PGandE GEYSERS RETROFIT PROJECT

MILESTONE REPORT NO. 2

(UNITS 5-12)

RECO Job No. S-79007

June 29, 1979

ROGERS
Engineering • San Francisco

DISCLAIMER

HR

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MILESTONE REPORT NO. 2

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MILESTONE REPORT NO. 2

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MILESTONE REPORT NO. 2

OUTLINE (Cont'd)

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1.0 INTRODUCTION

Milestone Report No. 1 was delivered on June 1, 1979 and related to the conversion of Units 1 - 4.

Milestone Report No. 2 describes the conversion of Units 5 - 12 from direct contact condensers which use the iron-catalyst/peroxide/caustic systems to surface condensers and H_2S abatement with the Stretford Process Unit.

This Report is a 10 week progress report that specifically addresses itself to the differences that are encountered between Units 5 - 6, 7 - 10 and 11 - 12. The task schedule shown in the Summary Section was originally presented to PGandE at the Project Kick-Off Meeting on Monday, April 23.

Units 11 and 12 retrofit concept which appears in this report was evaluated with a two pass surface condenser running parallel to the turbine shaft. This concept requires the relocation of the turbine lube oil tank, instrument air compressor and battery storage rack facilities. On Wednesday, June 27, the condenser supplier notified Rogers Engineering that it was feasible to design and install a four pass, two tube bundle condenser at right angle condenser to the turbine-generator shaft.

The four pass condenser concept will eliminate the need of relocating equipment sensitive to turbine operation. However, schedule requirements for Milestone Report No. 2 left no time to incorporate the benefits of the concept we believe will be recommended by Rogers. It will appear in the Final Milestone Report No. 4.

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2.0 SUMMARY

Milestone Report No. 2 presents technical and cost values for the surface condenser retrofit of Units 5 through 12. The Stretford Process Treatment of main condenser vent gases appears in a separate report titled "Milestone No. 3" issued concurrently with this report.

Page 2-2

2.1

1st # should have "exclusive of the power requirement for the Stretford process"

2nd #

The 43,000 gpm is for condenser alone — actual gpm is 47,040 ~~00~~ from Flow Sheet.

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2.1 UNITS 5 AND 6

The net power output for each turbine generator unit will be decreased from the existing net power of 53,020 kW to after conversion retrofit of a net power output per unit of 52,034 kW.

Two tube bundles will be installed in the condenser shell to provide for part load operation equal to 50% of full load when one tube bundle is being cleaned. The tube side cooling water flow originates at a wet pit adjacent to the cooling tower. Two half-sized vertical circulating water pumps discharge 43,000 GPM through underground FRP pipe that has a match line with stainless steel pipe above grade at the condenser water box.

A dry pit extending in front of the condenser water boxes and below grade for future tube installation and pulling operation is structured to withstand maximum truck loads when hauling equipment to and from the plant. The project costs at the time of Milestone No. 2 Report indicate:

GM Estimate Cost Total for Retrofit of Unit 5 and 6 is $4,747,300 and will result in an additional energy charge of 1.91 mills per kWh for each unit.

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2.2 UNITS 7 THROUGH 10

The operating performance differs from Units 5 and 6 because the cooling tower cold water out temperature differs by 1/2°F. The steam rate differs slightly however for this report. The net power output for each existing unit is 53,020 kW and the net after retrofit is 52,034 kW per unit. Otherwise the apparent difference is in circulating water system piping arrangement. All other features, such as two condenser tube bundles, inter and after condenser arrangement, condensate pump location and condenser tube bundles at right angles to the turbine shaft axis are similar.

The GM Estimate Cost Total for Retrofit is estimated to be the same as 5.

This will result in an additional energy charge of 1.91 mills per kWh for each unit.

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2.3 UNITS 11 AND 12

The turbine-generator is two turbines in tandem driving one alternator for this unit. The net power output for the existing unit is 106,000 kW. After retrofit the net power output will be 103,708 kW for both Units 11 and 12.

Two approaches are being investigated. Two, double pass tube bundles running parallel to the turbine shaft axis and two, four pass tube bundles at right angles to the turbine shaft. Schedule restrictions permit presentation of the two pass tube bundle only for this report.

The final report will discuss the benefits of the right angle, four pass tube bundle installation, which does not require relocation of the lube oil tank, associated pumps, and the plant and instrument air facilities.

The GM estimate cost total for retrofit of each unit is $8,927,300

The GM Estimate Cost Total for Retrofit of Units 11 will result in an additional energy charge of 1.80 mills per kWh.

WEEK OF	9	16	23	30	7	14	21	28	4	11	18	25	2	9	16	23	30	7
	APRIL				MAY				JUNE				JULY					
UNIT NO. 1																		
PROJECT MANAGEMENT AND TECHNICAL DIRECTOR																		
OPTIMIZE POWER CYCLE FOR SURFACE CONDENSER																		
OBTAIN QUOTES ON CONDENSER																		
DETERMINE LOCATION AND INSTALLATION COST FOR CONDENSER																		
RESIZE AND COST C.W. CIRCULATING PUMP, CHECK FAN CAPACITY AND NEW HOTWELL PUMP																		
SUMMARY COSTS AND CAPACITY																		
UNIT NO. 3																		
OPTIMIZE POWER CYCLE FOR SURFACE CONDENSER																		
OBTAIN QUOTES ON CONDENSER																		
DETERMINE LOCATION AND INSTALLATION COST FOR CONDENSER																		
RESIZE AND COST C.W. CIRCULATING PUMP, CHECK COOLING TOWER CAPACITY AND NEW HOTWELL PUMP																		
SUMMARY COSTS AND CAPACITY																		
SUBMIT INTERIM REPORT																		
UNIT NO. 5																		
DETERMINE MAXIMUM SIZE AND COST OF SURFACE CONDENSER BASED ON SPACE AVAILABILITY																		
RESIZE AND COST C.W. CIRCULATING PUMP, CHECK COOLING TOWER CAPACITY, SIZE NEW HOTWELL PUMP																		
OPTIMIZE POWER CYCLE ON BASIS OF AVAILABLE SURFACE																		
SUMMARY COSTS AND CAPACITY																		
UNIT NO. 11																		
DETERMINE MAXIMUM SIZE AND COST OF SURFACE CONDENSER BASED ON SPACE AVAILABILITY																		
OPTIMIZE POWER CYCLE																		
RESIZE AND COST C.W. CIRCULATING PUMP, CHECK COOLING TOWER CAPACITY, COST NEW HOTWELL PUMP																		
SUMMARY COST AND CAPACITY																		
SUBMIT INTERIM REPORT																		
STRETFORD UNIT FOR UNITS 1-6																		
DETERMINE FEED GAS QUANTITY AND OBTAIN PHONE QUOTATION, BASED ON AREAL REQUIREMENT																		
LOCATE SITE FOR UNIT																		
ESTIMATE INSTALLATION COST FOR THE STRETFORD UNIT																		
DESIGN AND ESTIMATE COST OF GAS GATHERING PIPING SYSTEM																		
DETERMINE OPERATING AND MAINTENANCE COSTS																		
PREPARE COST BENEFIT ANALYSIS																		
STRETFORD UNIT FOR UNITS 7-12																		
DETERMINE FEED CAPACITY & OBTAIN QUOTES FOR COMBINED UNIT IF PRACTICABLE; OTHERWISE, INDIVIDUAL UNITS																		
BASED ON AREAL REQUIREMENTS, LOCATE APPROPRIATE SITE FOR THE COMBINED STRETFORD UNIT (REVIEW WITH RESPECT TO UNITS 13 AND 14)																		
ESTIMATE INSTALLATION COST FOR THE STRETFORD UNIT																		
DESIGN AND ESTIMATE COST OF GAS GATHERING PIPING																		
DETERMINE OPERATING AND MAINTENANCE COST FOR THE STRETFORD UNIT																		
SUBMIT INTERIM REPORT																		
PREPARE COST BENEFIT ANALYSIS																		
SUBMIT FINAL REPORT																		
* UNITS 1-3-5-11																		
CONDENSER REPLACEMENT																		
a) COST COMPARISON; b) TECHNICAL PROBLEMS; c) DIRECT CONTACT REMAINING LIFE																		
STRETFORD SYSTEM INSTALLATION																		
a) MULTIPLE SITES, ONE S.S. b) PIPING-CONDENSER TO S.S. c) BATCH VS. CONTINUOUS																		
SCHEDULE OF WORK																		
MANPOWER REQUIREMENT FOR SURFACE CONDENSER DESIGN AND CONSTRUCTION FOR EACH PACKAGE																		
OPERATIONAL COST COMPARISON																		
a) AVAILABILITY AND CAPACITY FACTORS; b) MAINTENANCE AND REPLACEMENT;																		
c) CHEMICALS AND MATERIALS; d) AUXILIARY POWER REQUIREMENTS																		
RECOMMENDATIONS																		
a) CAPACITY-AVAILABILITY; b) OUTAGE-CAPACITY AND COST;																		
c) SCHEDULE-ESCALATION AND TRADEOFF; d) CURRENT TECHNOLOGY;																		
e) OPERATING COSTS; f) CONSTRUCTION AND ENGINEERING COSTS																		

DATA FROM PG&E

COST ANALYSIS FOR ALL UNIT PKGES

* COST BENEFIT ANALYSIS FOR UNITS 1, 3, 5 & 11

▲ = MILESTONES

REV.	ZONE	DATE	REVISION	DR.	CHK.	APPR. RECO.	APPR.
1		4/23/79	ISSUED FOR MAKE-SHARE & CO.	HE	SG		
2		4/30/79	ISSUED FOR KICK-OFF	HE	SG		

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

SCALE _____ DATE 4-20-79

DR. H.E. CHK. S.G. ENG. _____ APPROVED

PACIFIC GAS AND ELECTRIC CO.
GEYSERS PROJECT

APPROVALS

DATE

DATE

TASK SCHEDULE

JOB NO. S-79007

D - 07 - 001 | 1

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3.1 Equipment Sizing Criteria - Unit 5 or 6 and Units 7 thru 10

The Post Overhaul Performance Test for Unit 5 data wad examined for the 1976, 1977 and 1978 test periods. It was estimated that for the retrofit conceptual design an approach of 15.5°F could be obtained at a range of 37.7°F by a thorough cleaning of the cooling tower during the retrofit turn around. Similarly for Units 7 thru 10 it was estimated that an approach of 16.0°F could be obtained at a range of 37.6°F.

In order to prepare preliminary specifications for the entire surface condenser and steam jet ejector system the conceptual design was roughed out at a turbine exhaust of 4.3 inches of Hg Abs. (2.11 psia). It was assumed that the various equipment suppliers wouls respond to the specification by submitting proposals which would allow adjusting the conceptual design toward conditions of maximized power (as limited by the cooling tower). The conceptual design is shown on Drawing No. PD-004.

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TABLE 3.1

COMPARATIVE SUMMARY

UNIT 5 OR 6 (Unit 5 Typical)

	Base Reference Design Point	Conversion Retrofit
Throttle Flow lb./hr.	907,530	907,530
Noncondensable Gas % Wt.	1.0	0.8
General Electric Output kW	55,000	54,101
Auxiliary Power (Electric) kW		
Cooling Tower Fans	605	605
Miscellaneous Total	445	445
Circ. Water & Cond. Pumps	930	1,017
Noncondensable Gas Blower		(Later)
Net Unit Output kW	53,020	52,034 (1)
Heat Input Btu/Hr. (Ref. to 60°F)	$1,150 \times 10^5$	$1,140 \times 10^6$
Net Heat Rate Btu/kWh	21,690	21,910
Turbine Exh. Inch Hg Abs	4	4.3
Wet Bulb	65.0	65.0
C. W. T. Range/Approach °F	38.4	37.7/15.5

(1) Without Noncondensable Gas Blower Debit

*For expected gross output, multiply actual field output of unit by retrofit derating factor of 0.984

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TABLE 3.2

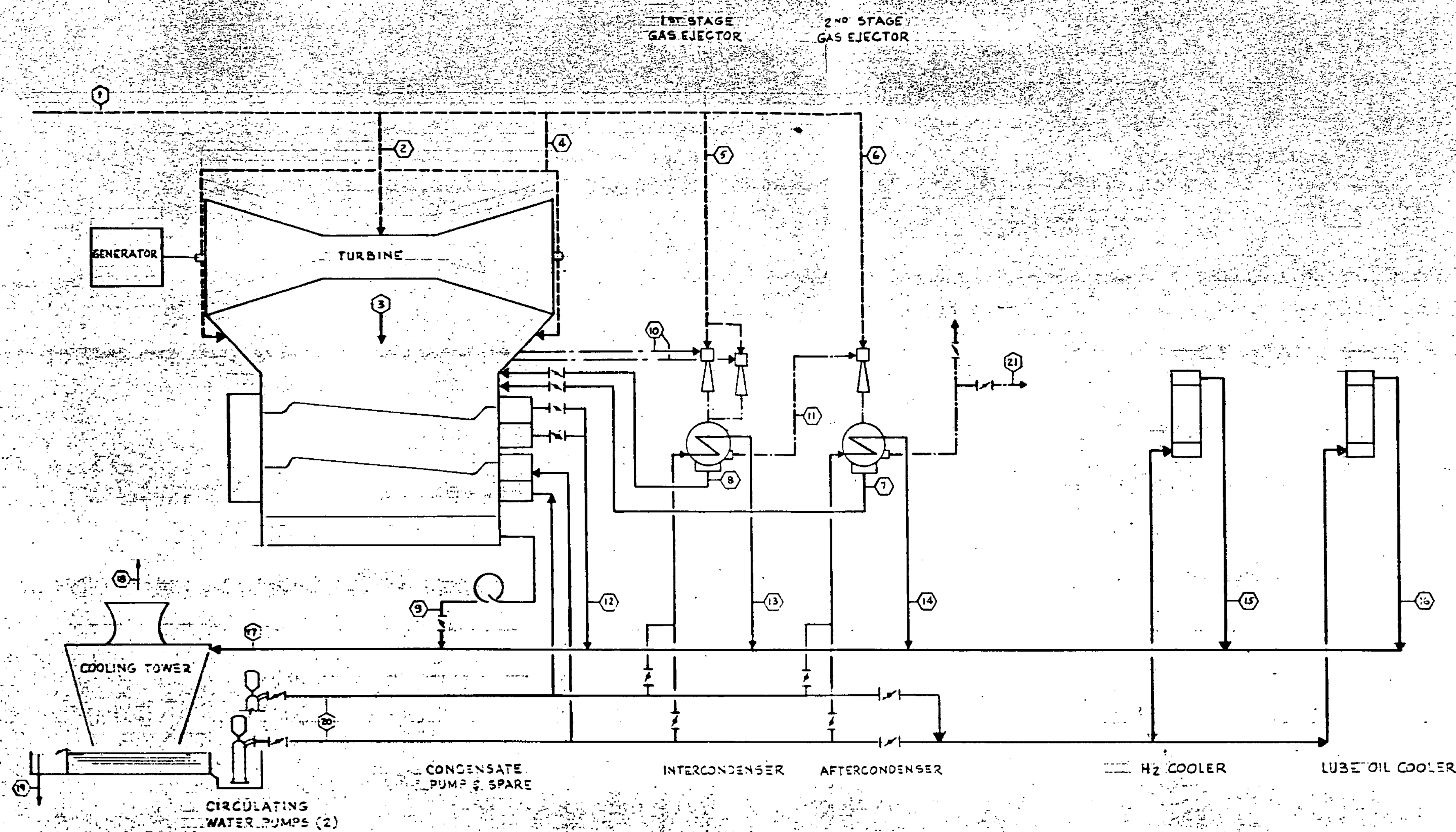
COMPARATIVE SUMMARY

UNITS 7 THRU 10 (Unit 7 Typical)

	Base Reference Design Point	Conversion Retrofit
Throttle Flow lb./hr.	907,530	907,530
Noncondensable Gas % Wt.	1.0	0.5
General Electric Output kW	55,000	54,101
Auxiliary Power (Electric) kW		
Cooling Tower Fans	605	605
Miscellaneous Total	445	445
Circ. Water & Cond. Pumps	930	1,017
Noncondensable Gas Blower		(Later)
Net Unit Output kW	53,020	52,034 (1)
Heat Input Btu/Hr. (Ref. to 60°F)	$1,150 \times 10^5$	$1,114 \times 10^6$
Net Heat Rate Btu/kWh	21,690	21,410
Turbine Exh. Inch Hg Abs	4	4.3
Wet Bulb	65.0	65.0
C. W. T. Range/Approach °F	40.4	37.6/16.0

