FRAME NO. OF MOTOR			
F. CONSTRUCTION AND MATERIAL			
CASE: OUTER	SS 316		
INNER	SS 316		
IMPELLER TYPE (OPEN) (CLOSED) (AXIAL) (MIXED FLOW)			
IMPELLER MTL	SS 316		
CASE WEAR RINGS			
IMPELLER WEAR RINGS	SS 316		
SHAFT IN PUMP BOWL	SS 316		
LINESHAFT	SS 316		
LINESHAFT DIAMETER			
LINESHAFT BEARING SPACING			
SHAFT SLEEVES	SS 316		
SHAFT ENCLOSING TUBE	SS 316		
DISCHARGE COLUMN OR PIPE	SS 316		
DISCHARGE HEAD OR ELBOW	SS 316		

LANTERN RING			
THROAT BUSHING			
CASING STUDS			
GLAND BOLTS			
GLAND			
BASEPLATE OR FLOOR PLATE			
COUPLING (RIGID) (FLEXIBLE) MANUFACTURER			
STRAINER			
FLOAT CONTROLS (TYPE & MFR)			
G. STUFFING BOX DETAILS			
STUFFING BOX, JACKETED OR PLAIN			
MECHANICAL SEAL - TYPE			
DIMENSIONS: LENGTH OF STUFF-BOX ______ IN.			
INSIDE DIAM. ______ IN.			
DIAM SHAFT OR SHAFT SLEEVE ______ IN.			
WIDTH LANTERN RING ______ IN.			
℄ LANT RING TO OPEN END OF BOX ______ IN.			
NO. RINGS & SIZE PACKING			
H. BEARINGS AND LUBRICATION			
TYPE BEARINGS - THRUST ______ (SAE NO.)			
RADIAL ______ (SAE NO.)			
LINESHAFT			
PUMP BOWL			
LUBRICATION: W = WATER, O = OIL, G = GREASE			
THRUST			
RADIAL			
LINESHAFT			
PUMP BOWL			
TYPE OF CLOSURES			
TYPE AND CAP. OF LUBRICATOR FOR PUMP			
TYPE AND CAP. OF LUBRICATOR FOR DRIVER OR GEAR			
THRUST BEARING TYPE AND CAPACITY			
THRUST LOAD (NORMAL / MAX)			
THRUST LOAD (AT START)			
THRUST BEARING LOCATION (MOTOR, HEAD, PUMP, ETC.)			
CLEARANCE ADJUSTMENT (COLLAR, NUT, COUPLING, ETC)			
J. TESTING			
DYNAMIC BALANCING OF IMPELLERS AT RATED SPEED			
PERFORMANCE TEST (WITNESSED) (NOT WITNESSED)			
HYDROSTATIC TEST (WITNESSED) (NOT WITNESSED)			
HYDROSTATIC TEST PRESSURE ______ PSIG			
INSPECTION REQUIRED?			
RUNNING TEST WITH ACTUAL DRIVER			
K. MISCELLANEOUS			
PRICE, EACH (FOB) (FAS) (NOT INCL. DRIVER)			
EXTRA COST FOR DRIVER			
EXTRA COST FOR			
EXTRA COST FOR			
WT. OF BARE PUMP ______ LB.			
WT. OF GEAR			
WT. OF DRIVER			
INPUT AND OUTPUT SPEEDS OF GEAR			
SHIPMENT FROM RECEIPT OF ORDER ______ WEEKS			

OUTLINE DIMENSION DRAWING NO.		
CROSS SECTION DRAWING NO.		
PERFORMANCE CURVE		
L. DIMENSIONAL DATA:		
SIZE OF BASE PLATE (DIAM) OR (___ X ___)		
DEPTH, BASE PLATE TO BOTTOM OF ASSEMBLY		
BOTTOM OF PIT TO BOTTOM OF ASSEMBLY		
INLET TO BOTTOM OF ASSEMBLY (IF VERT. INLET)		
MAX & MIN SUBMERGENCE		
SIZE OF WELL OR PIT		
MAX HT ABOVE BASE OR FLOOR (NORMAL)		
MAX HT ABOVE BASE OR FLOOR FOR PULLING PUMP		
MAX LIFT (LBS) FOR MAINTENANCE		
SUCTION, VERTICAL OR HORIZONTAL		
SIZE & RATING		
FACING		
FACE TO ℄ SHAFT (IF HORIZ)		
DIST. ABOVE OR BELOW BASE (STATE WHICH)		
DISCHARGE VERTICAL OR HORIZONTAL		
SIZE & RATING		
FACING		
FACE TO ℄ SHAFT		
DIST. ABOVE OR BELOW BASE (STATE WHICH)		

Notes: 1) Water contains corrosive H_2S.
2) The selected pump casing & impellers shall be sized to allow for an increase of at least 5% in head at design flow by a change in impeller diameter.

USE THIS SPACE FOR NOTES OR SKETCHES



REV.	DATE					DATE	
0	5/29/79	Issued for Milestone Report 1	EST	JMS			

PG&E Retrofit Project

JOB NO. S-79007-10 | REV. 0
DWG. NO. 14-002-A, 14-002-B

EQ 315

Rogers

3.0A UNIT 2 RETROFIT FOR ABATEMENT OF H_2S

Essentially the same methodology as used for Unit 1 will be applied to Unit 2.

3.1A Equipment Sizing Criteria

3.1.1A Noncondensable Gas Values
Same as Unit 1 - 0.5% wt. in steam

3.1.2A Field Test Data for Cooling Water Tower
This cooling tower was completely rebuilt and it is assumed that when clean that it will be capable of design rate operation.

3.1.3A Base Reference Design Point
Same as Unit 1 Data Book. The Unit 2 Conversion Process Flow Diagram PD-002 shows the expected unit performance after Retrofit.

3.2A Specification of Equipment for Conversion from Direct Contact to Surface Type Exchange - Unit 2

3.2.1A Main Condenser Cooling Water System Limitations

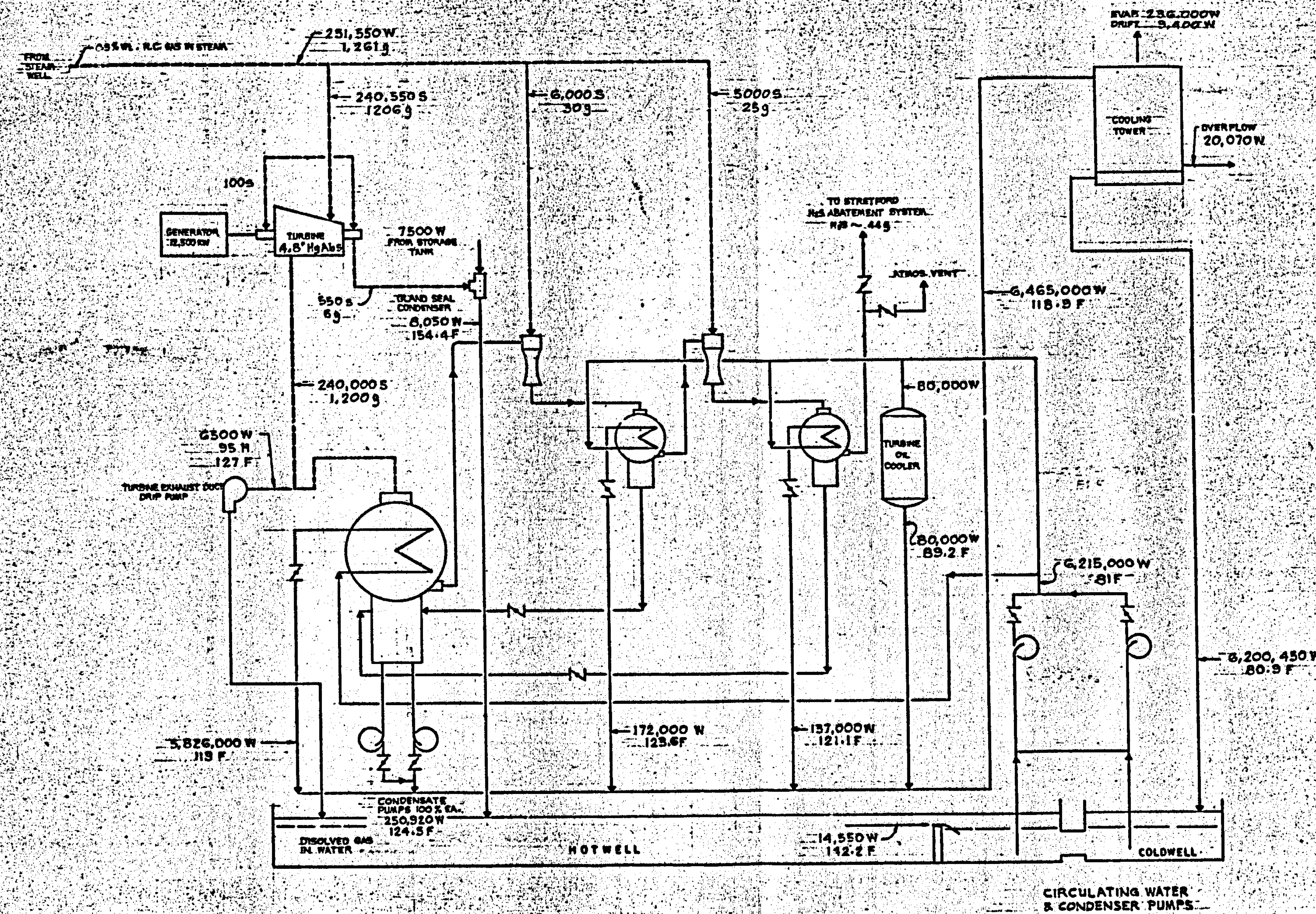
The Unit 2 cooling water tower at the base design point of 65°F wet bulb is expected to be close to meeting design. The approach has been relaxed from 15°F to 15.9°F and the range dropped from 40°F to 39°F. This will allow a reduction in turbine exhaust pressure to 4.8 inches Hg Abs compared to the Unit 1 5.0 inches Hg Abs.

3.2.1.1A Condensing and Gas Cooling Limitations

Since the Unit 2 cooling water is colder it is possible that the turbine exhaust pressure could be lowered to about 4.3 inches Hg Abs. To insure meeting a more severe installation space problem the exhaust pressure was held at 4.8 inches Hg Abs and the temperature differences specified are 10.2°F and 29.1°F respectively for the terminal temperature difference and the gas cooling outlet.

3.2.2A Intercondenser

With specified cooling water range and appoach the temperature differences specified are 38°F and 29.1°F respectively at the gas steam inlet and outlet using parallel flow cooling water.



PERFORMANCE

THROTTLE FLOW	240,550 #/HR
GENERATOR ELEC. OUTPUT	11,974 KW (2)
AUXILIARY POWER (ELECTRICAL)	
CIRC. WATER & COND. PUMPS	324 KW
COOLING TOWER FANS	96.2 KW
EXCITER	69.0
OTHER	7.8
TOTAL	497

NET UNIT OUTPUT	11,477 KW (1)
HEAT INPUT	294 x 10^6 BTU/HR
NET HEAT RATE	25,600 BTU/KW HR

REFERRED TO 60°F

CONDITIONS

GENERATOR POWER FACTOR — 1.0
CONDENSER BACK PRESSURE — 4.8 Hg
DRY BULB AIR TEMPERATURE — 75°F
WET BULB AIR TEMPERATURE — 63°F

GAS SHOWN ENTERING COOLING TOWER IS AIR ABSORBED BY WATER

GASES TO - AND FROM COOLING TOWER DO NOT INCLUDE COOLING AIR BUT ONLY THAT WHICH IS ABSORBED AND DEGASSED.

ANY AIR ABSORBED IN COOLING WATER IN HOTWELL IS NOT INCLUDED

LEGEND

MAIN STEAM LINE
WATER LINES
STEAM LINES
GAS LINES
S POUNDS PER HOUR STEAM
W POUNDS PER HOUR WATER
g POUNDS PER HOUR GASES
F DEGREES FAHRENHEIT
H STEAM ENTHALPY
A PRESSURE PSI ABSOLUTE
G PRESSURE PSI GAGE

(1) WITHOUT N.C. GAS BLOWER DEBIT

(2) FOR EXPECTED GROSS OUTPUT, MULTIPLY ACTUAL FIELD OUTPUT BY RETROFIT DERATING FACTOR 0.9579.

REFERENCE DRAWINGS

0 ISSUED FOR REPORT

REVISION

ROGERS ENGINEERING CO., INC.
ENGINEERS • ARCHITECTS
111 PINE STREET, SAN FRANCISCO, CALIFORNIA

SCALE NONE DATE 5-31-79
DR. G.O. CHK. ENG. BF APPROVED

APPROVALS
DATE
DATE

PG and E RETROFIT PROJECT
UNIT No. 2 CONVERSION
PROCESS FLOW DIAGRAM

JOB NO. 579007

PD-002 0

Rogers

3.2.3A Aftercondenser

The differences specified are 82°F and 29.1°F respectively at the gas steam inlet and outlet using parallel flow cooling water.

3.2.4A Steam Jet Ejectors

These units are specified to handle the noncondensable gas and steam vapor carry-over from the man and intercondensers at the pressure and temperature specified for subject equipment.

3.2.5A Cooling Water Pumps

Two pumps will be required almost identical to Unit 1.

3.2.6A Condensate Pumps

Two pumps will be required almost identical to Unit 1.

3.2.7A Process Flow Diagram

The Cooling Cycle Conversion Process Flow Diagram PD-002 shows the material balance at the suggested Retrofit conditions. Table 3.3A shows a comparison summary of the original Reference Design Base Point and the Conversion Retrofit.

3.2.8A The Equipment Data Sheets associated with Unit 2 are included herein.

3.2.9A Equipment Quotation Requests

Refer to Section 3.2.9 for Equipment Quotation Requests applicable to Unit 2.

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TABLE 3.3

COMPARATIVE SUMMARY

UNIT 2

	Base Reference Design Point	Conversion Retrofit
Throttle Flow lb./hr.	240,550	240,550
Noncondensable Gas % Wt.	0.75	0.5
General Electric Output kW	12,500	*11,974
Auxiliary Power (Electric) kW		
Cooling Tower Fans	96.2	96.2
Exciter	69.0	69.0
Miscellaneous	7.8	7.8
Circ. Water & Cond. Pumps	229.0	328.0
Noncondensable Gas Blower		(Later)
Net Unit Output kW	12,098	11,537 (1)
Heat Input Btu/Hr. (Ref. to 60°F)	293×10^6	294×10^6
Net Heat Rate Btu/kWh	24,215	26,500
Turbine Exh. Inch Hg Abs	4	4.5
Wet Bulb	65.0	65.0
C. W. T. Range/Approach °F	40/15	39/15.9

(1) Without Noncondensable Gas Blower Debit

EXCHANGER SPECIFICATION SHEET

3.2.8A.1

PROJECT GEYSERS RETROFIT	EXCHANGER MFR.
PLANT UNIT 2	REQ. NO.
EXCHANGER NO.	ITEM NO.
SERVICE OF UNIT MAIN CONDENSER	

SIZE TYPE CONNECTED IN SERIES PARALLEL

SURFACE PER UNIT EFF. GR. SHELLS PER UNIT SURFACE PER SHELL EFF. GR.

PERFORMANCE OF ONE UNIT

	SHELL SIDE	TUBE SIDE
FLUID CIRCULATED	STEAM + NONCONDENSABLES	COOLING WATER
TOTAL FLUID ENTERING LBS/HR	241,270	5,826,000
VAPOR		
LIQUID		(11,652 gpm)
STEAM		
NON-CONDENSIBLES	AIR 70 + N.C. GAS 1200 (MOL WT 30.3)	
FLUID VAPORIZED OR CONDENSED		
STEAM CONDENSED	238,550	
GRAVITY-LIQUID		
VISCOSITY-LIQUID		1.0
MOLECULAR WEIGHT-VAPORS		
SPECIFIC HEAT-LIQUIDS	1.0 B.T.U./#	1.0 B.T.U./#
LATENT HEAT-VAPORS	923.6 B.T.U./#	B.T.U./#
TEMPERATURE IN	°F	°F
TEMPERATURE OUT	NOTE 1 & 2 °F	°F
OPERATING PRESSURE	@ INLET 2.19 PSIA	
NUMBER OF PASSES per Shell	ONE	
VELOCITY	FT./SEC.	7 FT./SEC.
PRESSURE DROP ALLOW/CALC.	0.25/ #/SQ.IN.	15/ #/SQ.IN.
FOULING ~~RESISTANCE~~	HEI CLEANLINESS 70%	

HEAT EXCHANGED - BTU/HR. 221 X 10^6 M.T.D. (CORRECTED)

TRANSFER RATE - SERVICE CLEAN ACTUAL FOULING FACTOR

CONSTRUCTION

	SHELL SIDE	TUBE SIDE
DESIGN PRESSURE	FULL VAC & 14.6 #/SQ.IN.	75 #/SQ.IN.
TEST PRESSURE	#/SQ.IN.	113 #/SQ.IN.
DESIGN TEMPERATURE	150 °F	150 °F

TUBES 304L SS NO. O.D. 3/4" BWG. 22 AVG. MIN. LENGTH PITCH ○ ◁ □ ◇

SHELL 304L SS I.D. O.D. THICKNESS

SHELL COVER FLOATING HEAD COVER

CHANNEL CHANNEL COVER C.S. (COAL TAR EPOXY LINED)

TUBE SHEETS - STATIONARY 304LSS FLOATING

BAFFLES - CROSS TYPE THICKNESS

BAFFLE - LONG 304LSS TYPE THICKNESS

TUBE SUPPORTS 304LSS THICKNESS

GASKETS

CONNECTIONS - SHELL - IN OUT RATING

- CHANNEL - IN OUT RATING

CORROSION ALLOWANCE - SHELL SIDE NONE TUBE SIDE NONE

CODE REQUIREMENTS ASME TUBESIDE ONLY, HEI TEMA CLASS "C" SPEC.

