SUPPLEMENTAL PLAN OF OPERATIONS

SANTA YNEZ UNIT

HUMBLE OIL & REFINING COMPANY

UNIT OPERATOR

APPENDIX VOL. 4

APPENDIX 4.1

SUPPLEMENTAL PLAN OF OPERATIONS

SANTA YNEZ UNIT

APPENDIX 4.1

Preliminary Environmental Base Line Survey of Corral Canyon Site, Santa Barbara County, California

Metronics Associates, Inc.

February, 1971

TECHNICAL REPORT NO. 175A

PRELIMINARY ENVIRONMENTAL BASE LINE SURVEY OF CORRAL CANYON SITE SANTA BARBARA COUNTY, CALIFORNIA

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Prepared for:

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CONTENTS

I. SUMMARY AND RECOMMENDATIONS

1. The proposed Corral Canyon Site appears to show no unusual contamination of air, water, soil or vegetation on the basis of the preliminary site survey.

2. Air pollution potential appears to be the primary concern because of the high frequency of relatively calm stable conditions in the Santa Barbara area. Odorous emissions from site operations and also from off-shore operations should be kept to a minimum.

3. Air flow in the canyon is correlated with the winds at Santa Barbara Airport. The prevailing northeast and southwest winds at the airport correspond to down-canyon and up-canyon flows respectively. Depth and trajectories of the canyon flows are uncertain but, would be defined by air tracer tests.

4. Preliminary estimates of sulfur dioxide concentration from an assumed emission of one ton per day through a 60-ft stack indicate a possibility of exceeding the ambient air quality standard for 24-hour averages within the first three miles from the source.

5. It is recommended that further meteorological measurements be taken and air tracer tests be conducted to clearly define the depth and trajectories of the air flow in the canyon and along the coast line in order to quantitatively assess the air pollution potential of proposed operations at the site and off-shore.

6. It is recommended that additional air, soil, water and vegetation samples be taken to give a complete reference base line for the site and surrounding area and to assess the impact of proposed operations on the environment. In addition the flora and fauna of the area should be examined to see if there is any unusual chemical background in this area.

II. SITE LOCATION AND DESCRIPTION

The proposed site lies within the Canada del Corral and Las Flores Canyon stream drainage systems as shown in Figures 1 and 2. Property boundaries extend from the Pacific Ocean on the south between Refugio and El Capitan Beach State Parks to approximately two miles inland. Two north-south ridges reaching a maximum of 848 feet above sea level form the eastern and western boundaries. The stream channels of Las Flores Canyon and Canada del Corral converge near the center of the property and the latter stream continues to the Pacific Ocean approximately one mile downstream.

The tentative plant site lies in a relatively flat meadow near the northern boundary of the property designated as 1 in Figure 1. The Canada del Corral stream bed lies to the west of the site and rolling hills rise abruptly to the ridge on the east.

III. METEOROLOGY

Meteorological measurements taken at the Corral Canyon site at the position indicated in Figures 1 and 2 shows a high degree of regularity in the diurnal flow patterns particularly when winds in the Santa Barbara area are light. A plot of wind frequencies and speeds is shown in Figure 3 for the periods 13 Nov. to 23 Dec. 1970. The high frequency of down canyon flows from the north to northeast is due to the channeling of the air flow in the canyon as the air drains from the cooling slopes of the Santa Ynez mountains from late afternoon to late morning during the winter season. The secondary maximum frequency occurs with south to southwest winds up the canyon. This flow occurs with the onset of the sea breeze and is accelerated by solar heating of the slopes. The up canyon flows are weak and of short duration during the winter season but increase considerably and become more persistent during the summer season.

The wind frequencies at Santa Barbara Airport during the same period as the on-site measurements are shown in Figure 4. High frequencies of northeast and east winds were observed during the night and early morning hours. During the day the on-shore sea breezes are from a west southwest direction with a secondary maximum from the southeast. Comparison of winds at Santa Barbara Airport and at the site indicated that in most cases winds from the northwest and northeast quadrants at the airport correspond to down-canyon flow at the site and airport winds from the southeast and southwest quadrants correspond to up-canyon flow at the site. This comparison provides a means of converting climatological wind data obtained from Santa Barbara Airport observations to winds at the site.

A five year average wind frequency diagram at Santa Barbara Airport for December during the period 1960-1964 is shown in Figure 5. The frequencies are given to 16 compass points instead of 10 degree intervals as used in the observations. The wind frequencies in Figure 4 are similar to the 5-year average values except for a high frequency of easterly winds greater than 16 knots due to the unusually storm periods in November and December 1970.

A tabulation of winds by Pasquill stability classes was obtained from the National Climatic Center at Asheville, North Carolina. These stability classes are determined from standard meteorological observations of wind speed and cloudiness and from the solar elevation angle which show a diurnal and seasonal variation*. Atmospheric stability and wind speed determine the dispersion of gaseous and particulate materials in the atmosphere and diffusion parameters have been derived by Pasquill for several stability classes. The Santa Barbara Airport data was grouped into six stability classes by months. These stability classes are defined as follows:

Stability Class	Definition
A	Extremely unstable
B	Unstable
C	Slightly unstable
D	Neutral
E	Slightly stable
F	Stable to extremely stable

* D. Bruce Turner, Journal of Applied Meteorology, February 1964

Class A occurs with clear sunny days and light winds. Dispersion of airborne materials is very rapid under these conditions and concentration decreases rapidly with distance from the source. Class B and C also occur in daytime but with increasing cloudiness and/or stronger winds. Class D occurs day or night under overcast conditions or with broken cloudiness and moderate to strong winds. Classes E and F occur at night with the extreme stability of F occurring with light winds and clear skies.

The diffusion of airborne gases and particles decreases with increasing stability so that the concentration remains high for long distances from the source. The frequency of occurrence of stable conditions is of particular interest since this corresponds to a down-canyon flow from the site and off-shore flow along the coast. However, during transition periods the flow would parallel the coast and could cross the El Capitan area and Santa Barbara.

Table 1 shows the frequencies of the six stability classes by months and also on an annual basis. Classes C and D and F occur more than 75% of the time during all seasons of the year. Class F predominates during December and January and accounts for nearly 50% of the total because of the long nights and clear skies resulting in strong nocturnal cooling. The frequency of neutral conditions (Class D) increases to a maximum of nearly 50% in June while the frequency of Class F conditions decreases to 20% of the total hours. Neutral conditions can occur with both up-canyon and down-canyon flows and occasional cross-canyon flows. Frequencies of class A, B, and C also increase during the summer months and solar heating is increased then producing more favorable conditions for atmospheric diffusion of airborne materials.

The depths of the canyon flows have not been determined but could be measured with pilot balloon ascents from the site. The air flow patterns however are expected to be complex along the coast particularly during the transition periods between down-canyon and up-canyon flow. A definitive measure of these flows could be made with air tracer experiments.

Table 1

MONTHLY AND ANNUAL FREQUENCIES OF STABILITY CLASSES
(5-Year Averages For 1960 - 1964)
STABILITY CLASS

	A		B		C		D		E		F	
Month	Hrs.	%	Hrs.	%	Hrs.	%	Hrs.	%	Hrs.	%	Hrs.	%
Jan.	0.2	0.05	51	6.8	100	13.4	191	25.6	52	7.0	350	47.1
Feb.	5	0.7	49	7.4	96	14.3	219	32.5	63	9.4	240	35.7
Mar.	3	0.4	57	7.7	96	13.0	273	36.7	74	9.9	240	32.3
Apr.	7	0.9	75	10.4	118	16.3	243	33.7	65	9.1	213	29.5
May	8	1.0	72	9.7	135	18.2	248	33.4	75	10.1	206	27.7
Jun.	7	1.0	69	9.5	111	15.4	340	47.2	45	6.2	149	20.6
Jul.	4	0.6	95	12.7	141	18.9	272	36.5	68	9.2	164	22.1
Aug.	3	0.3	80	10.7	129	17.3	274	36.8	70	9.4	190	25.5
Sep.	2	0.3	55	7.6	123	17.0	274	38.1	55	7.6	212	29.4
Oct.	1	0.1	47	6.4	115	15.5	272	36.5	58	7.8	251	33.7
Nov.	1	0.1	33	4.6	96	13.4	254	35.2	63	8.8	272	37.8
Dec.	0	0.0	38	5.1	113	15.1	190	25.6	48	6.5	355	47.7
Annual	41	0.5	720	8.2	1371	15.7	3049	34.8	737	8.4	2841	32.4

IV. ESTIMATES OF CONCENTRATION FOR PASQUILL'S STABILITY CLASSES

Some preliminary estimates were made of sulfur dioxide concentrations downwind from an assumed 60-ft stack with an emission rate of one ton of SO_2 per day. These estimates are based upon the diffusion parameters derived by Pasquill for diffusion over open, flat terrain*. These estimates should give the order of magnitude of concentrations to be expected in the vicinity of the site but definitive concentration estimates and trajectories of the effluent gases can only be obtained by air tracer experiments in a hilly area such as this. The concentration estimates are given in Table 2 as a function of distance from the source. The calculated values are for ground-level centerline positions.

The ambient air quality standards for sulfur dioxide in California are 0.04 ppm (114 $\mu g/m^3$) for a 24-hour averaging period and 0.5 ppm (1430 $\mu g/m^3$) for a one-hour average. It appears likely that the 24-hour average of 0.04 ppm could be exceeded within the first mile or two with an emission of one ton per day.

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*Workbook of Atmospheric Diffusion Estimates, U.S. Dept. of Health, Education and Welfare. Public Health Service

Table 2

CONCENTRATION OF SULFUR DIOXIDE AS A FUNCTION
OF DISTANCE FROM THE SITE FOR PASQUILL'S STABILITY CLASSES
(Emission 1 ton/day through 60 ft. stack)
Concentration (ppm)

Distance (miles)	Stability Class A	B	C	D	E	F
0.5	0.0138	0.0394	0.064	0.108	0.092	0.010
1	0.0049	0.0105	0.023	0.054	0.092	0.079
2	0.0028	0.0026	0.0064	0.022	0.050	0.079
3	0.0019	0.0017	0.0032	0.012	0.029	0.059
4	0.0015	0.0013	0.0024	0.0084	0.021	0.049
5	0.0012	0.0010	0.0020	0.0061	0.016	0.039
10	0.0007	0.0006	0.0011	0.0023	0.0066	0.022

V. ENVIRONMENTAL SAMPLING PROGRAM

As part of Metronics, preliminary base line survey of the Corral Canyon site, a group of water, vegetation and soil samples were collected and analyzed. Figure 6 shows the locations where samples were taken.

A total of eleven samples were analyzed. Table 3 summarizes these samples as to collection date, type, analytical methods and laboratory. Appendix A gives complete analytical data for each sample.

Preliminary analysis of the soil and vegetation samples show no cause for concern. Note worthy is the absence of any heavy metal contamination. Of the seven soil samples examined, lead was below the limits of detection in two samples (2S1 and 3S1) and less than 0.005% in the remaining four (4S1 through 7S1). Soils from a region where lead was shown to be a problem in pasture grasses yielded soil lead values an order of magnitude higher.

Samples of pasture grasses were collected and separated into new grass, old grass and soil, and analyzed spectrographically. Grasses tend to concentrate heavy metals from the soil in their tissues late in their growth cycle and this is demonstrated by the Corral Canyon samples. For instance, only a trace of lead was observed in soil sample 2S1, and $<$0.001% was found in new (green) grass grown in the soil. But greater than four times this amount was observed in old, dry grass grown in the same soil sample. Note that the total amounts observed were small, however. The grass appeared normal and the cows feeding on it, healthy.

Three water samples were examined, two from a stream running through the property and one example of waste water from the Shell holding pond system. Of the two stream samples, one was taken from stagnant water and the other from the freely flowing stream. Each water sample was given a complete chemical analysis (see Appendix A). All samples appeared normal with the possible exception of the dissolved organic material observed in SB(W)-1 and SB(W)-2.

Table 3

SUMMARY OF ENVIRONMENTAL SAMPLES COLLECTED
AS PART OF A PRELIMINARY BASELINE SURVEY OF THE
CORRAL CANYON SITE, SANTA BARBARA COUNTY, CALIFORNIA

Sample[1]	Date Collected	Type	Analysis[2]	Laboratory[3]
SB(W)-1	11-13-70	Stagnant Pond	CW	CL
SB(W)-2	11-13-70	Waste Water	CW	CL
SB3A	12-4-70	Running Water	CW	CL
649-1G1	11-13-70	Old Grass	S	AS
649-2G1	11-13-70	New Grass	S	AS
649-2S1	11-13-70	Soil	S	AS
649-3S1	12-4-70	Soil	S	AS
649-4S1	11-4-70	Soil	S	AS
649-5S1	12-4-70	Soil	S	AS
649-6S1	12-4-70	Soil	S	AS
649-7S1	12-4-70	Soil	S	AS

NOTES:

1. Locations where samples were taken are shown in Figure .
2. S = Emission Spectrograph, full scan. A semi-quantitative analysis for some 29 elements.

   CW = Complete chemical water analysis for common cations and onions, hardness, alkalinity and minerals.
3. CL = Cook Laboratories, Inc., Menlo Park, California

   AS = American Spectrographic Laboratories, Inc., San Francisco, California.

No extraneous odors were detected on repeated visits to the site. Odors associated with the oil field were very light and limited to regions immediately associated with operations. No H_2S odors were observed or detected with sensitive lead-acetate tiles.

APPENDIX A

COMPLETE ANALYTICAL RESULTS FROM SOIL, VEGETATION AND WATER SAMPLES COLLECTED AT CORRAL CANYON SITE, SANTA BARBARA, CALIFORNIA

1. Soil Samples. Semi-quantitative spectrographic analyses on six soil samples. The following are reported as oxides of the elements indicated.