(1) Without Noncondensable Gas Blower Debit

*For expected gross output, multiply actual field output of unit by retrofit derating factor of 0.984



STREAM NO.	MOL. WT.	UNIT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
FLOWS IN LB/HR.		5 OR 6																					
STEAM	18	↓	972,660	907,530		2,130	42,000	21,000				12,110	1,590										470
NON CONDENSABLE GAS	31.9		7,844	7,319		15	340	170				7,319	7,659										6,275
AIR	29											440	440										440
CONDENSATE									21,120	52,520	969,060			21,500,000	1,450,000	600,000	98,200	72,000	24,689,260	855,500	113,560	23,720,200	
COOLING WATER																							
PRESSURE PSIA			113.7		2.11																		
ENTHALPY BTU/LB			1200		993.5																		
TEMPERATURE °F			355								125.0			118.0	118.0	118.0	102.5	99.5	118.2		80.5	80.5	
		7 THRU 10																					
STEAM	18	↓	950,660	907,530		2130	30,000	11,000	11,770	37,330	899,110	8,420	1,090										320
NON CONDENSABLE GAS	29.4		4,776	4,560		.11	150	55				4,710	4,765										3,821
AIR	29											440	440										440
CONDENSATE																							
COOLING WATER														21,500,000	1,350,000	500,000	88,200	72,000	24,468,400	866,500	81,700	23,520,200	
PRESSURE PSIA			113.7		2.11																		
ENTHALPY BTU/LB			1200		993.5																		
TEMPERATURE °F			355								125.0			118.5	118.5	118.5	103.0	100.0	118.6		81.0	81.0	

MAXIMUM H_2S VALUES	UNIT 5	UNIT 6
	317	407

MAXIMUM H_2S VALUES	UNIT 7	UNIT 8	UNIT 9	UNIT 10
	278	155	69	84

REFERENCE DRAWINGS | REVISION | REVISION

0 | 6/12/79 | ISSUED FOR REPORT | EA | BF

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

SCALE NONE DATE 6-7-79
DR. E.A. CHK. ENG. BF APPROVED [signature]

APPROVALS
DATE
DATE

PG and E RETROFIT STUDY
UNITS 5 THRU 10 CONVERSION
PROCESS FLOW DIAGRAM

JOB NO. S 79007 | PD-004 | 0

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3.2 Specifications for Equipment for Conversion from Direct Contact to Surface Type Heat Exchangers for Units 5 thru 10

The required conditions are detailed in Specification S-12-001, Rev. 1.

SPECIFICATON
FOR
SURFACE TYPE CONDENSERS
WITH
STEAM JET EJECTORS
FOR
55 MW TURBOGENERATORS

AT

PGandE GEYSERS POWER PLANTS

UNITS 5 THRU 10

Prepared by

ROGERS ENGINEERING CO., INC

SAN FRANCISCO, CALIFORNIA 94111

No.	Date	Description	Ck	R.App	C.App
1	6/28/79	ADDED GAS COOLING PAR. 5.1.4 - ISSUED FOR REPORT	BF		
0	6/7/79	ISSUED FOR QUOTATION	BF		

ROGERS ENGINEERING CO., INC. 111 PINE STREET SAN FRANCISCO, CALIF. 94111	MAIN CONDENSER UNITS 5 THRU 10 PGandE GEYSERS RETROFIT PROJECT	SPECIFICATION S-12-001	REV. 0
JOB NO. S-79007	Client PGandE Date	SHEET 1 OF 9	

GS-004

TABLE OF CONTENTS

1.0 PERFORMANCE REQUIREMENTS

1.1 Generation capability to be maximized within the constraints imposed by the existing cooling water tower capability, the availability of area for tube sheets and space for tube length and the desirability of maintaining a turbine throttle steam flow near existing conditions of 907,530 lbs./hr. Supplier shall be responsibile for complete design of condensing and vacuum system components for maximum power generation.

2.0 STEAM CONDITIONS

	Turbine Inlet	Steam Jet Inlet
Enthalpy Btu/lb. - 1,200		
Entropy Btu/lb. x R - 1.608		
Pressure psia - 113.7		105.7
Temperature °F - 355		355

Turbine exhaust (existing for reference only)

Pressure-psia (in. Hg Abs.) - 1.964 (4.0)

Enthalpy - Btu/lb. - 990 (calculated)

Gross Power @ 4 in. Hg Abs. - 55,000 kW

3.0 NONCONDENSABLE GAS CONDITIONS

Unit	% Wt. in Steam	Ave. Mol. Wt.
5 or 6	0.8	31.9
7 thru 10	0.5	29.4

4.0 AIR LEAKAGE ALLOWANCE

Units 5 thru 10 - 440 lb./hr. each

5.0 CONSTRAINTS

5.1 Cooling Water Availability (Best Preliminary Values)

5.1.1 Main Condenser

Unit	Item	
5 or 6	Cold °F	80.5
	Rise °F	37.5
	Flow gpm	43,000
7 thru 10	Cold °F	81.0
	Rise °F	37.5
	Flow gpm	43,000

5.1.2 Intercondenser

Unit	Item	
5 or 6	Cold °F	80.5
	Rise °F	37.5
	Flow gpm	2,900
7 thru 10	Cold °F	81.0
	Rise °F	37.5
	Flow gpm	2,700

5.1.3 Aftercondenser

Unit	Item	
5 or 6	Cold °F	80.5
	Rise °F	37.5
	Flow gpm	1,200
7 thru 10	Cold °F	81.0
	Rise °F	37.5
	Flow gpm	1,000

5.1.4 Main, Inter- and Aftercondenser Gas Cooling Exit Temperatures Preferred.

Units	Condenser	
5 thru 10	Main	114°F
	Inter	110°F
	After	110°F

5.2 Space Availability

Unit	Item
5 thru 10	Main Condenser (Note 1)
	Preferred Design
	Flow Split - Two Inlets and Two Outlets
	Passes - Two
	Tube Sheet Area - 35 sq. ft. x 4 Each End
	Tube Length - 40 ft. Maximum
	- 34 ft. Minimum
	Hot Well ~ 20 Ft. x 34 Ft. x (9" Minimum Depth)
	Inter- or Aftercondenser
	Tube Length - 16 Ft. Maximum
	Passes - Three Preferred

NOTE 1: Existing condenser (Information Only)
Opening approximately 10 ft. x 15 ft. and transists to a hemispherical section of 11 ft. radius by 30 ft. long. This upper section 22 ft. wide x 30 ft. long extends 12 ft. deep terminating in a flat bottomed hotwell. See SK-11 for equipment arrangement with surface condenser.

6.0 CONSTRUCTION

6.1 Main Condenser

Pressure

Shell Side - Full Vacuum to 14.6 psia

Tube Side - 75 psig

Temperature

Shell Side - 150°F

Tube Side - 150°F

HEI Cleanliness Factor - 70%

Tubes - 22 Ga x Δ pitch x size (3/4", 7/8" or 1")

Materials

Shell 304L SS Clad Steel

Internals - All 304L SS

Tube Sheets - All 304L SS

Tubes - 304L SS

Water Box Covers - Carbon Steel, Coal Tar Epoxy Lined

Code Requirements

Heat Exchanger Institute

ASME - Tube Side Only

6.2 Inter- or Aftercondensers

Pressure

Shell Side - Full Vacuum to 40 psig

Tube Side - 75 psig

Temperature

Shell Side - 210°F

Tube Side - 150°F

TEMA Fouling Resistance - Total 0.0011

Tubes - 3/4" x 22 Ga x Δ pitch

Materials

Shell, internals, tube sheets and tubes - All 304L SS

Water Channel Covers - Carbon Steel, Coal Tar Epoxy Lined

Code Requirements

ASME

TEMA Class "C"

6.3 Steam Jets

Pressure - Full Vacuum - 150 psi

Temperature °F - 355

Materials - All 304L SS

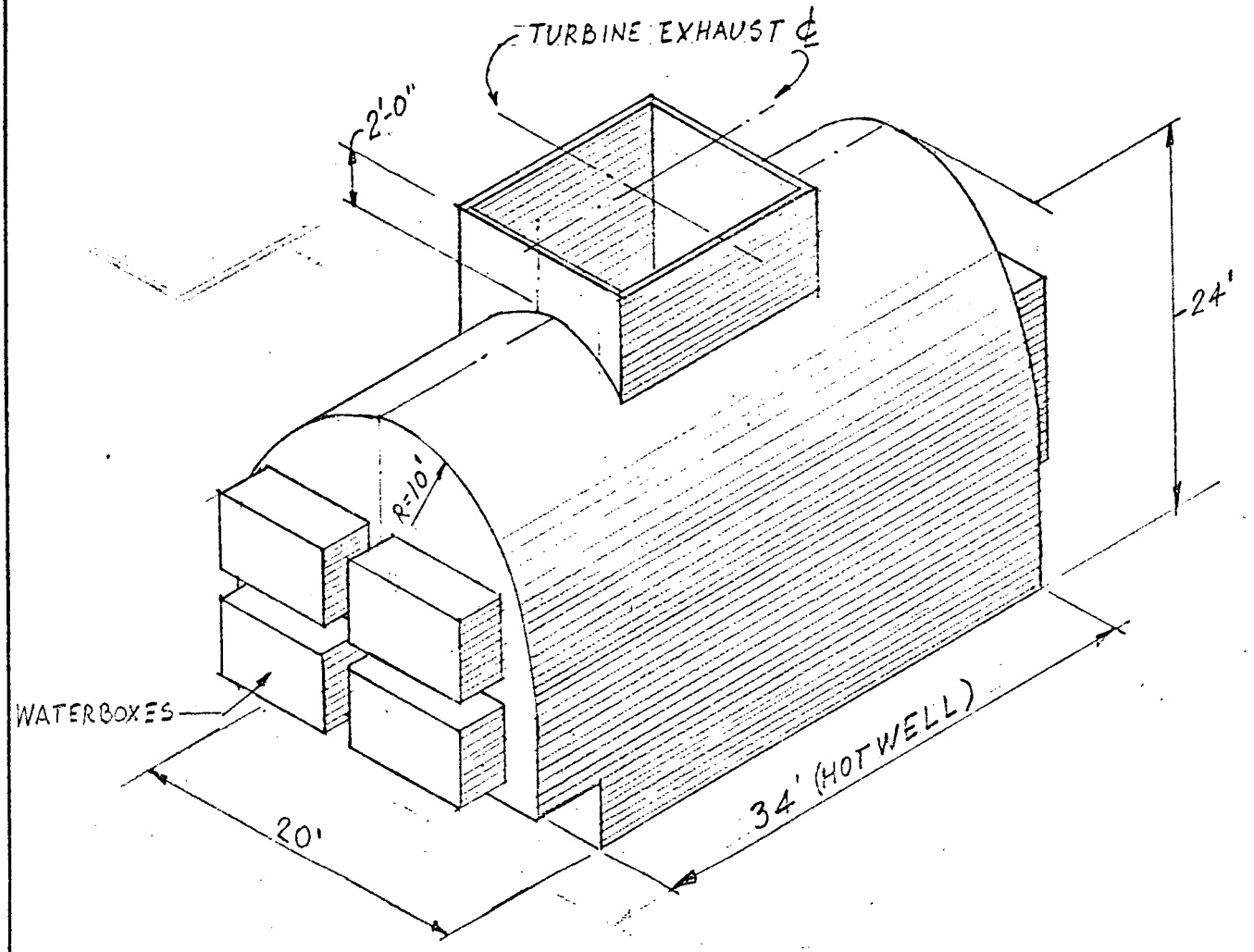
7.0 INFORMATION REQUIRED WITH BID

7.1 Supplier shall provide following data for proper evaluation of his proposal.

Unit	Item
5 and/or 6 separately	a. Turbine Exhaust Pressure - psia (in. Hg Abs)
	b. Main Steam Condenser
7 thru 10	Number of Tubes - Size - Length
	c. Intercondenser
	Shell Size - Number of Tubes - Length
	d. Aftercondenser
	Shell Size - Number of Tubes - Length
	e. Steam Vacuum Ejectors
	Each Stage - Motive Steam Flow
	Proposed lb./hr.

7.2 Weight and Budget Price Separately for Each Item

7.3 Expect Delivery Time - Weeks



TUBE & SHELL CONDENSER

ISOMETRIC - NO SCALE

No.	Date	Description	Ck.	R.App	C.App
0	6-6-79	ISSUED WITH SPECIFICATIONS.	BF	[illegible]	[illegible]

ROGERS ENGINEERING CO., INC.
111 PINE STREET
SAN FRANCISCO, CALIF. 94111
JOB NO. S 78007

PG and E RETROFIT STUDY
UNITS 5 THRU 10

Client PG and E Date 6-6-79

DRAWING NO SK-11 REV. 0

SHEET 1 OF 1

OG - 022

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

VERTICAL CENTRIFUGAL PUMP DATA SHEET

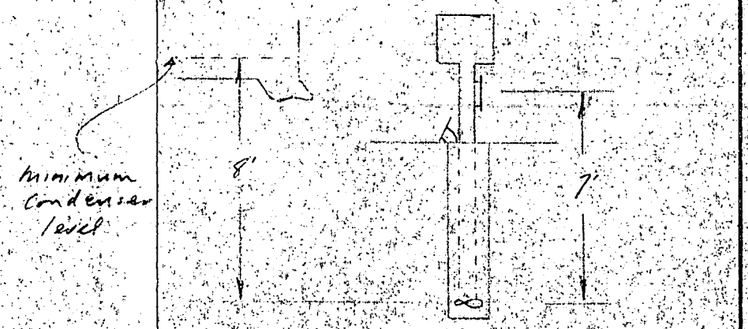
Units 5 through 10 Condensate Pumps

MANUFACTURER _____
SPECIFICATION NO _____ REQ. NO. _____

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

PUMP NUMBER			
A. SERVICE			
TYPE OF INSTALLATION (WELL, PIT, SUMP, DOUBLE CASE)	Cond. Can		
B. LIQUID CHARACTERISTICS			
LIQUID PUMPED	H20		
SPECIFIC GRAVITY AT FLOW TEMP			
FLOW TEMP F	125		
VISCOSITY AT FLOW TEMP (CENTISTOKES) (SSU)			
VAPOR PRESSURE AT FLOW TEMP PSIA	1.94		
C. CAPACITY AND PRESSURES			
GPM AT FLOW TEMP	2000		
SUCTION AT PUMP (IF NOT OPEN SUCTION) PSIA	5.4		
DIFFERENTIAL (INCL. LIFT FROM INLET) PSI	36.9		
DISCHARGE (AT DISCH. CONN.) PSIA	42.3		
DIFFERENTIAL HEAD (TOTAL, NOT INCL. VEL HEAD) FT	86.2		
N.P.S.H A) REQ'D & B) AVAILABLE FT	8		
SUBMERGENCE A) REQ'D & B) AVAILABLE	6'		
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			
R.P.M			
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	SS316		
INNER	SS316		
IMPELLER TYPE (OPEN) (CLOSED) (AXIAL) (MIXED FLOW)			
IMPELLER MTL	SS316		
CASE WEAR RINGS			
IMPELLER WEAR RINGS	SS316		
SHAFT IN PUMP BOWL	SS316		
LINESHAFT	SS316		
LINESHAFT DIAMETER			
LINESHAFT BEARING SPACING			
SHAFT SLEEVES	SS316		
SHAFT ENCLOSING TUBE	SS316		
DISCHARGE COLUMN OR PIPE	SS316		
DISCHARGE HEAD OR ELBOW	SS316		
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			
L. DIMENSIONAL DATA			
OUTLINE DIMENSION DRAWING NO.			
CROSS SECTION DRAWING NO.			
PERFORMANCE CURVE			
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		H	
SIZE & RATING			
FACING			
FACE TO ℄ SHAFT (IF HORIZ)			
DIST. ABOVE OR BELOW BASE (STATE WHICH)			
DISCHARGE VERTICAL OR HORIZONTAL		H	
SIZE & RATING			
FACING			
FACE TO ℄ SHAFT			
DIST. ABOVE OR BELOW BASE (STATE WHICH)			