WEIGHTS - EACH SHELL BUNDLE FULL OF WATER

NOTE INDICATE AFTER EACH PART WHETHER STRESS RELIEVED (S.R.) AND WHETHER RADIOGRAPHED (X-R)

REMARKS. -

NOTE 1. N.C. GAS + STEAM VAPOR SHALL BE COOLED TO 110°F

2. CONDENSATE SHALL BE COOLED TO 124.5°F

3. CONDENSATE HOT WELL SHALL HAVE A MINIMUM HOLD UP OF 133 CU. FT.

REV.	DATE				JOB NO.	DRWG. NO.	REV.
△ 0	6/1/79	ISSUED FOR REPORT NO. 1	BF	[illegible]	5-79007-10	DS-12-012	0

EQ 304

EXCHANGER SPECIFICATION SHEET

3.2.8A.2

No.			
1	PROJECT GEYSERS RETROFIT		EXCHANGER MFR.
2	PLANT UNIT 2		REQ. NO.
3	EXCHANGER NO.		ITEM NO.
4	SERVICE OF UNIT INTERCONDENSER		
5	SIZE	TYPE	CONNECTED IN SERIES PARALLEL
6	SURFACE PER UNIT	EFF. GR. SHELLS PER UNIT	SURFACE PER SHELL EFF. GR.
	PERFORMANCE OF ONE UNIT		
		SHELL SIDE	**TUBE SIDE**
7	FLUID CIRCULATED	STEAM + NONCONDENSABLES	COOLING WATER
8	TOTAL FLUID ENTERING LBS/HR	8,680	172,000
9	VAPOR		
10	LIQUID		(344 gpm)
11	STEAM		
12	NON-CONDENSIBLES	AIR 70 + N.C. GAS 1230 (MOL WT 30.3)	
13	FLUID VAPORIZED OR CONDENSED		
14	STEAM CONDENSED	7,200	
15	GRAVITY-LIQUID		1.0
16	VISCOSITY-LIQUID		
17	MOLECULAR WEIGHT-VAPORS		
18	SPECIFIC HEAT-LIQUIDS	1.0 B.T.U./#	1.0 B.T.U./#
19	LATENT HEAT-VAPORS	~1033 B.T.U./#	B.T.U./#
20	TEMPERATURE IN	~160 °F	81 °F
21	TEMPERATURE OUT	NOTE 1 & 2 °F	123.6 °F
22	OPERATING PRESSURE	AT INLET 5.3 PSIA	
23	NUMBER OF PASSES per Shell	ONE	
24	VELOCITY	FT./SEC.	7 FT./SEC.
25	PRESSURE DROP ALLOW/CALC.	0.1/ #/SQ.IN.	15/ #/SQ.IN.
26	FOULING RESISTANCE MIN.	0.0001	.0001
27			
28	HEAT EXCHANGED-B.T.U./HR. 7.3 X 10^6		M.T.D. (CORRECTED)
29	TRANSFER RATE-SERVICE	CLEAN	ACTUAL FOULING FACTOR
	CONSTRUCTION		
30	DESIGN PRESSURE	FULL VAC +60 #/SQ.IN.	75 #/SQ.IN.
31	TEST PRESSURE	90 #/SQ.IN.	113 #/SQ.IN.
32	DESIGN TEMPERATURE	210 °F	150 °F
33	TUBES 304L SS NO.	O.D. 3/4" BWG. 22 AVG. MIN.	LENGTH PITCH ◯ ◁ □ ◇
34	SHELL 304L SS	I.D. O.D.	THICKNESS
35	SHELL COVER		FLOATING HEAD COVER
36	CHANNEL		CHANNEL COVER C.S. (COAL TAR EPOXY LINED)
37	TUBE SHEETS - STATIONARY 304L SS		FLOATING
38	BAFFLES - CROSS	TYPE	THICKNESS
39	BAFFLE - LONG 304L SS	TYPE	THICKNESS
40	TUBE SUPPORTS 304L SS		THICKNESS
41	GASKETS		
42	CONNECTIONS - SHELL - IN	OUT	RATING
43	- CHANNEL - IN	OUT	RATING
44	CORROSION ALLOWANCE - SHELL SIDE NONE		TUBE SIDE NONE
45	CODE REQUIREMENTS ASME	TEMA CLASS "C"	SPEC.
46	WEIGHTS - EACH SHELL	BUNDLE	FULL OF WATER
47	NOTE INDICATE AFTER EACH PART WHETHER STRESS RELIEVED (S.R.) AND WHETHER RADIOGRAPHED (X-R)		
48	REMARKS: -		
49	NOTE 1. N.C. GAS + STEAM SHALL BE COOLED TO 110°F		
50	2. CONDENSATE SHALL BE COOLED TO 120°F		
51	3. CONDENSATE HOT WELL SHALL HAVE A MINIMUM HOLD UP OF 27 CU FT		

REV.	DATE				JOB NO.	DWG. NO.	REV.
△							
△							
△	6/1/79	ISSUED FOR REPORT NO. 1	BF	[illegible]	S-79007-10	DS-12-013	0

EXCHANGER SPECIFICATION SHEET

3.2.8A.3

PROJECT GEYSERS RETROFIT		EXCHANGER MFR.	
PLANT UNIT 2		REQ. NO.	
EXCHANGER NO.		ITEM NO.	
SERVICE OF UNIT AFTER CONDENSER			
SIZE	TYPE	CONNECTED IN	SERIES PARALLEL
SURFACE PER UNIT	EFF. GR. SHELLS PER UNIT	SURFACE PER SHELL	EFF. GR.

PERFORMANCE OF ONE UNIT

	SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED	STEAM + NONCONDENSABLES		COOLING WATER	
TOTAL FLUID ENTERING LBS/HR	6,575		137,000	
VAPOR				
LIQUID			(274 gpm)	
STEAM				
NON-CONDENSIBLES	AIR 70 + N.C. GAS 1255 (MOL WT 30.3)			
FLUID VAPORIZED OR CONDENSED				
STEAM CONDENSED	5,170			
GRAVITY-LIQUID				
VISCOSITY-LIQUID				
MOLECULAR WEIGHT-VAPORS				
SPECIFIC HEAT-LIQUIDS		B.T.U./#		B.T.U./#
LATENT HEAT-VAPORS	~1642	B.T.U./#		B.T.U./#
TEMPERATURE IN	~203	°F		°F
TEMPERATURE OUT	NOTE 1 & 2	°F		°F
OPERATING PRESSURE	@ INLET 14.1 PSIA			
NUMBER OF PASSES per shell	ONE			
VELOCITY		FT./SEC.	7	FT./SEC.
PRESSURE DROP ALLOW/CALC	0.1/	#/SQ.IN.	15/	#/SQ.IN.
FOULING RESISTANCE MIN.	0.0001		0.001	
HEAT EXCHANGED-B.T.U./HR. 5.5 X 10^6 /		M.T.D. (CORRECTED)		
TRANSFER RATE-SERVICE	CLEAN	ACTUAL FOULING FACTOR		

CONSTRUCTION

	SHELL SIDE		TUBE SIDE	
DESIGN PRESSURE	FULL VAC + 60	#/SQ.IN.	75	#/SQ.IN.
TEST PRESSURE	90	#/SQ.IN.	113	#/SQ.IN.
DESIGN TEMPERATURE	210	°F	150	°F

TUBES 304L SS NO. O.D. 3/4" BWG. 22 AVG. MIN. LENGTH PITCH △ ◁ □ ◇

SHELL 304L SS I.D. O.D. THICKNESS

SHELL COVER FLOATING HEAD COVER

CHANNEL CHANNEL COVER C.S. (COAL TAR EPOXY LINED)

TUBE SHEETS - STATIONARY 304L SS FLOATING

BAFFLES - CROSS TYPE THICKNESS

BAFFLE - LONG 304L SS TYPE THICKNESS

TUBE SUPPORTS 304L SS THICKNESS

GASKETS

CONNECTIONS - SHELL - IN OUT RATING

-CHANNEL-IN OUT RATING

CORROSION ALLOWANCE - SHELL SIDE NONE TUBE SIDE NONE

CODE REQUIREMENTS ASME TEMA CLASS "C" SPEC.

WEIGHTS - EACH SHELL BUNDLE FULL OF WATER

NOTE. INDICATE AFTER EACH PART WHETHER STRESS RELIEVED (S.R.) AND WHETHER RADIOGRAPHED (X-R)

REMARKS. -

NOTE 1. N.C. GAS + STEAM VAPOR SHALL BE COOLED TO 110°F.

2. CONDENSATE SHALL BE COOLED TO 136°F

3. CONDENSATE HOT WELL SHALL HAVE MINIMUM HOLD UP OF 27 CU. FT.

REV.	DATE				JOB NO.	DWG. NO.	REV.
△							
△							
△	6/1/79	ISSUED FOR REPORT NO. 1	BF	[illegible]	5-79007-10	DS-12-014	0

PLANT: UNIT NO. 2

	1st Jet	2nd Jet
A. INLET CONDITIONS		
1. MOTIVE STEAM		
Enthalpy (BTU/lb.) @ 113.9 psia	1196	1196
Available Pressure @ Jet psia	103	103
Flow Required (lb./hr.):		
Preliminary Eng. Calc.	~ 6,000	~ 5,000
Manufacturer Calc. *		
2. INLET GASES		
Air leakage (lb./hr.)	70	70
N. C. Gas (Mol. wt. 30.3) (lb./hr.)	1200	1230
Steam Vapor (lb./hr.)	1,450	250
Temperature (°F)	110	110
Pressure (psia)	1.84	5.3
B. DISCHARGE CONDITIONS		
Temperature (°F) *		
Pressure (psia)	5.4	14.1

C. SITE CONDITIONS

Temperature (°F) 65°F WET BULB

Pressure (psia) 13.9

*To be specified by Supplier

No.	Date	Description		Ck.	R.App	C.App
	6/1/79	ISSUED FOR REPORT NO. 1	BF		[illegible]	

ROGERS ENGINEERING CO., INC. 111 PINE STREET SAN FRANCISCO, CALIF. 94111	Geysers Retrofit Project Flow/Thermodynamic Information Sheet	DRAWING NO DS-12-024	REV. 0
JOB NO. S-79007-10	Client PGandE Date	SHEET OF	

DS-022

DATA SHEET FOR CENTRIFUGAL PUMPS

FOR PG&E Retrofit Project NO. 3.2.8A.5
ITEM NO.
SITE Geysers UNIT 2
SERVICE Condensate Pump MOTOR DRIVE ✓ TURBINE DRIVE
PUMP MFR SIZE AND TYPE NO. REQ'D 2
API STD. 610 APPLIES: YES NO X

OPERATING CONDITIONS		RATED	
LIQUID Water containing dissolved H_2S.	U.S. gpm at 124.5	507.5	
°F 124.5	DISCH PRESS., ~~psig~~	39.7	psia
SP GR at 124.5°F = 0.99	SUCT PRESS., psig	7.2	psia
VAP PRESS at 124.5 psia 1.92	DIFF PRESS., psi	32.5	
VIS at SSU	DIFF HEAD, ft	75	
CORR/EROS caused by dissolved H_2S	NPSH AVAIL., ft	6	

PERFORMANCE

PROPOSAL CURVE NO
NPSH REQ'D (WATER), ft
NO. OF STAGES RPM
DES EFF BHP
MAX BHP RATED IMP
MAX HEAD RATED IMP, ft
MIN CONTINUOUS, gpm (BY MFR)
ROTATION FACING COUPLING END
WATER COOLING
BEARINGS
STUFF. BOX
PEDESTAL
GLAND
TOTAL WATER REQ'D, gpm
PACKING COOLING
FLUSHING
AUX PIPING

CONSTRUCTION AND MATERIALS

CASING-MOUNTING (CENTERLINE) (FOOT) (BRACKET) (VERTICAL X)
SPLIT (AXIAL) (RADIAL)
TYPE (SINGLE VOLUTE) (DOUBLE VOLUTE) (DIFFUSER X)
TAPPED OPENINGS (VENT) (DRAIN) (GAGE CONNS.)

NOZZLES	SIZE	ASA RATING	FACING	POSITION
SUCTION				
DISCHARGE				

IMPELLER DIAM RATED MIN MAX TYPE
MFR'S BEARING NO. RADIAL THRUST
LUBRICATION LUBRICATOR TYPE & SIZE
COUPLING TYPE OR MAKE SIZE BASE PLATE
CPL'G GUARD, MEETING Cal. OSHA SAFETY REQMTS.
PACKING
MECH SEAL ✓ CLASS CODE MFR
Crane preferred.

MATERIAL CODE—EXTERNAL CASING SS INTERNAL PARTS

	INTERNALS CODE	I	B	S	C	X
I - CAST IRON	IMPELLER	~~I~~	~~B~~	~~S~~	~~C~~	SS 316
B - BRONZE	INNER CASE PARTS	~~I~~	~~I~~	~~S~~	~~C~~	SS 316
S - STEEL	SLEEVE (PACKED)	Ch	Ch	Af	Af	SS 316
C - 11-13% CHROME	SLEEVE (SEAL)	C	C	C	C	SS 316
A - ALLOY	WEAR PARTS	I	B	Ch	Ch	
h - HARDENED	SHAFT	S	S	S	S	SS 316
f - FACED						
X - AS NOTED						

SHOP TESTS	REQUIRED	WITNESSED
RUNNING PERF		
NPSH		
HYDROSTATIC PSIG		

MAX ALLOW. WP PSIG F
WEIGHTS: PUMP BASE
MOTOR TURBINE

MOTOR DRIVER BY

ITEM NO. MTD BY
HP RPM FRAME
MFR
TYPE TEFC INSUL
ENC TEMP RISE C
VOLTS/PHASE/CYCLES 460/3/60
BEARINGS LUBE
FULL LOAD AMPS

TURBINE DRIVER BY

ITEM NO. MTD BY
HP RPM MAT'L
MFR and TYPE
INLET STEAM psig TEMP F
EXHAUST
STEAM RATE, FL lb/BHP/HR
BEARINGS LUBE

NOZZLES	SIZE	ASA RATING	FACING	POSITION
INLET				
EXHAUST				

MFR FINAL DATA (AS BUILT)

ACTUAL IMPELLER DIAM
TEST CURVE NO.
OUTLINE DWG. NO.
PUMP SECT. DWG. NO.
SEAL DIM. DWG. NO.
PUMP SERIAL NO.

Notes: 1) The selected pump casing and impellers shall be sized to allow for an increase of at least 5% in head at design flow by a change of impeller diameter.
2) The selected pump shall include a flow inducer.

NO.	DATE						JOB NO.	DRAWING NO.	REV.
0	5/29/79	Issued for Milestone Report No. 1	JEJ	[illegible]	[illegible]		S-79007-10	14-005-A & 14-005-B	0

PR 252

POWER ______ VOLTS ______
______ CYCLES, ______ PHASES,
STEAM ______ PSIG ______ °F,
EXHAUST PRESS ______

VERTICAL CENTRIFUGAL PUMP DATA SHEET

MANUFACTURER: ______

SPECIFICATION NO. ______ REQ. NO. 3.2.8A.6

Report

INSTRUCTIONS TO BIDDERS— FILL IN EVERY SPACE FOR EACH PUMP TO MAKE BID COMPLETE

PUMP NUMBER: Unit No. 2

A. SERVICE Cooling water circ. pumps. (2 required)

TYPE OF INSTALLATION (WELL, PIT, SUMP, DOUBLE CASE): Sump

B. LIQUID CHARACTERISTICS

- LIQUID PUMPED: Water
- SPECIFIC GRAVITY AT FLOW TEMP: 1.0
- FLOW TEMP ______ F: 81.0
- VISCOSITY AT FLOW TEMP ______ (CENTISTOKES) (SSU)
- VAPOR PRESSURE AT FLOW TEMP ______ PSIA: 0.524

C. CAPACITY AND PRESSURES

- GPM AT FLOW TEMP: 7472
- SUCTION AT PUMP (IF NOT OPEN SUCTION) ______ PSIA: 15.4
- DIFFERENTIAL (INCL. LIFT FROM INLET) ______ PSI: 41.2
- DISCHARGE (AT DISCH. CONN.) ______ PSIA: 56.6
- DIFFERENTIAL HEAD (TOTAL, NOT INCL. VEL. HEAD) ______ FT: 102
- NPSH A) REQ'D & B) AVAILABLE ft.: 32
- SUBMERGENCE A) REQ'D & B) AVAILABLE ft.: 3.5
- ENTRANCE VEL. AT IMPELLER EYE AT RATING ______ FT/SEC.
- IMPELLER EYE AREA ______ SQ IN.
- MAX CASE WORKING PRESSURE ______ PSIG

D. MANUFACTURER'S SIZE & TYPE PUMP

- TYPE PUMP
- NUMBER OF STAGES
- SERIAL NUMBER (ON FINAL DATA SHEET)

E. OPERATION

- RPM
- EFFICIENCY AT RATING ______ %
- BHP AT RATING
- MAX BHP FOR BID IMPELLER DIAMETER
- DRIVER HORSEPOWER
- IMPELLER DIAMETER, MAXIMUM/MINIMUM ______ IN.
- IMPELLER DIAMETER FOR RATING ______ IN.
- ROTATION (CW) (CCW) VIEWED FROM TOP
- DRIVE: (MOTOR) (TURBINE) (RT ANGLE GEAR)
- DRIVER TO BE FURNISHED BY
- MOTOR OR TURBINE DATA SHEET NO.
- MOTOR TYPE (TEFC) (WEATHERPROOF) (EXPL PRF)
- NEMA FRAME NO. OF MOTOR

F. CONSTRUCTION AND MATERIAL

- CASE: OUTER: SS 316
- INNER: SS 316
- IMPELLER TYPE (OPEN) (CLOSED) (AXIAL) (MIXED FLOW)
- IMPELLER MTL: SS 316
- CASE WEAR RINGS
- IMPELLER WEAR RINGS: SS 316
- SHAFT IN PUMP BOWL: SS 316
- LINESHAFT: SS 316
- LINESHAFT DIAMETER
- LINESHAFT BEARING SPACING
- SHAFT SLEEVES: SS 316
- SHAFT ENCLOSING TUBE: SS 316
- DISCHARGE COLUMN OR PIPE: SS 316
- DISCHARGE HEAD OR ELBOW: SS 316

- LANTERN RING
- THROAT BUSHING
- CASING STUDS
- GLAND BOLTS
- GLAND
- BASEPLATE OR FLOOR PLATE
- COUPLING (RIGID) (FLEXIBLE) MANUFACTURER
- STRAINER
- FLOAT CONTROLS (TYPE & MFR)

G. STUFFING BOX DETAILS

- STUFFING BOX, JACKETED OR PLAIN
- MECHANICAL SEAL - TYPE
- DIMENSIONS: LENGTH OF STUFF-BOX ______ IN.
- INSIDE DIAM. ______ IN.
- DIAM SHAFT OR SHAFT SLEEVE ______ IN.
- WIDTH LANTERN RING ______ IN.
- ℄ LANT RING TO OPEN END OF BOX ______ IN.
- NO. RINGS & SIZE PACKING

H. BEARINGS AND LUBRICATION

- TYPE BEARINGS - THRUST ______ (SAE NO.)
- RADIAL ______ (SAE NO.)
- LINESHAFT
- PUMP BOWL
- LUBRICATION: W = WATER, O = OIL, G = GREASE
- THRUST
- RADIAL
- LINESHAFT
- PUMP BOWL
- TYPE OF CLOSURES
- TYPE AND CAP. OF LUBRICATOR FOR PUMP
- TYPE AND CAP. OF LUBRICATOR FOR DRIVER OR GEAR
- THRUST BEARING TYPE AND CAPACITY
- THRUST LOAD (NORMAL / MAX)
- THRUST LOAD (AT START)
- THRUST BEARING LOCATION (MOTOR, HEAD, PUMP, ETC.)
- CLEARANCE ADJUSTMENT (COLLAR, NUT, COUPLING, ETC.)

J. TESTING

- DYNAMIC BALANCING OF IMPELLERS AT RATED SPEED
- PERFORMANCE TEST (WITNESSED) (NOT WITNESSED)
- HYDROSTATIC TEST (WITNESSED) (NOT WITNESSED)
- HYDROSTATIC TEST PRESSURE ______ PSIG
- INSPECTION REQUIRED?
- RUNNING TEST WITH ACTUAL DRIVER

K. MISCELLANEOUS

- PRICE, EACH (FOB) (FAS) (NOT INCL. DRIVER)
- EXTRA COST FOR DRIVER
- EXTRA COST FOR
- EXTRA COST FOR
- WT. OF BARE PUMP ______ LB.
- WT. OF GEAR
- WT. OF DRIVER
- INPUT AND OUTPUT SPEEDS OF GEAR
- SHIPMENT FROM RECEIPT OF ORDER ______ WEEKS

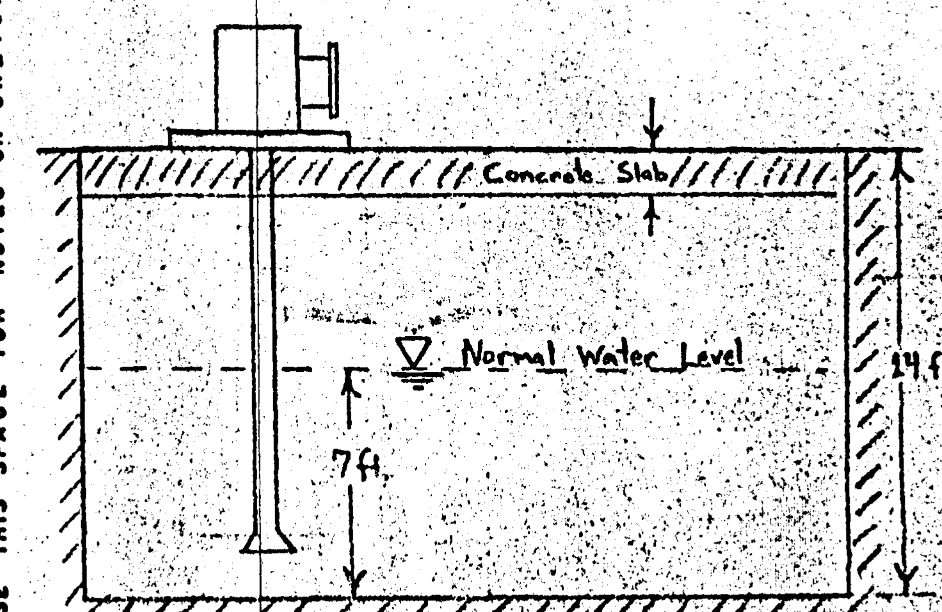
- OUTLINE DIMENSION DRAWING NO.
- CROSS SECTION DRAWING NO.
- PERFORMANCE CURVE

L. DIMENSIONAL DATA

- SIZE OF BASE PLATE (DIAM) OR (___ X ___)
- DEPTH, BASE PLATE TO BOTTOM OF ASSEMBLY
- BOTTOM OF PIT TO BOTTOM OF ASSEMBLY
- INLET TO BOTTOM OF ASSEMBLY (IF VERT. INLET)
- MAX & MIN SUBMERGENCE
- SIZE OF WELL OR PIT
- MAX HT ABOVE BASE OR FLOOR (NORMAL)
- MAX HT ABOVE BASE OR FLOOR FOR PULLING PUMP
- MAX LIFT (LBS) FOR MAINTENANCE
- SUCTION, VERTICAL OR HORIZONTAL
- SIZE & RATING
- FACING
- FACE TO ℄ SHAFT (IF HORIZ)
- DIST. ABOVE OR BELOW BASE (STATE WHICH)
- DISCHARGE VERTICAL OR HORIZONTAL
- SIZE & RATING
- FACING
- FACE TO ℄ SHAFT
- DIST. ABOVE OR BELOW BASE (STATE WHICH)

Notes: 1) Water contains corrosive H_2S
2) The selected pump casing & impellers shall be sized to allow for an increase of at least 5% in head at design flow by a change in impeller diameter.