	2S1	3S1	4S1	5S1	6S1	7S1
Al	15. %	13. %	15. %15.	15. %	15. %	15. %
Ca	3.	10.	12.	5.	12.	10.
Fe	5.	4.	4.	6.	5.	7.
Mg	2.3	2.3	2.	3.5	3.	3.5
Na	2.3	2.5	3.	2.3	2.5	2.5
K	2.5	3.	3.	3.5	3.5	3.5
P	--	3.	--	2.5(?)	3.5	3.
Pb	--	--	.005	.005	.005	.005
Ti	.5	.35	.35	.6	.6	.6
Ba	.08	.06	.2	.08	.08	.08
Mn	.08	.06	.07	.08	.08	.08
Sr	.05	.07	.07	.05	.06	.07
Cr	.03	.03	.02	.04	.04	.05
B	.04	.04	.03	.04	.04	.03
Zr	.02	.01	.015	.03	.035	.03
V	.02	.015	.02	.025	.02	.025
Ni	.01	.008	.008	.015	.015	.015
Y	.006	.006	.004(?)	.006	.008	.008
Cu	.003	.002	.003	.004	.004	.004
Ga	.002	.002	.002	.003	.003	.003
Co	.001	--	--	.001	.001	.001
Zn	.15	--	--	.15	--	--

Si + non-detectables: Balance in each.

The soil samples were dried 24 hours at 80°C before analysis.

2. Vegetation Samples. Semi-quantitative spectrographic analysis of two grass samples.

The following are reported as oxides of the elements indicated as found in the residues noted above. "P. C." indicates "Principal constituent".

	649-1G1 Old Grass	649-2G1 New Grass
Residue after ignition at 1100°F:	4.7 %	32. %
Ca	12.5	7.5
Mg	7.	3.
Na	1.25	2.
K	4.	6.
Si	40.	P.C.
Al	7.	17.5
Fe	2.	6.
P	3.5	3.
Pb	.02	.004
B	.03	.03
Ba	.08	.12
Mn	.05	.08
Sn	--	--
Ga	.001	.004
Cr	.007	.035
Ni	.004	.01
Bi	--	--
Ag	--	--
Mo	.015	.004
V	.005	.02
Cu	.01	.01
Ti	.1	.75
Li	.03	--
Cd	--	--
Zn	--	.1
Zr	.005	.015
Co	--	.001
Sr	.15	.06
Y	--	.006

The grass samples were dried 24 hours at 80°C before ignition and analysis.

3. Water Samples

	SB(W)-1		SB(W)-2		SB3A	
	mg/ℓ	equiv/M	mg/ℓ	equiv/M	mg/ℓ	equiv/M
Anions						
Nitrate (NO_3)	0.89	0.01	0.00	0.00	3.5	0.06
Chloride (Cl)	106.	2.99	402	11.34	36	1.02
Sulfate (SO_4)	585	12.19	29	0.60	325	6.77
Bicarbonate (HCO_3)	549	9.00	805	13.19	825	5.33
Carbonate (CO_3)	0.0	0.00	0.0	0.00	0.0	0.00
Phosphate (PO_4)	0.17	0.01	1.6	0.05	0.15	0.00
Total Equivalents Per Million		24.20		25.18		13.18
Cations						
Sodium (Na)	125	5.44	440	19.14	52	2.26
Potassium (K)	13	0.33	7.8	0.20	2.0	0.05
Calcium (Ca)	261	13.02	37	1.85	111	5.54
Magnesium (Mg)	153	12.59	10	0.82	63	5.18
		31.38		22.01		13.03
Phenolphthalein Alkalinity ($CaCO_3$)	0.0		0.0		0.0	
Methyl Orange Alkalinity ($CaCO_3$)	450		660		266	
Total Hardness ($CaCO_3$)	1280		134		536	
Calcium Hardness ($CaCO_3$)	652		92		276	
Magnesium Hardness ($CaCO_3$)	628		42		260	
Total Solids - Calculated	1544		1364		775	
Total Solids - Evaporation	2223		1480		830	
Loss on Ignition	421					
Total Fixed Residue	1802					
Silica (SiO_2)	22		28		19	
Iron (Fe)	0.70		0.30		0.00	
Manganese (Mn)	0.02		0.04		0.00	
Boron (B)	0.04		2.2		0.0	
Fluoride (F)	2.5		4.0		0.59	
Sp. Cond. Micromhos 25°C	2246		2116		1012	
Hyd. Ion Conc. (pH)	7.32		7.77		7.98	

NOTES:

1. SB(W)-1 Sample re-checked, and a considerable difference in the milli-equivalents is perhaps due to organic anions. Note the large loss on ignition.
2. SB(W)-2 Sample re-checked, unbalance in milli-equivalents could be due to organic cations.

Table A-1

LOCATION NOTES FOR ENVIRONMENTAL SAMPLES COLLECTED
AT CORRAL CANYON SITE, SANTA BARBARA COUNTY, CALIFORNIA

Sample	Date Collected	Type	Location and Notes
649-1G1	11-13-70	Old Grass	Line N of boundry from near road to 150 ft. E and 10 to 30 ft. from fence.
649-2G1	11-13-70	New Grass	(same as above)
649-2S1	11-13-70	Soil	(same as above)
649-3S1	12-4-70	Soil	W Slope ~ 30 ft. from top near head of canyon E of met. station. Cattle grazing nearby.
649-4S1	12-4-70	Soil	~ 10 ft. from watering trough (bath tub). Lots of green grass.
649-5S1	12-4-70	Soil	~ 50 ft. N of boundry, above met. station in pasture.
649-6S1	12-4-70	Soil	On hillside SE of met. station ~ 60 ft. from fence on E side of pasture and ~ 100 ft. from base of hill.
649-7S1	12-4-70	Soil	At base of hill where 649-6S1 was taken. ~ 30 ft. E of large tree in pasture.
SB(W)-1	11-13-70	Stagnant Water	Water sample from stagnant pond, about 100 ft north of boundry, in otherwise dry river bed. Near met. station.
SB(W)-2	11-13-70	Waste Water	Sample from entrance of viaduct under highway (on Shell side). Waste water from holding ponds. Estimate water temperature about 80°F.
SB3A	12-4-70	Running Water	Taken at first ford above corral, running stream.

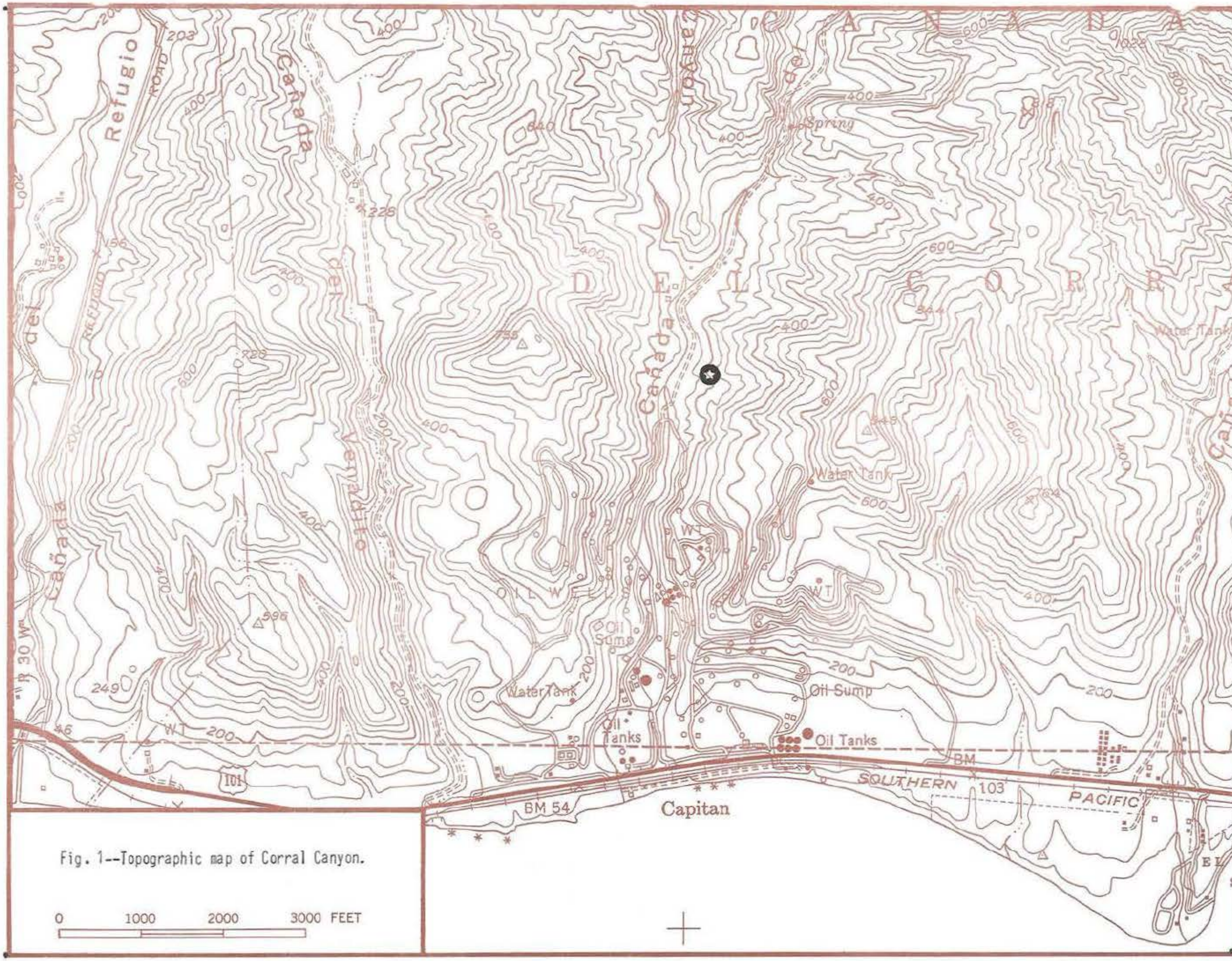

Fig. 1--Topographic map of Corral Canyon.

Fig. 2--Aerial photograph of Corral Canyon Site.

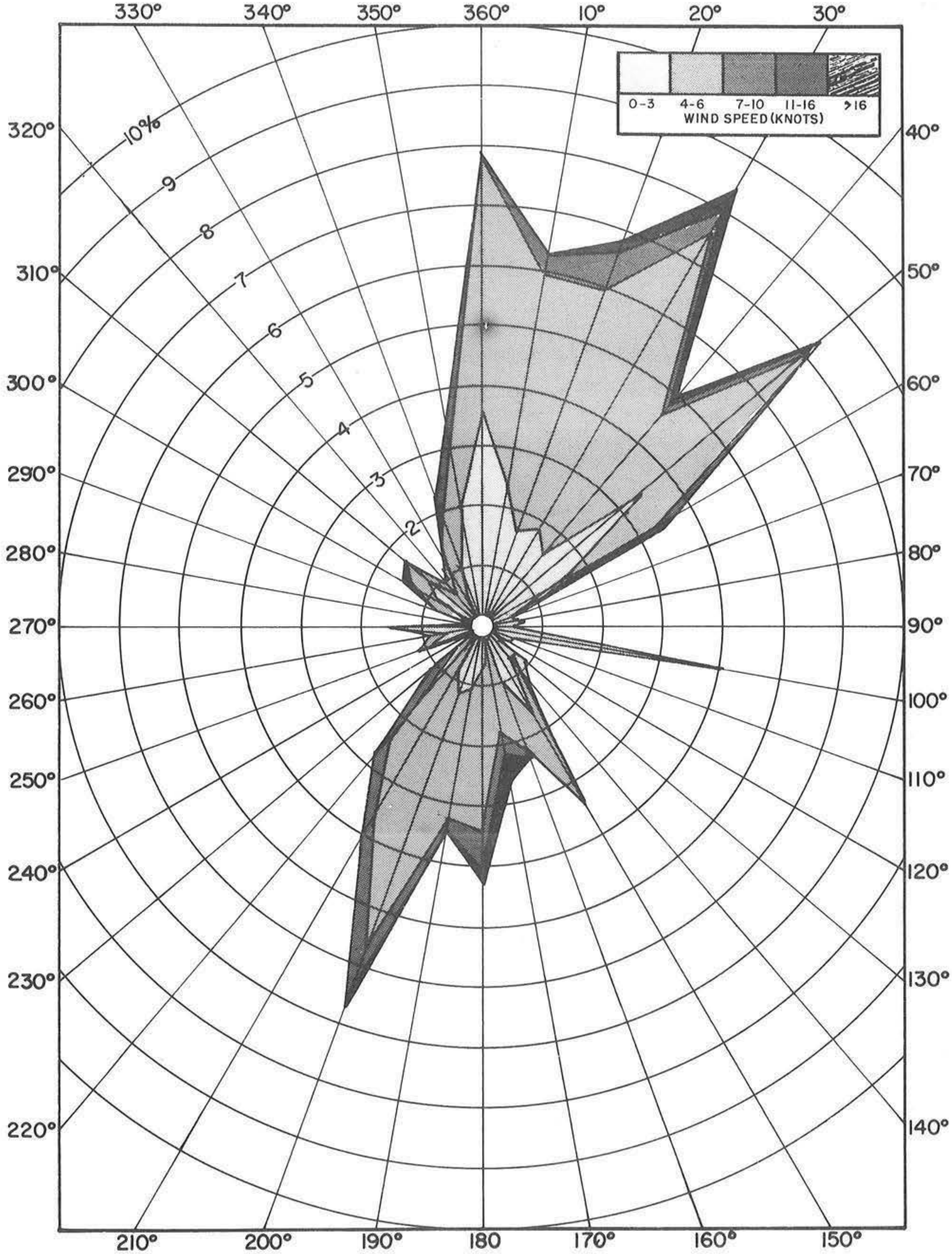

Fig. 3--Frequencies (%) of winds at site. (Nov. 13 - Dec. 23, 1970)