USE THIS SPACE FOR NOTES OR SKETCHES



Condensate pumps
Units 5-10

REV	DATE		DATE		JOB NO. 5-79007-30	REV
0	6/74	ISSUED FOR QUOTATIONS			DWG NO. DS-14-009	0

PG&E Geysers Retrofit

Q315

INDUCTION MOTOR DATA SHEET

MOTOR NO. / SERVICE	CONDENSATE PUMPS				
1. HORSEPOWER					
2. VOLTAGE	460				
3. PHASE	3				
4. FREQ. - CYCLES/SEC.	60				
5. TYPE					
6. SYNCHRONOUS SPEED R P M					
7. FULL LOAD SPEED R P M					
8. NEMA DESIGN LETTER					
9. INSULATION GLASS	B				
10. TEMPERATURE RISE °C.					
11. FULL LOAD CURRENT					
12. LOCKED ROTOR CODE LETTER					
13. STARTING CURRENT-100% VOLTS					
14. STARTING TORQUE - % F.L.					
15. PULL OUT TORQUE - % F.L.					
16. EFFICIENCY: 100% LOAD					
75% LOAD					
50% LOAD					
17. POWER FACTOR: 100% LOAD					
75% LOAD					
50% LOAD					
18. ENCLOSURE	TEFC				
19. MOUNTING (H), (V)	V				
20. BASE					
21. ROTATION (Viewed From End Opp. Coupling)					
22. BEARING TYPE					
23. THRUST CAPACITY					

MOTOR NO.	CONDENSATE PUMPS				
24. BUILT-IN THERMAL PROTECTION	NO				
25. FRAME NO.					
26. DRAINS, BREATHERS REQ'D.					
27. SPACE HEATERS REQ'D.	YES				
28. MANUFACTURER					
29. O.L. DIMENSION PRINT NO.					
30. TEST					
31. M.R. NO.					
32. SPECIAL MODIFICATIONS:					
A. ENCAPSULATED WINDINGS	✓				
B. POWER TERM. BOX. OVERSIZE					
C.					
D.					
E.					
F. MOTOR SHALL BE EITHER GENERAL ELECTRIC SEVERE DUTY TYPE, WESTINGHOUSE MILL & CHEMICAL TYPE OR EQUAL	✓				

ENCLOSURE: XP - EXPLOSION PROOF (CHEMICAL TYPE)
D.P. - DRIPPROOF
T.E.N.V. - TOTALLY ENCLOSED-NON-VENTILATED
T.E.F.C. - TOTALLY ENCLOSED-FAN-COOLED.
T.E.W.C. - TOTALLY ENCLOSED-WATER-COOLED.
WP-I - WEATHER PROTECTED TYPE I
WP-II - WEATHER PROTECTED TYPE II

UNITS S-12

NOTE:
MOTOR SUPPLIER SHALL FILL IN ALL BLANK SPACES

REVISIONS	DATE		DATE
0	6-28-77	Issued for Quotation	

PG&E GEYSERS RETROFIT

JOB NO. S-79007 REV.
DS 14-011 0

EM-001

3.3 Installation Description for Units 5 thru 10

Units 5 and 6 are mirror imaged turbine-generator units except for the cooling towers and associated piping between the towers and condensers. Equipment location, clearances, and accessibility were field checked on June 11, 1979, and verified against Drawings SK-013, -014 and -015. These drawings are included in this section and show the layout of the new equipment locations.

3.3.1 Main Condenser

Because of the location of the cooling towers, the intake and discharge to the main condenser will be located on the same end of the condenser. The condenser will have a split flow two pass tube bundle arrangement and two supply lines to facilitate the cleaning of half the condenser tubes at a time when necessary.

The condenser duty requirements should be satisfied with the current condenser shell size and configuration. However, the centerline of the condenser tube arrangement must be shifted 2 ft. inside the condenser shell to ensure column line clearance and tube pulling space. The condenser shell must also be shifted towards the cooling towers approximately 3 1/2' for attachment of the water boxes to the condenser shell. In addition, excavation for a dry pit will be required in front of the condenser and outside the power building to insure adequate tube pulling space.

Due to these condenser modifications, the turbine exhaust flange to the condenser neck connection will be shifted off center approximately 3 1/2'. No problem is foreseen in reconnecting to the turbine hood.

Existing condenser cooling water inlet piping can not be used. Attachment of new inlet water piping to the condenser will be positioned at the bottom of the inlet water boxes. The need for circulating water pumps and smaller condensate pumps offset from the tube pull space will preclude the use of existing discharge piping from the condenser. All new piping will be constructed of techite for underground service and stainless steel for piping above grade.

The present location of the auxiliary cooling and fire pumps is satisfactory. The existing condensate pumps will be removed.

Rogers

3.3.2 Intercondenser and Ejectors

The existing intercondenser and ejectors will be removed. The new surface type intercondenser and new first stage jet ejectors will be relocated to the southeast corner for Unit No. 5 (southwest for Unit No. 6) of the power building at elevation 3,211 ft. to allow for tube pulling space in front of the main condenser. New support steel will be required.

3.3.3 Aftercondenser and Ejector

The existing aftercondenser and ejectors will be removed. The new surface type aftercondense and new second stage jet ejectors will be relocated and stocked below the intercondenser at elevation 3,202 ft. to allow for tube pulling space in front of the main condenser. New support steel will be required.

3.3.4 Condensate Pumps

New condensate pumps will be sized and located based on the system and tube pulling requirements for the turbine and the tube and shell condenser. The new location is to place them in front of the lube oil coolers inside the power building at grade level to facilitate the necessary piping and sump location. The existing condensate pumps are of proper size and capacity to function on the new circulating water pumps. NPSH probably req. at sec. basement level.

3.3.5 Circulating Water Pump

The existing sumps in the cooling towers and connecting piping to the condenser will not be used. The new circulating water pumps with the wet pit will be located near the cooling tower riser and the piping routed to the condenser without interference to other equipment or condenser tube pulling space. The existing condensate pumps as stated above can be used as circulating water pumps. In this mode the pump shaft can be shortened to take advantage of the new NPSH requirements and save on excavating for the wet pit.

A wet pit diffuser will be used to reduce the fluid velocity of cooling tower basin discharge water to the cooling water pump wet pit. This will eliminate wet pit vortexing around the pumps as required.

Rogers

3.3A Installation Description for Units 7 through 10

Units 7 and 8 are mirror imaged turbine-generator units housed in the same power building. Units 9 and 10 are similarly arranged. Each unit is 55 MWe (Gross). A field check on June 12, 1979 confirmed building and equipment location as they appear on Drawings SK-012, -013 and -016. These drawings are included in this section and show the layout of the new equipment locations.

3.3.1A Main Condenser

The modifications to Units 7 through 10 to replace the existing condenser with surface condensers are in general identical to the changes on Units 5 and 6. This includes shifting of the condenser centerline the same distance to ensure adequate tube pulling space and water box placement along with condenser pump removal and modification to the use of condenser intake and discharge piping. In addition, excavation is required in front of the condenser for tube pulling space.

3.3.2A Intercondenser and Ejectors

The same modifications to Units 5 and 6 will hold for Units 7 through 10.

3.3.3A Aftercondenser and Ejectors

The same modifications to Units 5 and 6 will hold for Units 7 through 10.

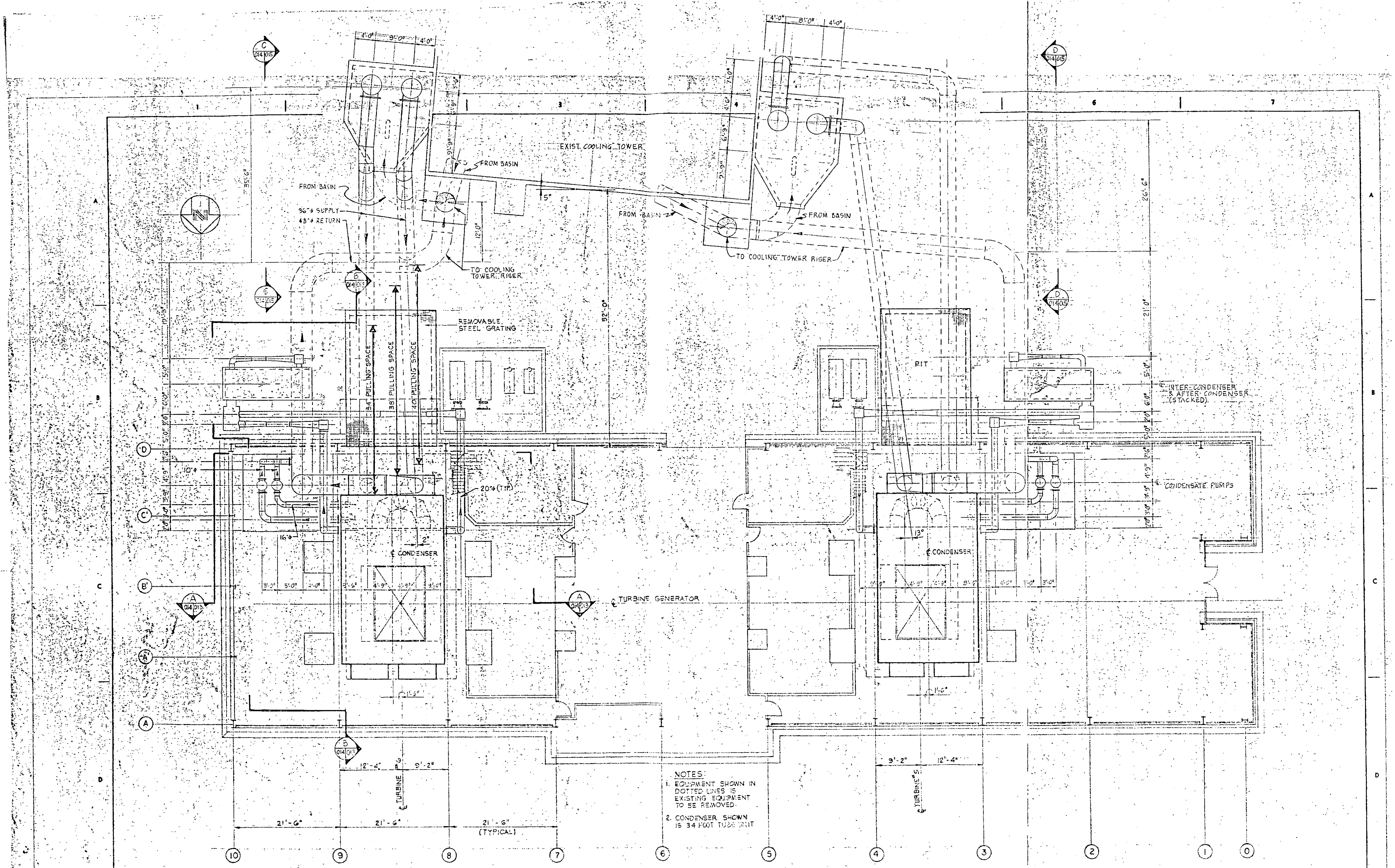
3.3.4A Condensate Pumps

The new condensate pumps will be placed in the same location as Units 5 and 6. To do this the auxiliary cooling water pumps will be relocated. The existing condensate pumps again will function on the new circulating water pumps.

3.3.5A Circulating Water Pump

The existing cooling tower sump locations can be used but the connecting discharge piping to the condenser will have to be rerouted. The new circulating water pumps will be located just outside the cooling tower with one pump on each side of the riser pipe to the top of the cooling tower. Piping from the cooling water pumps will be routed to the condenser with due consideration to layout clearances and pull condenser tube space. A wet pit diffuser again will

be used to reduce turbulence near the circulating water pump suction. As for Units 5 and 5, the condensate pumps will be modified for use as circulating water pumps.



REFERENCE DRAWINGS	REV.	ZONE	DATE	REVISION	DR.	CHK.	APPR. RECO	APPR.

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

SCALE 1/8" = 1'-0" DATE 6-28-79

DR. [illegible] CHK. [illegible] ENG. LFW APPROVED [illegible]

APPROVALS

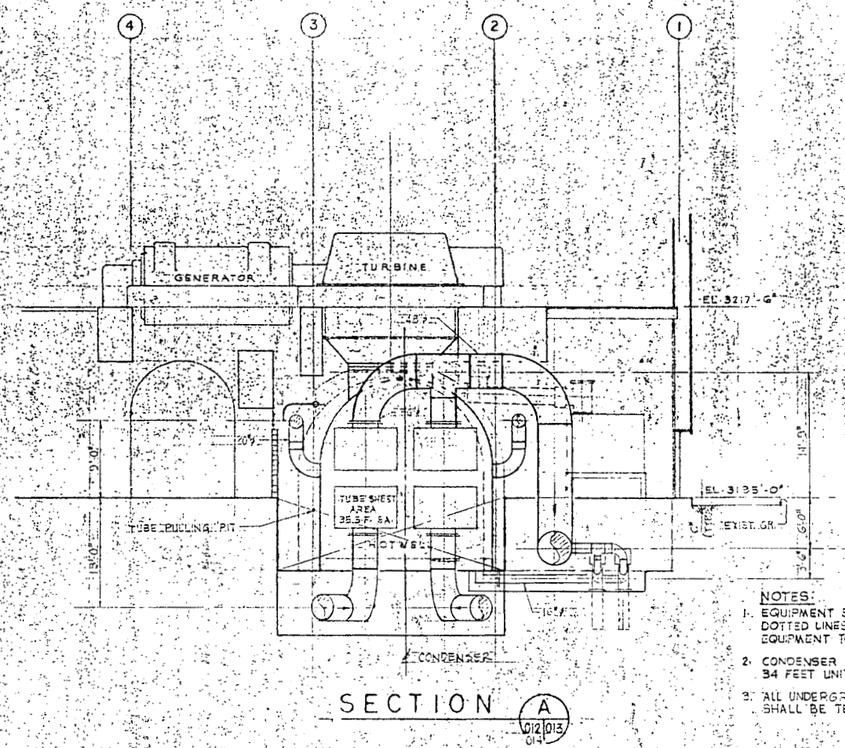
DATE
DATE

PG and E RETROFIT STUDY
UNITS 5 & 6
PLAN

JOB NO. S79007

SK-014

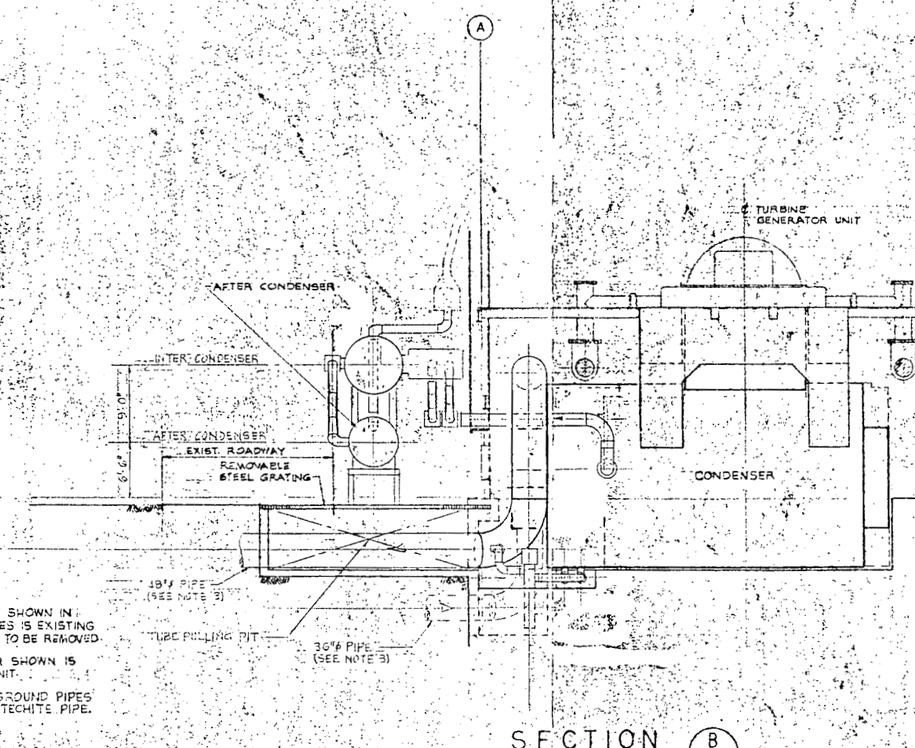
0



SECTION A (012/013)

NOTES:

1. EQUIPMENT SHOWN IN DOTTED LINES IS EXISTING EQUIPMENT TO BE REMOVED.
2. CONDENSER SHOWN IS 34 FEET UNIT.
3. ALL UNDERGROUND PIPES SHALL BE TECHITE PIPE.