USE THIS SPACE FOR NOTES OR SKETCHES



REV.	DATE		DATE	
0	5/29/79	Issued for Milestone Report		

PG&E Retrofit Project

JOB NO. S-7900-710 REV. 0

DWG. NO. 14-006-A + 14-006-B

Q 315

Rogers

3.3 Installation Description Unit 1 and 2

3.3.1 Main Condenser

The field verification procedure was based on Drawing SK-001 dated 5-18-79. The main purpose was to check the clearances and accessibility around and to the equipment.

The scope called for Unit No. 1 study as a prototype. However, the geometry of the plant does not allow the same installation and location of the main condenser at Unit No. 2.

With the overall estimated length of the main condenser of 46' it seems that sufficient space is available to install the main condenser at Unit No. 1. The total length required from the eastern existing supporting structural column of the barometric condenser is approximately 100'-0" and available. However this condition can be achieved by a small orientation away from the power plant fence. This disposition makes it desirable to relocate the existing auxiliary transformer. The lowest point of the main condenser shell should be 15' above grade. This height would permit vehicle traffic around the plant as exists now and fulfill the requirement for the hot well and the associated pump equipment located above grade.

This suggested layout assumes an even number of cooling water passes. The cooling water system would connect to the nearest existing water well taken the shorter distance from the condenser water box.

The existing turbine exhaust duct will be cut at a point above grade and the downstream ducting will be utilized as much as possible in the connection to the condenser inlet.

3.3.2 Intercondenser

The existing steel structure would be utilized to locate the intercondenser.

3.3.3 Aftercondenser

The existing steel structure would be utilized to locate the aftercondenser.

3.3.4 Ejectors

The same structure under 3.3.2 and 3.3.3 would be utilized to mount the ejectors.

3.3.5 Pumps

The existing condensate and circulating water pumps are not meeting the new requirements for the tube and shell condenser and have to be removed.

Under 3.3.1 was mentioned the location of condensate pump. The new circulating water pumps will be located in such a way that the existing well will be utilized. These vertical pumps have been selected.

3.3.6 Cooling Water System

The existing hot well and cold well have to be modified to allow free communication between the two sections and allow the installation of two circulating water pumps.

The existing hot well and cold well have to be modified to allow free communication between the two sections and allow the installation of two circulating water pumps (Refer to Dwg. No. B-02-001 for Unit 1 and Dwg. No. B-02-002 for Unit 2)

The existing cooling tower supply and condenser supply pumps did not have sufficient discharge head to meet the new system head requirement imposed by a 15 psi pressure drop through the tube side of the new surface condenser.

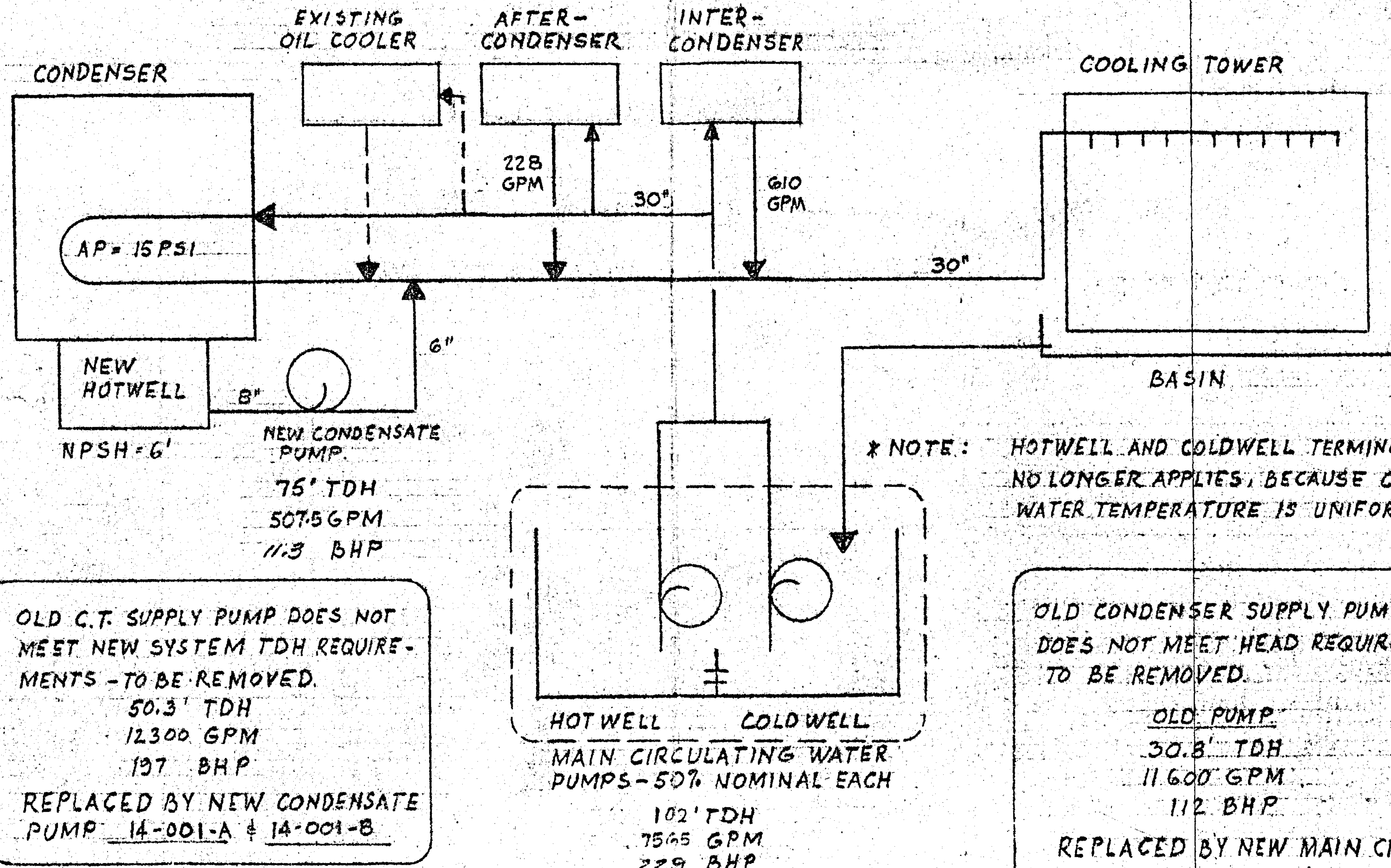
A small ~ 12 gpm drip pump which has been used to pump the hot water to the existing hot well should have its discharge routed to the new surface condenser hot well.

The cold water difference between Units 1 and 2 is ~ 5°F because of the difference in cooling tower performance.

The water from the tower is presently running at a pH = 7-8 and there has been no direction at this time to change the pH range.

The auxiliary power requirements for new pumping power will increase by 18%. It should be noted that the main circulating water pumps shown on Dwg. B-02-001and B-02-002 are 50% each nominally; however, the two new condensate pumps are capable of supplying 100% of required flow at full load. As shown in the cooling water system drawings the condensate pumps will discharge into the circulating water return header to the cooling tower. The project costs of the pumps installed are detailed in the project costs section of this report, and the system characteristics are on drawings located in this section.

UNIT 1



* NOTE: HOTWELL AND COLDWELL TERMINOLOGY NO LONGER APPLIES, BECAUSE COOLING WATER TEMPERATURE IS UNIFORM.

OLD C.T. SUPPLY PUMP DOES NOT MEET NEW SYSTEM TDH REQUIREMENTS - TO BE REMOVED.
50.3' TDH
12300 GPM
197 BHP
REPLACED BY NEW CONDENSATE PUMP 14-001-A & 14-001-B

OLD CONDENSER SUPPLY PUMP DOES NOT MEET HEAD REQUIREMENTS - TO BE REMOVED.
OLD PUMP
30.8' TDH
11600 GPM
112 BHP
REPLACED BY NEW MAIN CIRCULATING WATER PUMPS 14-002-A & 14-002-B

REV.	DATE	REVISION	ENG.	CHK.	RECO. APPR.	CLIENT APPR.
0	5/30/79	ISSUED FOR MILESTONE REPORT #1	EJM	BF	[illegible]	

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DR. EA CHK. EJM ENG. EJH APPROVED SWG [illegible]

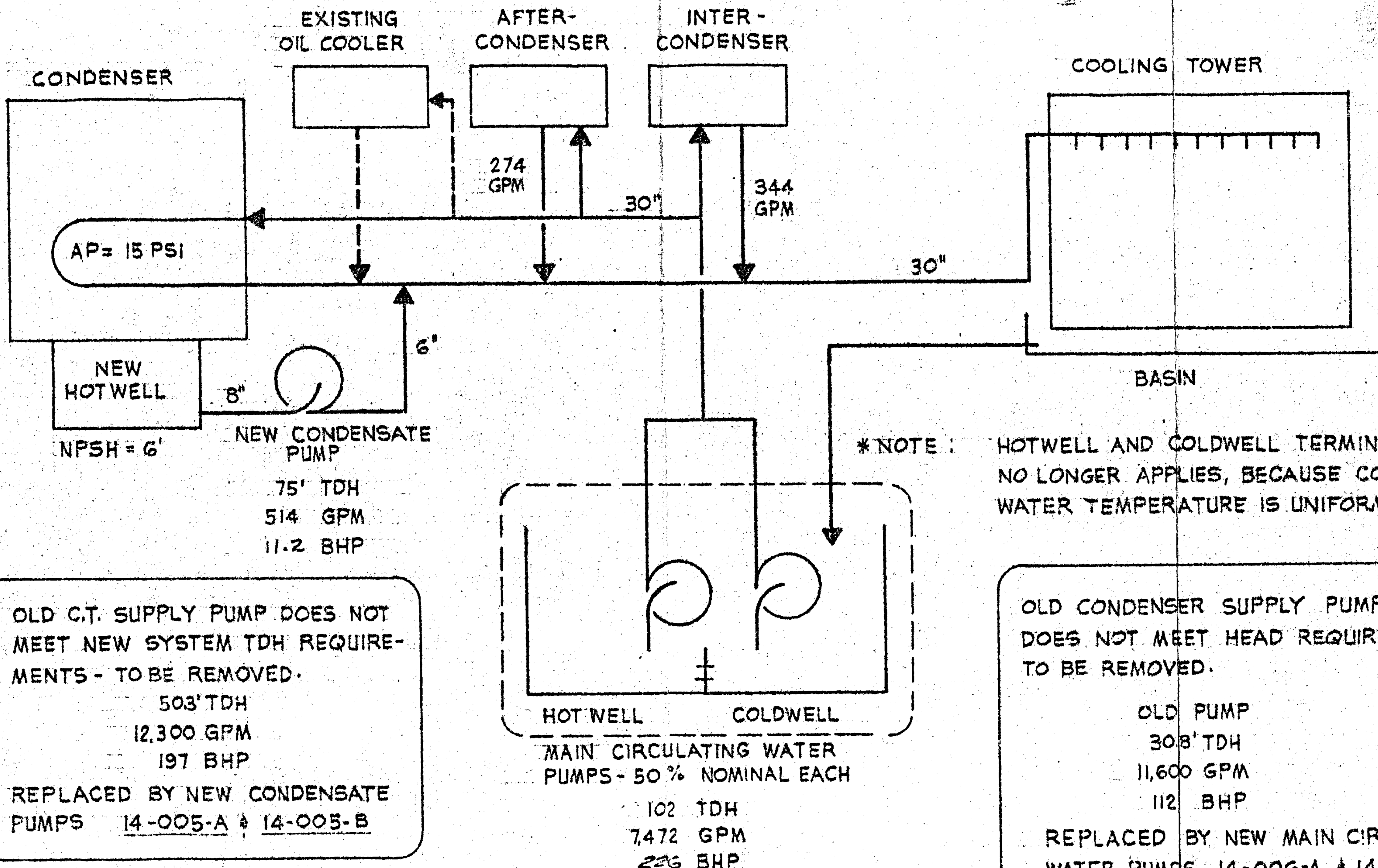
APPROVED: DATE

P.G. and E. RETROFIT PROJECT
UNIT 1 COOLING WATER SYSTEM

JOB NO. S 79007-10 | B-02-001 | REV. 0

DG-002

UNIT 2



*NOTE : HOTWELL AND COLDWELL TERMINOLOGY NO LONGER APPLIES, BECAUSE COOLING WATER TEMPERATURE IS UNIFORM.

OLD C.T. SUPPLY PUMP DOES NOT MEET NEW SYSTEM TDH REQUIREMENTS - TO BE REMOVED.
503' TDH
12,300 GPM
197 BHP
REPLACED BY NEW CONDENSATE PUMPS 14-005-A & 14-005-B

OLD CONDENSER SUPPLY PUMP DOES NOT MEET HEAD REQUIREMENTS - TO BE REMOVED.
OLD PUMP
308' TDH
11,600 GPM
112 BHP
REPLACED BY NEW MAIN CIRCULATING WATER PUMPS 14-006-A & 14-006-B

REV.	DATE	REVISION	ENG.	CHK.	RECO. APPR.	CLIENT APPR.
0	6/1/79	ISSUED FOR MILESTONE REPORT	EJM	BF	7BD	

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APPROVED: DATE

PG and E RETROFIT PROJECT
UNIT 2 COOLING WATER SYSTEM

JOB. NO. S 79007-10 B-02-002 REV. 0

DG-002

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3.3.7 Unit 2 - Main Condenser

The location and installation of shell and tube condensers at Unit 2 are shown on the following drawings, SK-007, SK-008 and SK-009. The available space to locate the equipment is extremely tight. The guiding principle applied at Unit 1 was followed at Unit 2. It was important to ascertain that no interference exists between the proposed new condenser installation and the main steam lines of Unit 1 and 2 and all exits from the turbine building to the yard are unobstructed.

3.3.8 Site Plan - Units 1 and 2

Enclosed herein is a Site Plan for Units 1 and 2, indicating the new conversion equipment locations with existing field survey dimensions on the presently existing equipment. This survey data was obtained from actual site investigations.

3.3.9 Auxiliary Power Requirements

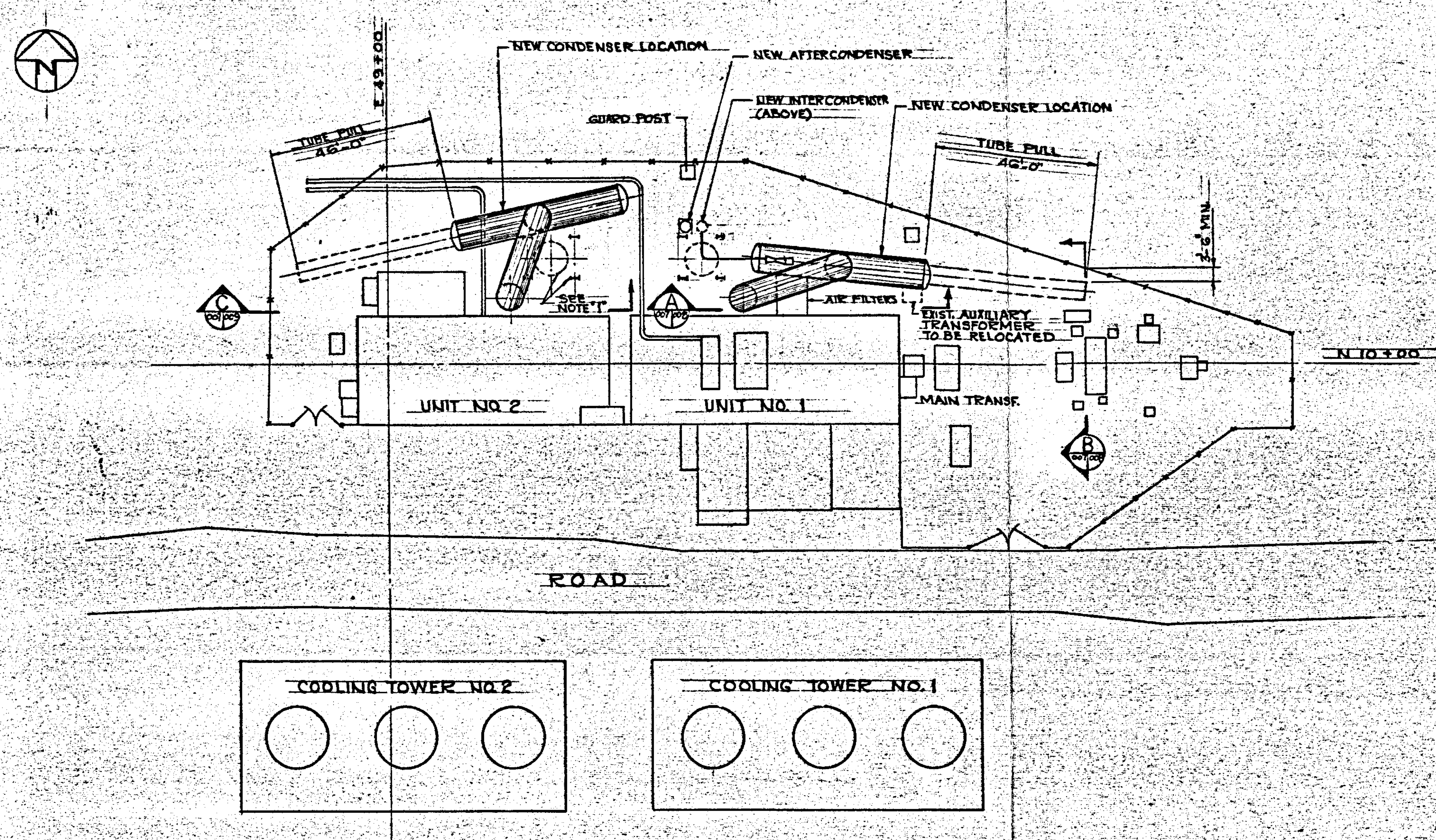
The auxiliary power requirements at full load as designed and the additional power necessary for the pumps after retrofit for Units 1 and 2 are shown below. (It should be noted that these figures do not include the power needed for the compressors to deliver the off-gas to the Stretford System.)

Unit	Name Plate		Actual Loading	After Retrofit
	Amp	kVA	Amp	Amp
#1------→	782	650---------→	625---------→	779
#2------→	782	650---------→	580---------→	717

Based on these figures, it appears that the auxiliary transformers of Units #1 and #2 will carry the additional load. (Ref.: PGandE Station Service Electric Loads as of May 14, 1979).

NOTES:

1. BAROMETRIC CONDENSER AND EXISTING INTER, AFTER CONDENSERS AND EJECTORS, ALONG WITH STRUCTURAL STEEL WILL BE REMOVED. AS MUCH OF THE STRUCTURAL STEEL AS POSSIBLE WILL BE USED ON THE RETROFIT.