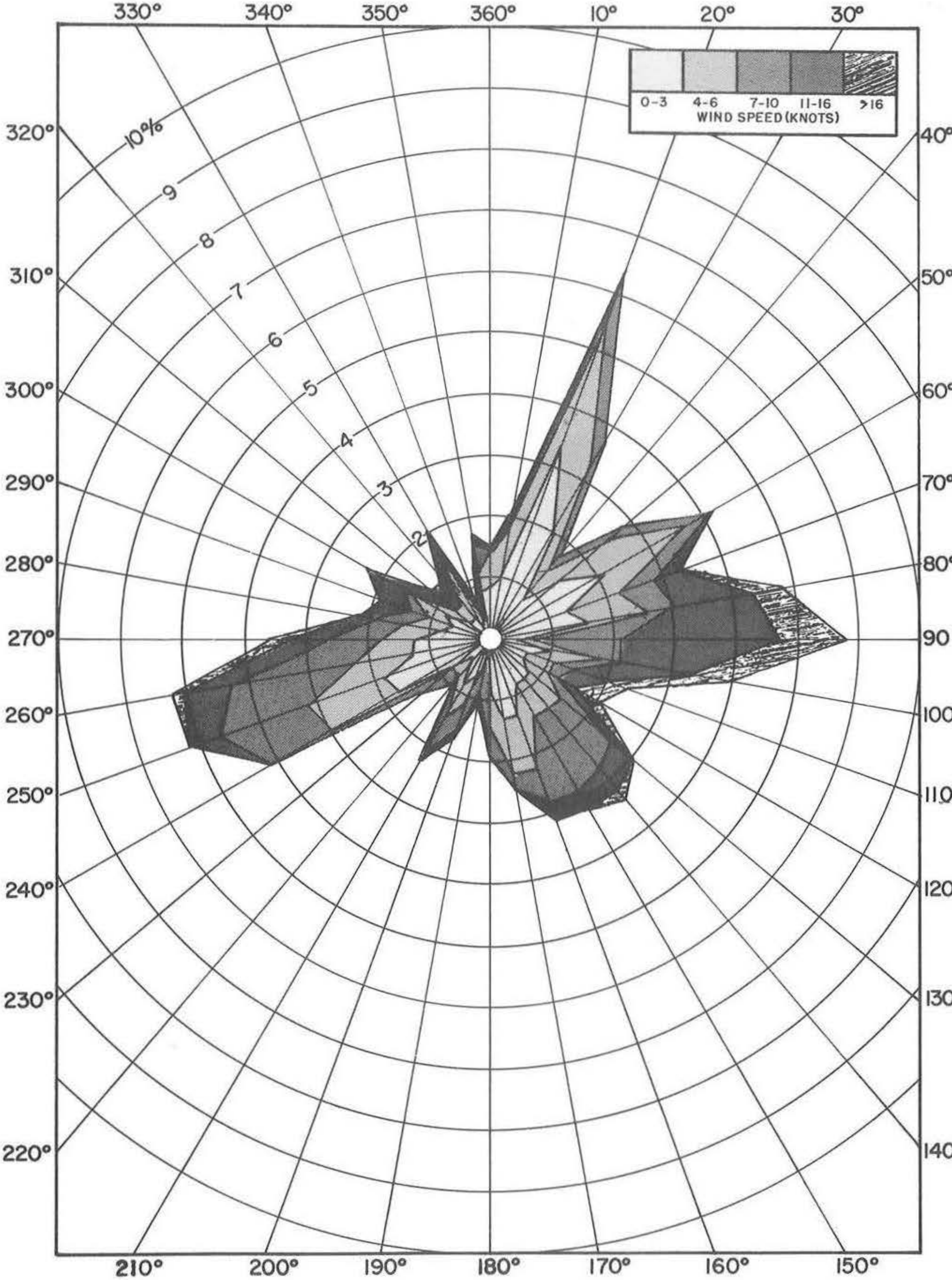

Fig. 4--Frequencies (%) of winds at Santa Barbara Airport. (Nov. 13 - Dec. 23, 1970)

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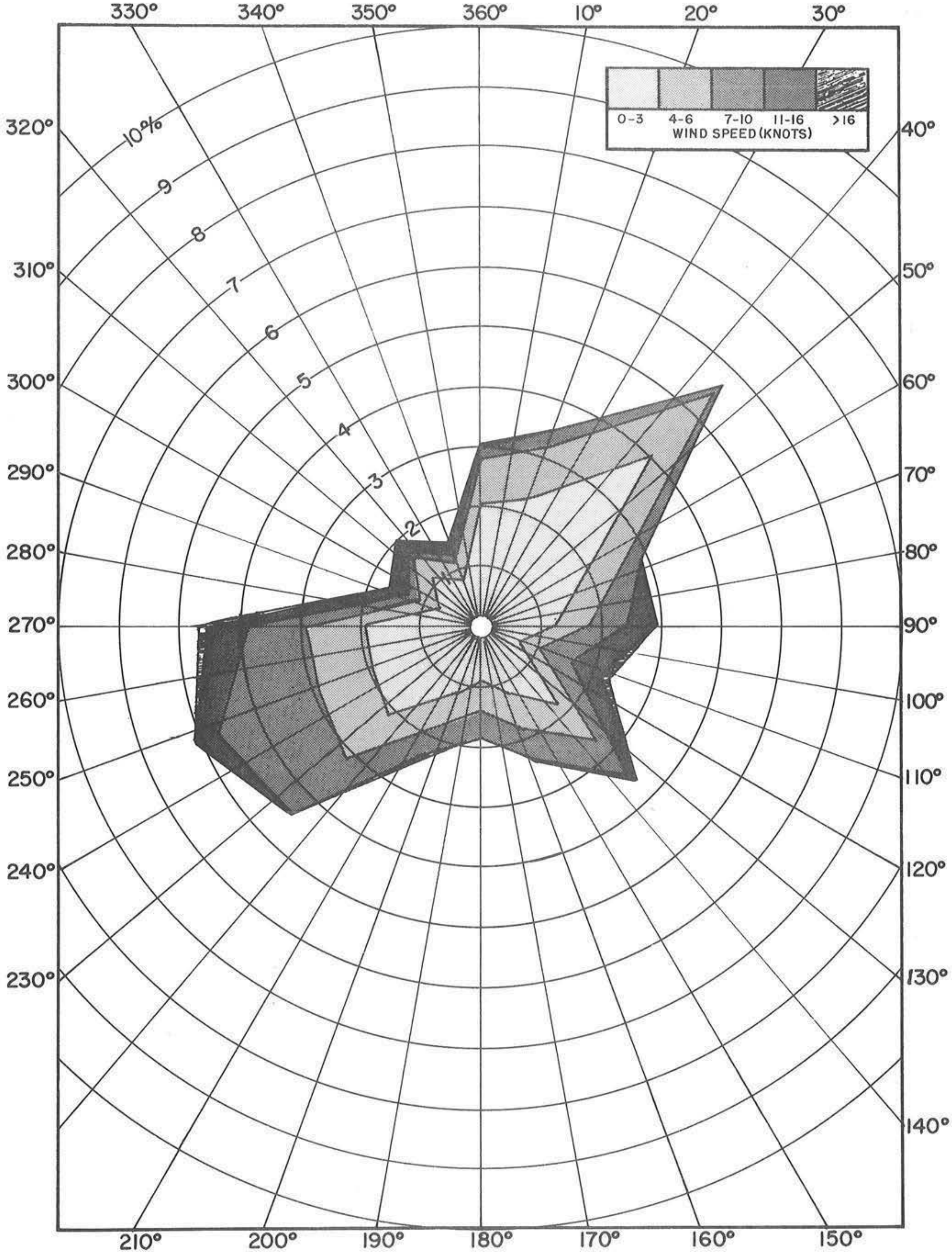

Fig. 5--Frequencies (%) of winds at Santa Barbara Airport. (5 year averages for December)

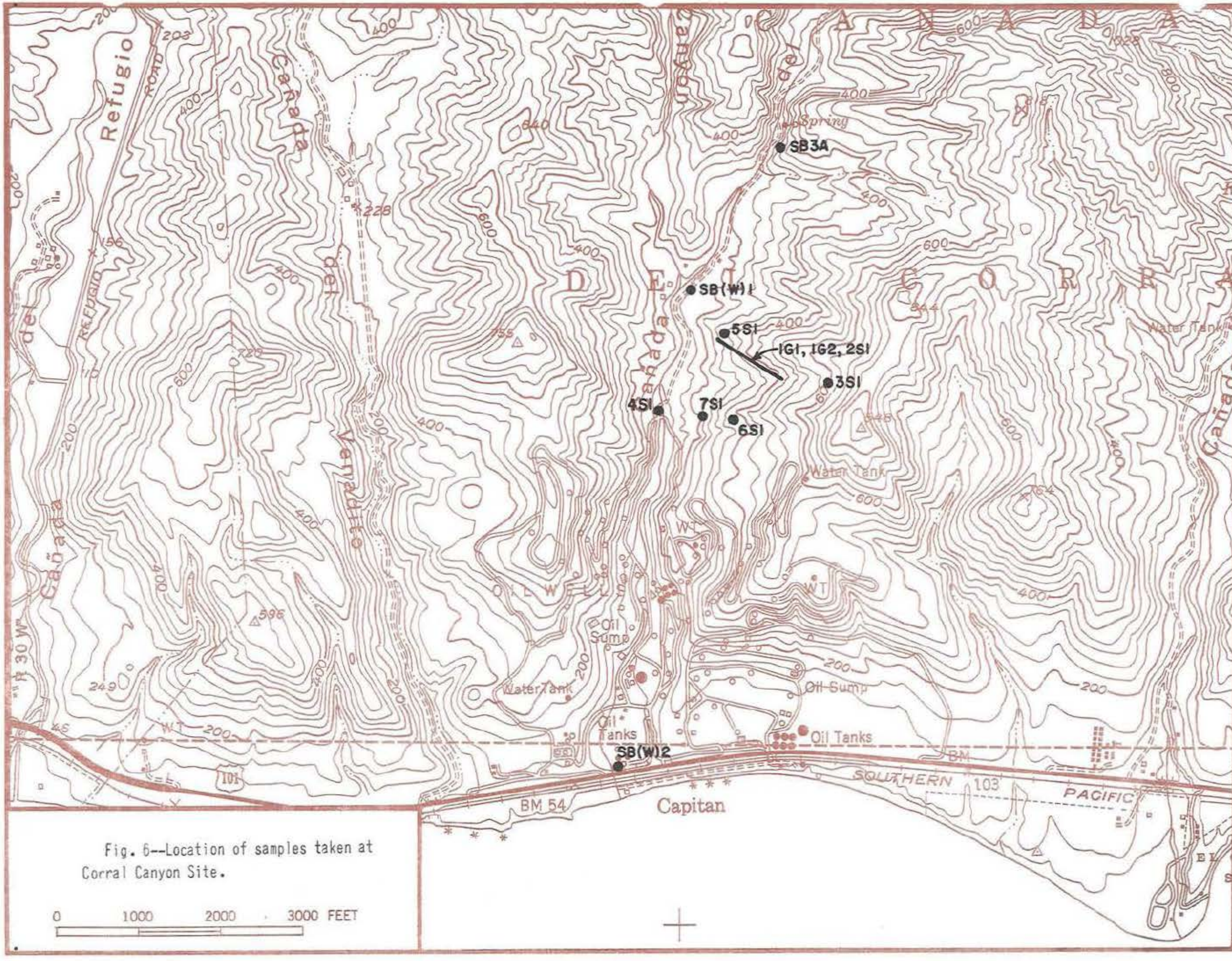

Fig. 6--Location of samples taken at Corral Canyon Site.

APPENDIX 4.2

SUPPLEMENTAL PLAN OF OPERATIONS

SANTA YNEZ UNIT

APPENDIX. 4.2

Airflow Tests at Santa Barbara, California

Metronics Associates, Inc

June, 1971

METRONICS

TECHNICAL REPORT NO. 177A

AIRFLOW TESTS
at
SANTA BARBARA, CALIFORNIA

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Prepared for:

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CONTENTS

I. INTRODUCTION

Humble Oil & Refining Company plans to locate a gas separation plant and on-shore holding facility (called the plant hereinafter) to handle crude from wells in the Santa Barbara Channel. Humble is concerned that the effluvia from the plant/wells could reach Santa Barbara, public beaches, residential areas or areas planned for residential development; in brief, they are concerned that the plant could be offensive outside the plant site. The air tracer test was conducted to assist in determining the maximum effluvia concentration in these areas and in the areas contiguous to the plant/wells.

II. SUMMARY AND CONCLUSIONS

1. A multiple source fluorescent particle (FP) air tracer test was conducted during the evening and early morning hours on 29 and 30 April 1971. Yellow and green FP were used to simulate stack and ground-level emissions from the Corral Canyon site and red FP to simulate offshore sources.

2. On the basis of the multiple source air tracer test emissions from the gas separation plant under normal operating conditions will provide negligible concentrations both within the Corral Canyon property and in surrounding areas. In the event that the sulfur plant is shut down during a period of poor meteorological conditions for dispersing the pollutants significant concentrations of sulfur dioxide will occur within the Corral Canyon but will be generally below the State standard of 0.5 ppm for 1-hour average and will be below the State standard of 0.04 ppm for 24-hour average outside of the Corral Canyon property. Concentrations will be negligible in Goleta and Santa Barbara.

3. A low-level crude spill from rupture of a 110,000 bbl tank releasing 2000 lb of hydrogen sulfide the first hour will result in concentrations exceeding the State standard of 0.03 ppm (30 ppb) within the Corral Canyon Site and on the beaches below the canyon but will not exceed 30 ppb outside of this area and the concentration in Goleta and Santa Barbara will be undetectable.

4. Emissions from normal offshore operations such as gas releases from wells and flarings of gas containing H_2S will produce negligible concentrations outside of the immediate vicinity of the source. A large crude spill, however, might produce a source of H_2S comparable to the rupture of a 110,000 bbl tank, i.e., 2000 lbs of H_2S per hour which would produce concentrations exceeding the State standard of 0.03 ppm within the first 4 or 5 miles from the source and some odors might be detected at the nearest coastal locations.

5. The depth of the down-canyon flow in the Corral Canyon appears to be 150 to 200 ft. on the basis of FP tracer samples taken at various elevations across the canyon. A 100-ft stack with a stack temperature of 1000°F should give a plume elevation of at least 150 ft. under the prevailing meteorological conditions. Peak ground level concentrations of sulfur dioxide in the lower canyon from the stack effluent would be approximately a third of that from the equivalent source at ground level. The difference would be smaller outside the Corral Canyon area but would not be likely to exceed the State standards even under the worst conditions with the sulfur plant down.

6. Complete details fo the FP tracer test and the dosage patterns are given in Appendicies B, D and E and the corresponding equivalent concentrations of SO_2 and H_2S for possible source emissions are given in Appendix F.