SECTION B (012/013)

REFERENCE DRAWINGS	REV.	ZONE	DATE	REVISION	DR.	CHK.	ENGR. RECD	APPR.

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

SCALE 1/8" = 1'-0" DATE 6-28-79

DR. R.W.B. CHK. E.S. ENG. L.F.W. APPROVED

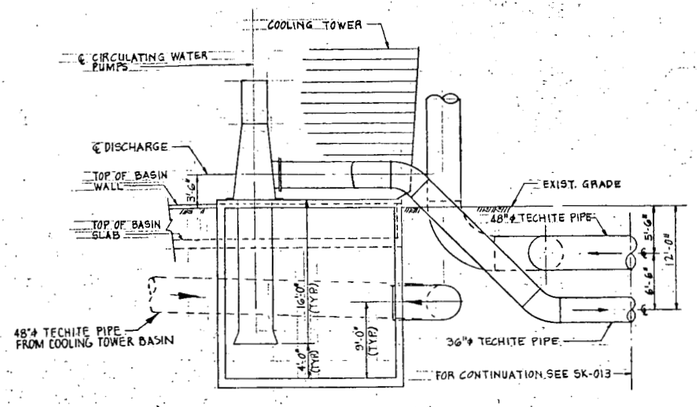
APPROVALS

DATE
DATE

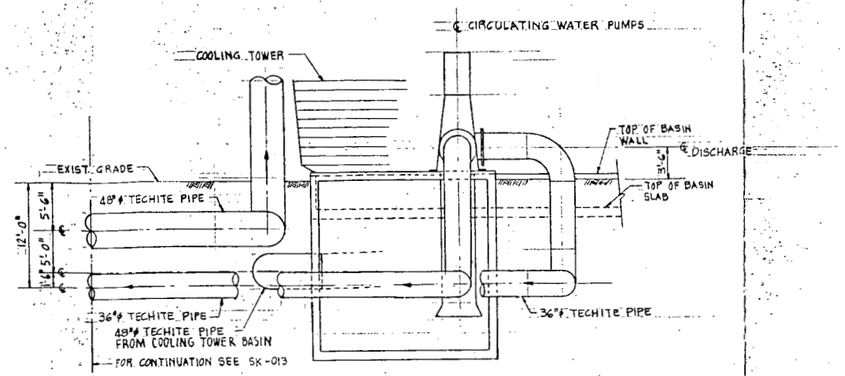
PG and E RETROFIT STUDY
UNITS 5 THRU 10
SECTIONS A & B

JOB NO. 579007 | SK-013 | 0

GE 227



SECTION C (014|015)



SECTION D (014|015)

REFERENCE DRAWINGS

REV.	ZONE	DATE	REVISION	DR.	CHK.	APPR. RECO	APPR.

ROGERS ENGINEERING CO., INC.
ENGINEERS - ARCHITECTS
16 BEALE STREET, SAN FRANCISCO, CALIFORNIA 94105

SCALE 1/8" = 1'-0" DATE 6-22-79
DR. R.S./R.P. CHK. RS/DK ENG. LFW APPROVED LFW

APPROVALS
DATE
DATE

PG and E RETROFIT STUDY
UNITS 5 & 6
SECTIONS C & D

JOB NO S.79007 | SK-015 | 0

GE 212

PRINTED ON DIEPO NO. 1080M CLEARPRINT 10-67

COOLING TOWER

FIRE WATER PUMPS

TO COOLING TOWER-RISER

℄ CIRCULATING WATER PUMPS

30"ϕ SUPPLY

R O A D W A Y

REMOVABLE STEEL GRATING

18"ϕ RETURN

℄ INTER-CONDENSER & AFTER CONDENSER (STACKED)

34' PULLING SPACE

38' PULLING SPACE

40' PULLING SPACE

20"ϕ (TYP.)

℄ CONDENSATE PUMPS

℄ CONDENSER

℄ TURBINE GENERATOR UNIT #7

P.I.T.

℄ CIRCULATING WATER PUMPS

℄ INTER-CONDENSER & AFTER CONDENSER (STACKED)

℄ CONDENSATE PUMPS

℄ CONDENSER

℄ CONDENSATE PUMPS

℄ TURBINE #8

℄ TURBINE #7

21'-0" (TYPICAL)

NOTES:

1. EQUIPMENT SHOWN IN DOTTED LINES IS EXISTING EQUIPMENT TO BE REMOVED.
2. CONDENSER SHOWN IS 34 FOOT TUBE UNIT

REFERENCE DRAWINGS

REV. | ZONE | DATE | REVISION | DR. | CHK. | APPR. RECO | APPR.

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

SCALE 1/8" = 1'-0" DATE 6-28-79

DR. RG/RP CHK. RS ENG. LFW APPROVED [illegible]

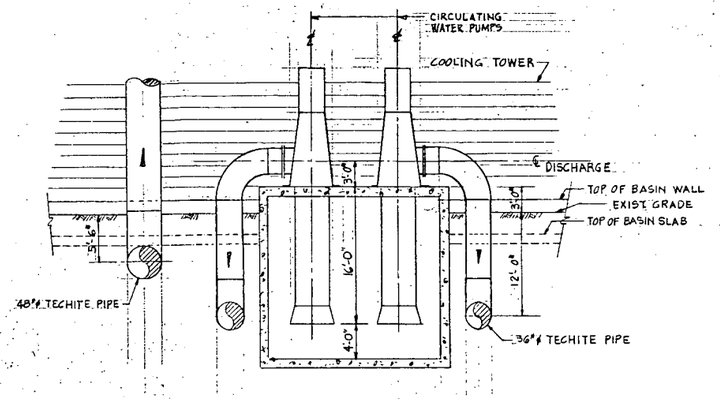
APPROVALS

DATE

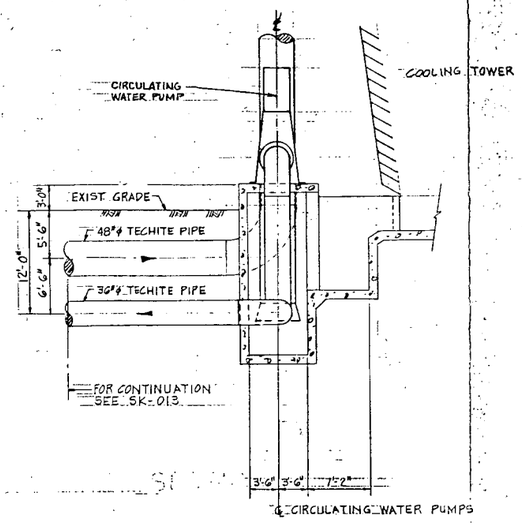
DATE

PG and E RETROFIT STUDY
UNITS 7 & 8
PLAN

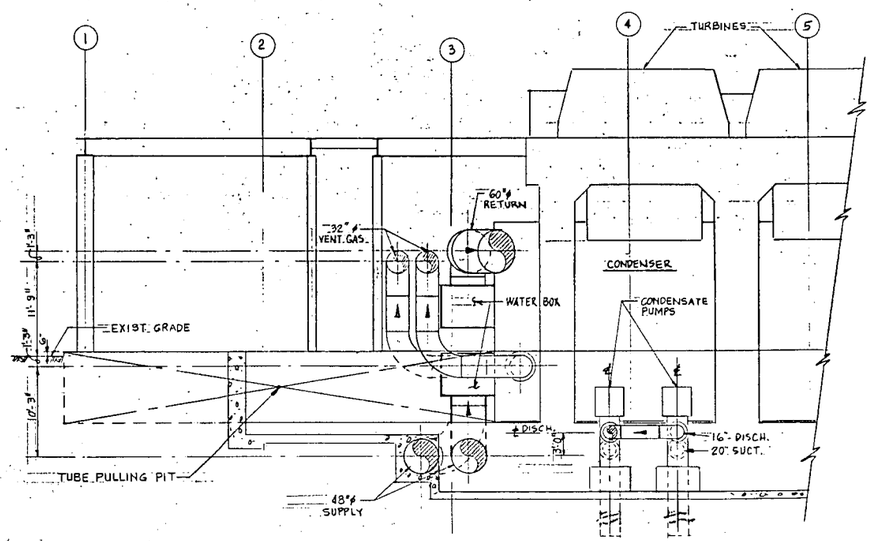
JOB NO. S79007 | SK-012 | 0



SECTION C 012|016



SECTION D 012|016



SECTION B 017|016

REFERENCE DRAWINGS	REV.	ZONE	DATE	REVISION	DR.	CHK.	APPR RECO	APPR.

ROGERS ENGINEERING CO., INC.
ENGINEERS - ARCHITECTS
16 BEALE STREET, SAN FRANCISCO, CALIFORNIA 94105

SCALE 1/8" = 1'-0" DATE 6-25-79

DR. R.P./R.S. CHK. RS/JOY ENG L.F.W. APPROVED

APPROVALS

DATE

DATE

PG and E RETROFIT STUDY
UNITS 7, 8, 11 & 12
SECTIONS B, C & D

JOB NO S79007 | SK-016 | 0

GE 212

PRINTED ON SHEPD NO. 1000H CLEARPRINT 10-67

Rogers

3.4 Equipment Quotations

As in previous sections suppliers of equipment were contacted for the same equipment, described herein, in this section.

3.4.1 Condensers and Ejectors

As in previous requests we contacted DeLaval and Ecolaire, and as a result of discussion with Marley Heat Transfer Co. (Formerly Westinghouse Condenser), equipment specifications were also provided to them. Because of press of factory work load they were unable to respond with estimating prices for this study; but indicated a willingness to quote if and when formal quotations will be forthcoming.

As in Units 1 through 4 response was not complete in all requested details and again DeLaval information was obtained from the local office without input from DeLaval Engineering.

3.4.2 Vendors Comments

3.4.2.1 Ecolaire used H. E. I. Leakage Rate of _____ #/hr. vs specification rate of 440 #/hr.

3.4.2.2 DeLaval had previously given us a design basis of 3" Hg Abs turbine back pressure, but did no further work on specifications submitted to them for Milestone Report No. 2. We question whether this design is attainable with the cooling tower cold water temperature available. DeLaval used H. E. I. 70% cleanliness factor for oil condensers.

3.4.2.3 Neither Ecolaire or DeLaval have provided us with ejector steam rates.

3.4.3 Condensate and Circulating Water Pumps

Identical vendors as previously selected for requests for quotations were contacted:

Ingersoll Rand
Peerless
Byron Jackson
Worthington

Rogers

TABLE 3.4.1

SURFACE CONDENSER SUMMARY

UNITS 5 THROUGH 10

Specification Main Condenser	Vendor Ecolaire	DeLaval
H. E. I. Cleanliness Factor: 70%	70%	70%
Shellside Allowable ΔP: Vendor's Choice	N. S. (Not Stated)	N. S.
Cooling Water Flow: 43,000 gpm	To Spec.	To Spec
Tube Length Max. Ft.: 40	40	N. S.
Tube Size : 22 ga., 3/4", 7/8" or 1" Vendor's Choice	3/4"	3/4"
No. of Passes H_2O Side: 2	2 (Note 1)	N. S.
Surface Area Sq. Ft.: As required	107,000	101,000
Cost of Tubes $:	Included (Note 2)	200,000 (Est.) (Note 2)
Dimensions	50'L x 25'W x 20'H	N. S.
Turbine Exhaust Pressure:	As Specified	3" Hg Abs
Inter- and Aftercondensers & Rejectors: Required	Included in Price w/Tubing Provided Installed	Included in Price w/Tubing Installed
TEMA Fouling Resistance Overall: 0.0011	H. E. I. 50% C. F.	H. E. I. 70% Cleanliness Factor
Conformity to Material Specs:	Yes	Yes
Purchase Price $:	1,493,000	1,100,000
Add for Tubing Cost Main Condenser $:	Included	200,000 (Est. by Vendor)
Total Price $:	1,493,000	1,300,000

NOTE 1: To minimize tube sude ΔP, velocity held to 5.4 ft./sec.
NOTE 2: Installation of tubes in Main Condenser is not included in above prices

Rogers

TABLE 3.4.2

EQUIPMENT SUMMARY SHEET - PUMPS UNITS 5 thru 10

Specifications	I. R.	VENDORS Peerless	Byron Jackson	Worthington
Condensate Pump				
Capacity: 2,000 gpm		Spec.		
Differential Head: 86.2 ft.		Spec.		
Materials: All 316SS		Spec.		
Type: Can		Spec.		
NPSH Available: 8 ft./Req'd:		8 Ft.		
Efficiency %:		77		
Motor HP/rpm		75/1185		
Price:		$56,000		

C. W. Circulation Pumps

For C. W. circulation pumps it would be the least project cost to reuse the present Peerless 36H 11 XB single stage vertical condensate pumps. Present capacity is 24,500 gpm with a differential head of 75 to 80 ft.

For Units 5 through 10 a modification to shorten pump shaft to reduce wet pit depth is all that is required. Peerless estimates the cost to be $5-10,000/pump.

3.5 Project Costs - Units 5-10

This milestone report is a mid-term report presenting partial cost and economic information pertaining to Units 5-10 surface condenser installation. This report presents two economic aspects: Equipment sizing and capital cost estimate aspect 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.

51-20	Structures and Improvements
52-50	Main Steam Piping
54-20	Turbine-Generator - Condensate System
54-30	Turbine-Generator - Circulating Water System
54-40	Lube Oil System
54-70	Turbine-Generator - Instrumentation
55-30	Control and Power Connection
55-60	Auxiliary Electrical Equipment - Station Power
56-10	Compressed Air System
365	Engineering and Other Cost Allocations

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

3.5.1 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 a 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 the determination of the level annual factors they use to evaluate generation alternatives. The method is a level annual representation of all cost differences between equivalent alternatives. This method 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 the enclosed Tables. All the figures in these tables as noted are level annual numbers and all dollar differences across the boundary have been presented to make the alternatives equivalent economically.

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 equipment installation.

3.5.2 Major Equipment Cost

Suppliers of the major equipment, condensers and pumps, were contacted by telephone followed up by transmittal of pertinent equipment data sheets. 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

An appropriate Section of this Report 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 addressed. The costs in the estimate for each piece of major equipment reflect our best judgment as to the eventual bid on the equipment data sheets.

In the cost estimate 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.

Rogers

3.5.3 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.

The estimated materials and labor shown are based upon the conceptual layout drawings and field investigations at the site for each installation. There is 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 $15 per hour to be an overall good concept estimate direct figure and has been used in this report. 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 are derived as follows:

Man-hours = 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.

3.5.4 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.

Rogers

3.5.4.1 Cost Estimate

The factors included in the Equipment and Material and labor parts of the estimate have been discussed. The cost estimate for the removal and installation of specified equipment to facilitate the operation of a surface condenser at Unit 5, typical for Unit 5-10 is here presented in summary account form. The account details are itemized in the next table from the summary.

(Question Amount? Refer to Table 3.5)

TABLE 3.3

SUMMARY COST ESTIMATE - UNITS 5 THRU 10

Item No.	Description	Cost @ Site	Man-hours	Labor Dollars	Total Dollars
51-20	Building	$ 44,520	4,248	$ 98,777	$ 178,347
54-20	Condensate System	2,197,126	38,110	886,059	3,397,593
54-30	Circ. Water System	224,508	13,707	318,696	656,290
54-70	Instrumentation	25,440	882	20,501	53,215
55-60	Station Pwr System	34,344	3,717	86,430	151,443
365	Eng & Other Alloc Cst	0	0	0	0
	Totals	$2,525,938	60,665	$1,410,463	$3,936,401

The estimated cost in June 1979 dollars to retrofit Unit 5 for a surface condenser is $4,747,300. To this estimate sub total must be added the GM overheads.

3.5.4.2 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 5 is estimated to be $4,747,300.

3.5.5 Project Differential Costs

The capital involved to accomplish the retrofit project using a surface condenser will require a level annual revenue of 1.91 mills per kilowatthour. The project differential cost and GM estimate capital cost 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.