SITE PLAN UNIT 1 & 2

1" = 20'-0"

REV.	ZONE	DATE	REVISION	DR.	CHK.	APPR. RECO	APPR.
0		5/30/79	ISSUED FOR MILESTONE REPORT #1	H-E.	LFW		

REFERENCE DRAWINGS

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111 PINE STREET, SAN FRANCISCO, CALIFORNIA 94111

SCALE AS SHOWN DATE 5-30-79
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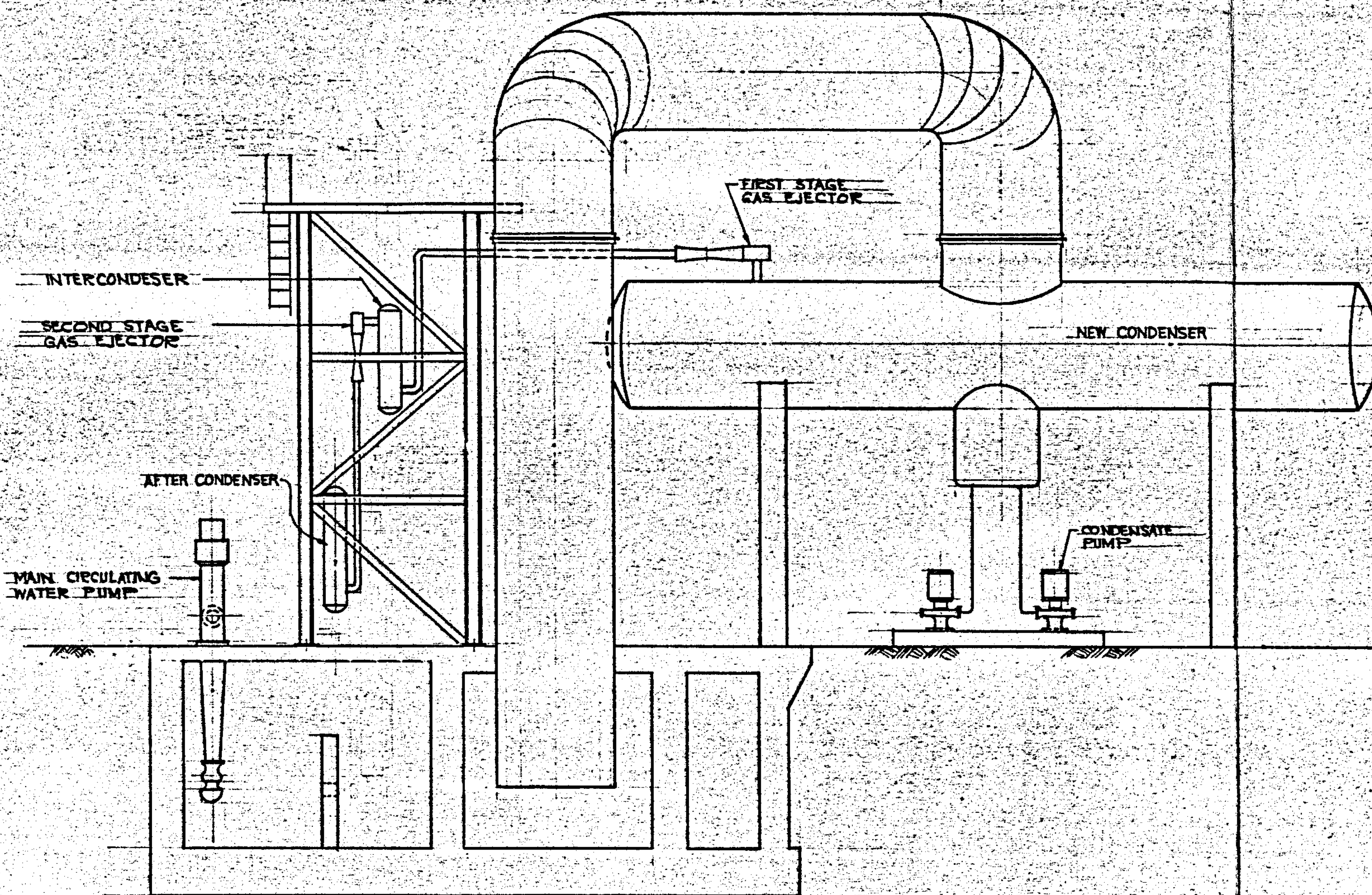
APPROVALS

DATE
DATE

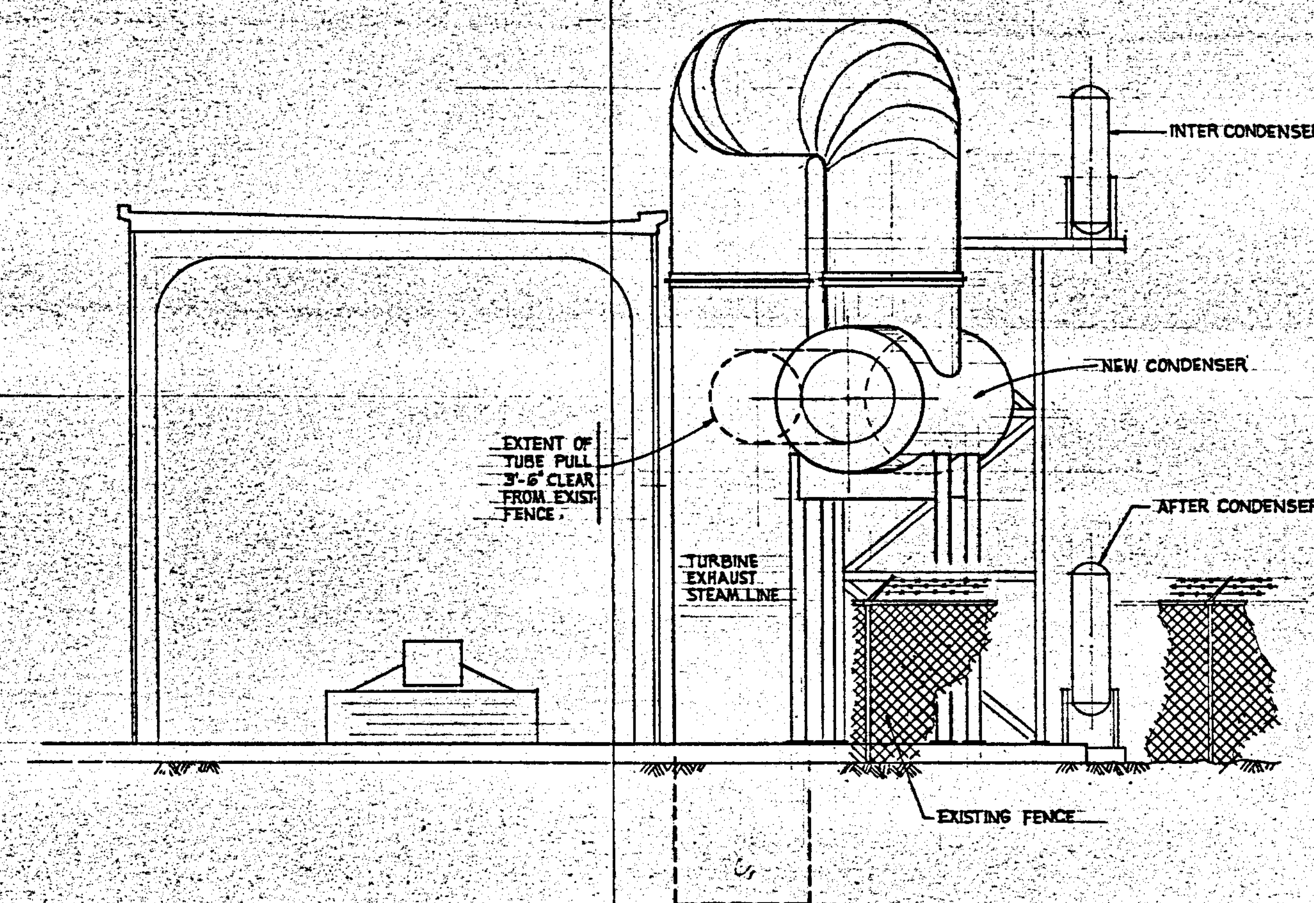
PG and E RETROFIT STUDY
UNITS 1 & 2
SITE PLAN

JOB NO. S79007

SK-007 0



SECTION A
D07 C08



SECTION B
D07 D08

REV.	ZONE	DATE	REVISION	DR.	CHK.	APPR. RECO	APPR.
0		5/31/79	ISSUED FOR MILESTONE REPORT #1	C.O.	LFW		

REFERENCE DRAWINGS

ROGERS ENGINEERING CO., INC.
ENGINEERS - ARCHITECTS
18 PINE STREET, SAN FRANCISCO, CALIFORNIA 94111

SCALE 3/16" = 1'-0" DATE 5-30-79
DR. C.O. CHK. LFW ENG. PJM APPROVED

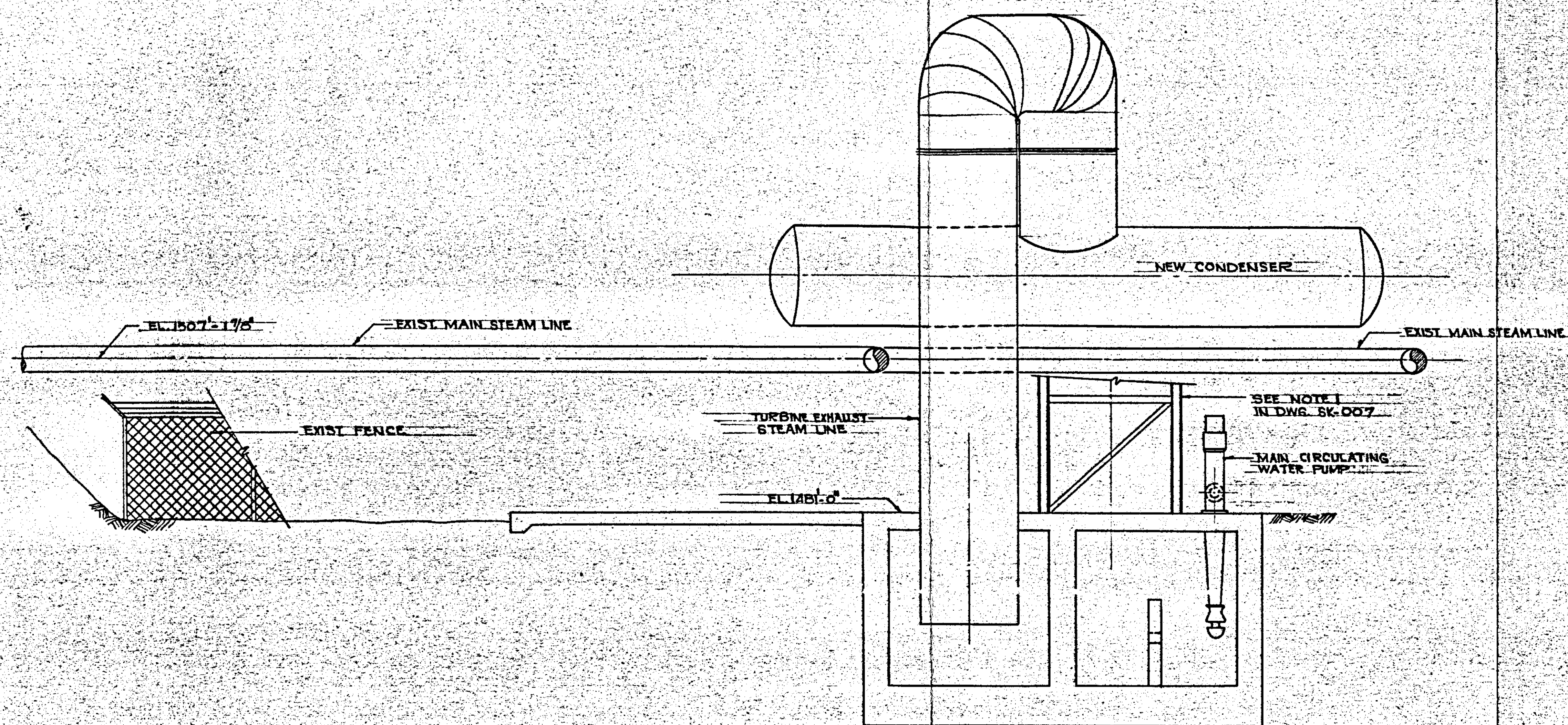
APPROVALS
DATE
DATE

PG and E RETROFIT STUDY
UNITS 1 & 2
SECTIONS A & B

JOB NO. S79007

SK-008

0



SECTION C
3/16" = 1'-0"
007 | 009

REV.	ZONE	DATE	REVISION	DR.	CHK.	APPR. RECO	APPR.
0		5/31/79	ISSUED FOR MILESTONE REPORT #1	H.E.	LFW		

REFERENCE DRAWINGS

ROGERS ENGINEERING CO., INC.
ENGINEERS - ARCHITECTS
111 PINE STREET, SAN FRANCISCO, CALIFORNIA 94111

SCALE 3/16" = 1'-0" DATE 5-30-79
DR. Hagob CHK. LFW ENG. ejm APPROVED

APPROVALS
DATE
DATE

PG and E RETROFIT STUDY
UNITS 1 & 2
SECTION C

JOB NO. S79009
SK-009
0

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3.4 Project Costs - Units 1 and 2

This milestone report is a mid-term report presenting partial cost and economic information pertaining to Units 1 and 2 surface condenser installation. This report presents two economic aspects: Equipment sizing and capital cost. Each case has certain guide lines and constraints. They will be discussed in this Section along with the respective data.

The cost estimate has been prepared by categories and are those accounts used by Pacific Gas and Electric for their own estimates. Only the following accounts are included by the nature of this project work.

54-20	Turbine Generator - Condensate System
54-30	Turbine Generator - Circulating Water System
54-70	Turbine Generator - Instrumentation
55-60	Auxiliary Electrical Equipment - Station Power

The cost figures in this Section are in June 1979 dollars. These will be modified due to escalation and project timing when a schedule is prepared later in the overall project.

3.4.1 Equipment Sizing Evaluation:

The process used to evaluate alternative equipment sizes and design operating conditions is a specialized procedure. It requires that alternatives be equivalent. By nature the alternatives have differences; however, by drawing the same boundary around each alternative the differences crossing this boundary can be evaluated in terms of money. This procedure is only an evaluation tool. It is not necessarily how the costs are incurred.

The Engineering Planning Department Generation Section was consulted in preparation of and determination of the factors they use to evaluate generation alternatives. The overall method is a level annualization of all cost differences between equivalent alternatives. This annualization utilizes system wide figures for capital and energy. It also includes projections of fuel costs, capital costs of new units and allowed rate base return (capital cost).

These methods and figures have been used along with the technical parameter differences to derive Tables 3-2 and 3-3. All the figures in these tables as noted are annual levelized numbers and all dollar differences across the boundary have been presented to make the alternatives equivalent economically.

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This discussion of equipment sizing, alternatives and equivalences is used to arrive at the first step in the cost estimate process, the selection of the design conditions for the installation. The second and third steps can follow: getting manufacturer quoted major equipment costs and estimating the installation costs a contractor will charge to perform the designated quipment installation.

3.4.2 Major Equipment Cost:

Suppliers of the major equipment, condensers and pumps, were contacted by telephone followed up by transmittal of pertinent equipment data sheets (See 3.2.8). In the majority of cases, vendors were contacted who have had some experience in the special problems associated with geothermal plants.

The following item costs are adjusted quoted figures:

Condensers and Ejectors
Condensate Pumps
Circulating Water Pump

The Section 3.2.9 compares the quotations with the data sheets sent out for quote. In addition, any adjustments required because of design condition changes from those quoted are also addresses. The costs in the estimate for each piece of major equipment reflect our best judgment as to the eventual bid on the "selected" equipment data sheets.

In the cost estimate presented in Section 3.4.4, the manufacturer's cost includes the major equipment and materials cost. Cost at the site in the presentation includes 6 percent use tax on equipment and material and a contingency of 20 percent since this is a conceptual estimate and unestimated items may amount to that figure. The estimate assumes that Pacific Gas and Electric will purchase all major equipment and supply it to the contractor for installation as has been the practice at the Geysers Plant.

3.4.3 Installation Cost:

The estimated installation cost is the cost anticipated to be charged by an outside contractor to perform the removal of the old and installation of the new equipment. Most of the larger project construction work at the Geysers has been done by outside contractors and this guide has been used in preparation of this estimate. This decision affects the labor overheads and labor efficiency as well as the general overheads of a GM estimate discussed in Section 3.4.4.

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The estimated materials and labor shown in Section 3.4.3 are based upon the conceptual layout drawings and field investigations at the site for each installation. There is also some judgment used whenever making such an estimate and this estimate has been prepared by people who have been a part of other geothermal plant construction.

In consultation with General Construction about contractor performance and costs at the Geysers certain figures were developed for use in this conceptual report. The current labor direct rates show a $15 per hour to be an overall good concept estimate direct figure. The labor efficiency has been estimated to be 60 percent and has been used in the estimate. The contractor overhead includes his profit and all indirect expenses. It has been estimated that 55 percent is a good value from past Geysers experience in contractor bidding.

As all recognize in the construction industry these above figures vary depending on time of bid, overall conditions and the specific project requirements. Since this is a conceptual design report, some knowledge of what difference these variations of parameters can make in total project cost is worth having a feel for. Cost sensitivity analysis was performed on the Unit 1 estimate to demonstrate the total cost vulnerability to parameter variation. This vulnerability is also a function of the labor to equipment and material ration.

TABLE 3-4.1
SENSITIVITY ANALYSIS - 1
(Labor Direct Rate to Total Project Cost)
(Constant Base Efficiency)

Rate ($/hr.)	Labor/Equipment	Total Project (Per Unit)
13.50	0.24	0.98
15.00	0.27	1.00
16.50	0.29	1.02

Fifteen dollars an hour was considered to be the base rate. A ten percent change in the labor rate gives a 2 percent change in total project cost.

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TABLE 3-4.2
Sensitivity Analysis - 2
(Labor Efficiency to Total Project Cost0
(Constant Base Labor Rate)

Efficiency %	Labor/Equipment	Total Project (Per Unit)
50%	0.32	1.04
60%	0.27	1.00
70%	0.23	0.97
89%	0.20	0.95

A ten point change in efficiency of labor affects the total between 3 to 4 percent. Sixty percent efficiency is considered to be the base for the Geysers and this project estimate.

In addition to the above basic parameter discussions a twenty percent contingency has been included in the direct man-hours for this conceptual estimate. The labor man-hours shown in Section 3.4.4 are derived as follows:

Manhours = Basic Estimate x One Divided By Efficiency x Contingency
2.0 = 1.0 x 1.67 x 1.2

The costs for direct labor and labor overhead are separated in the detailed estimate of Section 3.4.4.

3.4.4 GM Estimate:

The GM Estimate preparation is the last step in the cost estimate process. The GM estimate is used to get moneys approved for the project. Engineering Services in consultation with Engineering and General Construction puts the final GM numbers together. Engineering Services has been consulted in the methods and factors used in preparation of GM estimates.

3.4.4.1 Cost Estimate

The factors included in the Equipment and Material and labor parts of the estimate have been discussed in Sections 3.4.2 and 3.4.3. The cost estimate for the removal and installation of specified equipment to facilitate the operation of a surface condenser at Unit 1 typical for Unit 1 and 2 is here presented in summary account form. The account details are itemized in the next table from the summary.

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TABLE 3-4.3

SUMMARY COST ESTIMATE - UNIT 1

Account	Description	Equip. & Mat'l	Labor	Total
54-20	Condensate System	$690,124	$188,235	$ 878,359
54-30	Circ. Water System	264,576	53,955	318,531
54-70	Instrumentation	16,790	12,115	28,905
55-60	Station Pwr System	19,716	10,810	30,526
	Totals	$991,206	$265,115	$1,256,321

The estimated cost in June 1979 dollars to retrofit Unit 1 for a surface condenser is $1,300,000. To this estimate sub total must be added the GM overheads.

3.4.4.2 GM Overheads and Cost Total

The GM overheads are a function of who does the construction. The estimate prepared here is based upon an outside contractor doing the construction.

The overheads include:

Item	Percent of Estimate
Indirects	0.0
General Engineering & Administration	16.0
ADC (9 month Construction Estimate)	3.6
Ad Valorem	1.0
Total	20.6%

The GM Estimate Cost total for the retrofit of Unit 1 is estimated to be $1,568,000.

3.4.5 Energy Charge:

The capital involved to accomplish the retrofit using a surface condenser will require a levelized annual energy charge of 2.89 mills per kilowatthour. This calculation uses the generation plan-

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ning charge rate, an 80 percent capacity factor and the calculated net output power on the process diagram. The energy charge and GM estimate capital do not include the vent gas processing equipment for environmental control. These are treated separately in later work.