III. SITE/PLANT

From most points of view, the Corral Canyon Site is ideal. It is closest to the oil field, it is on property previously used for petroleum storage and wells, it is on owned property which has been owned by other oil companies for years and it is in a deep secluded canyon which should hide it from public view. An aerial view is shown in Fig. 3. This same canyon, under normal meteorological conditions will cause the wind to transport the plant effluvia to sea or into the uninhabited hills. The planned characteristics of the plant, of significance in estimating air pollution are shown in Appendix F.

IV. TEST PLAN

The objectives of the air tracing test was to determine air flow trajectories from sources simluating components of Humble's Santa Barbara complex. The test was planned to be conducted under "worst conditions" that is during very stable meteorological conditions with a moderate west wind offshore and a down-valley air flow from the site.

Three Aerosol Generators (AG) which were the source simulators, were located as follows:

One (green) located at the plant site.

One (yellow) located on a ridge east of the plant site, and

One (red) located on the Humble Drilling Ship WODECO IV in the Santa Barbara Channel (see Figs. 1 and 2).

The Green AG, dispersed an aerosol of green fluorescent particles (FP). Any sampler in the test array that collected green FP thus would collect it from air that passed through the plant site. The fraction of the total number of green FP released that was found on any sampler gave a quantitative indication of the dilution that occurs between the green AG and the sampler. (See Appendix A for a more complete discussion of the FP Air Tracer System.)

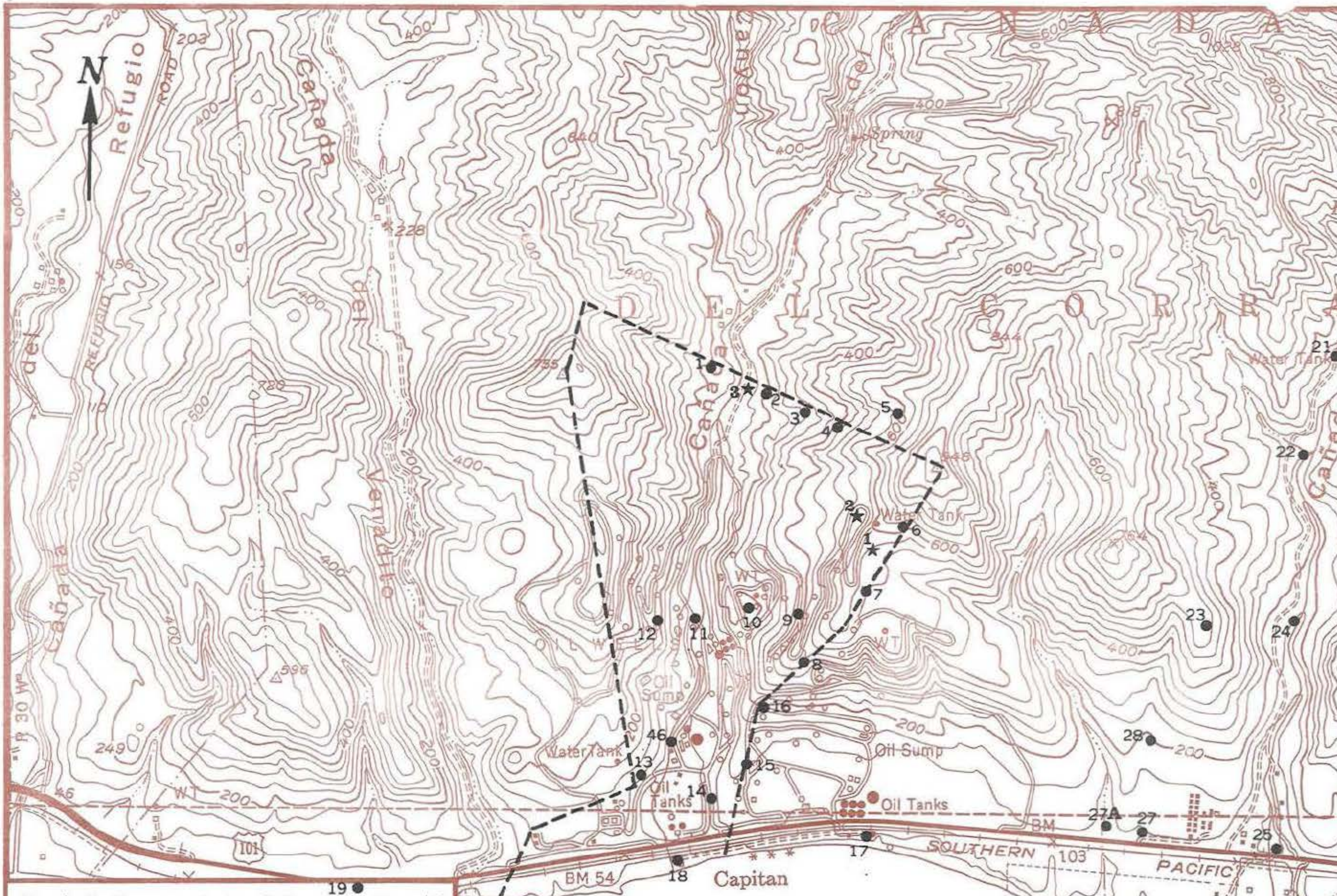

Fig. 1--Capitan area showing FP Source Locations (★) and Sampling Stations (●).

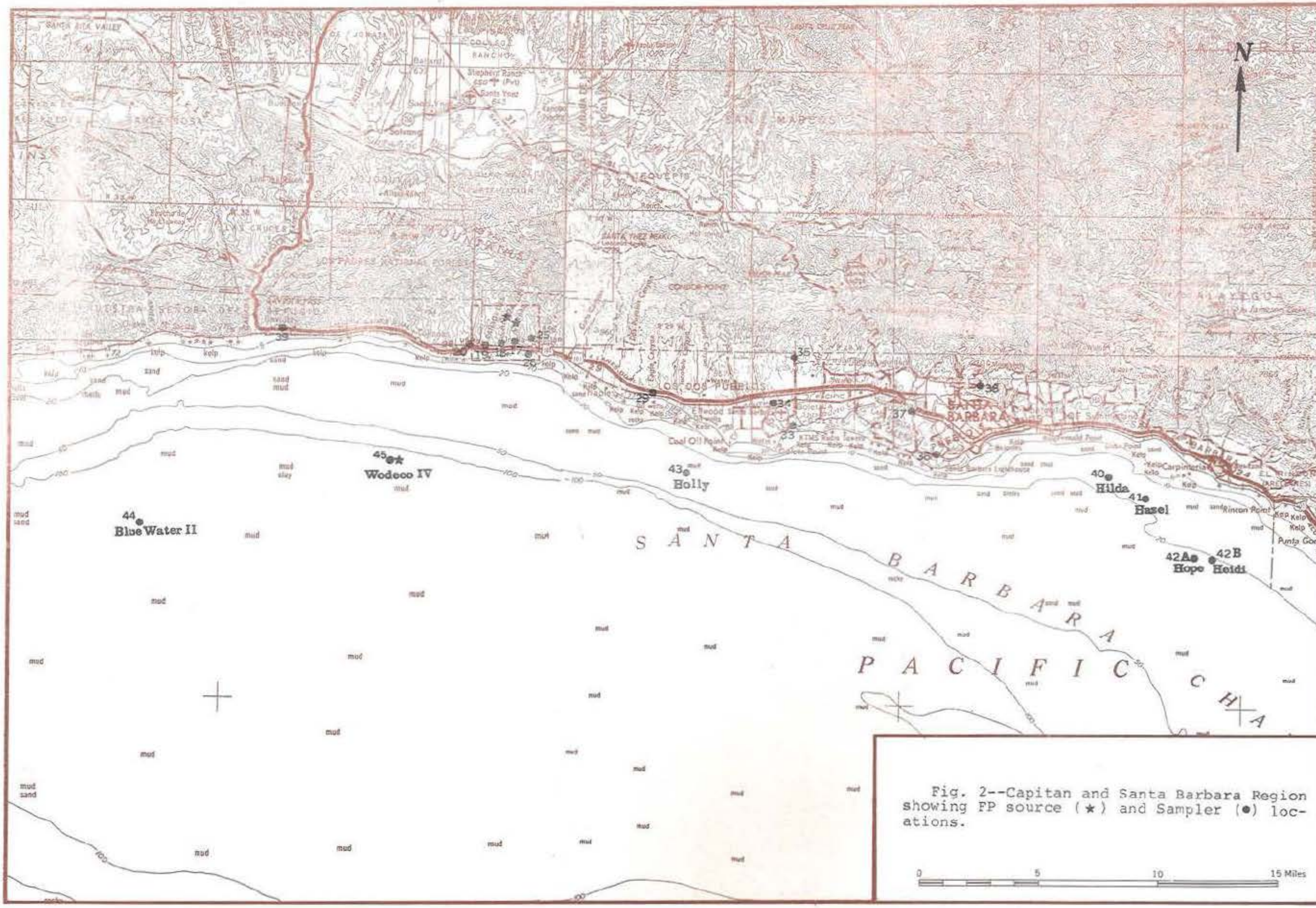

Fig. 2--Capitan and Santa Barbara Region showing FP source (★) and Sampler (●) locations.

The Yellow AG was located on a ridge above the plant site for two reasons:

First, to approximate the performance of a stack on the plant; and,

Second, to give "depth" to the expected down valley flow so as to be better able to determine the thickness of the layer of air whose movement is controlled mainly by topography and to locate the level at which the ambient wind predominates. These data are important in determining the location/height parameters for the stack.

The Red AG was located on a ship in the channel to measure the flow of the effluvia from the producing wells/stripping plants in the channel.

The sampler array consisted of two types; one that measures total FP dosage and one that relates FP dosage to time. The latter type is used to obtain a picture of the passage of the FP cloud.

The first array was located to observe the flow up and down Corral Canyon Site, along the surrounding ridges and in the adjacent valleys. Also, obviously it also would collect any red FP that would flow into the area.

The second array was positioned to observe the flow along the shore and down the channel toward Santa Barbara.

The third array was located at Goleta and Santa Barbara to determine the FP dosage that would arrive in these particularly sensitive areas.

The last array was located offshore on platforms and drilling ships to determine if the FP, once transported out over the ocean returned to shore with the morning onshore flow. (See Figs. 1 and 2 for the location of the test array samplers.) Selected photographs of FP sources and sampling stations are shown in Figs. 6 through 16.

V. METEOROLOGY

At the beginning of the test at 1900 PDT 29 April 1971 the surface wind at the Corral Canyon site was light and variable at 1-3 mph. The wind on the ridge (yellow AG) was easterly at 2-3 mph. On the drilling ship. WODECO IV (red AG) it was West at 17 mph and at Santa Barbara Airport it was southwest at 9 mph. The down-canyon winds at the site were very low all through the night and the Santa Barbara winds changed to northeasterly at 5 to 8 mph after 2100 PDT until 0900 PDT when the onshore wind began. Skies were clear throughout the night with some low clouds in the morning.

These were the conditions sought for the test. These are the "worst conditions" for the transport of plant/well effluvia to the sensitive populated areas. It is under these conditions that very little mixing takes place and so if the plant can be operated within standards under these conditions, it will have met the most stringent test.

Further details on Santa Barbara meteorology are given in Appendix C.

IV. CONDUCT OF THE TESTS

The exact period in which the test would be conducted was accomplished by forecasting local stable conditions (Pasquill E or F class described in Appendix C) from synoptic data. We sought a period of three days to give us time to set up our equipment, disperse the FP and observe two complete diurnal cycles.

The synoptic forecast for the Pacific coast appeared to be satisfactory on 26 April 1971. The next day we moved our equipment to Santa Barbara. The rest of that day and the next were spent in positioning the equipment and making arrangements for assistance for the test. The tests started at 7 PM on 29 April 1971. 20 lbs of FP were dispersed from each of the yellow and green AG's and 12 lb from the red AG. The dispersal period was one hour.

Fig. 3--Aerial view of south end of Canada del Corral.

Fig. 4--Wind Station at north boundary of Corral Canyon site looking west.

Fig. 5--View northeast from north boundary of site on east side of Canada del Corral.

Fig. 6--Yellow FP Aerosol Generator on ridge east of Canada del Corral.

Fig. 7--Green FP Aerosol Generator at north boundary of site.

Fig. 8--Red FP Aerosol Generator on stern of Wodeco IV.

Fig. 9--View southwest from Station 8.

Fig. 10--Station 18 near drain below Canada del Corral.

Fig. 11--Station 34 at Rotor Aids, Santa Barbara Airport.

Fig. 12--Station 35 near north end of Fairview Ave., Goleta.

Fig. 13--Sequential Sampler at Station 36, Fire Station, 1802 Cliff Drive, Santa Barbara.

Fig. 14--Rotorod Sampler at Station 36, Fire Station, 1802 Cliff Drive, Santa Barbara.

Fig. 15--Sequential Sampler at Station 41 on Platform Hazel.

Fig. 16--Station 45 Rotorod Sampler on Wodeco IV.

Drum sampler collection or 5-minute sequential samplers were located at Station 46 in Corral Canyon, at Station 34 at Santa Barbara Airport and Station 36 at the Cliff Street Fire Station in order to determine arrival time for the FP tracer at these locations. All samplers were started by 7 PM, 29 April 1971.

As each sampler array was shut down, the collector system was taken to the Holiday Inn in Goleta where a field assay station had been established. Critical collectors were quickly evaluated and the preliminary results were given to Mr. D. M. Griffiths.

In our laboratory each sample (55 were collected during the test) was evaluated, a time consuming process. FP dosage isopleths then were plotted on area maps.

These data then were converted into pollutant concentrations (H_2S and SO_2) and the resulting concentration patterns are shown in Appendix F.

VII. ACKNOWLEDGEMENTS

The air tracer test was possible only through the cooperation and assistance of many people. Metronics is grateful for the assistance of Mr. D. M. Griffiths, Mr. H. P. Benzer, Mr. Thomas Hicks and other personnel of Humble Oil Company and Rotor Aids Offshore, Inc. for storing equipment and arranging helicopter transportation and assistance in moving aerosol generator and sampling equipment to the offshore platforms and drilling ships . Metronics is also grateful to Mr. William Ryherd of Standard Oil Company for boat transportation to platforms Hilda, Hazel, Hope and Heidi and to Mr. Elmer Robertson of ARCO for permission to install a sampler on platform Holly.