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

JOB NO. DG-023

ROGERS ENGINEERING CO.,INC. COST ESTIMATE

JOB NAME-UNIT 5 JOB NO.-S79007 CLIENT-P G AND E ESTIMATE DATE- 29 JUNE 79

ITEM NO.	DESCRIPTION	MATL&EQPT	INSTALL	MANHOURS	TOTAL
51-22-1	REMOVE BLDG CONCRETE	0.	14910.	641.	14910.
54-21-1	TUBE PULL PIT	44520.	83867.	3607.	128387.
ACCOUNT TOTAL		44520.	98777.	4248.	143297.
54-21-1	COND PUMP CONCRETE	1908.	9319.	401.	11227.
54-21-2	COND PUMP EXC & BKFL	2250.	16773.	721.	19063.
54-22-2	RMV AUX COND STRUCT	2544.	3494.	150.	6038.
54-22-3	AUX COND STRUCTURE	19080.	46593.	2004.	65673.
54-23-1	COND SYSTEM EQUIP R	30528.	93186.	4008.	123714.
54-23-2	REMVOE STEAM JETS	0.	1491.	64.	1491.
54-23-3	REMOVE AUX CONDSRS	0.	8387.	361.	8387.
54-23-4	REMOVE STEAM PIPE JE	0.	466.	20.	466.
54-23-5	CONDENSER QUOTE	1844400.	0.	0.	1844400.
54-23-6	CONSENSER IN PLACE	50880.	465930.	20040.	516810.
54-23-7	CONDENSER TRANSITION	31800.	32615.	1403.	64415.
54-23-8	CONDENSER EQUPT R	63600.	32615.	1403.	96215.
54-24-1	REMOVE COND PUMPS	0.	4659.	200.	4659.
54-24-2	COND PUMP QUOTE	82680.	0.	0.	82680.
54-24-3	COND PP SET IN PLACE	3816.	23297.	1002.	27113.
54-25-1	REMOVE MN CND PIPE R	2544.	16773.	721.	19317.
54-25-2	REMOVE AUX COND PIPE	0.	3727.	160.	3727.
54-25-3	REMOVE NC GAS PIPE	0.	4659.	200.	4659.
54-25-4	COND PIPING	35616.	32615.	1403.	68231.
54-33-1	REMOVE CW PIPING	0.	5591.	240.	5591.
54-25-4	COND MISC PIPING	25440.	83867.	3607.	109307.
ACCOUNT TOTAL		2197126.	886059.	38110.	3083185.
54-31-1	CW PUMP CONCRETE	15264.	18637.	802.	33901.
54-31-2	CW PIPING TRENCH	5088.	27956.	1202.	33044.
54-33-2	CW PIPING	152640.	186372.	8016.	339012.
54-33-3	CW PIPING EQUIPT R	10176.	9319.	401.	19495.
54-34-1	REMOVE CW PUMPS	0.	3727.	160.	3727.
54-34-2	CW PUMP QUOTE REWORK	29256.	0.	0.	29256.
54-34-3	CW PUMP SET IN PLACE	11448.	69890.	3006.	81338.
54-39-1	RELOCATE FIRE H.CAB	636.	2796.	120.	3432.
ACCOUNT TOTAL		224508.	318696.	13707.	543204.

TABLE 3.5.1
SUMMARY COST ESTIMATE - UNIT 5 THRU 10

DRAWING NO.

REV.

SHEET 1 OF 2

ROGERS ENGINEERING CO., INC.
111 PINE STREET
SAN FRANCISCO, CALIF. 94111
JOB NO.
09-023

ROGERS ENGINEERING CO..INC. COST ESTIMATE

JOB NAME-UNIT 5 JOB NO.-S79007 CLIENT-P G AND E ESTIMATE DATE- 29 JUNE 79

ITEM NO.	DESCRIPTION	MATL&EQPT	INSTALL	MANHOURS	TOTAL
54-74-1	INST CONDENSARE SYS	15264.	10250.	441.	25514.
54-74-2	INST CW SYSTEM	10176.	10250.	441.	20426.
ACCOUNT TOTAL		25440.	20501.	882.	45941.
55-64-1	REMOVE COND PPS ELEC	0.	23297.	1002.	23297.
55-64-1	CW PUMP STARTERS	6360.	20967.	902.	27327.
55-64-2	COND PUMP STARTERS	7632.	8387.	361.	16019.
55-64-3	COND PP POWER SUPPLY	5088.	11648.	501.	16736.
55-64-4	ELECTRIC POWER SUPLY	15264.	8154.	351.	23418.
55-64-5	REMOVE CW PPS ELECT	0.	13978.	601.	13978.
ACCOUNT TOTAL		34344.	86430.	3717.	120774.
365-1	CONST FIELD	0.	0.	0.	0.
365-2	GENRL ENG	0.	0.	0.	0.
365-3	OTHR ENGINEERING	0.	0.	0.	0.
ACCOUNT TOTAL		0.	0.	0.	0.

TABLE 3.5.1
SUMMARY COST ESTIMATE -
UNIT 5 THRU 10

DRAWING NO.

REV.

SHEET 2 OF 2

Rogers

4.1 Equipment Sizing Criteria Units 11 and 12

The Results of Post Overhaul Performance Test for Unit 11 of September 18, 1978 was received. It was estimated that for the retrofit conceptual design an approval of 16.0°F could be obtained at a 38°F range by a thorough cleaning of the cooling tower during the retrofit turnaround. A similar methodology as was used on Units 5 thru 10 was used to prepare the conceptual design at a turbine exhaust of 4.3 inches of Hg Abs (2.11 psia). The conceptual design is shown on Drawing No. PD-005.

Rogers

TABLE 4.1

COMPARATIVE SUMMARY

UNIT 11

	Base Reference Design Point	Conversion Retrofit
Throttle Flow lb./hr.	1,808,000	1,808,000
Noncondensable Gas % Wt.	1.0	0.85
General Electric Output kW	110,000	108,147
Auxiliary Power (Electric) kW		
Cooling Tower Fans	1,242	1,242
Miscellaneous Total	982	982
Circ. Water & Cond. Pumps	1,776	2,215
Noncondensable Gas Blower		(Later)
Net Unit Output kW	106,000	103,708 (1)
Heat Input Btu/Hr. (Ref. to 32°F)	$2,266 \times 10^6$	$2,314 \times 10^6$
Net Heat Rate Btu/kWh	21,376	22,310
Turbine Exh. Inch Hg Abs	4.0	4.3
Wet Bulb	65.0	65.0
C. W. T. Range/Approach °F	40.4	38/16.0

(1) Without Noncondensable Gas Blower Debit

*For expected gross output, multiply actual field output of unit by retrofit derating factory of 0.983

Rogers

TABLE 4.2

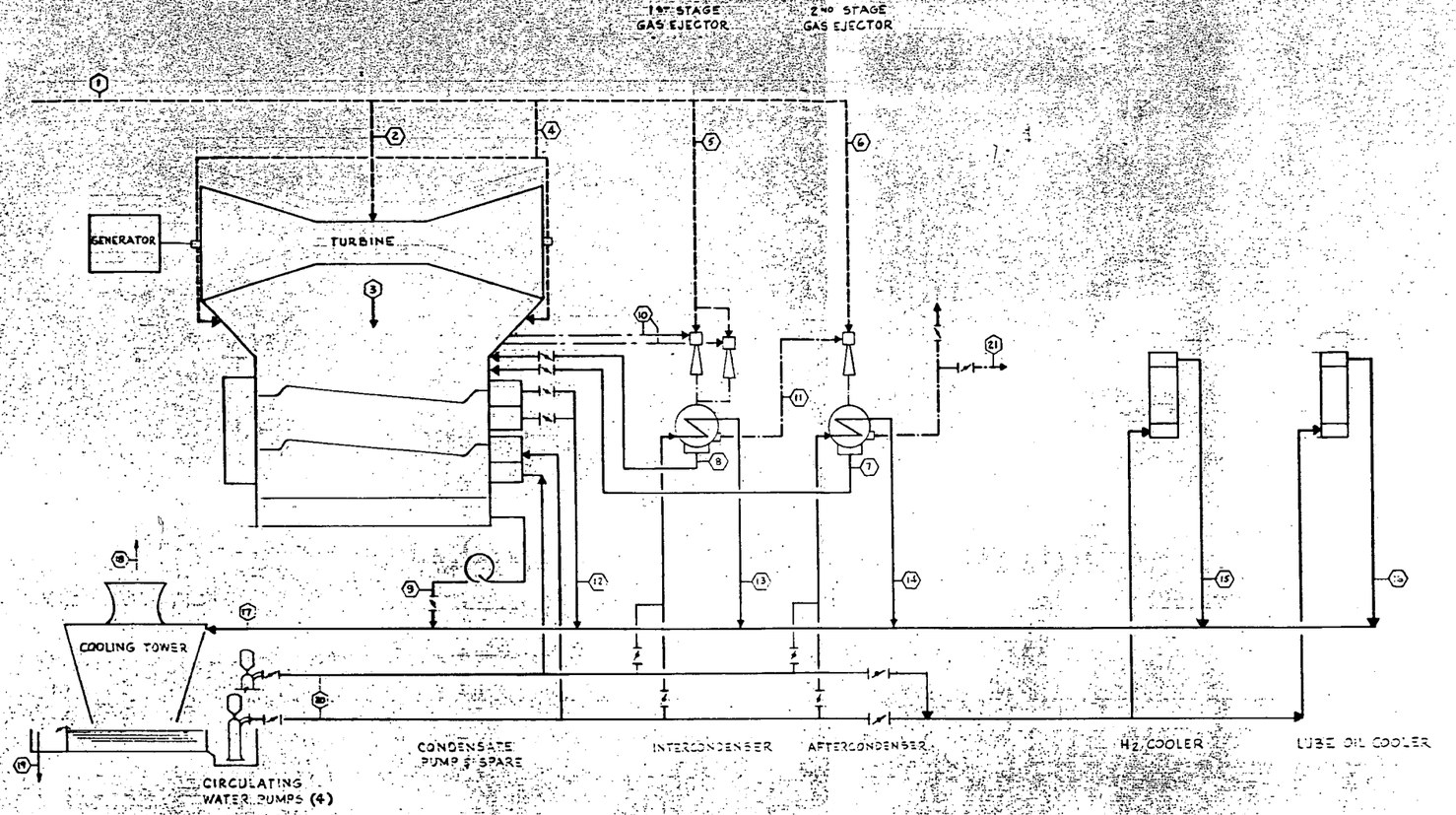
COMPARATIVE SUMMARY

UNIT 12

	Base Reference Design Point	Conversion Retrofit
Throttle Flow lb./hr.	1,808,000	1,808,000
Noncondensable Gas % Wt.	1.0	0.5
General Electric Output kW	110,000	108,147
Auxiliary Power (Electric) kW		
Cooling Tower Fans	1,242	1,242
Miscellaneous Total	982	982
Circ. Water & Cond. Pumps	1,776	2,153
Noncondensable Gas Blower		(Later)
Net Unit Output kW	106,000	103,770 (1)
Heat Input Btu/Hr. (Ref. to 32°F)	$2,266 \times 10^6$	$2,255 \times 10^6$
Net Heat Rate Btu/kWh	21,376	21,730
Turbine Exh. Inch Hg Abs	4.0	4.3
Wet Bulb	65.0	65.0
C. W. T. Range/Approach °F	40.4	38/16.0

(1) Without Noncondensable Gas Blower Debit

*For expected gross output, multiply actual field output of unit by retrofit derating factory of 0.983



STREAM NO.	MOL. WT.	UNIT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
FLOWS IN LB/HR.		11																					
STEAM	18		1928,260	1,808,000		4,260	78,000	38,000				23,140	3,040										890
NON CONDENSABLE GAS	35.6		16,536	15,500		36	670	330				15,500	16,170										13,228
AIR	29											930	930										930
CONDENSATE									40,150	98,100	1,923,110												
COOLING WATER														42,263,000	2,663,000	1,105,000	350,000	277,500	43,581,610	1,738,500	184,310	45,503,420	
PRESSURE PSIA			113.4		2.11																		
ENTHALPY BTU/LB			1200		992.8																		
TEMPERATURE °F			355								125.0			119.0	119.0	119.0	103.0	100.0	119.0		81.0	81.0	
		12																					
STEAM	18		1,879,760	1,808,000		4,260	49,000	18,000				14,230	1,850										550
NON CONDENSABLE GAS	35.6		9447	9,090		21	246	90				9,090	9,335										7,558
AIR	29											930	930										930
CONDENSATE									19,300	61,380	1,874,450												
COOLING WATER														42,275,000	1,700,000	551,000	350,000	277,500	42,207,950	1,689,600	184,850	45,333,500	
PRESSURE PSIA			113.4		2.11																		
ENTHALPY BTU/LB			1200		992.8																		
TEMPERATURE °F			355								125.0			119.0	119.0	119.0	103.0	100.0	119.0		81.0	81.0	

MAXIMUM UNIT 11
H_2S VALUE 797

MAXIMUM UNIT 12
H_2S VALUE 170

REFERENCE DRAWINGS

REV.	ZONE	DATE	REVISION	DR.	CHK.	APPR. RECD	APPR.
0		5/5/79	ISSUED FOR REPORT	E.A.	BF		

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

SCALE NONE DATE 6-7-79
DR. E.A. CHK. ENG. BF APPROVED

APPROVALS
DATE
DATE

PG and E RETROFIT STUDY
UNIT 11 & 12 CONVERSION
PROCESS FLOW DIAGRAM

JOB NO. 5 7900.7 PD-005 0

Rogers

4.2 Specifications for Equipment for Conversion from Direct Contact to Surface Type Heat Exchangers for Units 11 and 12

The required conditions are detailed in Specification S-12-002, Rev. 0 and Addendum to subject specification.

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

VERTICAL CENTRIFUGAL PUMP DATA SHEET

Units 11 & 12 Circ. Water & Condensate Pumps

MANUFACTURER _____
SPECIFICATION NO _____ REQ. NO. _____

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

	PUMP NUMBER	Cond pump	Circ. Water	
A. SERVICE				
TYPE OF INSTALLATION (WELL, PIT, SUMP, DOUBLE CASE)		Can	Sump	
B. LIQUID CHARACTERISTICS				
LIQUID PUMPED		H2O	H2O	
SPECIFIC GRAVITY AT FLOW TEMP				
FLOW. TEMP F		125	86	
VISCOSITY AT FLOW TEMP (CENTISTOKES) (SSU)				
VAPOR PRESSURE AT FLOW TEMP PSIA		1.94	.507	
C. CAPACITY AND PRESSURES				
GPM AT FLOW TEMP		4000	25,000	
SUCTION AT PUMP (IF NOT OPEN SUCTION) PSIA		5.4		
DIFFERENTIAL (INCL. LIFT FROM INLET) PSI		40.7	38.5	
DISCHARGE (AT DISCH. CONN.) PSIA		46.15	45.6	
DIFFERENTIAL HEAD (TOTAL, NOT INCL. VEL. HEAD) FT		95	90'	
N.P.S.H A) REQ'D & B) AVAILABL		8	43'	
SUBMERGENCE A) REQ'D & B) AVAILABLE		6	12'	
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		SS316	SS316	
INNER		SS316	SS316	
IMPELLER TYPE (OPEN) (CLOSED) (AXIAL) (MIXED FLOW)				
IMPELLER MTL		SS316	SS316	
CASE WEAR RINGS				
IMPELLER WEAR RINGS		SS316	SS316	
SHAFT IN PUMP BOWL		SS316	SS316	
LINESHAFT		SS316	SS316	
LINESHAFT DIAMETER				
LINESHAFT BEARING SPACING				
SHAFT SLEEVES		SS316	SS316	
SHAFT ENCLOSING TUBE		SS316	SS316	
DISCHARGE COLUMN OR PIPE		SS316	SS316	
DISCHARGE HEAD OR ELBOW		SS316	SS316	
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				

USE THIS SPACE FOR NOTES OR SKETCHES

	Circ Water	Cond Pump	
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)			

REV.	DATE		DATE
0	6/27/79	ISSUED FOR QUOTATION	

PG&E Geysers Retrofit

JOB NO. 5-79007-00 REV.
DWG NO. DS-14-010 0

Q315

SPECIFICATON
FOR
SURFACE TYPE CONDENSERS
WITH
STEAM JET EJECTORS
FOR
110 MW TURBOGENERATORS

AT

PGandE GEYSERS POWER PLANTS

UNITS 11 AND 12

Prepared by

ROGERS ENGINEERING CO., INC

SAN FRANCISCO, CALIFORNIA 94111

No.	Date	Description	Ck	R.App	C.App
1	6/28/79	ADDED GAS COOLING PAR. 5.1.4 - ISSUED FOR REPORT	BF		
0	12JUNE79	ISSUED FOR QUOTATION	BF		

ROGERS ENGINEERING CO., INC. 111 PINE STREET SAN FRANCISCO, CALIF. 94111	MAIN CONDENSER UNITS 11 AND 12 PGandE GEYSERS RETROFIT PROJECT	SPECIFICATION S-12-002	REV. 0
JOB NO. S-79007	Client PGandE Date	SHEET 1 OF 9	

GS-004

TABLE OF CONTENTS

1.0 PERFORMANCE REQUIREMENTS

1.1 Generation capability to be maximized within the constraints imposed by the existing cooling water tower capability, the availability of area for tube sheets and space for tube length and the desirability of maintaining a turbine throttle steam flow near existing conditions of 1,808,000 lbs./hr. Supplier shall be responsibile for complete design of condensing and vacuum system components for maximum power generation.