The analysis presented reflects only the physical installation costs. The economic comparison with alternative methods adds cost differences between methods in addition to the above stated costs. This economic comparative analysis is part of later work.

OGERS ENGINEERING CO, INC.
1 PINE STREET
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OB NO. S-79007

G-023

TABLE 3 - 4.4
COST ESTIMATE DETAIL
UNIT 1 SURFACE CONDENSER

DRAWING NO. - - -

SHEET - OF -

REV.

ROGERS ENGINEERING CO.,INC. COST ESTIMATE

JOB NAME- UNIT NO 1 JOB NO.- S79007 CLIENT- P G AND E ESTIMATE DATE- 31 MAY 79

ITEM NO.	DESCRIPTION	MFG COST	COST@SITE	MANHOURS	LABOR DOL	TOT DOL
54-21-1	CONDST PMP EXC&BKFL	250.	318.	200.	3006.	3324.
54-21-2	CONDST PMP CONCRETE	300.	382.	160.	2405.	2786.
54-22-1	TBN EXT PIPNG STEELW	1500.	1908.	200.	3006.	4914.
54-22-2	RMV PART SUPT STRUCT	500.	636.	160.	2405.	3041.
54-23-1	RMV CONDSR	3000.	3816.	1122.	16834.	20650.
54-23-2	COND M,INT,AFT&EJTR	437000.	555864.	0.	0.	555864.
54-23-3	COND STEEL WORK	5000.	6360.	802.	12024.	18384.
54-23-4	COND MECH	1000.	1272.	2405.	36072.	37344.
54-24-1	CONDST PMP MECH	24000.	30528.	200.	3006.	33534.
54-25-1	COND PIPING & MISC	4000.	5088.	641.	9619.	14707.
54-25-2	CONDST PMP PIPING EQ	5000.	6360.	1002.	15030.	21390.
54-25-3	TBN EXT PIP MECH	61000.	77592.	1202.	18036.	95628.
			--------	--------	--------	--------
BASE COSTS,MHS			690124.	8096.	121442.	811566.
OVERHEAD/PROFIT			0.		66793.	66793.
ITEM NO.	DESCRIPTION	MFG COST	COST@SITE	MANHOURS	LABOR DOL	TOT DOL
54-31-1	CW PMP CONCRETE	1000.	1272.	481.	7214.	8486.
54-31-2	CW PIPING EXCV&BKFL	500.	636.	240.	3607.	4243.
54-33-1	CW PIPING & EQ	36000.	45792.	902.	13527.	59319.
54-34-1	CW PMP MECH	170000.	216240.	537.	8056.	224296.
54-39-1	RELOCATE FIRE MAIN	500.	636.	160.	2405.	3041.
			--------	--------	--------	--------
BASE COSTS,MHS			264576.	2321.	34809.	299385.
OVERHEAD/PROFIT			0.		19145.	19145.
ITEM NO.	DESCRIPTION	MFG COST	COST@SITE	MANHOURS	LABOR DOL	TOT DOL
54-74 1	INSTMT CONDST SYS	9000.	11448.	240.	3607.	15055.
54-74-2	INSTMT CW SYS	4200.	5342.	281.	4208.	9551.
			--------	--------	--------	--------
BASE COSTS,MHS			16790.	521.	7816.	24606.
OVERHEAD/PROFIT			0.		4299.	4299.
ITEM NO.	DESCRIPTION	MFG COST	COST@SITE	MANHOURS	LABOR DOL	TOT DOL
55-61	RELOCATE AUX TRNSF F	150.	191.	48.	721.	912.
55-63	RELCT AUX TRANSF	350.	445.	120.	1804.	2249.
55-64-1	CW PMP ELECTRICAL	13000.	16536.	200.	3006.	19542.
55-64-2	CONDST PMP ELECT	2000.	2544.	96.	1443.	3987.
			--------	--------	--------	--------
BASE COSTS,MHS			19716.	465.	6974.	26690.
OVERHEAD/PROFIT			0.		3836.	3836.

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4.0 UNIT 3 RETROFIT FOR ABATEMENT OF H_2S

Essentially the same methodology as used for Unit 1 is applicable to Unit 3 Retrofit. Since Unit 4 is essentially identical in capability the detailed elements apply similarly to Unit 4 Retrofit.

4.1 Equipment Sizing Criteria

4.1.1 Noncondensable Gas Values

Original base reference design point was 1.0% wt. noncondensable gas in the steam. Based on updated field data the agreed value is now 0.8% wt. The gas composition is shown in detail in Appendix A. The average mol wt. is 32.4.

4.1.2 Field Test Data for Cooling Water Tower

The cooling tower for Unit 4 was tested 20 May 1969, when clean. At a wet bulb of 60.9°F, with a circulating water flow of 31,860 gpm and a range of 37.3°F the approach to wet bulb was 17.9°F. This test indicates the tower is at design rating. Unit 3 cooling water tower is of similar design. The last test on Unit 3 tower was 25 August 1978 and concluded that the system was not thoroughly cleaned of iron oxide since performance was poor. For this report it will be assumed both Units 3 and 4 cooling water towers can be reworked to achieve design ratings.

4.1.3 Base Reference Design Point

The Data Book Heat Balance Diagram for Maximum Guaranteed Load is the base reference design point. The calculated gross power will be based on essentially the same turbine throttle flow at the retorfit conditions. Net power will then be calculated based on the additional station auxiliary power requirements. The Unit 3 conversion Process Flow Diagram shows the expected Unit performance after Retrofit.

4.2 Specification of Equipment for Conversion from Direct Contact to Surface Type Heat Exchange - Unit 3

4.2.1 Main Condenser

4.2.1.1 Cooling Water System Limitation

The Unit 3 cooling tower at the base design of 65°F wet bulb is expected to meet a design approach of 15°F with the range relaxed from 40°F to 39.4. To obtain the lowest turbine exhaust flange

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TABLE 4.1

COMPARATIVE SUMMARY

UNIT 3

	Base Reference Design Point	Conversion Retrofit
Throttle Flow lb./hr.	509,600	510,000
Noncondensable Gas % Wt.	1.0	0.8
General Electric Output kW	27,500	26,817
Auxiliary Power (Electric) kW		
Cooling Tower Fans	310	310
Exciter & Other Misc.	100	100
Circ. Water & Cond. Pumps	310	704
Noncondensable Gas Blower		(Later)
Net Unit Output kW	26,500	25,702 (1)
Heat Input Btu/Hr.	633×10^6	648×10^6
Net Heat Rate Btu/kWh		26,500
Turbine Exh. Inch Hg Abs	4	4.5
Wet Bulb	65.0	65.0
C. W. T. Range/Approach °F	39/15	38.4/14.9

(1) Without Noncondensable Gas Blower Debit

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pressure it is proposed to use for the main condenser an 8°F terminal temperature difference. A gas cooling outlet approach of 34°F is proposed to keep the first vacuum jet ejector and intercooler system from being grossly oversized.

4.2.2 Intercondenser

With the specified cooling water tower range and approach, the temperature differences specified are 41°F and 30°F respectively at the gas steam inlet and outlet.

4.2.3 Aftercondenser

The temperature differences specified are 81°F and 30°F respectively for the steam gas inlet and outlet.

4.2.4 Steam Jet Ejectors

These units are specified to handle the noncondensable gas and steam vapor carryover from the main- and intercondensers at the pressures and temperatures specified for subject equipment.

4.2.5 Cooling Water Pumps

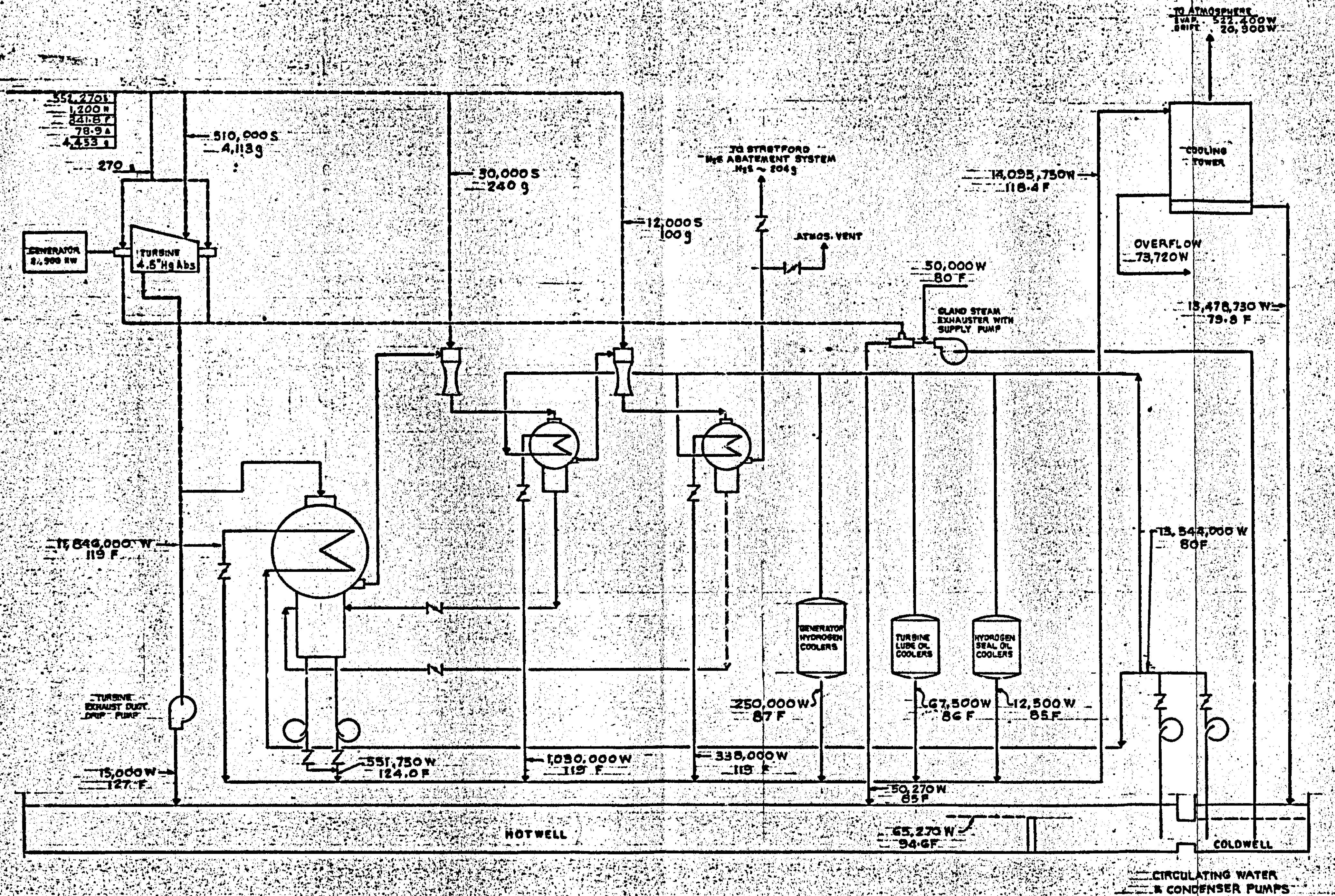
The existing cooling water system is of the "open" type utilizing atmospheric vented hot and cold wells. Two new pumps will be specified and the system revised to a "closed" type to reduce pumping power requirements. The hot and cold wells will be rearranged for use as a common supply of cold water. As was proposed on Unit 1 there are two small warm water streams that will be mixed as a "hot bypass" into the cold water. In the conversion Process Flow Diagram this requirement is met by showing the calculated colder tower off temperature required to absorb this heat.

4.2.6 Condensate Pumps

These units are specified to remove the approximately 1,000 gpm of condensate from the main condenser. The total differential head required is based on pumping from expect vacuum into the cooling water tower return header at system design head.

4.2.7 Process Flow Diagram

The conversion Process Flow Diagram PD-003 shows the material balance at the suggested Retrofit conditions. Table 4.1 shows a comparison summary of the original Reference Design Base Point and the Conversion Retrofit.



PERFORMANCE

THROTTLE FLOW — 510,270 #/HR.
GENERATOR ELEC. OUTPUT — 26,817 KW(2)
AUXILIARY POWER (ELECTRICAL)
CIRC. WATER & COND. PUMPS — 704 KW
COOLING TOWER FANS — 310 KW
OTHER — 100 KW
TOTAL — 1,114 KW

NET UNIT OUTPUT — 25,702 KW (1)
HEAT INPUT 648 x 10^6 BTU/HR
NET HEAT RATE 25,200 BTU/KWHR
REFERRED TO 60°F

CONDITIONS

GENERATOR POWER FACTOR — 0.80
TURBINE EXHAUST BACK PRESSURE - 4.5 Hg
WET BULB AIR TEMPERATURE — 63°F
ALL STEAM FLOWS INCLUDE NON-CONDENSABLE GASES

LEGEND

MAIN STEAM LINE
WATER LINE
STEAM LINE
GAS LINE
S POUNDS PER HOUR OF STEAM
W POUNDS PER HOUR OF WATER
g POUNDS PER HOUR OF GASES
F DEGREES FAHRENHEIT
H ENTHALPY OF STEAM BTU/LB
A ABSOLUTE PRESSURE PSI
G GAUGE PRESSURE PSIG
(1) WITHOUT N.C. GAS BLOWER DEBIT
(2) FOR EXPECTED GROSS OUTPUT, MULTIPLY ACTUAL FIELD OUTPUT BY RETROFIT DERATING FACTOR OF 0.975

REFERENCE DRAWINGS | REVISION | REVISION

0 ISSUED FOR REPORT CO BF

ROGERS ENGINEERING CO., INC.
ENGINEERS - ARCHITECTS
111 PINE STREET, SAN FRANCISCO, CALIFORNIA 94111

SCALE NONE DATE 8-31-79
DR. C.O. CHK. ENG. BF APPROVED [illegible]

APPROVALS
DATE
DATE

PG and E RETROFIT PROJECT
UNIT No. 3 CONVERSION
PROCESS FLOW DIAGRAM

JOB NO. S79007 PD 003 0

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4.2.8 Equipment Data Sheets

The Equipment Data Sheets associated with the conversion equipment for Units 3 and 4 are included herein. The Flow/Thermodynamic Information Sheet is only prepared for Unit 3. Exchanger Specification Sheets have been prepared for Unit 3 Main Condenser, Intercondenser, Aftercondenser, as well as Data Sheets for the Condensate and Main Water Circulating Pumps and Drivers.

4.2.9 Equipment Quotation Requests

4.2.9.1 As in previous sections, suppliers of equipment were contacted for the same equipment, described therein, in this Section.

Condensers and Ejectors

At this time data and pricing is sparse on condensers except for information furnished from DeLaval nothing has been received from Ecolaire.

DeLaval's estimate is approximately $560,000 which includes inter- and aftercondensers and ejectors but no tubes in main condenser. Estimated surface required is 45,000 sq. ft. at approximately a cost of $100,000. Installation cost of tubing is covered under installation costs, Section 6.4.2.

Condensate and Circulating Water Pumps

To date we have only one telephone quote. Byron Jackson quote for circulating water pump with motor in cast iron construction $66,500, in all stainless $171,500.

Other vendors have promised to respond but none in hand at this time.

4.2.9.2 Evaluated Equipment Costs, Units 3 and 4

The condenser and gas ejection system was bid to specification by Graham, the low bidder. The bid cost was $750,000. A figure of $760,000 was used in the cost estimate; (a larger hotwell will be proposed).

Changes in the specification would have the following estimated cost changes at the factory:

From TEMA (Tube .001; Shell .0001 to HEI 70% CF---Reduce by 15%
N. C. gas cooling from 95°F to 114°F---Reduce by 15%

NOTE: The steam jet ejector flows have not been given by the Suppliers.

Rogers

4.2.9.3 Equipment Summary Sheet - Units 3 and 4

TABLE 4.2

PUMP SUMMARY

UNITS 3 AND 4

Specifications	Vendors' I. R.	Peerless	Byron Jackson	Worthington
Condensate Pump		**		
Materials: All 316SS	Yes	N. Q.		Yes
Vertical In Line	Yes	N. Q.		Yes
NPSH Min. Required: 6 ft.	17' Req'd	N. Q.		Yes
Flow Inducer: Required	No	N. Q.		No
Efficiency %:	Not Stated	N. Q.		75%
Motor HP/rpm	40/1750	N. Q.		35
Price $:	$4,600	N. Q.		$27,500
C. W. Circulation Pump				
Material: All S. S.	N. Q.		Yes	Yes
Alt. C. I. w/C. S. Trim	N. Q.		Yes	Yes
Type Vertical	N. Q.		Yes	Yes
Pit Pump	N. Q.		Yes	Yes
Efficiency	N. Q.		Not Stated	84%
Motor HP	N. Q.		600	585
Price $: 316 SS			$171,500	$224,053
Alt. C. I. w/C. S. Trim			$ 66,500	$ 56,850

*C. I. Bronze Construction

**Peerless does not manufacture - In Line - S. S., will quote on C. W. circulating pump 1st week of 6/4/79

TABLE 4.3

Units 3 and 4 Equipment Summary Sheets

SURFACE CONDENSER SUMMARY
UNITS 3 AND 4

Specification Main Condenser	Ecolaire	DeLaval	Graham	Southwestern
			VENDOR	
Fouling Factor Tube 0.001) Shell 0.0001)	To Specs	To Specs	To Specs	No Quote
Shell Side Δp allow. 0.3 psi	To Specs	To Specs	To Specs	No Quote
Cooling H_2O Flow gpm: 26,500	26,500	26,500	26,500	No Quote
Tube Length Max.: 40 ft.	~41'	Not Stated	46.5	No Quote
Number of Passes: Water Side	2	Not Stated	2	No Quote
Surface Area: As Required Sq. Ft.	53,800	45,000	58,000	No Quote
Cost of Tubes (Less Installation) @ $1.19/ft. 304L Welded, ERW .075" 22 ga.	~329,000	100,000 Est.	Included	No Quote
Temperature Outlet Gas °F 95	To Specs	To Specs	To Specs	No Quote
Condensate Outlet Temperature °F: 124 est.	Not Stated (Alt. 1 & 2) Not Stated	Not Stated -	Not Stated	No Quote
Dimensions: As Required (Overall)	18' W x 47.5' L	Not Stated	9'-10" W x 59'L x 17'H	No Quote
Inter- and Aftercondenser: & Ejectors Required	Yes	Yes	Yes	No Quote
Purchase Price $:	$1,119,000	$670,000	$750,000	No Quote
Delivery	Not Stated	Not Stated	32-36 Weeks	No Quote

EXCHANGER SPECIFICATION SHEET

4.2.8.1

PROJECT	GEYSERS RETROFIT	EXCHANGER MFR.	
PLANT	UNIT 3 OR 4	REQ. NO.	
EXCHANGER NO.		ITEM NO.	
SERVICE OF UNIT	MAIN CONDENSER		
SIZE	TYPE	CONNECTED IN	SERIES / PARALLEL
SURFACE PER UNIT	EFF. GR.	SHELLS PER UNIT	SURFACE PER SHELL EFF. GR.