APPENDIX A

THE FLUORESCENT PARTICLE AIR TRACER SYSTEM

The fluorescent particle (FP) tracer was developed to trace the airborne transport and diffusion of both gases and aerosols emitted into the atmopshere. The characteristic fluorescent colors of the FP tracer materials are readily distinguishable from fluorescent materials found in the ambient atmosphere making it possible to relate concentrations of FP observed downwind directly to the source of the FP without interference from other sources. By using FP with different fluorescent colors the contributions from different sources to concentrations downwind can be measured simultaneously. Alternatively by emitting different colors of FP in sequence from the same source, variations in plume trajectories and concentrations with time can be measured without the use of expensive sequentially operated sampling equipment. Both the multiple source and sequential source techniques have been used.

Since the number of FP released from each source is known the FP concentrations downwind are directly proportional to the concentrations of any non-reactive gas or aerosol emitted at the same source location, under the same meteorological conditions. Hence, if the source strength of the gas or aerosol is specified the concentration can be calculated directly from the FP tracer measurements.

The detection levels for the FP tracer are generally much lower than those for commonly measured gases and aerosols and quantitative measurements are obtained at levels of the order of 1 part per billion or less when the FP results are converted to concentrations for existing or predicted emissions from industrial operations.

A complete description of the fluoresent particle atmospheric tracer is given in the attached reprint from the Journal of Applied Meteorology, June 1965.

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ABSTRACT

This paper describes the current status and discusses the validity of the fluorescent particle (FP) tracer technique. Properties of the material itself, the blower generator, membrane filter, drum impactor, and Rotorod samplers, and of counting techniques, are described. The inherent and operational errors involved are evaluated, and evidence on the atmospheric diffusion, fallout and impaction, and fluorescent stability of the particles is presented. It is concluded that in the present state of development of the technique the errors, in terms of 90% confidence intervals, are approximately ±5–10% for source strength determination, ±10–12% (if 300 particles are counted) for dosages determined by the Rotorod, and ±17–20% for dosages determined by the membrane filter sampler. The effects of atypical diffusion on the validity of the method appear to be insignificant, and fluorescence losses may be controlled by proper selection of materials. For ground releases the losses by fallout and impaction may amount to from 1% to 10% during the first few miles of travel, depending on the rate of rise of the cloud and the nature of the ground cover. For larger travel distances, if the cloud height exceeds 100 meters the fallout loss should be below 2% per hour.

1. Introduction

Shortly after World War II the development of a tracer system for use in studies of airflow trajectories and the travel and diffusion of airborne materials was undertaken at Stanford University under contract with the U. S. Army Chemical Corps. The decision to use a fluorescent particulate in the 1–5μ size range, with assessment by counting individual particles, was made in 1946 (Grinnell *et al.*), the first field trial with this tracer was conducted in 1947 (Leighton *et al.*), the system was publicly described in 1951 (Perkins *et al.*), and an operational manual covering the technique as developed up to that time was published in 1955 (Leighton).

Since 1955 the technique has been improved, several fundamental questions on the validity of the method have been raised and answered, and its capabilities and limitations have been further investigated. Since 1955, also, the use of tracers has expanded and at least one other system has been proposed for general use (Robinson *et al.*, 1959; Dumbauld, 1962). In view of these advances, it is considered timely to present this description of the current status of the fluorescent particle (FP) tracer technique, with emphasis on its limitations as well as on its capabilities.

2. Requirements and choice of an atmospheric tracer

The suitability of any material for use as an atmospheric tracer may be assessed in terms of its ability to meet a number of requirements. First, the material must possess a specific property, not duplicated by any other substance normally present in the atmosphere, which will permit its detection in extremely small amounts. Second, there should be a simple, rapid, and convenient method for the quantitative estimation of small amounts of the material through this property. Third, the material should be available at reasonable expense in uniform lots large enough to permit the desired use, and it should not deteriorate during storage. Fourth, it should be readily and quantitatively dispersible into the atmosphere at controllable rates and in the required amounts. Fifth, it should be stable while in the atmosphere and its diffusion by atmospheric turbulence should be essentially that of an inert gas. Sixth, it should retain its specific property at least through the sampling and assessment operations and preferably after. Finally, it should be safe to handle and non-toxic to man, animals or plants.

Materials which have been used at least to some extent as tracers include oil fog (Barad and Shorr, 1954), biologicals such as *Lycopodium* spores (Hay and Pasquill, 1957), gases such as sulfur dioxide (Cramer, 1958b, 1959), radioactive materials such as Xenon 133 (Eggleton and Thompson, 1961), materials such as antimony oxide in which radioactivity may be excited after airborne travel (Haines and Hemeon, 1958), water soluble dyes such as uranine (Robinson *et al.*, 1959; Dumbauld, 1962), and inorganic fluorescent particulates (Grinnell *et al.*, 1946; Leighton *et al.*, 1947; Perkins *et al.*, 1952; Braham *et al.*, 1952; Leighton, 1955; Crozier and Seely, 1955; Hilst, 1957; Cramer, 1958b, 1959; Barad and Fuquay, 1962; Bierly and Gill, 1963).

None of these materials is ideal with respect to all of the requirements for an atmospheric tracer, and any choice must represent a compromise. For some specific uses one material, and for other uses another, may be the best choice. For a limited range of use, where certain requirements may be relaxed, e.g., small scale travel from a ground release over open unpopulated terrain in dry weather, any one of several tracers would be satisfactory. But the wider the intended range of use, the more rigid are the requirements, and the more limited is the range of choice. It is in this category of a wide range of usefulness that the inorganic fluorescent particulates have proven of greatest value as atmospheric tracers.

3. Properties of inorganic fluorescent particulates suitable for tracer use

A number of fluorescent inorganic particulates, mostly zinc silicates, zinc sulfides, and zinc-cadmium sulfides, with various elements added in small amounts as activators, have been developed for use as luminescent paint pigments and are commercially available in reasonably uniform lots. Under a microscope with ultraviolet illumination the fluorescence of single particles of most of these materials, down to approximately 0.5μ diameter or 3×10^{-13} g in mass, may be observed and the number in a given area counted. The fluorescence thus offers a simple and very sensitive method of detection and quantitative estimation. The materials may be disseminated at low or high rates as single particles, they are safe to handle and non-toxic at any dosage likely to be attained in air, and the fluorescent property is retained indefinitely during storage. It should be emphasized, however, that not all of the available fluorescent pigments are suitable for use as tracers. The fluorescent colors of some are almost indistinguishable from those of naturally occurring substances in air, some are not acceptably stable, and some have too wide a range of particle size distribution.

The best fluorescent colors, i.e., those most readily distinguished from natural fluorescent particles, are yellow and orange. Creen and red are acceptable, but blue and white should be avoided. The question of the stability, both fluorescent and chemical, of any material which is being considered should be investigated under the conditions which will be encountered in use, and the material rejected if not found satisfactory.

The particle size distribution may vary substantially, not only between different materials, but also, as illustrated in Table 1, between different lots of the same material. In some cases, the distribution is nearly log normal, in others it approaches a Rosin-Rammler distribution (Rosin and Rammler, 1933). The optimum particle size with relation to ease of counting, airborne behavior, and collection efficiency on impaction-type samplers, is between 1 and 3μ, and the larger the fraction of the particles in this size range the better. Materials with large numbers of either small or large particles should be avoided, since small particles are difficult to count and more likely to be unstable, while larger particles increase fallout losses and decrease the number of particles per unit weight. As a practical guide, not more than approximately 20% of the particles should be below 1μ, and not more than 5% above 5μ in diameter. Cn this basis, lot A in Table 1 is acceptable but lot B is not, and it should be noted that this difference is not disclosed by the mass mean diameters (MMD) or the number of particles per gram in the two lots.

TABLE 1. Particle size data on two lots of FP 2266.

Size range, μ	Lot A Per cent of particles	Lot B Per cent of particles
<1	17	34
1–2	40	29
2–3	25	17
3–4	10	10
4–5	4	4
>5	4	6
Mass mean diameter, μ	3.0	3.2
Number median diameter, μ	1.8	1.4
Number of particles per gram	1.7×10^{10}	1.4×10^{10}

The flow characteristics and dispersibility of the inorganic fluorescent pigments may be improved by treatment with hydrophobic materials. For this purpose, good results have been obtained by blending the pigment with 0.5% Valron Estersil, a hydrophobic silica product manufactured by du Pont (U. S. Patent No. 2,657,149 issued 27 Cctober 1953).

The fluorescent particulate which has been most widely used by this laboratory is a zinc cadmium sulfide, designated as FP 2266, formerly made by the New Jersey Zinc Company (NJZ) and now made by the United States Radium Corporation (USRC). FP 2267, also made by USRC, is 2266 which has been selected to have a maximum number of particles between 0.75μ and 3.0μ in diameter, and which has been treated to improve its flow characteristics.

The fluorescence of FP 2266-7 is excited by near ultraviolet radiation, and the 3660A lines of the mercury arc are a convenient excitation source. When so excited, the fluorescence forms a continuous band extending from blue to red, with a maximum in the yellow. To the eye, the color is yellow, with a spectral hue of 5700A. When excited by 3660A, the fluorescence occurs to some extent throughout the particle volume, hence the fluorescent flux per particle is proportional to something between the square and the cube of the particle diameter, approaching the cube as the diameter decreases. The half decay time of the fluorescence, after the exciting light is removed, is approximately one millisecond.

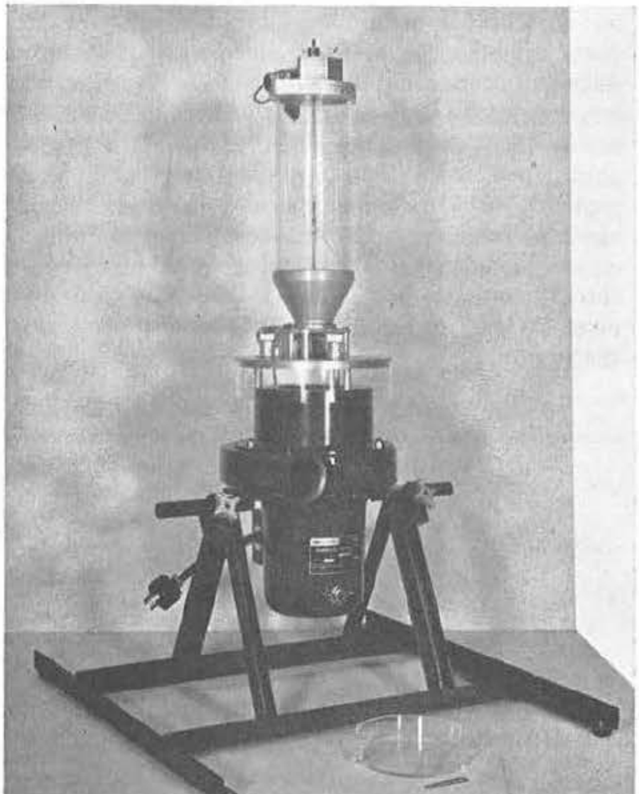


FIG. 1. The blower generator, Model 5.

Under high magnification the individual particles of FP 2266 usually appear to be nodular, i.e., basically nearly spherical or ellipsoidal with small rounded protuberances and occasionally somewhat faceted. About 7% of the particles appear to be aggregates consisting of 2 or more nodular particles sintered together. Their density is approximately 4. The material is not affected by water or by heat up to 450C, it dissolves only slowly in strong acids, and appears to be stable with respect to all conditions likely to be encountered in storage and atmospheric travel except one: exposure to sunlight. This effect, which is significant for some lots of material and negligible for others, will be examined in Section 5d.

When a known mixture of two materials with different fluorescent colors is aerosolized, the relative counts on samples taken after airborne travel agree quite well with those in the starting mixture. The release of the materials from separate sources, with simultaneous sampling on a single array of samplers, provides a means of determining the amount of intermixing of clouds and the relative contributions, at various points, from the separate sources. Two green fluorescing pigments, USRC 2210 and 3206, have been used in conjunction with FP 2267 for this purpose.

One distinct advantage of FP as a tracer is that the samples are not destroyed by the process of assessment, and may be stored as permanent original records. In a number of instances questions regarding sampler performance, individual dosages, and particle size distribution have been answered by re-examining stored samples; in one case from trials which had been run over ten years previously.

4. Equipment

a. *Dissemination.* The equipment developed for disseminating the FP tracer is of the generator type, designed for the continuous production of a tracer cloud over a finite time, which may range from less than a minute to several hours. The principal requirements for this type of equipment are that it shall disperse the tracer as an aerosol of single particles, at a desired and constant rate, with a known and reproducible source strength in terms of number of particles disseminated. Ideally, the disseminator should completely deagglomerate the bulk powder into its primary particles, but should not further subdivide these primary particles.

These requirements are closely approached by the blower generator, and this generator has been widely used in the field. In this device, the material to be dispersed is fed from a stirred hopper by a rotating toothed wheel into the intake of a high speed centrifugal blower (Fig. 1). The feed rate may be varied by changing the size and speed of the toothed wheel, and rates ranging from 1 to 250 g min^{-1} have been used. The hopper shown in Fig. 1 has a capacity of 2500 grams of FP but may be refilled while in operation if continuous dissemination for long periods is required.

Since the toothed wheel feeds material into the blower by increments, generally from 3 to 10 per second, the output is not time-continuous, an effect which is normally inconsequential due to mixing by atmospheric turbulence, but which must be taken into account when sampling for short times or small cloud travel distances, especially if the generator is carried on a rapidly moving source. The incremental effect may be avoided, at some sacrifice in certainty of operation, by use of a vibrating feed device of the type developed by Bierly and Gill (1963).

With the FP tracer the source strength Q is normally expressed in terms of the number of particles released. In this case $Q=W\cdot F_S$, where W is the weight of FP fed through the generator and F_S is the observed number of particles made airborne per unit weight. The method employed for measuring F_S from the blower generator uses actual aerosolization with isokinetic sampling in a restricted plume (Leighton, 1955). Comparisons of F_S, so determined, with the number of primary particles per unit weight in the undispersed material indicate that the dispersal efficiency of the blower generator for surface treated FP is close to unity.