2.0 STEAM CONDITIONS

	Turbine Inlet	Steam Jet Inlet
Enthalpy Btu/lb. -	1,200	
Entropy Btu/lb. x R -	1.606	
Pressure psia -	113.4	105.4
Temperature °F -	355	355

Turbine exhaust (existing for reference only)

Pressure-psia (in. Hg Abs.) - 1.964 (4.0)

Enthalpy - Btu/lb. - 989.3 (calculated)

Gross Power @ 4 in. Hg Abs. - 110,000 kW

3.0 NONCONDENSABLE GAS CONDITIONS

Unit	% Wt. in Steam	Ave. Mol. Wt.
11	0.85	35.6
12	0.5	35.6

4.0 AIR LEAKAGE ALLOWANCE

Units 11 or 12 - 930 lb./hr. each

5.0 CONSTRAINTS

5.1 Cooling Water Availability (Best Preliminary Values)

5.1.1 Main Condenser

Unit	Item	
11 or 12	Cold °F	81.0
	Rise °F	38.0
	Flow gpm	85,000

5.1.2 Intercondenser

Unit	Item	
11	Cold °F	81.0
	Rise °F	38.0
	Flow gpm	5,300
12	Cold °F	81.0
	Rise °F	38.0
	Flow gpm	4,000

5.1.3 Aftercondenser

Unit	Item	
11	Cold °F	81.0
	Rise °F	38.0
	Flow gpm	2,200
12	Cold °F	81.0
	Rise °F	38.0
	Flow gpm	1,200

5.1.4 Main, Inter- and After Condenser Gas Cooling Exit Temperatures Preferred.

Units	Condenser	
11 or 12	Main	114°F
	Inter	110°F
	After	110°F

5.2 Space Availability

Unit	Item
11 or 12	Main Condenser (Note 1)
	Preferred Design
	Flow Split - Two Inlets and Two Outlets
	Passes - Two
	Tube Sheet Area - 45 sq. ft. x 2 Each End
	55 sq. ft. x 2 Each End
	Tube Length - 48 ft. Maximum
	- 40 ft. Minimum
	Hot Well ~ 20 Ft. x 34 Ft. x (20" Minimum Depth)
	Inter- or Aftercondenser
	Tube Length - 16 Ft. Maximum
	Passes - Three Preferred

NOTE 1: Existing condenser (Information Only)

Two openings approximately 14 ft. x 15 ft. and transists to a hemispherical section of 25 ft. radius by 48 ft. long. This upper section 25 ft. wide x 48 ft. long extends 11 ft. deep terminating in a flat bottomed hotwell. See SK-12 for equipment arrangement with surface condenser.

6.0 CONSTRUCTION

6.1 Main Condenser

Pressure

Shell Side - Full Vacuum to 14.6 psia

Tube Side - 75 psig

Temperature

Shell Side - 150°F

Tube Side - 150°F

HEI Cleanliness Factor - 70%

Tubes - 22 Ga x Δ pitch x size (3/4", 7/8" or 1")

Materials

Shell 304L SS Clad Steel

Internals - All 304L SS

Tube Sheets - All 304L SS

Tubes - 304L SS

Water Box Covers - Carbon Steel, Coal Tar Epoxy Lined

Code Requirements

Heat Exchanger Institute

ASME - Tube Side Only

6.2 Inter- or Aftercondensers

Pressure

Shell Side - Full Vacuum to 40 psig

Tube Side - 75 psig

Temperature

Shell Side - 210°F

Tube Side - 150°F

TEMA Fouling Resistance - Total 0.0011

Tubes - 3/4" x 22 Ga x Δ pitch

Materials

Shell, internals, tube sheets and tubes - All 304L SS

Water Channel Covers - Carbon Steel, Coal Tar Epoxy Lined

Code Requirements

ASME

TEMA Class "C"

6.3 Steam Jets

Pressure - Full Vacuum - 150 psi

Temperature °F - 355

Materials - All 304L SS

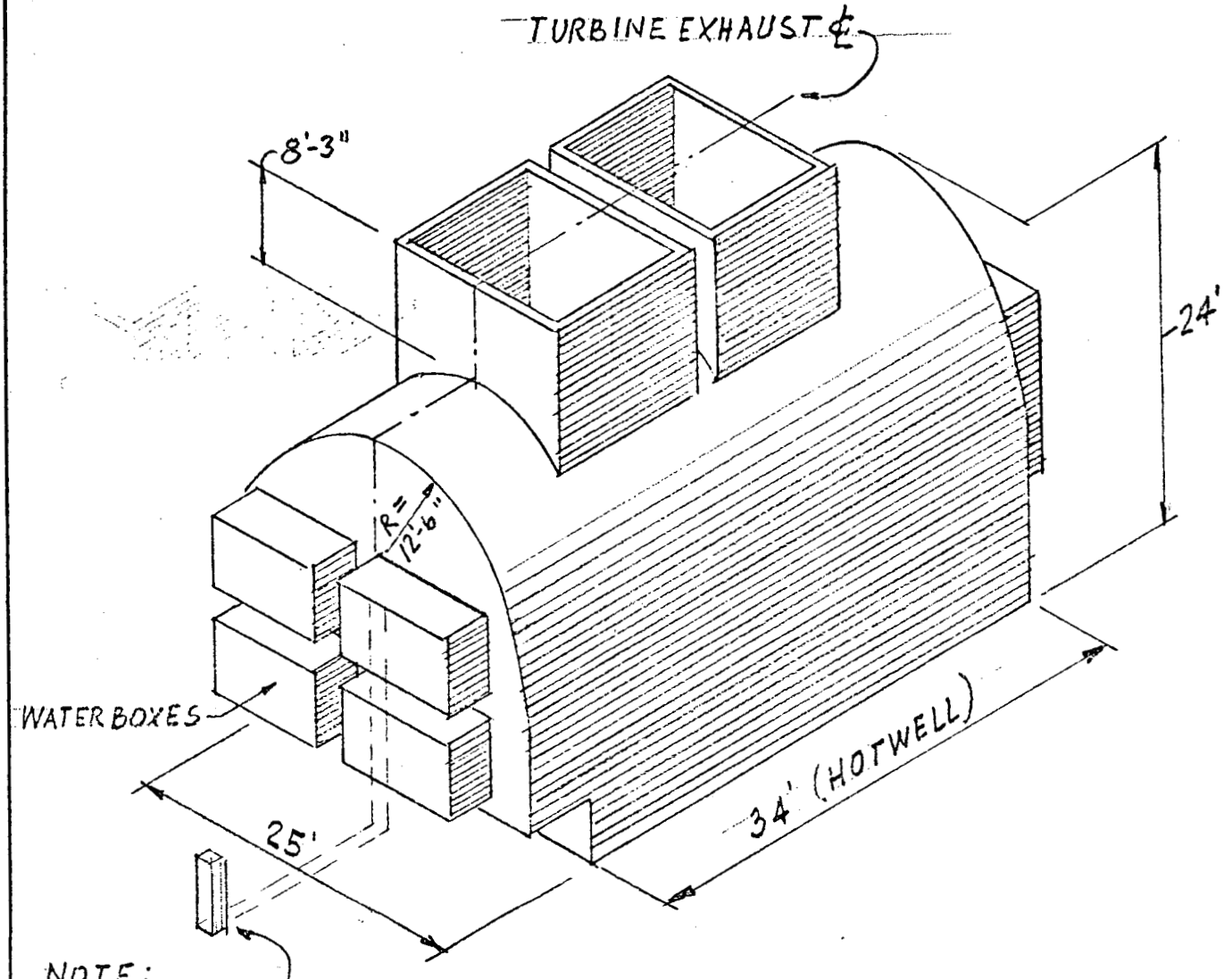
7.0 INFORMATION REQUIRED WITH BID

7.1 Supplier shall provide following data for proper evaluation of his proposal.

Unit		Item
11	a.	Turbine Exhaust Pressure - psia (in. Hg Abs)
separately	b.	Main Steam Condenser
12		Number of Tubes - Size - Length
	c.	Intercondenser
		Shell Size - Number of Tubes - Length
	d.	Aftercondenser
		Shell Size - Number of Tubes - Length
	e.	Steam Vacuum Ejectors
		Each Stage - Motive Steam Flow
		Proposed lb./hr.

7.2 Weight and Budget Price Separately for Each Item

7.3 Expect Delivery Time - Weeks



NOTE:
BLDG. COLUMN OBSTRUCTS TUBE PULLING AREA 1'-0" WIDTH

TUBE & SHELL CONDENSER

ISOMETRIC - NO SCALE

No.	Date	Description	Ck.	R.App	C.App
0	6-11-79	ISSUED WITH SPECIFICATIONS	BF		

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

PG and E RETROFIT STUDY
UNITS 11 and 12

DRAWING NO: SK-14 | REV: 0

JOB NO. S-78007 | Client P G and E | Date 6-11-79 | SHEET 1 OF 1

G-022

MATERIAL REQUISITION

JOB NO. S-79007-404
REQ NO.
REV NO.
SHEET 1 OF 2

SHOP INSPECTION: REQD ___ NOT REQD ___

MATERIAL: MAIN CONDENSER
UNIT 11 OR 12 - ADDENDUM TO SPEC S-12-002 REV 0

ATTACHMENTS

SHEET 30P-18 & 30P-19

FURNISH AND DELIVER THE ITEMS BELOW TO: ___

MATERIAL REQUIRED AT JOB SITE NOT LATER THAN

ITEM NO.	QUANTITY AND UNIT	SIZE AND DESCRIPTION	TAG NO
1	1 LOT	DRAWINGS AND DATA AS REQUIRED	
2	1 ea	MAIN TURBINE CONDENSER - 4 PASS TUBES 90° TO T-G SET &	UNIT 11 UNIT 12
		Attached SHEETS 30P-18 & 30P-19 show the face area available for 22 ET tubes.	
		FOR LONGER TUBES SUPPLIER SHALL DEDUCT SHADOW OF BLDG. COL FROM FACE AREA OF EACH PASS.	
		CONDENSER SHALL BE COMMON TO BOTH TURBINE OUTLETS. N.C. GAS SHALL BE LOCATED ON CALLED WEST END ONLY.	

NO	DATE	REVISIONS	ORIGINATOR (NAME)	APPROVALS
0	21 JUNE	ISSUED FOR QUOTATION - ADDENDUM TO SPEC	BF	

GP-003

MATERIAL REQUISITION

JOB NO. 5-79007-40/41
REQ. NO.
REV. NO.
SHEET 2 OF 2

ITEM NO.	QUANTITY AND UNIT	SIZE AND DESCRIPTION	CODE
		ALTERNATE FOR 3PASS	
		SUPPLIER SHALL USE VERTICAL FACE DIMENSION OF 21'-0" SHOWN ON SHEET 30P-19. AND LAYOUT PROPOSED VERTICAL WATER BOX AND 3PASS TUBE SHEET FACE AREA,	
		ALL OTHER REQUIREMENTS FOR TUBE PULLING SHALL BE SAME AS FOR 4PASS ARRGT	

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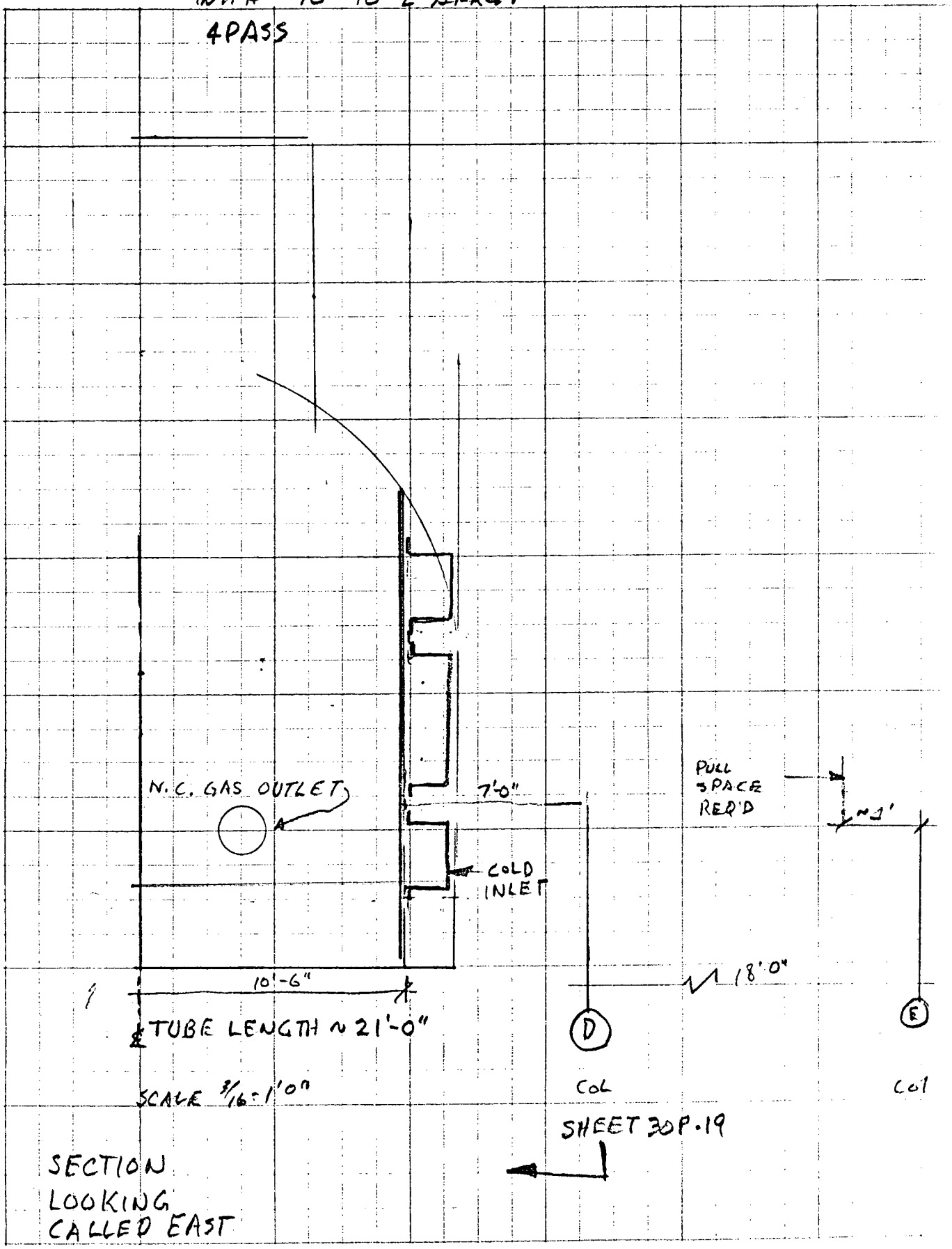
SUBJECT GEYSERS RETROFIT

UNIT 11

SHEET NO. 30P-18 OF .....
JOB NO. S-79007-40/41
BY B.Fraser DATE 20 June 79
CHKD. BY ..... DATE .....