PERFORMANCE OF ONE UNIT	SHELL SIDE	TUBE SIDE
FLUID CIRCULATED	STEAM + NONCONDENSABLES	COOLING WATER
TOTAL FLUID ENTERING LBS/HR	514,293	11,846,000
VAPOR		
LIQUID		(23,690 gpm)
STEAM		
NON-CONDENSIBLES	AIR 180 + N.C. GAS 4113 (MOL WT 32.4)	
FLUID VAPORIZED OR CONDENSED		
STEAM CONDENSED	500,420	
GRAVITY-LIQUID		1.0
VISCOSITY-LIQUID		
MOLECULAR WEIGHT-VAPORS		
SPECIFIC HEAT-LIQUIDS	1.0 B.T.U./#	1.0 B.T.U./#
LATENT HEAT-VAPORS	923.6 B.T.U./#	B.T.U./#
TEMPERATURE IN	°F	80 °F
TEMPERATURE OUT	NOTE 1 & 2 °F	119 °F
OPERATING PRESSURE ~~PSIG~~	@ INLET 2.05 PSIA	
NUMBER OF PASSES per Shell	ONE	
VELOCITY	FT./SEC.	7 FT./SEC.
PRESSURE DROP ALLOW/CALC.	0.25 / #/SQ.IN.	15 / #/SQ.IN.
FOULING ~~RESISTANCE~~ MIN.	HEI CLEANLINESS 70% →	

HEAT EXCHANGED - B.T.U./HR	462 X10⁶	M.T.D. (CORRECTED)	
TRANSFER RATE - SERVICE	CLEAN	ACTUAL FOULING FACTOR	

CONSTRUCTION	SHELL SIDE	TUBE SIDE
DESIGN PRESSURE	FULL VAC & 14.6 #/SQ.IN.	75 #/SQ.IN.
TEST PRESSURE	#/SQ.IN.	113 #/SQ.IN.
DESIGN TEMPERATURE	150 °F	150 °F

TUBES 304L SS	NO.	O.D. 3/4" BWG. 22 AVG. MIN. LENGTH	PITCH △ ◁ □ ◇
SHELL 304L SS	I.D. O.D.	THICKNESS	
SHELL COVER		FLOATING HEAD COVER	
CHANNEL		CHANNEL COVER C.S. (COAL TAR EPOXY LINED	
TUBE SHEETS - STATIONARY 304L SS		FLOATING	
BAFFLES - CROSS	TYPE	THICKNESS	
BAFFLE - LONG 304L SS	TYPE	THICKNESS	
TUBE SUPPORTS 304L SS		THICKNESS	
GASKETS			
CONNECTIONS - SHELL - IN	OUT	RATING	
-CHANNEL-IN	OUT	RATING	
CORROSION ALLOWANCE - SHELL SIDE NONE		TUBE SIDE NONE	
CODE REQUIREMENTS ASME TUBE SIDE, HEI		TEMA CLASS "C"	SPEC.
WEIGHTS - EACH SHELL	BUNDLE	FULL OF WATER	

NOTE INDICATE AFTER EACH PART WHETHER STRESS RELIEVED (S.R.) AND WHETHER RADIOGRAPHED (X-R)

REMARKS: -

NOTE 1. N.C. GAS + STEAM VAPOR SHALL BE COOLED TO 114°F
2. CONDENSATE SHALL BE COOLED TO 124°F
3. CONDENSATE HOT WELL SHALL HAVE MINIMUM HOLD UP OF 133 CU.FT.

REV.	DATE				JOB NO.	DRWG. NO.	REV.
△							
△							
△	6/1/79	ISSUED FOR REPORT NO. 1	BF	[illegible]	579007-20	DS-12-015	0

EXCHANGER SPECIFICATION SHEET

4.2.8.2

#					
1	PROJECT GEYSERS RETROFIT			EXCHANGER MFR.	
2	PLANT UNIT 3 OR 4			REQ. NO.	
3	EXCHANGER NO.			ITEM NO.	
4	SERVICE OF UNIT INTER CONDENSER				
5	SIZE	TYPE	CONNECTED IN	SERIES	PARALLEL
6	SURFACE PER UNIT	EFF. GR. SHELLS PER UNIT		SURFACE PER SHELL	EFF. GR.
	PERFORMANCE OF ONE UNIT				
		SHELL SIDE		TUBE SIDE	
7	FLUID CIRCULATED	STEAM + NONCONDENSABLES		COOLING WATER	
8	TOTAL FLUID ENTERING LBS/HR	44,113		1,030,000	
9	VAPOR				
10	LIQUID			(2060 gpm)	
11	STEAM				
12	NON-CONDENSIBLES	AIR 180 + N.C. GAS 4353 (MOL WT 32.4)			
13	FLUID VAPORIZED OR CONDENSED				
14	STEAM CONDENSED	38,620			
15	GRAVITY-LIQUID			1.0	
16	VISCOSITY-LIQUID				
17	MOLECULAR WEIGHT-VAPORS				
18	SPECIFIC HEAT-LIQUIDS		B.T.U./#	1.0	B.T.U./#
19	LATENT HEAT-VAPORS	1,042	B.T.U./#		B.T.U./#
20	TEMPERATURE IN	~160 °F	°F	80	°F
21	TEMPERATURE OUT	NOTE 1 & 2	°F	119	°F
22	OPERATING PRESSURE	@ INLET 4.75 PSIA			
23	NUMBER OF PASSES per Shell	ONE			
24	VELOCITY		FT./SEC.	7	FT./SEC.
25	PRESSURE DROP ALLOW/CALC.	0.1/	#/SQ.IN.	15/	#/SQ.IN.
26	FOULING RESISTANCE MIN.	0.0001		0.001	
27					
28	HEAT EXCHANGED - B.T.U./HR. 40.2 X10⁶		M.T.D. (CORRECTED)		
29	TRANSFER RATE - SERVICE	CLEAN		ACTUAL FOULING FACTOR	
	CONSTRUCTION				
30	DESIGN PRESSURE	FULL VAC + 60	#/SQ.IN.	75	#/SQ.IN.
31	TEST PRESSURE	90	#/SQ.IN.	113	#/SQ.IN.
32	DESIGN TEMPERATURE	210	°F	150	°F
33	TUBES 304L SS NO.	O.D. 3/4" BWG. 22 AVG. MIN.	LENGTH	PITCH	△ ◁ □ ◇
34	SHELL 304L SS	I.D. O.D.	THICKNESS		
35	SHELL COVER		FLOATING HEAD COVER		
36	CHANNEL		CHANNEL COVER C.S. (COAL TAR EPOXY LINED)		
37	TUBE SHEETS - STATIONARY 304 LSS		FLOATING		
38	BAFFLES - CROSS	TYPE	THICKNESS		
39	BAFFLE - LONG 304LSS	TYPE	THICKNESS		
40	TUBE SUPPORTS 304LSS		THICKNESS		
41	GASKETS				
42	CONNECTIONS - SHELL - IN	OUT	RATING		
43	-CHANNEL-IN	OUT	RATING		
44	CORROSION ALLOWANCE - SHELL SIDE NONE		TUBE SIDE NONE		
45	CODE REQUIREMENTS ASME	TEMA CLASS "C"		SPEC.	
46	WEIGHTS - EACH SHELL	BUNDLE	FULL OF WATER		
47	NOTE INDICATE AFTER EACH PART WHETHER STRESS RELIEVED (S.R.) AND WHETHER RADIOGRAPHED (X-R)				
48	REMARKS: -				
49	NOTE 1. N.C. GAS + STEAM VAPOR SHALL BE COOLED TO 110 °F				
50	2. CONDENSATE SHALL BE COOLED TO 120 °F				
51	3. CONDENSATE HOT WELL SHALL HAVE MINIMUM HOLD UP OF 27 CU. FT.				

REV.	DATE				JOB NO.	DRWG. NO.	REV.
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△							
△	6/1/79	ISSUED FOR REPORT NO. 1	BF	[illegible]	S-79007-20	DS-12-016	0

EXCHANGER SPECIFICATION SHEET

4.2.8.3

PROJECT	GEYSERS RETROFIT	EXCHANGER MFR.	
PLANT	UNIT 3 OR 4	REQ. NO.	
EXCHANGER NO.		ITEM NO.	
SERVICE OF UNIT	AFTER CONDENSER		
SIZE	TYPE	CONNECTED IN	SERIES PARALLEL
SURFACE PER UNIT	EFF. GR. SHELLS PER UNIT	SURFACE PER SHELL	EFF. GR.

PERFORMANCE OF ONE UNIT

	SHELL SIDE	TUBE SIDE
FLUID CIRCULATED	STEAM + NONCONDENSABLES	COOLING WATER
TOTAL FLUID ENTERING LBS/HR	17,593	338,000
VAPOR		
LIQUID		(676 gpm)
STEAM		
NON-CONDENSIBLES	AIR 180 + 4453 N.C. GAS (MOL WT 32.4)	
FLUID VAPORIZED OR CONDENSED		
STEAM CONDENSED	12,710	
GRAVITY-LIQUID		1.0
VISCOSITY-LIQUID		
MOLECULAR WEIGHT-VAPORS		
SPECIFIC HEAT-LIQUIDS	1.6 B.T.U./#	1.0 B.T.U./#
LATENT HEAT-VAPORS	~1042 B.T.U./#	B.T.U./#
TEMPERATURE IN	~201 °F	80 °F
TEMPERATURE OUT	NOTE 1 & 2 °F	119. °F
OPERATING PRESSURE	@ INLET 14.1 PSIA	
NUMBER OF PASSES		
VELOCITY	FT./SEC.	7 FT./SEC.
PRESSURE DROP ALLOW/CALC.	0.1/ #/SQ.IN.	15/ #/SQ.IN.
FOULING RESISTANCE MIN.	0.0001	0.001

HEAT EXCHANGED - B.T.U./HR.	13.2 x 10^6 BTU/HR	M.T.D. (CORRECTED)	
TRANSFER RATE - SERVICE	CLEAN	ACTUAL FOULING FACTOR	

CONSTRUCTION

	SHELL SIDE	TUBE SIDE
DESIGN PRESSURE	FULL VAC + 60 #/SQ.IN.	75 #/SQ.IN.
TEST PRESSURE	90 #/SQ.IN.	113 #/SQ.IN.
DESIGN TEMPERATURE	210 °F	150 °F

TUBES 304L SS	NO. O.D. 3/4" BWG. 22 AVG. MIN.	LENGTH	PITCH △◁□◇
SHELL 304L SS	I.D. O.D.	THICKNESS	
SHELL COVER		FLOATING HEAD COVER	
CHANNEL		CHANNEL COVER C.S. (COAL TAR EPOXY LINED	
TUBE SHEETS - STATIONARY 304L SS		FLOATING	
BAFFLES - CROSS	TYPE	THICKNESS	
BAFFLE - LONG 304L SS	TYPE	THICKNESS	
TUBE SUPPORTS 304L SS		THICKNESS	
GASKETS			
CONNECTIONS - SHELL - IN	OUT	RATING	
- CHANNEL - IN	OUT	RATING	
CORROSION ALLOWANCE - SHELL SIDE NONE		TUBE SIDE NONE	
CODE REQUIREMENTS ASME	TEMA CLASS "C"	SPEC.	
WEIGHTS - EACH SHELL	BUNDLE	FULL OF WATER	

NOTE INDICATE AFTER EACH PART WHETHER STRESS RELIEVED (S.R.) AND WHETHER RADIOGRAPHED (X-R)

REMARKS: -

NOTES 1. N.C. GAS + STEAM VAPOR SHALL BE COOLED TO 110°F
2. CONDENSATE SHALL BE COOLED TO 136°F
3. CONDENSATE HOT WELL SHALL HAVE MINIMUM HOLD UP OF 27 CU.FT.

REV.		DATE				JOB NO.	DRWG. NO.	REV.
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	△							
	△	6/1/79	ISSUED FOR REPORT NO.1	BF	[illegible]	5-7900-20	DS-12-017	0

EQ 304

PLANT: UNIT NO. 3 OR 4

	1st Jet	2nd Jet
A. INLET CONDITIONS		
1. MOTIVE STEAM		
Enthalpy (BTU/lb.) @ 78.9 psia	1200	1200
Available Pressure @ Jet psia	65	65
Flow Required (lb./hr.):		
Preliminary Eng. Calc.	~30,000	~12,000
Manufacturer Calc. *		
2. INLET GASES		
Air leakage (lb./hr.)	180	180
N. C. Gas (Mol. wt. 32.4) (lb./hr.)	4,110	4,340
Steam Vapor (lb./hr.)	9,580	960
Temperature (°F)	114	110
Pressure (psia)	1.7	4.65
B. DISCHARGE CONDITIONS		
Temperature (°F) *		
Pressure (psia)	4.85	14.1

C. SITE CONDITIONS

Temperature (°F) 65°F WET BULB

Pressure (psia) 13.9

*To be specified by Supplier

No.	Date	Description		Ck.	R.App	C.App
0	6/1/79	ISSUED FOR REPORT NO. 1	BF			

ROGERS ENGINEERING CO., INC.
111 PINE STREET
SAN FRANCISCO, CALIF. 94111

Geysers Retrofit Project
Flow/Thermodynamic information Sheet

DRAWING NO: DS-12-027 REV.: 0

JOB NO. S-79007-20 Client PGandE Date SHEET OF

DS-022

DATA SHEET FOR CENTRIFUGAL PUMPS

FOR PG&E Retrofit Project NO. 4.2.8.5

ITEM NO.

SITE Geysers UNIT 3 or 4

SERVICE Condensate Pump MOTOR DRIVE ✓ TURBINE DRIVE

PUMP MFR SIZE AND TYPE NO. REQ'D. 2 per unit.

API STD. 610 APPLIES. YES NO X

OPERATING CONDITIONS		RATED		PERFORMANCE
LIQUID Water containing dissolved H_2S	U.S. gpm at 124°F	1116		PROPOSAL CURVE NO
°F 124	DISCH PRESS., ~~psig~~	38.0	psia	NPSH REQ'D (WATER), ft
SP GR at 124°F = 0.99	SUCT PRESS., ~~psig~~	5.5	psia	NO. OF STAGES RPM
VAP PRESS at 124°F psia 1.89	DIFF PRESS., psi	32.5		DES EFF BHP
VIS at SSU	DIFF HEAD, ft	75		MAX BHP RATED IMP
CORR/EROS caused by dissolved H_2S	NPSH AVAIL., ft	6		MAX HEAD RATED IMP, ft
				MIN CONTINUOUS, gpm (BY MFR)

CONSTRUCTION AND MATERIALS

CASING-MOUNTING (CENTERLINE) (FOOT) (BRACKET) (VERTICAL X)

SPLIT (AXIAL) (RADIAL)

TYPE (SINGLE VOLUTE) (DOUBLE VOLUTE) (DIFFUSER X)

TAPPED OPENINGS (VENT) (DRAIN) (GAGE CONNS.)

NOZZLES	SIZE	ASA RATING	FACING	POSITION
SUCTION				
DISCHARGE				

IMPELLER DIAM RATED MIN MAX TYPE

MFR'S BEARING NO. RADIAL THRUST

LUBRICATION LUBRICATOR TYPE & SIZE

COUPLING TYPE OR MAKE SIZE BASE PLATE

CPL'G GUARD, MEETING Cal. OSHA SAFETY REQMTS.

PACKING

MECH SEAL ✓ CLASS CODE MFR

Crane preferred.

ROTATION FACING COUPLING END

WATER COOLING

BEARINGS

STUFF. BOX

PEDESTAL

GLAND

TOTAL WATER REQ'D, gpm

PACKING COOLING

FLUSHING

AUX PIPING

MATERIAL CODE — EXTERNAL CASING INTERNAL PARTS

	INTERNALS CODE	I	B	S	C	X
I - CAST IRON	IMPELLER	I	B	S	C	SS 316
B - BRONZE	INNER CASE PARTS	I	I	S	C	SS 316
S - STEEL	SLEEVE (PACKED)	Ch	Ch	Af	Af	SS 316
C - 11-13% CHROME	SLEEVE (SEAL)	C	C	C	C	SS 316
A - ALLOY	WEAR PARTS	I	B	Ch	Ch	
h - HARDENED	SHAFT	S	S	S	S	SS 316
f - FACED						
X - AS NOTED						

SHOP TESTS	REQUIRED	WITNESSED
RUNNING PERF		
NPSH		
HYDROSTATIC PSIG		

MAX ALLOW. WP PSIG F

WEIGHTS: PUMP BASE

MOTOR TURBINE

MOTOR DRIVER BY

ITEM NO. MTD BY

HP RPM FRAME

MFR

TYPE TEFC INSUL

ENC. TEMP RISE C

VOLTS/PHASE/CYCLES 460/3/60

BEARINGS LUBE

FULL LOAD AMPS

TURBINE DRIVER BY

ITEM NO. MTD BY

HP RPM MAT'L

MFR and TYPE

INLET STEAM psig TEMP F

EXHAUST

STEAM RATE, FL lb/BHP/HR

BEARINGS LUBE

NOZZLES	SIZE	ASA RATING	FACING	POSITION
INLET				
EXHAUST				

MFR FINAL DATA (AS BUILT)

ACTUAL IMPELLER DIAM

TEST CURVE NO.

OUTLINE DWG. NO.

PUMP SECT. DWG. NO.

SEAL DIM. DWG. NO.

PUMP SERIAL NO.

Notes: 1) The selected pump casing & impellers shall be sized to allow for an increase of at least 5% in head at design flow by a change of impeller diameter.
2) The selected pump shall include a flow inducer

NO.	DATE					JOB NO.	DRAWING NO.	REV.
0	5/29/79	Issued for Milestone Report No. 1	EZ	[illegible]	[illegible]	S-79007-20	14-003-A & 14-003-B	0

PR 252

POWER ______ VOLTS ______ CYCLES ______ PHASES ______
STEAM ______ PSIG ______ °F
EXHAUST PRESS ______

VERTICAL CENTRIFUGAL PUMP DATA SHEET

MANUFACTURER: 4.2.8.6
SPECIFICATION NO. ______ REQ. NO. ______

INSTRUCTIONS TO BIDDERS- FILL IN EVERY SPACE FOR EACH PUMP TO MAKE BID COMPLETE

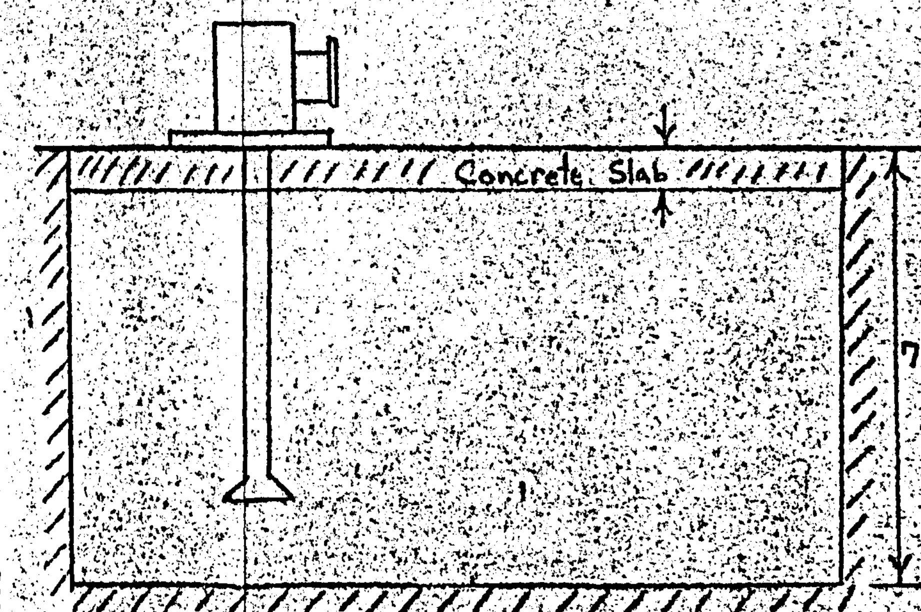
PUMP NUMBER	Unit 3 or 4		
A. SERVICE Cooling water circ pumps (2 required.)			
TYPE OF INSTALLATION (WELL, PIT, SUMP, DOUBLE CASE)	Sump		
B. LIQUID CHARACTERISTICS			
LIQUID PUMPED	Water		
SPECIFIC GRAVITY AT FLOW TEMP	1.0		
FLOW TEMP F	80.0		
VISCOSITY AT FLOW TEMP (CENTISTOKES) (SSU)			
VAPOR PRESSURE AT FLOW TEMP PSIA	0.507		
C. CAPACITY AND PRESSURES			
GPM AT FLOW TEMP	16,282		
SUCTION AT PUMP (IF NOT OPEN SUCTION) PSIA	15.4		
DIFFERENTIAL (INCL. LIFT FROM INLET) PSI	44		
DISCHARGE (AT DISCH. CONN.) PSIA	59.4		
DIFFERENTIAL HEAD (TOTAL, NOT INCL. VEL. HEAD) FT	104		
NPSH A) REQ'D & B) AVAILABLE	32		
SUBMERGENCE A) REQ'D & B) AVAILABLE	3		
ENTRANCE VEL. AT IMPELLER EYE AT RATING FT/SEC			
IMPELLER EYE AREA SQ IN.			
MAX CASE WORKING PRESSURE PSIG			
D. MANUFACTURER'S SIZE & TYPE PUMP			
TYPE PUMP			
NUMBER OF STAGES			
SERIAL NUMBER (ON FINAL DATA SHEET)			
E. OPERATION			
RPM			
EFFICIENCY AT RATING %			
BHP AT RATING			
MAX BHP FOR BID IMPELLER DIAMETER			
DRIVER HORSEPOWER			
IMPELLER DIAMETER, MAXIMUM/MINIMUM IN.			
IMPELLER DIAMETER FOR RATING IN.			
ROTATION (CW) (CCW) VIEWED FROM TOP			
DRIVE: (MOTOR) (TURBINE) (RT ANGLE GEAR)			
DRIVER TO BE FURNISHED BY			
MOTOR OR TURBINE DATA SHEET NO.			
MOTOR TYPE (TEFC) (WEATHERPROOF) (EXPL PRF)			
NEMA FRAME NO. OF MOTOR			
F. CONSTRUCTION AND MATERIAL			
CASE: OUTER	SS 316		
INNER	SS 316		
IMPELLER TYPE (OPEN) (CLOSED) (AXIAL) (MIXED FLOW)			
IMPELLER MTL	SS 316		
CASE WEAR RINGS			
IMPELLER WEAR RINGS	SS 316		
SHAFT IN PUMP BOWL	SS 316		
LINESHAFT	SS 316		
LINESHAFT DIAMETER			
LINESHAFT BEARING SPACING			
SHAFT SLEEVES	SS 316		
SHAFT ENCLOSING TUBE	SS 316		
DISCHARGE COLUMN OR PIPE	SS 316		
DISCHARGE HEAD OR ELBOW	SS 316		