In the dissemination of the tracer from aircraft, feed rates higher than those obtainable from the blower generator are usually required. For this purpose, a broad feed wheel with five groups of offset teeth, which provides a feed rate of 10 lb min^{-1} from a stirred hopper into a downspout extending through the aircraft fuselage, or into an external venturi, using the inflight airstream past the end of the downspout or through the venturi for dispersal, has been employed. However, the source strengths of these devices are difficult to determine and their dispersal efficiency is low; measurements of the horizontal particle flux past a series of samplers mounted on a tower directly downwind of the flight path indicate efficiencies of 60% or less.

b. *Sampling*. The first requirements for the sampling device are that it must be able to collect the particles at high dilution in air and deposit them individually on a smooth surface in a manner which is suitable for the excitation of their fluorescence and for counting. The three devices currently in widest use, each of which has both virtues and limitations, are the membrane filter, the drum impactor, and the Rotorod.

Porous cellulose acetate-nitrate membranes, which have been used for FP sampling since 1950, have the advantages that the collection efficiency is virtually 100%, most of the particles are deposited on the upstream face rather than in the pores of the filter, the material is reasonably uniform in permeability, it may be dyed to give a dark background favorable for counting, and after use it may be stored as a permanent original record. The chief disadvantages are that the membranes are fragile and the flow rates attainable are limited. The fragility of the membranes requires a holder with a porous backing; both sintered glass discs and wire screens have been used for this purpose. The current holder (Fig. 2) employs a 100-mesh stainless steel screen, surrounded by a circular magnet, which, with a steel retaining ring, keeps the membrane in place. When desired, a truncated cone for isokinetic sampling may be mounted on the holder. Two sizes of membranes, both circular, 25 and 50 mm in diameter have been employed. Mounted in their holders, the diameters of the corresponding deposition patterns are 16 and 41 mm, and the deposition areas approximately 2 and 13 cm^2.

The flow rate generally used in practice is about 5 liters per min per cm^2 of deposition area, and the pressure drop across the membrane required to produce this flow rate is 4 to 5 cm Hg. The permeability of the membranes varies with the lot of material, and for a given lot at pressure drops up to about 0.2 atm the flow rate is nearly proportional to the square root of the pressure drop. When adequate pumping capacity is available, a critical orifice may be used in the line to maintain a constant flow rate. The maximum useful sampling period, before the filter surface becomes so loaded with atmospheric particulates as to obscure the fluorescent particles, will, of course, depend on the amount of such material in the air; in clean air, sampling periods of 10 hours or more per filter are quite possible, while in city air the limit may be less than 1 hour.

Although the membrane filter (MF) is primarily useful for total dosage, a sequence may be obtained by changing filters by hand, or by using a bank of filters with a mechanical switching device. A rotary distributor, activated by a clock timer, capable of switching the line from a single pump to each of 12 samplers, has been so used. For operations requiring time resolution, however, such as obtaining time-concentration curves during the passage of a cloud over a stationary location or obtaining cross-sectional and axial concentration curves by traversing a cloud with a sampler mounted in an aircraft, the most satisfactory device is the drum impactor.

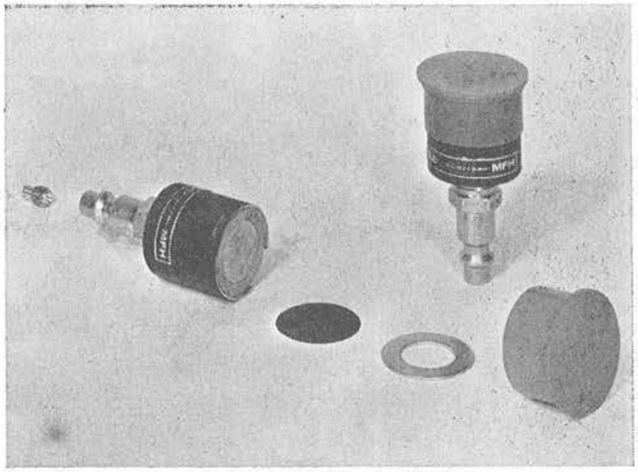


FIG. 2. Membrane filter holder.

In the current model of the drum impactor a strip of aluminum tape, coated on one side with silicone grease or rubber cement, is mounted on a 12.5 cm diameter drum which is enclosed in a housing so that it can be rotated by increments beneath the rectangular orifice of a conical nozzle (Fig. 3). The orifice, which is generally about 0.7 mm in width by 7 mm in length, is oriented at right angles to the direction of rotation of

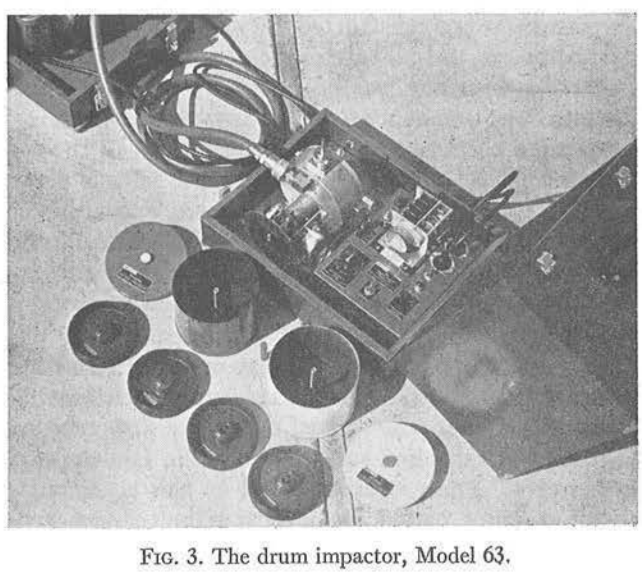


FIG. 3. The drum impactor, Model 63.

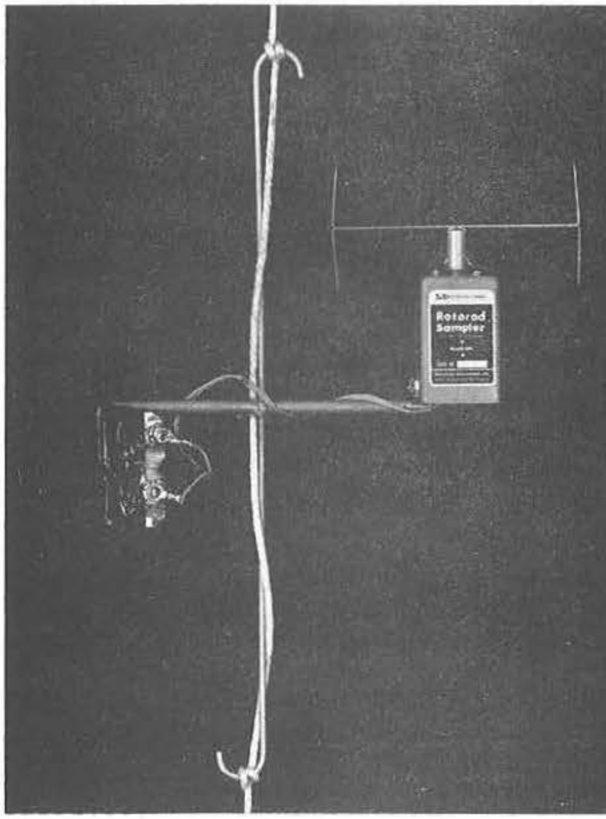


FIG. 4. The Rotorod sampler, equipped for mounting on a balloon cable.

the drum. With a spacing of 3.3 mm between increments a total of 116 patterns may be obtained on a single tape. The dwell time on any one pattern may be varied from 15 seconds upward, and the time required to move from one pattern to the next is 0.2 second.

The collection efficiency of the drum impactor, as with any impaction device, depends on the jet velocity, the orifice size, the clearance between the orifice and the collecting surface, the nature of the collecting surface, and the materials of which the nozzle and collecting drum are constructed. In early models, using a plastic nozzle and a Scotch tape collecting surface, the collection efficiency was only $\sim 30\%$, and the central pattern was surrounded by a halo which contained even more particles than the pattern itself. In the current model, using a brass nozzle and a silicone grease or rubber cement on aluminum surface, and adjusting the clearance to maximum pumping efficiency (minimum vacuum to give maximum flow rate) the collection efficiency is 95% or better and the halo is virtually eliminated.

When so adjusted, the flow rate is ~ 50 l min^{-1} and the size of the pattern on the collection surface is not much larger than the orifice, hence the flow rate per unit area of collection surface is high, in fact approximately 1000 l min^{-1} per cm^2, and on this account the useful sampling period per pattern is limited, generally to 3 minutes or less.

The Rotorod sampler, the virtues of which are its cheapness, simplicity, light weight, and low power requirement, is based on the idea of moving the collector through the air rather than pumping the air past a collector. Two collectors, consisting of thin metal bars coated with silicone grease, are attached by a cross arm to the shaft of a small battery-driven motor so that they are parallel to the axis of rotation (Fig. 4). With collecting surfaces of 0.38×60 mm, a rotation radius of 60 mm, and a rotation speed of 2400 rpm, the effective sampling rate of this device is approximately 40 l min^{-1} or approximately 90 l min^{-1} per cm^2 of surface. Rotation speed and hence sampling rate is constant to $\pm 2\%$; the power consumption is 0.7 watt.

The chief disadvantage of the Rotorod, in the form described above, is that its collection efficiency is low and is sharply dependent on the particle size. Collection efficiencies observed in field trials with different lots of tracer range from 28% for a lot of FP 2266 with an MMD of 1.8μ and a particle per gram count of 7.9×10^{10}, to 73% for a lot of FP 2267 with an MMD of 3.1μ and a particle per gram count of 1.6×10^{10}. It is important to use a standard procedure for coating the collector rods (Webster, 1963) and to determine the collection efficiency with each lot of tracer which is employed.

The collection rate of the Rotorod is little affected by wind speed, u, as long as it is smaller than the speed of the collector arm, v (15.1 m sec^{-1} for a 60 mm rotation radius at 2400 rpm). When u exceeds v the collection rate increases; for $u/v=1.5$ this increase is about 10% and for $u/v=2$ it is about 22%. High winds also increase the drag on the rod and hence the load on the motor. The use of multiple arms appears to have little effect on the collection efficiency.

The light weight of the Rotorod and the small size of the required battery are advantageous for sampling aloft. In fact, the unit shown in Fig. 4, which weighs 330 g complete with batteries, was designed for mounting on a balloon cable, and a series of as many as 20 such units, mounted at intervals along the cable, has been used for sampling up to 750 ft aloft.

c. *Assessment.* The primary task of assessment is to count the particles collected within the deposition area of a sampler. Basically this involves only two requirements, a means of illuminating the particles with ultraviolet radiation to excite the fluorescence, and a means of observing this fluorescence and thereby counting the particles. Since the fluorescence is excited by near ultraviolet radiation, mercury arcs which provide a high intensity in the region of the 3660A line of the mercury spectrum may be employed for illumination. For visual counting, a General Electric H85A3 mercury lamp in a light-tight housing equipped with two 50 mm diameter $\times 96$ mm focal length plano-convex lenses and a Corning 5840 or 5970 filter is mounted above and behind the stage of a monocular microscope so that the arc image is focussed on the stage directly below the objective, and a Wratten 2A filter is mounted on the eyepiece. For work requiring very intense illumination in a small area the PEK 109, a high pressure quartz capillary arc manufactured by PEK Laboratories, 825 E. Evelyn St., Sunnyvale, Calif., may be used. With filter and lenses this arc delivers a UV flux about 20 times that from the General Electric H85A3.

In visual counting a 16 mm, 0.25 N.A. achromatic objective and a 10× eyepiece, giving 100× magnification, are normally employed. The appearance of a field so magnified, in visible and UV light, is illustrated in Fig. 5. The eyepiece is equipped with a reticule to mark off specific areas in the deposition pattern and the number of particles in each area are counted in turn. Reticules of different degrees of fineness are used for patterns of different density of population; the best results are obtained when each field of the reticule contains fewer than ~50 particles. If the sample is heavily populated it is necessary only to count, in randomly selected but known portions, the number of particles necessary to bring the statistical variance within desired limits (Section 5a).

The labor involved in visually counting large numbers of samples directs attention to the possibility of automatic counting. The automatic system developed at Hanford (Barad and Fuquay, 1962), involving irradiation of a membrane filter sample with alpha particles from plutonium and measurement by photomultiplier of the resulting fluorescence from the entire filter, may be used for filters on which ~1000 or more particles have been deposited. For smaller populations either individual counts or the empty cell technique (Leighton, 1960) are preferable to measurements of total radiation. With ultraviolet illumination, single parttticles yield a sufficient fluorescent intensity to permit their detection by photomultiplier, but when deposited on a membrane filter the limiting factor is background radiation from the filter itself. Thus, with a system consisting of a PEK 109 lamp equipped with two 4.5 mm Corning 5540 CS7-60 filters and a 6127 photomultiplier equipped with Wratten K3 and CC-30 filters, the responses obtained from single particles of FP 2267 are in the range of 10^2 to 10^5 picolumens, while the background light from a membrane filter is from 10^5 to 10^6 picolumens per mm^2 on filter surface. To obtain a satisfactory signal to noise ratio under these conditions it is necessary, therefore, to limit the field to a small fraction of a square millimeter.

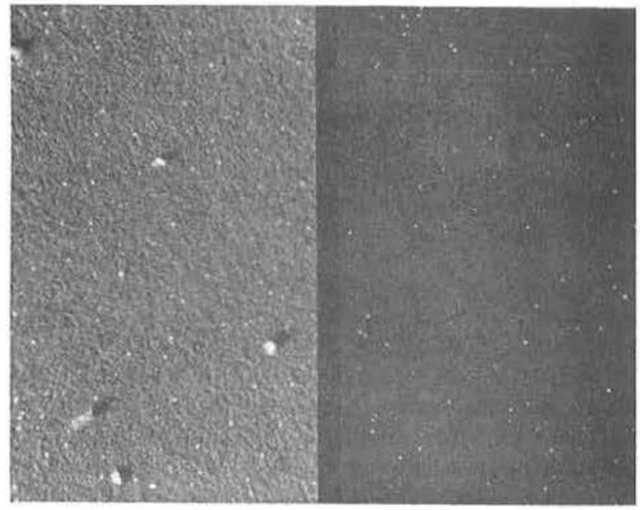


FIG. 5. Photomicrographs of FP collected on a membrane filter; left, under visible light; right, same field under ultraviolet light.