WITH 90° TO ℄ ARRGT

4 PASS



SCALE 3/16 = 1'0"

SHEET 30P-19

SECTION LOOKING CALLED EAST

Rogers

SUBJECT GEYSERS RETROFIT

UNIT 11

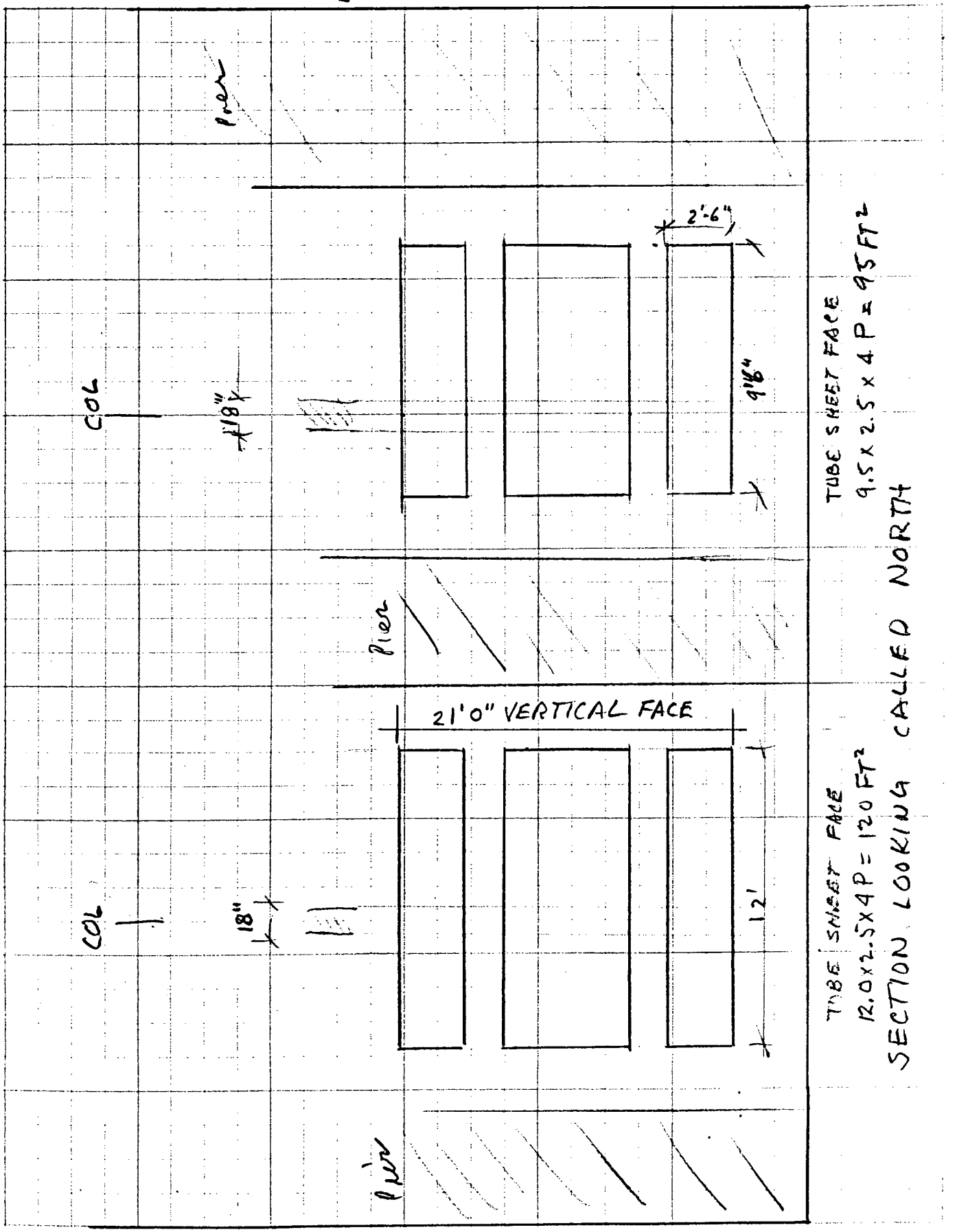
WITH 90° TO E ARRGT - 4PASS

SHEET NO. 30P-19 OF .....

JOB NO. 5-79007-40/41

BY B Fraser DATE 20 June 79

CHKD. BY ..... DATE .....



DG001

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

VERTICAL CENTRIFUGAL PUMP DATA SHEET

Units 11 & 12 Circ. Water & Condensate Pumps

MANUFACTURER _____
SPECIFICATION NO _____ REQ. NO. _____

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

	PUMP NUMBER	Cond pump	Circ. Water	
A. SERVICE				
TYPE OF INSTALLATION (WELL, PIT, SUMP, DOUBLE CASE)		Can	Sump	
B. LIQUID CHARACTERISTICS				
LIQUID PUMPED		H2O	H2O	
SPECIFIC GRAVITY AT FLOW TEMP				
FLOW. TEMP F		125	86	
VISCOSITY AT FLOW TEMP (CENTISTOKES) (SSU)				
VAPOR PRESSURE AT FLOW TEMP PSIA		1.94	.507	
C. CAPACITY AND PRESSURES				
GPM AT FLOW TEMP		4000	25,000	
SUCTION AT PUMP (IF NOT OPEN SUCTION) PSIA		5.4		
DIFFERENTIAL (INCL. LIFT FROM INLET) PSI		40.7	38.5	
DISCHARGE (AT DISCH. CONN.) PSIA		46.15	45.6	
DIFFERENTIAL HEAD (TOTAL, NOT INCL. VEL. HEAD) FT		95	90'	
N.P.S.H A) REQ'D & B) AVAILABL		8	43'	
SUBMERGENCE A) REQ'D & B) AVAILABLE		6	12'	
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		SS316	SS316	
INNER		SS316	SS316	
IMPELLER TYPE (OPEN) (CLOSED) (AXIAL) (MIXED FLOW)				
IMPELLER MTL		SS316	SS316	
CASE WEAR RINGS				
IMPELLER WEAR RINGS		SS316	SS316	
SHAFT IN PUMP BOWL		SS316	SS316	
LINESHAFT		SS316	SS316	
LINESHAFT DIAMETER				
LINESHAFT BEARING SPACING				
SHAFT SLEEVES		SS316	SS316	
SHAFT ENCLOSING TUBE		SS316	SS316	
DISCHARGE COLUMN OR PIPE		SS316	SS316	
DISCHARGE HEAD OR ELBOW		SS316	SS316	
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				

USE THIS SPACE FOR NOTES OR SKETCHES

	Circ Water	Cond Pump	
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)			

REV.	DATE		DATE
0	6/27/79	ISSUED FOR QUOTATION	

PG&E Geysers Retrofit

JOB NO. 5-79007-00 REV.
DWG NO. DS-14-010 0

Q315

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4.3 Installation Description for Units 11 and 12

Units 11 and 12 are identical turbine-generator units and housed in their own power building at two different sites. Equipment location and other dimensions were field checked on June 12, 1979 and verified against Drawings SK-017, -018 and -019. These drawings are included in this section and show the new equipment locations.

4.3.1 Main Condenser

As shown in the above drawings, the axis of the condenser is parallel to the power building. The initial conceptual design assumed the new surface type condenser tube pulling space to be along this axis. Condenser duty requirements are satisfied with 48 foot tube length and a two pass tube bundle arrangement. To be capable of cleaning half the condenser while operational, water to the condenser will be split flow. For a split flow two pass tube bundle arrangement, the necessary tube pulling space requires the removal of the lube oil tank and associated pumps and piping and the main compressor and tanks. In addition, one column and two walls will have to be removed. For this configuration, the condenser shell will not have to be modified to ensure the placement of the water boxes. Despite these difficulties, an adequate gas cooling section in the new condenser is ensured with this design.

A second alternative to the design is to place the condenser tubes perpendicular to the condenser axis. Condenser duty requirements are satisfied with a split flow four pass tube bundle arrangement. Except for condensate pump removal a minimum of equipment removal is required for the condenser tube pulling space. In addition, the piping following removal of the existing condensate pumps from the condenser to cooling tower has less turns and is shorter in distance than the first alternative. The condenser shell however, for this alternative cannot be salvaged and must be cut out and replaced with a shell compatible with the new tube bundle requirements. For this design there may be some difficulty in achieving an adequate gas cooling section in the new condenser.

Existing condenser cooling water inlet piping can be used with attachment to the condenser positioned at the bottom of the inlet water boxes. The need for circulating water pumps and smaller condensate pumps offset from the tube pull space will preclude the use of existing discharge piping from the condenser. All new piping will be constructed of techite for underground service and stainless steel for piping above ground.

4.3.2 Intercondenser and Ejectors

The existing intercondenser and ejectors will be removed. The new surface type intercondenser and new first stage jet ejector will be relocated to the southwest corner outside the power building, 16 ft. above grade and stacked above the aftercondenser to allow for tube pulling space for the main condenser. New support steel will be required.

4.3.3 Aftercondenser and Ejectors

The existing aftercondenser and ejectors will be removed. The new surface type aftercondenser will be stacked below the intercondenser, 6 ft. above grade.

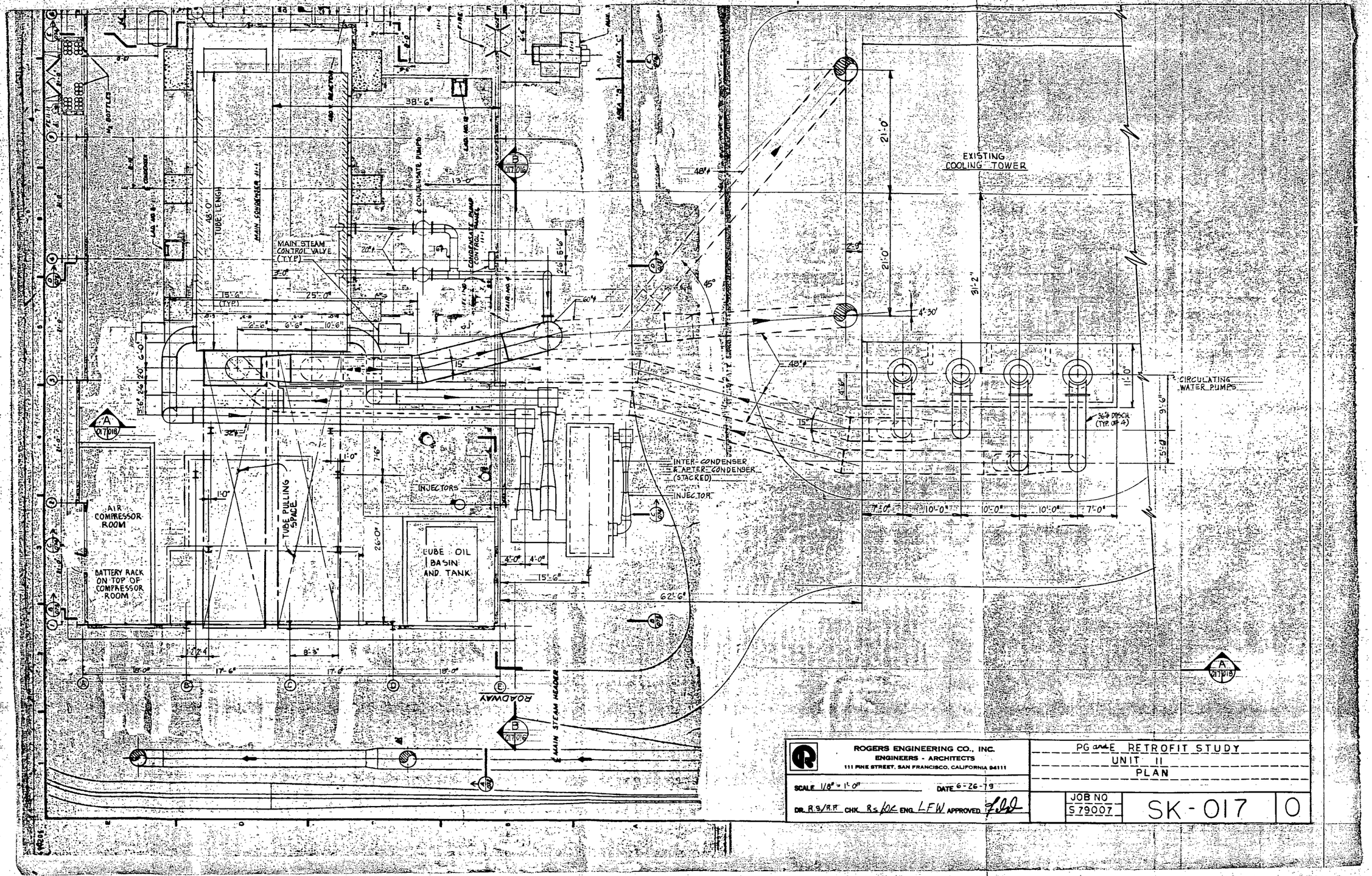
4.3.4 Condensate Pumps

The existing condensate pumps will be removed and new condensate pumps sized and located adjacent to the condenser inside the power building with their own wet pit. Again the condensate pumps will be used as circulating water pumps for the new system configuration.

4.3.5 Circulating Water Pumps

The four circulating water pumps will be located at the west end of the cooling tower near the cooling tower sump. Each pair of pumps will supply water to half the condenser. Cold well water will flow by gravity to the circulating water pump wet pit where a diffuser will reduce vorteces before entering the pump suction.

The existing condensate pumps can be used as the circulating water pumps for these units. The pump, however, must be redesigned in order to satisfy the additional head requirements for the 110 MW unit.



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

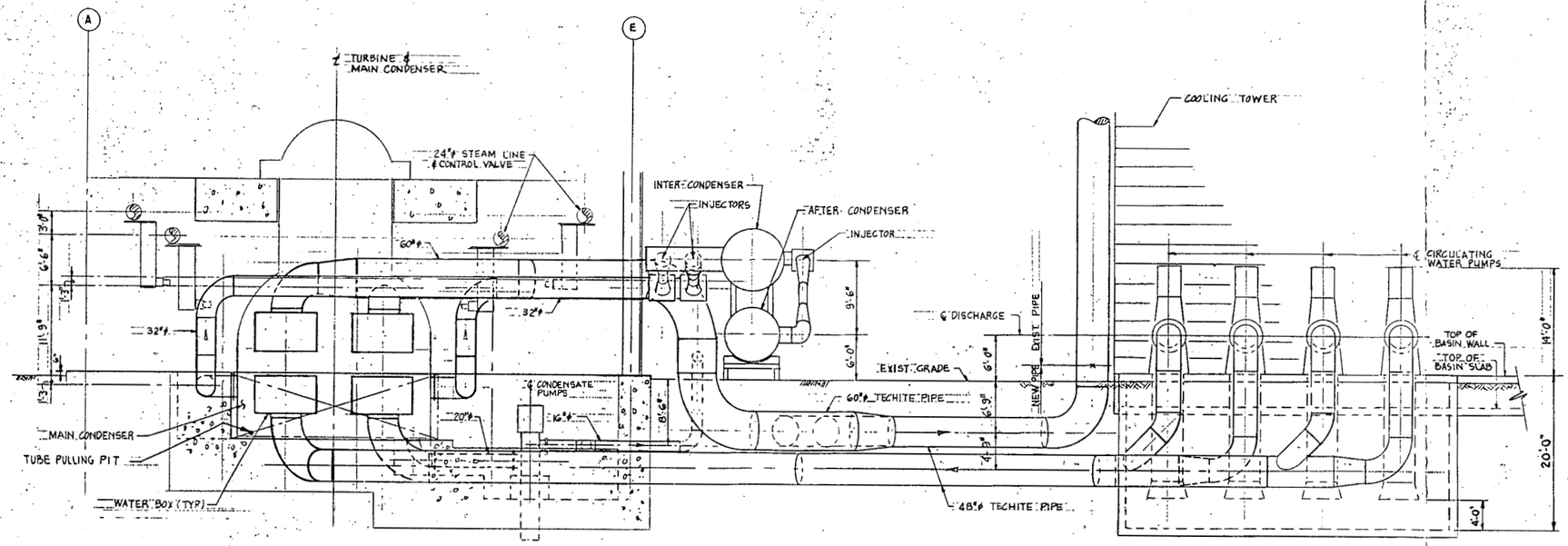
SCALE 1/8" = 1'-0" DATE 6-26-79

DR. R.S./R.P. CHK. R.S. for ENG. L.F.W. APPROVED

PG and E RETROFIT STUDY
UNIT II
PLAN

JOB NO. S79007

SK-017 0



SECTION A (D17/D18)

REFERENCE DRAWINGS	REV.	ZONE	DATE	REVISION	DR.	CHK.	APPR. RECO	APPR.