LANTERN RING			
THROAT BUSHING			
CASING STUDS			
GLAND BOLTS			
GLAND			
BASEPLATE OR FLOOR PLATE			
COUPLING (RIGID) (FLEXIBLE) MANUFACTURER			
STRAINER			
FLOAT CONTROLS (TYPE & MFR)			
G. STUFFING BOX DETAILS			
STUFFING BOX, JACKETED OR PLAIN			
MECHANICAL SEAL - TYPE			
DIMENSIONS: LENGTH OF STUFF-BOX IN.			
INSIDE DIAM. IN.			
DIAM SHAFT OR SHAFT SLEEVE IN.			
WIDTH LANTERN RING IN.			
℄ LANT RING TO OPEN END OF BOX IN.			
NO. RINGS & SIZE PACKING			
H. BEARINGS AND LUBRICATION			
TYPE BEARINGS - THRUST (SAE NO.)			
RADIAL (SAE NO.)			
LINESHAFT			
PUMP BOWL			
LUBRICATION: W = WATER, O = OIL, G = GREASE			
THRUST			
RADIAL			
LINESHAFT			
PUMP BOWL			
TYPE OF CLOSURES			
TYPE AND CAP. OF LUBRICATOR FOR PUMP			
TYPE AND CAP. OF LUBRICATOR FOR DRIVER OR GEAR			
THRUST BEARING TYPE AND CAPACITY			
THRUST LOAD (NORMAL / MAX)			
THRUST LOAD (AT START)			
THRUST BEARING LOCATION (MOTOR, HEAD, PUMP, ETC.)			
CLEARANCE ADJUSTMENT (COLLAR, NUT, COUPLING, ETC.)			
J. TESTING			
DYNAMIC BALANCING OF IMPELLERS AT RATED SPEED			
PERFORMANCE TEST (WITNESSED) (NOT WITNESSED)			
HYDROSTATIC TEST (WITNESSED) (NOT WITNESSED)			
HYDROSTATIC TEST PRESSURE PSIG			
INSPECTION REQUIRED ?			
RUNNING TEST WITH ACTUAL DRIVER			
K. MISCELLANEOUS			
PRICE, EACH (FOB) (FAS) (NOT INCL. DRIVER)			
EXTRA COST FOR DRIVER			
EXTRA COST FOR			
EXTRA COST FOR			
WT. OF BARE PUMP LB.			
WT. OF GEAR			
WT. OF DRIVER			
INPUT AND OUTPUT SPEEDS OF GEAR			
SHIPMENT FROM RECEIPT OF ORDER WEEKS			

OUTLINE DIMENSION DRAWING NO.			
CROSS SECTION DRAWING NO.			
PERFORMANCE CURVE			
L. DIMENSIONAL DATA			
SIZE OF BASE PLATE (DIAM) OR (__ X __)			
DEPTH, BASE PLATE TO BOTTOM OF ASSEMBLY			
BOTTOM OF PIT TO BOTTOM OF ASSEMBLY			
INLET TO BOTTOM OF ASSEMBLY (IF VERT. INLET)			
MAX & MIN SUBMERGENCE			
SIZE OF WELL OR PIT			
MAX HT ABOVE BASE OR FLOOR (NORMAL)			
MAX HT ABOVE BASE OR FLOOR FOR PULLING PUMP			
MAX LIFT (LBS) FOR MAINTENANCE			
SUCTION, VERTICAL OR HORIZONTAL			
SIZE & RATING			
FACING			
FACE TO ℄ SHAFT (IF HORIZ)			
DIST. ABOVE OR BELOW BASE (STATE WHICH)			
DISCHARGE VERTICAL OR HORIZONTAL			
SIZE & RATING			
FACING			
FACE TO ℄ SHAFT			
DIST. ABOVE OR BELOW BASE (STATE WHICH)			

USE THIS SPACE FOR NOTES OR SKETCHES

Notes: 1) Water contains corrosive H_2S.
2) The selected pump casing and impellers shall be sized to allow for an increase of at least 5% in head at design flow by a change of impeller diameter.



REV.	DATE		DATE
0	5/29/79 Issued for Milestone Report 1 JEJ [illegible]		

PG&E Retrofit Project

JOB NO. S-79007-20 REV.
DWG. NO. 14-004-A-1, 14-004-B — 0

Q315

Rogers

The main C. W. pumps as bid to specification varied from a low of $171,500 (Byron Jackson) to a high of $224,053 (Worthington). A figure of $165,000 was used in the cost estimate; adjusted to cover the reduction in pump capacity from 17,275 gpm to 16, 282 gpm. These pumps are rated at 60% system capacity.

The condensate pumps as bid to specification resulted in one bid of $27,500 (Worthington). In this case a judgment was made to use a figure of $20,000 since we believe other bidders would, given time, bid a figure less than Worthington.

4.3 Installation Description

4.3.1 The dimensions verifications in the field were based on design drawings obtained from PGandE and the drawings showing the proposed location of the tube and shell condenser and the associated equipment. It should be noted that the location and configuration of the turbine exhaust duct of Unit 3 is different from Unit 4. Therefore, the principal of the proposed modification is the same but not the detailed execution.

The passageway between the turbine building and the cooling tower has been kept clear, being the main artery of this plant and exits from the turbine building to this area are unobstructed as well. The lowest point of the main condenser shell should be 15'-0" above grade.

With the assumed main condenser length of 46'-0" it seems that sufficient space is available to install the new equipment. The total required length including tube pulling area is 100'-0". This allows a clearance from the property cyclone fence of 4'-0".

4.3.2 The intercondenser can be mounted in the existing steel structure as the existing equipment.

4.3.3 The aftercondenser also will be located in the existing steel structure.

4.3.4 The steam ejectors will be supported in the existing steel structure.

4.3.5 The circulating water pump as specified and will be installed on the existing concrete pad before the cooling tower.

The existing condensate pump will be removed and replaced by a horizontal centrifugal pump as specified.

Rogers

4.3.6 The existing hot and cold well has to be modified to allow free communication between the two wells and also allow the installation of two circulating water pumps.
(Refer to B-02-003)

The existing cooling tower and condenser supply pumps did not meet the required 15 psi pressure drop across the tube side of the surface condenser to satisfy the new system discharge head requirement.

A small ~ 30 gpm existing drip pump delivering drips to the existing hot well should have its discharge rerouted to the new shell condenser drip pot.

The water from the tower presently has a pH value between 7 and 8. There has been no direction at this time to change the pH range.

The auxiliary power requirements for the new pumps will increase.

It should be noted that the main circulating water pumps are 50% each nominally; however, the two new condensate pumps are capable of supplying 100% of the required flow at full load. As shown in the cooling water system diagram the condensate pumps will discharge into the circulating water return header to the cooling tower. The project costs of the pumps installed are detailed in the project costs section of this report. The system characteristics are shown on drawings at the end of this section.

4.3.7 The installation and location of the tube and shell condenser at Unit 3 are shown on the enclosed drawings. The principle applied at Unit 3 was followed at Unit 4. The only variance is the turbine exhaust duct configuration of Unit 4.

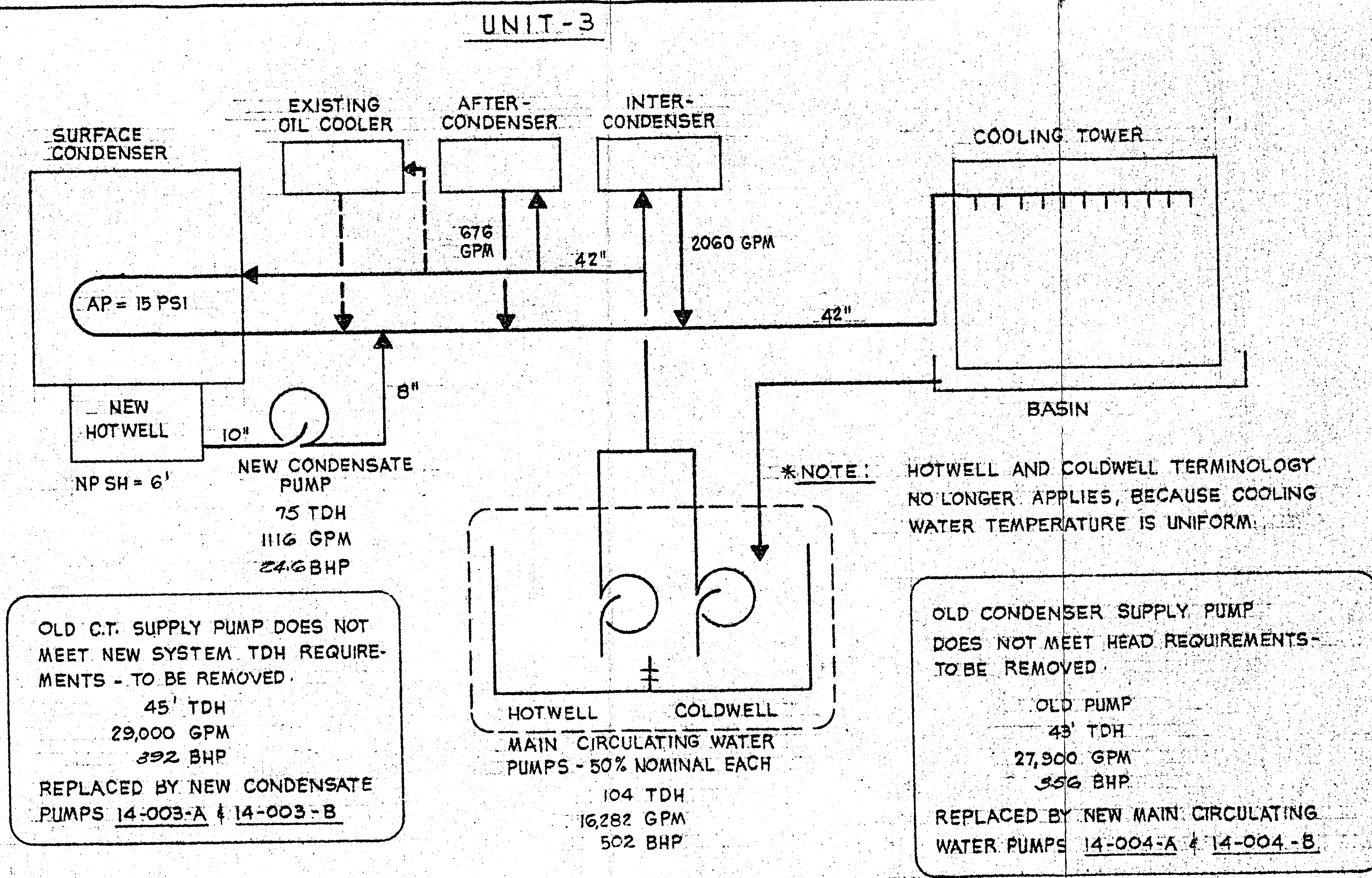
The east corner of the power building of Unit 4 has some equipment retired in place. This machinery will have to be removed before new equipment can be installed.

4.3.8 Site Plan - Units 3 and 4

Enclosed herein is a Site Plan for Units 3 and 4, indicating the new conversion equipment locations with existing field survey dimensions on the presently existing equipment. This survey data was obtained from actual site investigations.

4.3.9 Auxiliary Power Requirements

The auxiliary power requirements at full load as designed and the additional power necessary for the pumps after retrofit for Units 3



REV.	DATE	REVISION	ENG.	CHK.	RECO. APPR.	CLIENT APPR.
0	7/3/79	ISSUED FOR MILESTONE REPORT #1	EJM	BF	[illegible]	

ROGERS ENGINEERING CO., INC.
ENGINEERS & ARCHITECTS
111 PINE STREET, SAN FRANCISCO, CALIF. 94111

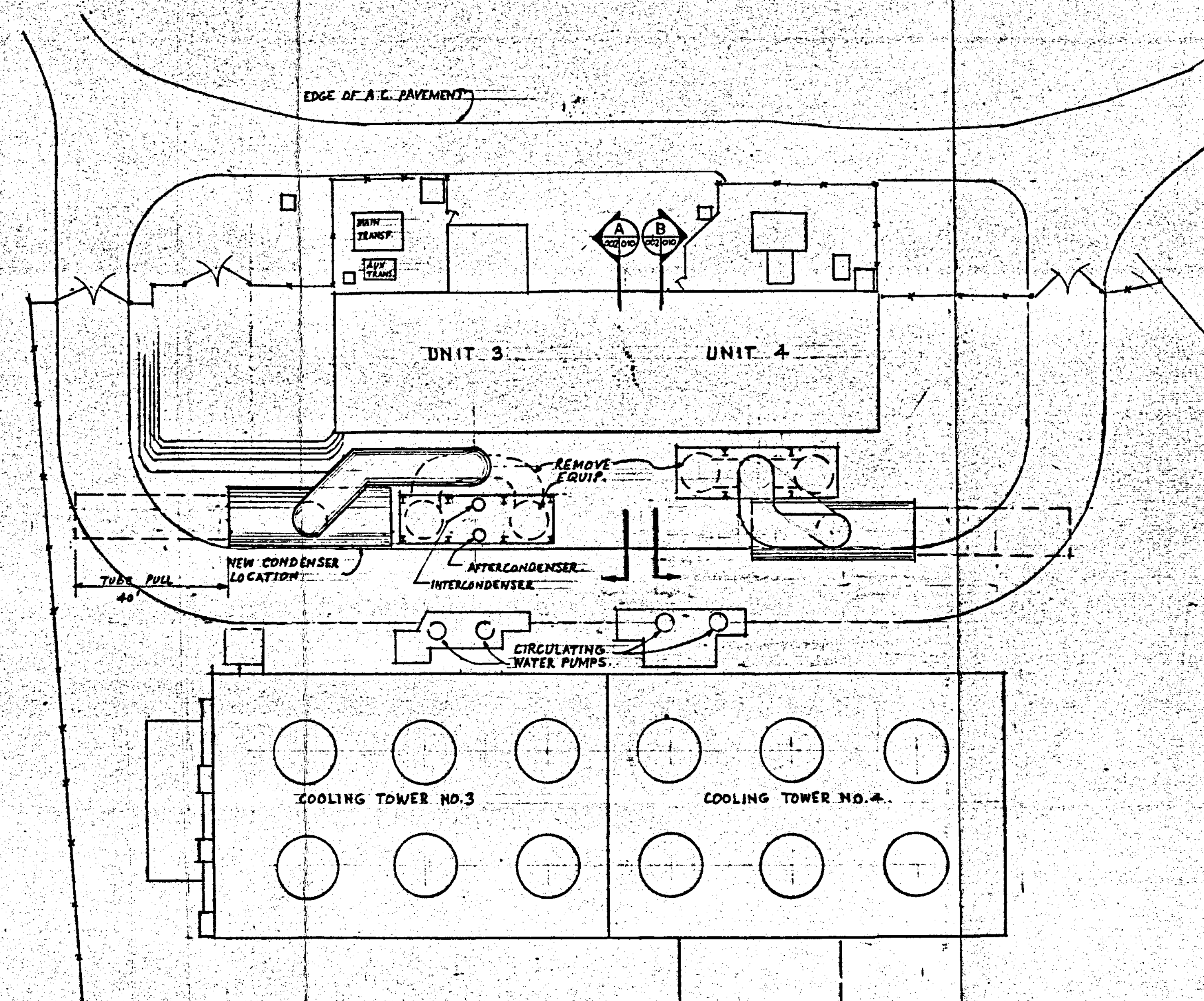
SCALE: NONE DATE 5-29-79
DR. GO CHK. EJM ENG. EJM APPROVED [illegible]

APPROVED: DATE

PG and E RETROFIT PROJECT
UNIT 3 COOLING WATER SYSTEM

JOB NO. S79007-10
B-02-003
REV. 0

DG-002



SITE PLAN - UNITS 3 & 4

1" 20'-0"

REFERENCE DRAWINGS	REV.	ZONE	DATE	REVISION	DR.	CHK.	APPR. RECO	APPR.
	0		5/31/79	ISSUED FOR MILESTONE REPORT #1	E.A.	LFW		

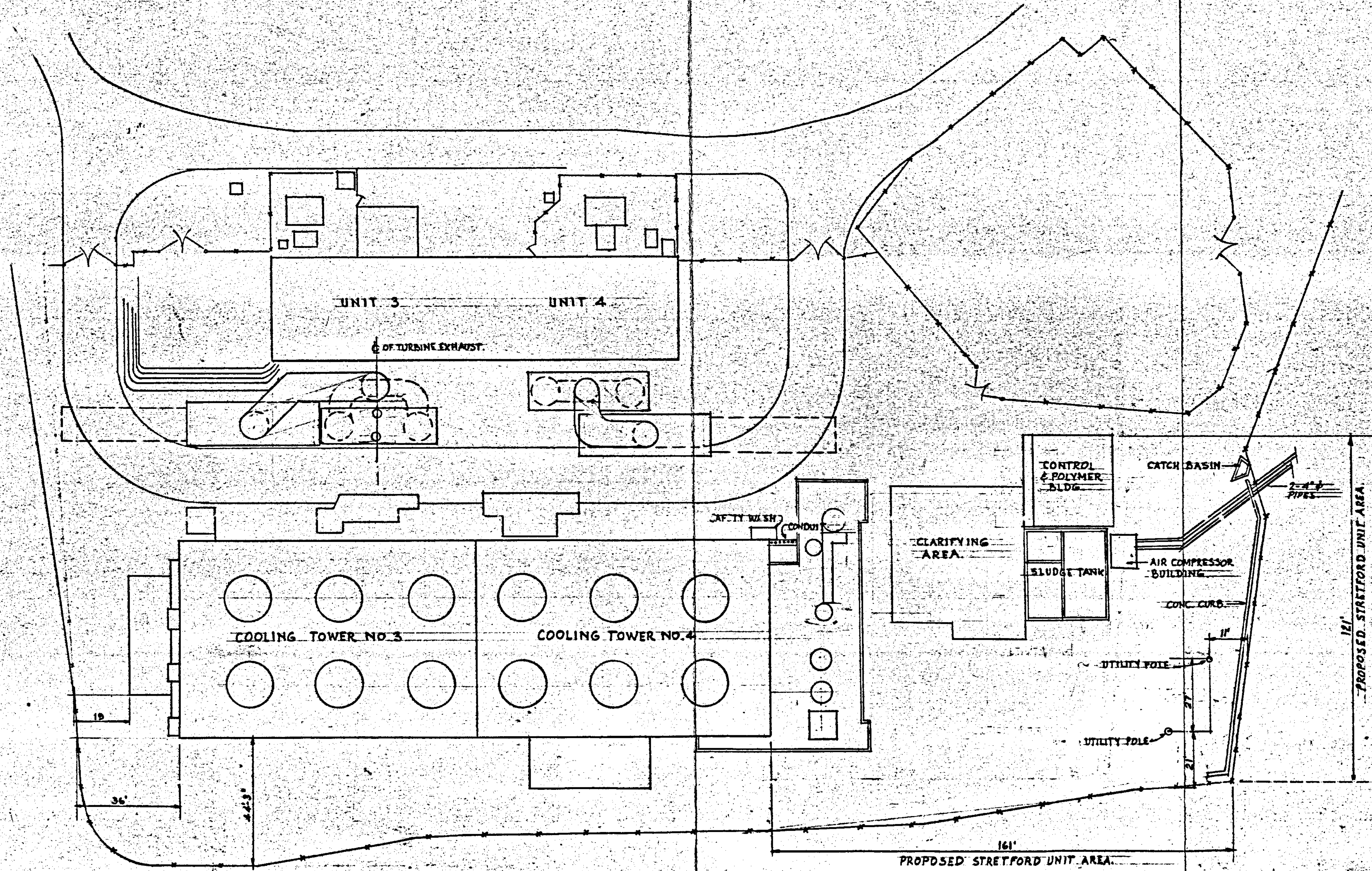
ROGERS ENGINEERING CO., INC.
ENGINEERS - ARCHITECTS
111 PINE STREET, SAN FRANCISCO, CALIFORNIA 94111