Whether visual or photoelectric counting is used, the lower limit of particle fluorescence which may be observed will depend on a number of factors, including the intensity of UV illumination, the optical arrangement employed, the nature of both the tracer material and the background, and the visual acuity and the experience of the observer or the sensitivity of the photocell. Since, for small particles, the fluorescent flux approaches porportionality to the cube of the diameter there is generally, for any given arrangement, a fairly sharp lower size limit which may be observed, and with increasing intensity of illumination this limit is extended downward. The counts obtained, therefore, will depend on the illumination intensity to an amount which

TABLE 2. Operational variation in F_S determination.

FP material	Lot or specimen No.	No. of tests	No. of samples	Mean value of F_S, particles per gram	Rel. std. error of the mean, %	Coefficients of variation among individual samples: Observed V_F	Poisson V_P
NJZ 2266	9BM5	7	22	5.94×10^{10}	±2.9	0.132	0.049
USRC 2267	WS-11	5	15	1.33×10^{10}	2.5	0.092	0.055
USRC 2267	128	2	6	1.56×10^{10}	2.4	0.054	0.047
USRC 2267	140	2	6	1.56×10^{10}	4.3	0.097	0.053
USRC 2267	142	2	6	1.38×10^{10}	5.2	0.116	0.057
USRC 3206	129	2	6	1.62×10^{10}	3.2	0.071	0.046
USRC 3206	141	2	6	2.24×10^{10}	5.3	0.118	0.053
USRC 3206	143	2	6	1.64×10^{10}	6.6	0.148	0.055
USRC 3206	145	2	6	1.33×10^{10}	4.4	0.099	0.053
						Mean: 0.103	0.052

is in turn dependent on the fraction of very small particles in the material. It is important that for any given series of tests, involving a given lot of material, the same counting equipment and procedures be used throughout, both on field samples and on the samples obtained during source strength determination.

5. Validity

a. *Operational errors.* In dissemination, the chief operational error normally encountered is in the determination of the source strength Q. Since the weight of material released may be determined with some precision, the indeterminate error in Q is essentially equal to that in the value used for F_S, the number of particles per gram. The magnitude of this error, as encountered in source strength determinations with the blower generator is illustrated in Table 2; the corresponding 90% confidence intervals are mostly in the range of ±5–10%. With other methods of dissemination, such as those depending on the slipstream of aircraft, the uncertainty in source strength may be substantially greater than these figures would indicate.

In sampling and assessment, since single particles of the tracer are observed and counted, the theoretical sensitivity limit is $1/Q$. For at least two reasons, however, a substantial number of particles must be collected and counted if the result is to have an acceptable quantitative significance. First, small background counts are difficult to avoid, and second, for small counts, the statistical uncertainty becomes very large. Thus for a Poisson distribution, such that the coefficient of variation of particle counts, V_P, is inversely proportional to the square root of the number counted, a count of 10 particles will yield a result which is within ±25% of the true value only 57% of the time, and a count of 270 is required to yield a value which has a 90% probability of being correct to within ±10%. For these reasons, sample counts of fewer than 10 particles are best regarded as not significant, and the quantities of tracer released should be sufficient to yield counts of 100 or more on samples taken throughout the area or the air volume which is of interest.

The magnitudes of the random errors to be expected in sampling and assessment have been investigated in a number of field tests by using closely spaced arrays of samplers at one or more locations, with the results summarized in Tables 3 and 4. The values of V_P given in these tables are the coefficients of variation to be expected as the result of a Poisson distribution in the population of particles, and are based on the number of particles actually counted on each sample. Comparison of these with the observed coefficients of variation V_D, shows that substantially more than Poisson variability is involved in the determination of dosage with the MF sampler, but not with the Rotorod. Likewise, comparison of the values of V_F and V_P in Table 2 shows more than Poisson variability in the determination of F_S, a result which would be expected from the fact that the samples in these determinations were collected by membrane filter (MF).

The 90% confidence intervals for dosages from individual samplers, i.e., the intervals about the true dosage within which an individual value will lie 90% of the time, based on the operational errors disclosed by the close array experiments and the Poisson variance, are shown in Fig. 6. The Rotorod intervals include the statistical uncertainty in collection efficiency corresponding to the relative standard errors in Table 4.

Sources of operational error which may lead to still greater uncertainty than that indicated by Fig. 6 include cloud inhomogeneity, sampler position or orientation, impaction or electrostatic deposition, obscuration

TABLE 3. Variations in dosage among close arrays of membrane filter samplers.

Field Expt. No.	No. of trials	No. of samples	Coefficients of variation V_D	V_P
138	8	47	0.123	0.058
139	8	48	0.093	0.041
140	8	48	0.097	0.019
141	8	48	0.104	0.042
142	8	48	0.105	0.044
143	6	54	0.103	0.022
			Mean: 0.104	0.038

TABLE 4. Variation in collection efficiency and individual dosages among close arrays of Rotorod samplers.

Field Expt. No.	Lot No.	Material MMD, μ	Particles per gram	No. of trials	No. of samples	Collection efficiency: Mean value %	Collection efficiency: Rel. std. error in mean, %	Coefficients of variation in individual dosages V_D	V_P
138	H324–2	2.4	3.3×10^{10}	8	24	54.1	±1.9	0.048	0.035
139	DPG12–21	3.4	1.2×10^{10}	8	24	60.7	2.4	0.032	0.033
140	1339–2	3.1	1.6×10^{10}	8	24	74.7	1.8	0.040	0.040
141	1339–2	3.1	1.6×10^{10}	8	24	73.7	1.8	0.053	0.058
142	1339–2	3.1	1.6×10^{10}	8	24	72.5	2.8	0.045	0.054
143	1339–2	3.1	1.6×10^{10}	6	24	71.4	1.7	0.057	0.046
								Mean: 0.046	0.044

by dust or other airborne particulates, non-random distribution of particles over the collector surface, subjective error, particularly with inexperienced personnel, and faulty equipment or procedure.

Data bearing on the effects of meteorological conditions, obtained with close arrays of MF samplers placed approximately 50 yards downwind from a fixed blower generator which was operated for approximately 5 minutes, are summarized in Table 5. Although these results suggest an increase in dosage variation with conditions favoring increased inhomogeneity of the cloud, by the t-test the differences are not significant. MF samplers oriented in different directions during these trials, horizontally facing upward and downward, and vertically facing toward and away from the wind, showed no significant variations due to orientation with the exception of the samplers facing into the wind during the thunderstorm in one field test; in this case the values obtained were low, probably due to washoff of the filter surfaces by rain.

The contributions of impaction and electrostatic deposition have been assessed by comparing the number of particles collected on aspirated and unaspirated membrane filters placed side by side and facing into the wind. This comparison indicated that with 25 mm filters operated at a flow rate of 13 l min^{-1} in a 10 mph wind, at 5 yd from the source 3.2% of the particles were deposited by impaction and electrostatic deposition, at 15 yd from the source this contribution had decreased to 1.5% and at 50 yd from the source it was 0.5%. This decrease with distance from the source suggests that the deposition in this instance was mostly electrostatic, due to particle charges acquired during dissemination but rapidly dissipated during airborne travel.

In the obscuration of fluorescent particles by atmospheric particulates which are deposited on the collection surface, the greatest effect is produced by deposition after the FP cloud has passed. Rates of obscuration which have been observed by reoperation of samplers on which FP had been collected range from 0 to 10% per hour for membrane filters and 1 to 15% per hour for Rotorods, depending on the clarity of the air. It is important, therefore, that the period of sampler operation after cloud passage be held to a minimum.

Non-random distribution, which sometimes occurs with high winds on upward oriented membrane filters, may be observed and taken into account during the

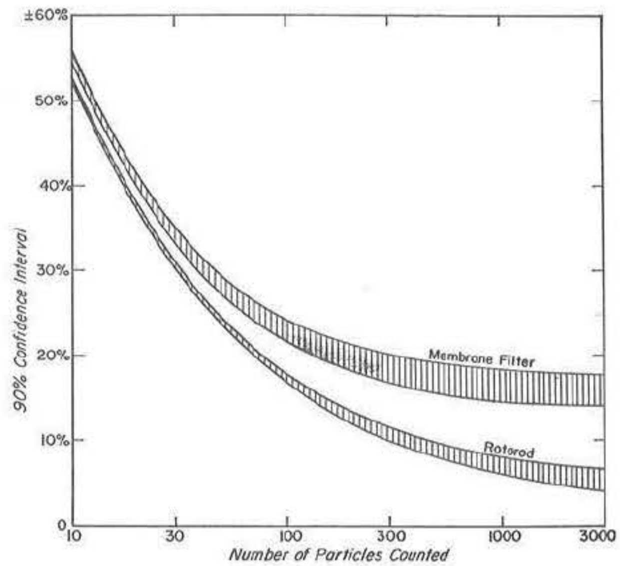


FIG. 6. Confidence intervals for dosages from individual samplers.

analysis. Subjective error, and error due to faulty operation, may often be disclosed by re-examination of the data or equipment if a given result appears to be out of line.

b. *Atmospheric diffusion.* The use of an inorganic particulate of density 4 as a tracer immediately raised the question of possible atypical diffusion of the material during atmospheric travel. Since any such effect should be most marked in a comparison of the diffusion of FP with that of gases, relative diffusion studies of FP and two gases, ammonia and sulfur dioxide, were carried out.

The comparisons with ammonia, which were carried out during the early stages of development of the technique, disclosed no significant differences in behavior over travel distances of up to 120 meters, and showed the importance of using, in such comparisons, both coincidental release and coincidental sampling of the two clouds.

These procedures were adopted in a much more extensive series of comparison between FP and sulfur dioxide. Coincident release was accomplished by feeding both agents into the intake of a modified blower generator, using metering devices which permitted independently variable feed rates of from 2 to 20 g min^{-1} of FP and 200–3000 g min^{-1} of SO_2. Coincident sampling was accomplished by drawing the air first through a

TABLE 5. Effect of meteorological conditions on dosage variability with membrane filter samplers.

Field expt. No.	Conditions	No. of trials	No. of samples	Coefficient of variation in dosage, V_D	Extreme range in any trial
38	Stable bayshore wind, 10–15 mph	3	21	±0.095	1.4:1
78 A,B	Unstable mountaintop wind, 10–20 mph	2	12	0.122	1.5:1
78 C	Thunderstorm, wind 30–40 mph	1	6	0.176	1.7:1

membrane filter for FP removal, then through an impinger bubbler for SO_2. No interference between the two agents was found on passing through the generator, and the presence of sulfur dioxide had no effect on the FP sampling. There was, however, a serious loss in SO_2 while passing through the FP sampler, which was found to be due to adsorption on the metal parts of the membrane filter holder in the presence of moist air. This loss was reduced to 5% or less by coating the metal filter holder with Bakelite varnish. The sulfur dioxide was absorbed in 0.01 M NaOH containing a small amount (7×10^{-4}M) of glycerol, which was found to be superior to benzyl alcohol as a bisulfite oxidation inhibitor, and determined by the fuchsin-formaldehyde colorimetric method.

Eight exploratory and 24 full scale field trials were conducted using 51 samplers distributed concentrically with a $7\frac{1}{2}°$ spacing along arcs of 44, 91, and 183 meters radius from the source. In addition, during the last nine trials 9 portable samplers were operated at downwind distances of 238 to 366 meters from the source. For each test the release period was 5 minutes and the typical amounts of FP and SO_2 made airborne were, respectively, 25 and 11,000 grams. Wind speed varied from 1 to 7 m sec^{-1} and stability conditions from strong lapse (day) to strong inversion (night) during the trials. Light rain occurred just before or during three of the trials.

To facilitate the comparison of the two agents, all sampling results were converted to dosage per unit source strength, D/Q. D and Q were measured in grams for SO_2 and in number of particles for FP. Since these units cancel in the ratio D/Q, and by virtue of coincident sampling the two agents were sampled with the same flow rate, for ideal behavior and perfect technique the ratio $(D/Q)_{FP}/(D/Q)_{SO_2}$ should be unity.

In analyzing the data three bases of comparison of the two agents were used: isodosage areas, crosswind integrated dosages (CWID), and the dosage ratios at individual sampling stations. The results are summarized in Table 6.

In drawing the contours to be used for isodosage area comparisons, the same D/Q levels were used for both agents. Subjectivity was minimized by encoding the data so that neither the trial number nor the agent was known to the evaluator, and as a test of reproducibility twelve sets of data involving 42 contours were independently reevaluated. For the two sets of evaluations, a value of 1.057 was obtained for the variance factor, the antilogarithm of the coefficient of variation of the logarithms of the ratios.

TABLE 6. FP/SO_2 comparison ratios.

	No. of cases	Geometric mean ratio, FP/SO_2	Variance factor	Extreme range
Isodosage area ratios	59	0.98	1.29	0.31–1.45
Dosage-area product ratios	24	1.03	1.14	0.83–1.39
CWID ratios	69	1.08	1.38	0.43–1.91
Individual dosage ratios:				
Exploratory trials	23	0.97	1.27	0.62–1.40
Full scale trials	337	1.07	1.67	0.35–3.2

Comparisons of the areas within the contours for FP and SO_2 were made in two ways: on the basis of the ratio of areas within each pair of isodosage contours, and on the basis of the ratio, for each trial, of the dosage area products, $\int\int c\,dt\,dA$, the integral of concentration, c, with respect to time, t, and to area, A. The data, summarized in Table 6, were analyzed with respect to meteorological categories, and the t-test applied to the ratios for each meteorologically similar category, with the conclusion that the two agents were equally responsive to meteorological changes and showed no statistically significant differences in area coverage under any of the meteorological conditions which were encountered.