ROGERS ENGINEERING CO., INC.
ENGINEERS - ARCHITECTS
16 BEALE STREET, SAN FRANCISCO, CALIFORNIA 94105

SCALE 1/8" = 1'-0" DATE 6-25-79

DR. RS/RP. CHK. RJ/DL ENG. LFW APPROVED. [signature]

APPROVALS

DATE

DATE

PG and E RETROFIT STUDY
UNITS 11 & 12
SECTION

JOB NO 579007 | SK-018 | 0

GE 212

PRINTED ON DIAZO NO. 1 HIGH CLEARPRINT 10-77

4.4 Equipment Quotations

We contacted some suppliers as for Units 5 through 10.

4.4.1 Condensers and Ejectors

Quotation requests were sent to DeLaval, Ecolaire and Marley Heat Transfer Co. Marley could not respond as previously indicated and DeLaval was unable to devote any time to consideration of 4 pass alternative.

Ecolaire gave us data on a standard design 2 pass condenser which would be installed in line with turbine-generator center line. However this design would require relocation of turbine lube oil system and instrument air system, for tube pulling tubes would be 46 ft. long.

As an alternative we requested Ecolaire to investigate if a 4 pass cooling water design would be feasible, using 22 ft. tubes.

Althogh they have never built a unit in this water side configuration, they agreed it would be technically feasible and would guarantee the performance, at no sacrifice of design turbine back pressure.

4.4.2 Vendors Comments

4.4.2.1 Ecolaire used H. E. I. Air Leakage rate of 112#/hr. vs specification of 930#/hr. Hotwells same length as condenser and two water boxes are supplied rather than four.

4.4.2.2 DeLaval previously gave us a design basis of 3" Hg Abs turbine back pressure. Some comments apply as per condensers for Units 5 through 10.

4.4.2.3 Neither Ecolaire or DeLaval provided ejector steam rates.

4.4.3 Condensate and Circulating Water Pumps

Same vendors contacted as for Units 5 through 10.

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TABLE 4.4.1

SURFACE CONDENSER SUMMARY

UNITS 11 AND 12

Specification Main Condenser	Vendor Ecolaire	Vendor DeLaval
H. E. I. Cleanliness Factor: 70%	70%	70%
Shellside Allowable ΔP: Vendor's Choice	N. S.	N. S.
Cooling Water Flow: 85,000 gpm	To Spec.	To Spec
Tube Length Base Case: 48 ft. max./ft.	46	N. S.
No Passes Base Case: 2	2	N. S.
Tube Length Alt. Case: 22 Ft.:	22	N. Q.
No Passes Alt. Case: 4	4	N. Q.
Surface Area Sq. Ft.: As Required	215,000	202,000
Tube Size : 22 ga., 3/4", 7/8" or 1" Vendor's Choice	3/4"	N. S.
Cost of Tubes $:	Included (Note 1)	400,000 (Est.) (Note 1)
Dimensions: Base Case	46'L x 25'W x 22'-6"H	N. S.
Dimensions: Alt. Case	To Suit Space Allocated	N. Q.
Turbine Exhaust Pressure:	As Specified	3" Hg Abs
Inter- and Aftercondensers & Rejectors: Required	Included in Price w/Tubing Provided Installed	Included in Price w/Tubing Installed
TEMA Fouling Resistance Overall: 0.0011	H. E. I. 50% C. F.	H. E. I. 70% Cleanliness Factor
Conformity to Material Specs:	Yes	Yes
Purchase Price Base Case $:	3,000,000	1,950,000
Purchase Price Alt. Case $:	3,000,000	N. Q.
Add for Tubing Cost Main Condenser $:	Included	400,000 (Est. by Vendor)
Total Price $:	3,000,000	2,350,000

NOTE 1: Installation of tubes in Main Condenser, not included in above prices

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TABLE 4.4.2

EQUIPMENT SUMMARY SHEET - PUMPS - UNITS 11 AND 12

Specifications	Vendors' I. R.	Peerless	Byron Jackson	Worthington
Condensate Pump				
Capacity: 4,000 gpm		Spec.		
Differential Head: 95 ft.		Spec.		
Materials: All 316SS		Spec.		
Type: Can		Spec.		
NPSH Available: ft./Req'd:		10 ft.		
Efficiency %:		75		
Motor HP/rpm		150/885		
Price $:		$88,300		

C. W. Circulation Pump

As for Units 5 through 10, least project cost would be to use existing Peerless condensate pumps. Peerless advise the modification would consist of a new motor, new shaft, additional bowl for each pump. Modification would cost approximately $42,000 vs $120,000 for a new pump.

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4.5 Project Costs - Units 11and 12

This milestone report is a 10 week progress report presenting partial cost and economic information pertaining to Units 11 and 12 surface condenser installation. This report presents two economic aspects: Equipment sizing and capital cost estimate. Each aspect 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.

51-20	Structures and Improvements
52-50	Main Steam Piping
54-20	Turbine-Generator - Condensate System
54-30	Turbine-Generator - Circulating Water System
54-40	Lube Oil System
54-70	Turbine-Generator - Instrumentation
55-30	Control and Power Connection
55-60	Auxiliary Electrical Equipment - Station Power
56-10	Compressed Air System
365	Engineering and Other Cost Allocations

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.

4.5.1 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 a 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 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 11 and 12 equipment comparisons and are not repeated. However, the actual design point was determined separately for Units 11 and 12.

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 equipment installation.

4.5.2 Major Equipment Cost

Suppliers of the major equipment, condensers and pumps, were contacted by telephone followed up by transmittal of pertinent equipment data sheets. 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

An appropriate Section of this Report 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 addressed. 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 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.

4.5.3 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.

The estimated materials and labor 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 $15 per hour to be an overall good concept estimate direct figure and has been used in this report. 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 are derived as follows:

Man-hours = 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.

4.5.4 GM Estimate

The factors included in the Equipment and Material and labor parts of the estimate have been discussed. The cost estimate for the removal and installation of specified equipment to facilitate the operation of a surface condenser at Unit 11, typical for Unit 12 is here presented in summary account form. The account details are itemized in the next table from the summary.

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TABLE 4.3

SUMMARY COST ESTIMATE - UNITS 11

Item No.	Description	Cost @ Site	Labor Dollars	Total Dollars
51-20	Building	$ 19,080	$ 147,700	$ 219,189
54-20	Condensate System	4,369,320	1,473,271	6,365,364
54-30	Circ. Water System	542,890	470,123	1,179,831
54-40	Lubw Oil System	22,642	80,140	131,218
54-70	Instrumentation	35,107	46,593	98,233
55-60	Station Pwr System	70,087	47,059	133,844
56-10	Compressed Air System	10,812	67,560	102,345
365	Eng & Other Alloc Cost	0	0	0
	Totals	$5,069,938	$2,332,446	$7,402,383

The estimated cost in June 1979 dollars to retrofit Unit 11 for a surface condenser is ~~$8,927,300~~ $7,402,383. To this estimate sub total must be added the GM overheads.

4.5.4.2 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 11 is estimated to be ~~$2,964,000.~~ $8,927,300.—

4.5.5 Project Differential Costs

The capital involved to accomplish the retrofit project using a surface condenser will require a level annual revenue of 1.80 mills

Rogers

per kilowatthour. The project differential cost and GM estimate capital cost 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.

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

JOB NO.

DG-023

ROGERS ENGINEERING CO.,INC. COST ESTIMATE

JOB NAME-UNIT 11 JOB NO.-S79007 CLIENT-P G AND E ESTIMATE DATE- 29 JUNE 79

ITEM NO.	DESCRIPTION	MATL&EQPT	INSTALL	MANHOURS	TOTAL
51-21-1	RMV BLDG CONC FL/WLL	1272.	18637.	802.	19909.
51-21-2	RMV STR STL COLS	636.	46593.	2004.	47229.
51-21-3	CONST LO SUMP & PES	1272.	13978.	601.	15250.
51-21-4	INSTALL BLDG STR STL	4452.	34945.	1503.	39397.
51-21-5	CONST TURB PULL PIT	11448.	33547.	1443.	44995.
ACCOUNT TOTAL		19080.	147700.	6353.	166780.
54-21-1	COND PUMPS EXC & BFL	4070.	27956.	1202.	32026.
54-21-2	COND PUMPS CONC	3562.	16773.	721.	20335.
54-22-1	SUP STRUCT INT/AFT/E	22896.	55912.	2405.	78808.
54-22-2	RMV SUP STR INT/AFT	0.	9319.	401.	9319.
54-23-1	RMV CONDENSER	3816.	130460.	5611.	134276.
54-23-2	R CRANE	38160.	16308.	701.	54468.
54-23-3	EQ COND M/INT/AFT/EJ	3816000.	0.	0.	3816000.
54-23-4	INSTALL M COND MECH	76320.	838674.	36072.	914994.
54-23-5	R CRANE/EQUIP	63600.	32615.	1403.	96215.
54-23-6	INSTL INT/AFT/EJ	2544.	46593.	2004.	49137.
54-24-1	RMV COND PUMPS MECH	0.	18637.	802.	18637.
54-24-2	EQ CONDS PUMPS QUOTE	139920.	0.	0.	139920.
54-24-3	INSTALL COND PUMP ME	6360.	39604.	1703.	45964.
54-25-1	RMV COND PIPING	3816.	37274.	1603.	41090.
54-25-2	R CRANE	2544.	3727.	160.	6271.
54-25-3	RMV NC GAS PIPING	0.	9319.	401.	9319.
54-25-4	RMV MISC SMALL PIPE	0.	9319.	401.	9319.
54-25-5	NC GAS PIPING	63600.	60571.	2605.	124171.
54-25-9	CONDS PIPING	61056.	55912.	2405.	116968.
54-25-6	EQ TURB EXH CONN	57240.	0.	0.	57240.
54-25-7	INSTALL TURB EXH CON	1272.	60571.	2605.	61843.
54-25-8	R CRANE	2544.	3727.	160.	6271.
ACCOUNT TOTAL		4369320.	1473271.	63366.	5842591.

TABLE 4.5.1
SUMMARY COST ESTIMATE -
UNITS 11 AND 12

SHEET 1 OF 3

DRAWING NO.

REV.

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

JOB NO.

DG-023

TABLE 4.5.1
SUMMARY COST ESTIMATE -
UNITS 11 AND 12

DRAWING NO.

REV.

SHEET 2 OF 3

ROGERS ENGINEERING CO., INC. COST ESTIMATE

JOB NAME-UNIT 11 JOB NO.-S79007 CLIENT-P G AND E ESTIMATE DATE- 29 JUNE 79

ITEM NO.	DESCRIPTION	MATL&EQPT	INSTALL	MANHOURS	TOTAL
54-32-1	RMV COLD WELL	1272.	13978.	601.	15250.
54-32-2	CONST COLDWELL	25440.	104834.	4509.	130274.
54-33-1	CW PIPING	228960.	209669.	9018.	438629.
54-33-2	R CRANE/EQUIP	3816.	4659.	200.	8475.
54-34-1	EQ CW PUMPS REWRK	254400.	0.	0.	254400.
54-34-2	INSTALL CW PUMPS ME	20352.	116483.	5010.	136835.
54-34-3	R CRANE	7632.	9319.	401.	16951.
54-39-1	RELOCATE FHC & PIPG	1018.	11182.	481.	12200.
ACCOUNT TOTAL		542890.	470123.	20220.	1013013.
54-41-1	CONS CONC BERM & STR	509.	22365.	962.	22873.
54-43-1	RELOCATE LO RES & EQ	1272.	9319.	401.	10591.
54-43-2	R CRANE	2544.	3727.	160.	6271.
54-43-3	MOD & EXT PIPING SYS	18317.	44729.	1924.	63046.
ACCOUNT TOTAL		22642.	80140.	3447.	102782.
54-74-1	INSTR COND SYS	19080.	18637.	802.	37717.
54-74-2	INSTR CW SYS	15264.	18637.	802.	33901.
54-74-3	INSTR LUBE OIL SYS	636.	4659.	200.	5295.
54-74-4	INSTR COMP AIR SYS	127.	4659.	200.	4787.
ACCOUNT TOTAL		35107.	46593.	2004.	81700.
55-64-1	COND PUMP ELECT	20352.	6057.	261.	26409.
55-64-2	CW PUMPS ELECT	47064.	31217.	1343.	78281.
55-64-3	RELOCATE LO ELECT	1526.	3727.	160.	5254.
55-64-4	RELOCATE COMP A ELEC	382.	2330.	100.	2711.
55-64-5	RELOCATE DC BATT SYS	763.	3727.	160.	4491.
ACCOUNT TOTAL		70087.	47059.	2024.	117146.

ROGERS ENGINEERING CO., INC.
111 PINE STREET
SAN FRANCISCO, CALIF. 94111
JOB NO.
PG-023

ROGERS ENGINEERING CO..INC. COST ESTIMATE

JOB NAME-UNIT 11 JOB NO.-S79007 CLIENT-P G AND E ESTIMATE DATE- 29 JUNE 79

ITEM NO.	DESCRIPTION	MATL&EQPT	INSTALL	MANHOURS	TOTAL
56-11-1	CONST CONC BLK ROOM	6360.	27956.	1202.	34316.
56-13-1	RELOCATE COMP AIR EQ	636.	9785.	421.	10421.
56-13-2	R CRANE	1272.	1864.	80.	3136.
56-13-3	MOD & EXT C A PIPING	2544.	27956.	1202.	30500.
ACCOUNT TOTAL		10812.	67560.	2906.	78372.
365-1	CONST FIELD	0.	0.	0.	0.
365-2	GENRL ENG	0.	0.	0.	0.
365-3	OTHR ENGINEERING	0.	0.	0.	0.
ACCOUNT TOTAL		0.	0.	0.	0.

TABLE 4.5.1
SUMMARY COST ESTIMATE -
UNITS 11 AND 12

DRAWING NO.

REV.

SHEET 3 OF 3

APPENDIX A

CAPITAL: The single life 30 year level annual revenue requirement (LARR) factor for generation planning is 0.1465.

OPERATION AND MAINTENANCE: The 30 year level annual factor for generation planning is 2.19.

STEAM AT GEYSERS: The 30 year level annual steam cost in mills per kWh is 24.4.

POWER VALUES: (for base loaded units)

Year	30 Year Level	Single Value
1979	61	33
*1980	65	37
1981	68	39
1982	72	50
1083	75	55

*Data used in Milestone One Report

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CONSTRUCTION COST:

Direct Labor Rate: 15.00 dollars per hour
Efficiency: 60 percent of hours
Indirects and Profit: 55 percent of direct labor cost
Contingency: 20 percent on direct labor hours

Major Equipment: Evaluated manufacturer cost
Materials and Rentals: Estimated
Contingency: 20 percent on equipment and materials

Engineering and Other Allocatable Costs: 20 percent on labor and equipment

GM FACTORS:

Indirect Costs: (Construction by Outside Contractor)	0.0 percent
General Overheads:	
Engineering and Administration	16.0
ADC (estimate 9 months)	3.6
Ad Valorem	1.0
Total	20.6 percent

No.	Date	Description	Ck	R.App	C.App
1	6/29/79	Revised for milestone report #2			
0	6/15/79	Data used in milestone report #1			

ROGERS ENGINEERING CO., INC. 111 PINE STREET SAN FRANCISCO, CALIF. 94111	ECONOMIC FACTORS AND METHODS DATA SHEET	SPECIFICATION S-00-001	REV. 1
JOB NO. S-79007-70	Client PGandE Date 29 June 1979	SHEET 1 OF 2	

GS-004

METHODS:

1. For alternative comparison, the alternatives must be equal. All costs and their differences are compared to make a selection.

2. The costs of an installation is only the capital cost which must be authorized in a GM.

CALCULATIONS:

1.0 LEVEL ANNUAL STEAM

Level Annual Steam Factor (LASF) = 0.0244 $/kWh
Steam #/hr. x 0.049 kW/# x Capacity Factor x hrs./yr. x LASF = Level Annual $/yr.

2.0 LEVEL ANNUAL OPERATIONS AND MAINTENANCE

Note exclude electrical energy use factor of Section 3.0.
Level Annual Operations and Maintenance Factor (LAOMF) = 2.19
Operation and Maintenance Cost/yr. x LAOMF = Level Annual $/yr.

3.0 LEVEL ANNUAL ELECTRICAL ENERGY

Level Annual Power Value Factor (LAPVF) = 0.065 $/kWh
kWh/yr. x LAPVF = Level Annual $/yr.

4.0 LEVEL ANNUAL CAPITAL COST

Level Annual Capital Factor (LACF) = 0.1465
(Account 314 Only)
Capital Cost $ x LACF = Level Annual $/yr.

5.0 CAPITAL COST

Construction Cost x GM Factor = Capital Cost