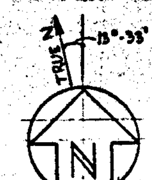
SCALE 1" = 20'-0" DATE 5-29-79
DR. E.A. CHK. LFW ENG. EJM APPROVED

APPROVALS
DATE
DATE

P G and E RETROFIT STUDY
UNITS 3 & 4
SITE PLAN

JOB NO. S-79007 | SK-002 | 0





UNIT 3 & UNIT 4 SITE PLAN WITH PROPOSED STRETFORD UNIT AREA

REFERENCE DRAWINGS	REV.	ZONE	DATE	REVISION	DR.	CHK.	APPR. RECO	APPR.
	0		5/31/79	ISSUED FOR MILESTONE REPORT #1	E.A.	LFN	[signature]	

ROGERS ENGINEERING CO., INC.
ENGINEERS • ARCHITECTS
111 PINE STREET, SAN FRANCISCO, CALIFORNIA 94111

SCALE 1" = 20'-0" DATE 5-25-79

DR. E.A. CHK LFN ENG. EJM APPROVED [signature]

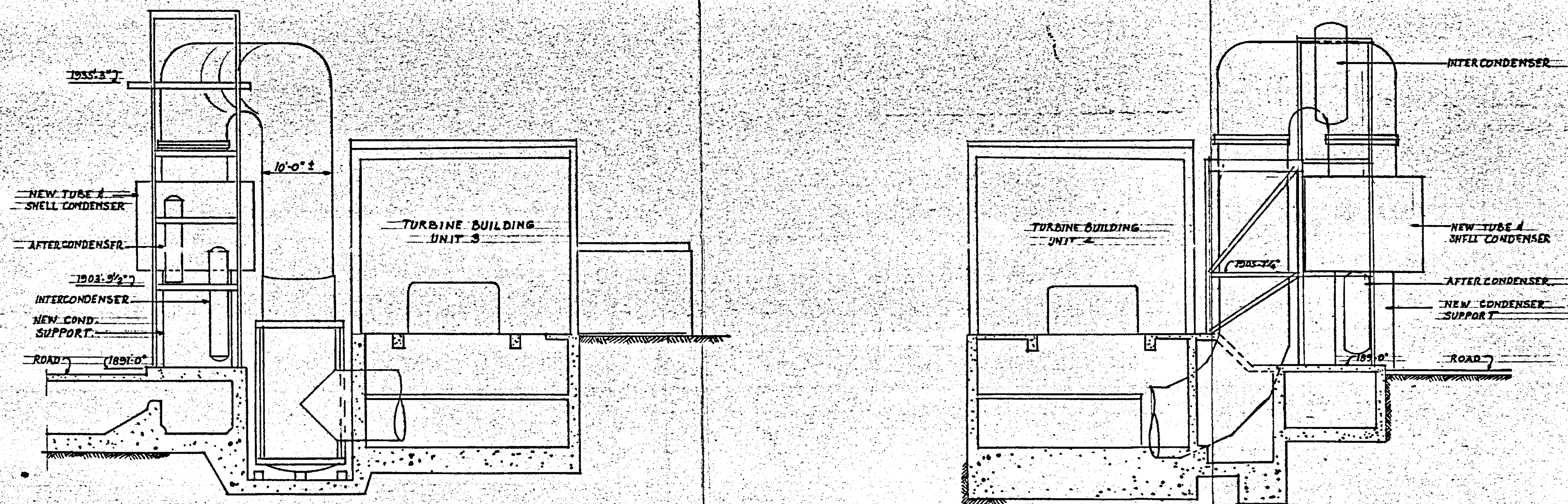
APPROVALS

DATE

DATE

PG and E RETROFIT STUDY
PROPOSED STRETFORD UNIT SITE
FOR UNITS 1 TO 6

JOB NO. S 79007 | SK-006 | 0



SECTION A (002/010)
UNIT 3

SECTION B (002/010)
UNIT 4

REV.	ZONE	DATE	REVISION	DR.	CHK.	APPR. RECO	APPR.
0		5/31/79	ISSUED FOR MILESTONE REPORT # 1	E.A.	LFW		

REFERENCE DRAWINGS

ROGERS ENGINEERING CO., INC.
ENGINEERS • ARCHITECTS
111 PINE STREET, SAN FRANCISCO, CALIFORNIA 94111

SCALE NONE DATE 5-31-79
DR. E.A. CHK. LFW ENG. EJM APPROVED

APPROVALS
DATE
DATE

PG and E RETROFIT STUDY
UNITS 3 & 4
SECTIONS A-A & B-B

JOB NO. S-79007 SK-010 0

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and 4 are shown below. (It should be noted that these figures do not include the power needed for the compressors to deliver the off-gas to the Stretford System.)

Unit	Name Plate Amp.	Name Plate kVA	Actual Loading Amp	After Retrofit Amp
#3--------→	1443	1200	1425	1587
#4--------→	1443	1200	1400	1560

Based on these figures, it appears that the auxiliary transformers of Units #3 and #4 are somewhat deficient in load capacity. Additional transformer capability will be needed for Units #3 and #4. The costs associated with such are small in comparison to the total Unit #3 and #4 retrofit costs and have not been included in this Milestone Report No. 1. They will be included however, in the detail design phase of this program. (Reference PGandE Station Service Electric Loads as of May 14, 1979.)

4.4 Project Costs - Unit 3 and 4

This milestone report is a mid-term report presenting partial cost and economic information pertaining to Units 3 and 4 surface condenser installation. This report presents two economic aspects: Equipment sizing and capital cost. Each case has certain guide lines and constraints. They will be discussed in this Section along with the respective data.

The cost estimate has been prepared by categories and are those accounts used by Pacific Gas and Electric for their own estimates. Only the following accounts are included by the nature of this project work.

- 54-20 Turbine Generator - Condensate System
- 54-30 Turbine Generator - Circulating Water System
- 54-70 Turbine Generator - Instrumentation
- 55-60 Auxiliary Electrical Equipment - Station Power

The cost figures in this Section are in June 1979 dollars. These will be modified due to escalation and project timing when a schedule is prepared later in the overall project.

4.4.1 Equipment Sizing Evaluation:

The process used to evaluate alternative equipment sizes and design operating conditions is a specialized procedure. It requires that alternatives be equivalent. By nature the alternatives have differences; however, by drawing the same boundary around each alternative the differences crossing this boundary can be evaluated in terms of dollars. This procedure is only an evaluation tool. It is not necessarily how the costs are incurred.

The technical parameters and differences for equipment design conditions were evaluated economically in Tables 3.2 and 3.3 in a previous section. These differences and conclusions of economics and technical design parameters are applicable to Units 3 and 4 equipment comparisons and are not repeated (See Section 4.0). However, the actual design point was determined separately for Units 3 and 4.

This discussion of equipment sizing, alternatives and equivalences is used to arrive at the first step in the cost estimate process, which is the selection of the design conditions for the installation. The second and third steps can follow: getting manufacturer quoted major equipment costs and estimating the installation costs a contractor will charge to perform the designated quipment installation.

4.4.2 Major Equipment Cost:

Suppliers of the major equipment, condensers and pumps, were contacted by telephone followed up by transmittal of pertinent equipment data sheets (See 4.2.8). In the majority of cases, vendors were contacted who have had some experience in the special problems associated with geothermal plants.

The following item costs are adjusted quoted figures:

Condensers and Ejectors
Condensate Pumps
Circulating Water Pump

The Section 4.2.9 compares the quotations with the data sheets sent out for quote. In addition, any adjustments required because of design condition changes from those quoted are also addresses. The costs in the estimate for each piece of major equipment reflect our best judgment as to the eventual bid on the "selected" equipment data sheets.

In the cost estimate presented in Section 4.4.4, the manufacturer's cost includes the major equipment and materials cost. Cost at the site in the presentation includes 6 percent use tax on equipment and material and a contingency of 20 percent since this is a conceptual estimate and unestimated items may amount to that figure. The

Rogers

estimate assumes that Pacific Gas and Electric will purchase all major equipment and supply it to the contractor for installation as has been the practice at the Geysers Plant.

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4.4.3 Installation Cost:

The estimated installation cost is the cost anticipated to be charged by an outside contractor to perform the removal of the old and installation of the new equipment. Most of the larger project construction work at the Geysers has been done by outside contractors and this guide has been used in preparation of this estimate. This decision affects the labor overheads and labor efficiency as well as the general overheads of a GM estimate discussed in Section 4.4.4.

The estimated materials and labor shown in Section 4.4.4 are based upon the conceptual layout drawings and field investigations at the

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site for each installation. There is also some judgment used whenever making such an estimate and this estimate has been prepared by people who have been a part of other geothermal plant construction.

In consultation with General Construction about contractor performance and costs at the Geysers certain figures were developed for use in this conceptual report. The current labor direct rates show a $15 per hour to be an overall good concept estimate direft figure. The labor efficiency has been estimated to be 60 percent and has been used in the estimate. The contractor overhead includes his profit and all indirect expenses. It has been estimated that 55 percent is a good value from past Geysers experience in contractor bidding.

In addition to the above basic parameter discussions a twenty percent contingency has been included in the direct man-hours for this conceptual estimate. The labor man-hours shown in Section 3.4.4 are derived as follows:

Manhours = Basic Estimate x One Divided By Efficiency x Contingency
2.0 = 1.0 x 1.67 x 1.2

The costs for direct labor and labor overhead are separated in the detailed estimate of Section 4.4.4.

4.4.4 GM Estimate:

The GM Estimate preparation is the last step in the cost estimate process. The GM estimate is used to get moneys approved for the project. Engineering Services in consultation with Engineering and General Construction puts the final GM numbers together. Engineering Services has been consulted in the methods and factors used in preparation of GM estimates.

4.4.4.1 Cost Estimate

The factors included in the Equipment and Material and labor parts of the estimate have been discussed in Sections 4.4.2 and 4.4.3. The cost estimate for the removal and installation of specified equipment to facilitate the operation of a surface condenser at Unit 3 typical for Unit 3 and 4 is here presented in summary account form. The account details are itemized in the next table from the summary.

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TABLE 4.4.1

SUMMARY COST ESTIMATE - UNIT 3

Account	Description	Equip. & Mat'l	Labor	Total
54-20	Condensate System	$1,392,331	$ 346,652	$1,738,983
54-30	Circ. Water System	521,138	112,755	633,893
54-70	Instrumentation	19,080	13,046	32,126
55-60	Station Pwr System	39,432	13,046	52,478
	Totals	$1,971,981	$ 485,499	$2,457,480

The estimated cost in June 1979 dollars to retrofit Unit 3 for a surface condenser is $2,500,000. To this estimate sub total must be added the GM overheads.

4.4.4.2 GM Overheads and Cost Total

The GM overheads are a function of who does the construction. The estimate prepared here is based upon an outside contractor doing the construction.

The overheads include:

Item	Percent of Estimate
Indirects	0.0
General Engineering & Administration	16.0
ADC (9 month Construction Estimate)	3.6
Ad Valorem	1.0
Total	20.6%

The GM Estimate Cost total for the retrofit of Unit 1 is estimated to be $2,964,000.

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4.4.5 Energy Charge:

The capital involved to accomplish the retrofit using a surface condenser will require a levelized annual energy charge of 2.41 mills per kilowatthour. This calculation uses the generation planning charge rate, an 80 percent capacity factor and the calculated net output power on the process diagram. The energy charge and GM estimate capital do not include the vent gas processing equipment for environmental control. These are treated separately in later work.

The analysis presented reflects only the physical installation costs. The economic comparison with alternative methods adds cost differences between methods in addition to the above stated costs. The economic comparative analysis is part of later work.

ROGERS ENGINEERING CO., INC.
1 PINE STREET
SAN FRANCISCO, CALIF. 94111

JOB NO. S-79007

G-023

TABLE 4.3
COST ESTIMATE DETAIL
UNIT 3 SURFACE CONDENSER

ROGERS ENGINEERING CO.,INC. COST ESTIMATE

JOB NAME- UNIT NO 3 JOB NO.- S79007 CLIENT- P G AND E ESTIMATE DATE- 31 MAY 79

ITEM NO.	DESCRIPTION	MFG COST	COST@SITE	MANHOURS	LABOR DOL	TOT DOL
54-21-1	CONDST PMP CONCRETE	500.	636.	281.	4208.	4844.
54-21-2	CONDST PMP EXC &BKFL	600.	763.	501.	7515.	8278.
54-22-1	TBN EXT PIPNG STLWK	4000.	5088.	501.	7515.	12603.
54-22-2	RMV PRT SUPT STRUCTR	1000.	1272.	321.	4810.	6082.
54-23-1	RMV CONDENSER	5000.	6360.	2084.	31262.	37622.
54-23-2	COND STEELWORK	12000.	15264.	1603.	24048.	39312.
54-23-3	COND MECH	2500.	3180.	5010.	75150.	78330.
54-23-4	COND M,INT,AFT &EJTR	862500.	1097100.	0.	0.	1097100.
54-24-1	CONDST PMP MECH	40000.	50880.	601.	9018.	59898.
54-25-1	COND PIPNG &MISC	13000.	16536.	1403.	21042.	37578.
54-25-2	CONDST PIPNG & EQPT	12000.	15264.	601.	9018.	24282.
54-25-3	TBN EXT MECH &PIP MT	141500.	179988.	2004.	30060.	210048.
			--------	--------	--------	--------
BASE COSTS,MHS			1392331.	14910.	223646.	1615978.
OVERHEAD/PROFIT			0.		123006.	123006.

ITEM NO.	DESCRIPTION	MFG COST	COST@SITE	MANHOURS	LABOR DOL	TOT DOL
54-31-1	CW PMP CONCRETE	3000.	3816.	1283.	19238.	23054.
54-31-2	CW PIPNG EXC &BKFL	1200.	1526.	601.	9018.	10544.
54-33-1	CW PIPNG PIPE &EQPT	55000.	69960.	1603.	24048.	94008.
54-34-1	CW PMP MECH	350000.	445200.	1202.	18036.	463236.
54-39-1	RELOCATE FIRE MAIN	500.	636.	160.	2405.	3041.
			--------	--------	--------	--------
BASE COSTS,MHS			521138.	4850.	72745.	593884.
OVERHEAD/PROFIT			0.		40010.	40010.

ITEM NO.	DESCRIPTION	MFG COST	COST@SITE	MANHOURS	LABOR DOL	TOT DOL
54-74-1	INSTMT CONDST SYS	9000.	11448.	281.	4208.	15656.
54-74-2	INSTMT CW SYS	6000.	7632.	281.	4208.	11840.
			--------	--------	--------	--------
BASE COSTS,MHS			19080.	561.	8417.	27497.
OVERHEAD/PROFIT			0.		4629.	4629.

ITEM NO.	DESCRIPTION	MFG COST	COST@SITE	MANHOURS	LABOR DOL	TOT DOL
55-64-1	CW PMP ELECTRICAL	27000.	34344.	401.	6012.	40356.
55-64-2	CONDST PMP ELECT	4000.	5088.	160.	2405.	7493.
			--------	--------	--------	--------
BASE COSTS,MHS			39432.	561.	8417.	47849.
OVERHEAD/PROFIT			0.		4629.	4629.

DRAWING NO. - - -

REV.

SHEET - OF -

Rogers

PROJECT CONFERENCE NOTE

Number 23
ROGERS Job No. S-79007-02
Date 11 May 1979
Place San Ramon
By S. W. Giampapa

CONFIRMATION OF CONFERENCE (Telephone ____ Meeting X)

ATTENDING:

PGandE
P. McClure
G. Dorighi
D. Barton

Rogers
S. Giampapa

SUBJECT: PGandE Geysers Retrofit Project
Meeting at PGandE, Department of Engineering Research,
San Ramon - May 11, 1979 (all day)

The definitive non-condensible gas criteria to replace plant data book values for engineering and design are listed below for use in sizing and costs of the Stretford System. These values are also applicable in condenser performance analysis and evaluation.

Unit No.	Main Steam Design (lb./hr.)	Design Total N.C. (%) wt.	Design H_2S (lb./hr.)	NH_3 (lb./hr.)
1	250,820	0.5	45	28
2	246,150	0.5	45	28
3	532,920	0.8	214	196
4	540,190	0.8	214	196
5	968,000	0.8	350	265
6	968,000	0.8	450	265
7	968,000	0.5	315	186
8	968,000	0.5	175	128
9	968,000	0.5	78	34
10	968,000	0.5	95	36
11	1,888,260	0.85	867	411
12	1,888,260	0.5	190	86

The above design criteria was agreed to by PGandE's Dave Barton at DER, Friday, May 11. Rogers is in agreement to these design criteria for the Geysers Retrofit Project.

Distribution:

ROGERS

HR	SWG
BF	JTK
LFW	JHGS
HIR	EJM
FDD	RGB
HCS	File: S-79007

CLIENT
J.P. Finney
J.R. Gormly
D. Barton

OTHERS

DG-016

Rogers

PROJECT CONFERENCE NOTE (Cont'd)

Number 23
Job Number S-79007-02
Date 11 May 1979

The selected basis for the N. C. gas composition in the steam from 1977-1978 UOC data and 1979 DER data is as follows:

Pipeline No.	M. W. Avg.	PPM (wt.) CH_4	H_2	N_2	H_2S	CO_2	Ar*	NH_3
1	30.3	101	50	22	178	2800	0	111
3	32.4	293	85	65	397	7300	6.2	367
5	31.9	195	67	55	350	5200	0	274
6	29.4	361	94	69	450	5200	0	274
11	35.6	175	61	65	392	8000	0	217

*In excess of air

Data for compilation was submitted by Dave Barton on May 10 in the form of the following reports:

1. Geysers Power Plant,March 4, 1976, Non-condensible Gases by J. Pietruszkiewicz to L. J. Ezzell.

2. Estimate of H_2S Emissions from Geysers Geothermal Power Plants by L. R. Krumland to C. J. Weinberg, April 7, 1978.

Additional data was obtained at DER. Pete McClure has indicated that data older than one year has been influenced by a UOC piping matrix and field piping distribution change.

Attached is our John Stuart's trend compilation of H_2S, NH_3, and total N. C. in the main steam supply from years 1976 through 1978 for PGandE's review.

SWG:mvw

Rogers

PGandE Geysers
N. C. Gas Sample Comparisons
Compilation of Trend 1976-78

	PGandE 3/4/76*			Union Oil 1977			Union Oil 1978		
UNIT	ppm wt. H_2S	ppm wt. NH_3	N.C. Total %	H_2S	NH_3	N.C. %	H_2S	NH_3	N.C. %
1 and 2	149	148	.6	177	123	0.3	178	113	0.3
3 and 4	377	335	.59	419	334	0.8	397	370	0.8
5 and 6	298	226	.64	335	299	0.5	288	274	0.6
7	275	167	.5	274	198	0.5	302	192	0.7
8	275	167	.5	211	137	0.2	168	133	0.4
9	134	22	.5	87	13	0.2	75	35	0.3
10	134	22	.5	98	12	0.3	92	37	0.4
11	204	143	.43	392	238	0.9	404	219	1.1**
12							104	46	0.2

*Excludes gases contained in the sample condensate.

**0.85 on test 3 days later. Above was from new wells.