The CWID ratios were analyzed with respect to variation with downwind distance and with meteorological conditions. The results, expressed as slopes of log CWID/log distance lines, are summarized in Fig. 7. Random distribution tests and a distribution-free

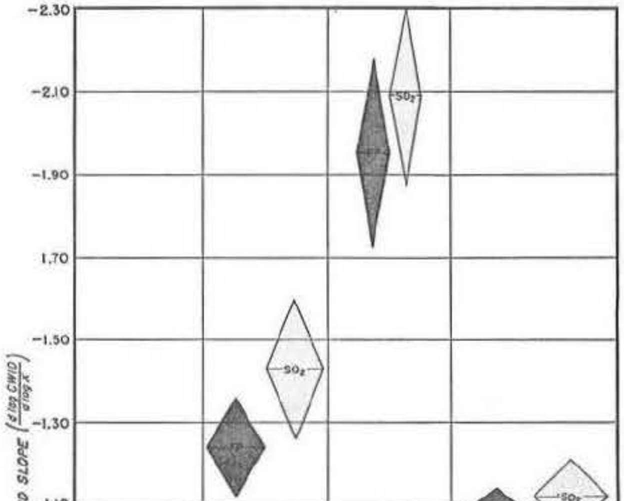


FIG. 7. Comparison by meteorological categories of FP and SO_2 CWID slope data. The half height of each diamond is equal to one standard error, the width is proportional to the number of trials.

analysis disclosed no significant differences, either between the CWID ratios or the CWID-distance slopes for the two agents.

The dosage ratios yielded by individual samplers were analyzed with respect to their distribution about a central value, the slope of a plot of log $(D/Q)_{SO_2}$ vs. log $(D/Q)_{FP}$ for all data, application of the t-test to similar plots for individual trials, and application of the distribution-free method to the ratios at each sampling distance in each trial. The latter indicated an apparently significant attenuation in the SO_2 dosage with downwind distances, relative to FP, in two afternoon trials under strong lapse conditions. With this exception, the dosage ratios showed no significant departures from unity by any test.

The overall conclusion from the FP-SO_2 comparison trials is that, within the range of travel distances and meteorological conditions represented, any differences in atmospheric diffusion are too small to be resolved by the field test methods which were employed. No evidence of atypical behavior on the part of FP was found; indeed, insofar as the dosage areas and CWID-distance slopes were concerned, the differences between the two agents were smaller than the differences between meteorologically similar trials with the same agent.

c. *Fallout and impaction*. In the absence of other removal processes it may be expected that all FP released in the air will, by sedimentation, eventually reach the ground. The fraction which has reached the ground at any given time, i.e., the fallout loss, will depend on the particle size distribution of the material used, the sedimentation velocity over this size range, the height of the cloud, and the amount of vertical mixing by atmospheric turbulence.

Since most individual particles of FP approach spherical dimensions, it may be assumed that their settling velocity in quiescent air approaches the Stokes velocity, which for spherical particles of the density of FP and diameter d in microns, in air at normal temperature and pressure, is $0.012\ d^2$ cm sec^{-1}. Thus a 1μ particle of FP in quiescent air may be expected to require approximately 140 minutes to fall 1 meter, while a 5μ particle will fall this distance in about 5.5 minutes.

Due to the d^2 relation, the fallout loss on a number basis will be smaller for a tracer material with a distribution of particle sizes than it would be for a uniform tracer material with the same density and MMD. For example, the loss due to Stokes settling, from a uniform cloud in quiescent air, of material A in Table 1 would be 55% at the time at which it would reach 100% if the particle size were uniform. For low level releases of tracer, another factor which reduces fallout loss is vertical mixing by atmospheric turbulence. The extent of this effect, estimated for several conditions of vertical mixing, is illustrated in Fig. 8 for a material of uniform particle size. Combining curve B of this figure with the particle size distribution of an actual lot of FP (material A of Table 1) leads to the estimate of fallout loss as a function of cloud height in Fig. 9.

Field measurements of fallout loss have been conducted by measuring the amount of material collected on vaseline coated plates at ground level and varying distances from the source. The vaseline coating was used because plates so coated, whether of glass or metal, collected 10 to 15% more particles than did uncoated glass while uncoated metal plates when close to the generator collected an atypical number of small particles, possibly due to electrostatic deposition. In

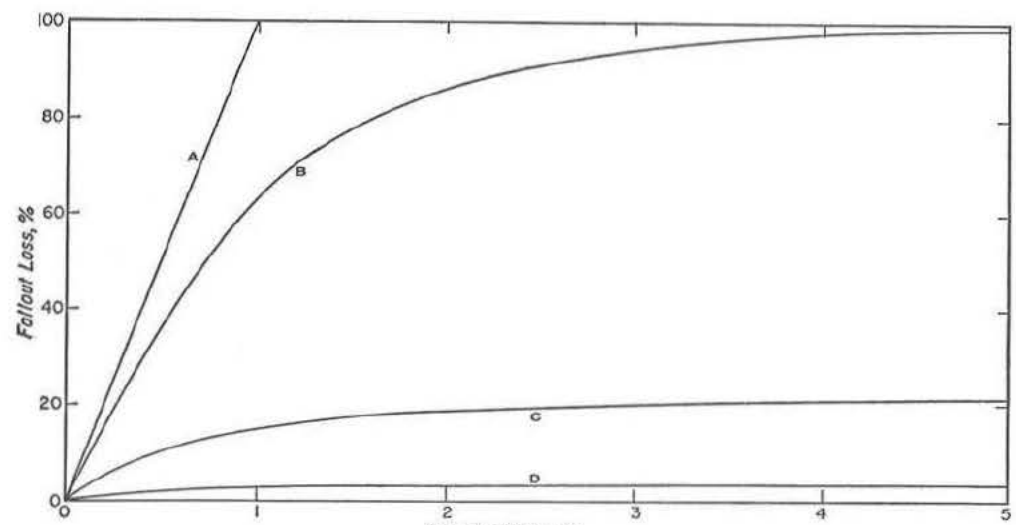


FIG. 8. Estimated effect of atmospheric mixing on fallout loss. A = Stokes settling in quiescent air for a material of uniform particle size, uniformly dispersed to initial height Z_i; 100% loss occurs in time t_s. B = Uniform mixing maintained to constant height Z_i. C = Uniform mixing maintained to a height increasing from Z_i at a rate of $\Delta Z/\Delta X = 0.01$, with a wind velocity of 3 mph and 2.5 u particles of density 4. D = Same as C, except $\Delta Z/\Delta X = 0.1$.

one series of measurements, the plates were set out from 1.2 to 39 m downwind in order to determine the initial fallout loss from a blower generator plume at a release height of 56 cm above the ground. With untreated FP 2266, the losses ranged from 12 to 18% by weight of the material released, and consisted chiefly of clumps of particles 30μ or more in diameter; with surface-treated material the loss was reduced to less than 1%.

In another series of trials, involving travel distances up to one mile across urban areas, it was found that the number of particles collected per unit area on each plate was approximately proportional to the dosage at the plate position. With this proportionality constant, k, it follows that the total fallout loss up to travel distance x should be

$$N_f = k \int \mathrm{CWID}\, dx,$$

where CWID is the crosswind integrated dosage. Assuming this relation, it becomes possible to estimate from the glass plate and dosage data the total sedimentation loss for different distances of cloud travel.

The average of such estimates for eight trials in Winnipeg, five of which were at night, are shown in Fig. 10. The average wind velocity during these trials was 1.4 m sec^{-1}. In another series of four trials in highly urbanized St. Louis, all at night with average wind speeds of 1.7 m sec^{-1}, the average fallout loss up to approximately one mile of travel was 0.45%. Vertical sampling showed that the rate of rise of the cloud during these trials was substantial, approaching or even exceeding the $\Delta Z/\Delta X = 0.1$ of curve D in Fig. 8. The small observed losses are therefore consonant with the predictions of this figure.

During one tracer trial over Palo Alto, conducted during the afternoon with a surface wind of 2.7 m sec^{-1} and an overhead inversion at 90 m, the number of particles deposited on leaves collected at distances up to 4.5 miles from the source were measured by microscopic examination. From the results, together with an estimate of the total leaf area (2.5×10^9 cm^2 per sq mi or about 10% of the ground area), it was concluded that 3.4% of the material released was deposited on leaves during 4.5 miles of travel.

Most of the particles were deposited on the edges of the leaves, and most of the deposition occurred near the source. The concentration of the deposition on the leaf edges suggests that of the two processes, fallout and impaction, which might cause deposition on leaves, in this case impaction was the more important. The concentration near the source is consonant with the facts that the cloud was released near ground level and apparently diffused upward by vertical mixing with $\Delta Z/\Delta X \sim 0.1$ until it reached the inversion base. The total fallout during 4.5 miles of travel under these conditions may be estimated from Figs. 8 and 9 at between 3 and 4%, which would indicate that in this trial the losses from fallout and impaction were comparable.

In general, impaction loss during cloud travel over wooded areas may be expected to increase with wind velocity, leaf density, and with the fraction of the cloud which is below treetop level. In addition, it may be expected to be a function of the leaf nature; pine needles should be more efficient impactors than broad leaves.

d. *Fluorescent stability*. With most of the fluorescent zinc sulfide and zinc cadmium sulfide pigments, exposure to sunlight or to UV irradiation produces a reversible surface darkening in the bulk powder and irreversibly changes the fluorescence of some of the single particles. Early in the development of the FP tracer system the extent to which these effects might alter

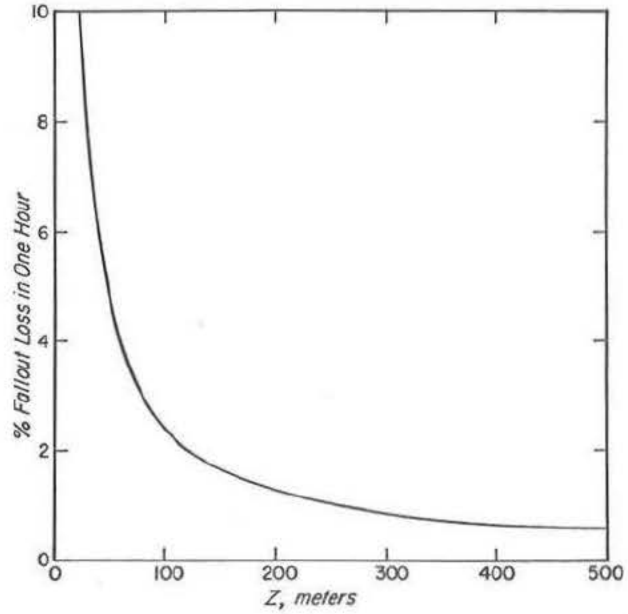


FIG. 9. Fallout loss as a function of cloud height. Estimated for FP material A of Table 1, under conditions which maintain uniform mixing to a constant height Z.

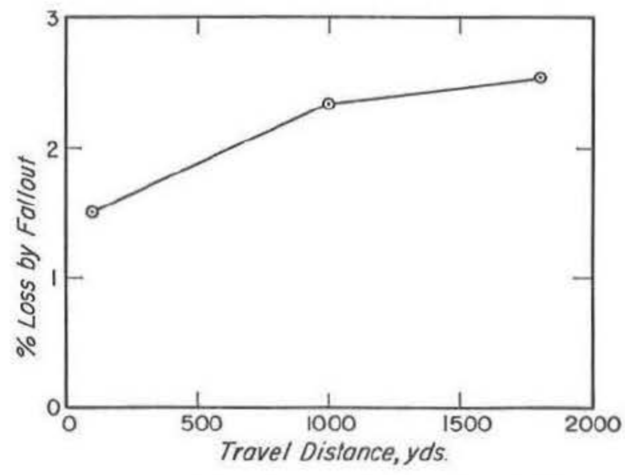


FIG. 10. Average fallout loss as a function of travel distance for eight tracer trials in Winnipeg.

particle counts was investigated with the NJZ 2266 which was then in use. In these tests the fluorescence of over six hundred particles, dispersed on glass plates, was individually noted and recorded before and after successive periods of exposure to sunlight. Expressed in terms of percentage per plate, the fluorescence of 3% to 9% of the particles was reduced below detectable limits by exposure to sunlight for 3 to 15 hours. The effect was greatest during periods of high humidity, all of the particles so affected were below 1μ in diameter, most of the quenching occurred during the first few hours of irradiation, and few additional particles were lost even with long exposures. In addition, 15% to 25% of the particles showed changes which did not prevent their being counted. Some of these showed changes in fluorescent intensity over the entire particle, some appeared to change only in spots, and some showed evidence of a shift in the fluorescent radiation toward longer wavelengths. From 70% to 80% of the particles showed no changes detectable by eye, even with exposures of 16 to 18 hours.

More recently, Eggleton and Thompson (1961) have reported losses of up to 50% of the particles of a zinc cadmium sulfide pigment, made by Derby Luminescents, during about 2 hours of airborne travel in sunlight. This led to a reinvestigation of the fluorescent stability, both of the original NJZ 2266 and of several current materials, including that of Derby Luminescents.

In this reinvestigation, particles of each material were collected on membrane filters, counted, exposed to ultraviolet radiation, and again counted. In most of the exposures the filters were placed in a closed chamber containing air at 100% relative humidity, and irradiated for 8 hours with mercury arcs which gave an ultraviolet intensity at the filter surface about 1½ times that of normal noon sunlight. The air temperature during the irradiations was maintained at 125F and the temperature of the filter surface was 125–130F. In one series of tests the relative humidity in the chamber was reduced to 20%, and in another series, the filters were exposed to direct sunlight with aspiration in ambient air. In counting, the filters were illuminated in some cases with the standard H85A3 lamps, and in others, to obtain higher intensity, with the PEK-109 lamp. Counts were made by standard procedures.

The results, summarized in Table 7, show a wide range of stabilities among the materials tested. The low losses shown by the NJZ 2266 confirm the earlier measurements on this material, and the high losses shown by the Derby 1318/10 are in line with the observations of Eggleton and Thompson. Fig. 11 gives photographic evidence of this difference. On the basis of both its fluorescent instability and its excessive numbers of small particles, 44% below 1μ for lot 8231, the Derby material should be rejected as unsuitable for tracer use.

The tests with USRC 2267 show that differences in stability may be expected even among different lots of the same material. Lot 1339-2 of USRC 2267 appears to be nearly as stable as the standard NJZ 2266, while the other lots are questionable. Of the two lots of green fluorescing material tested, USRC 3206 and 2210, the latter was the more stable.

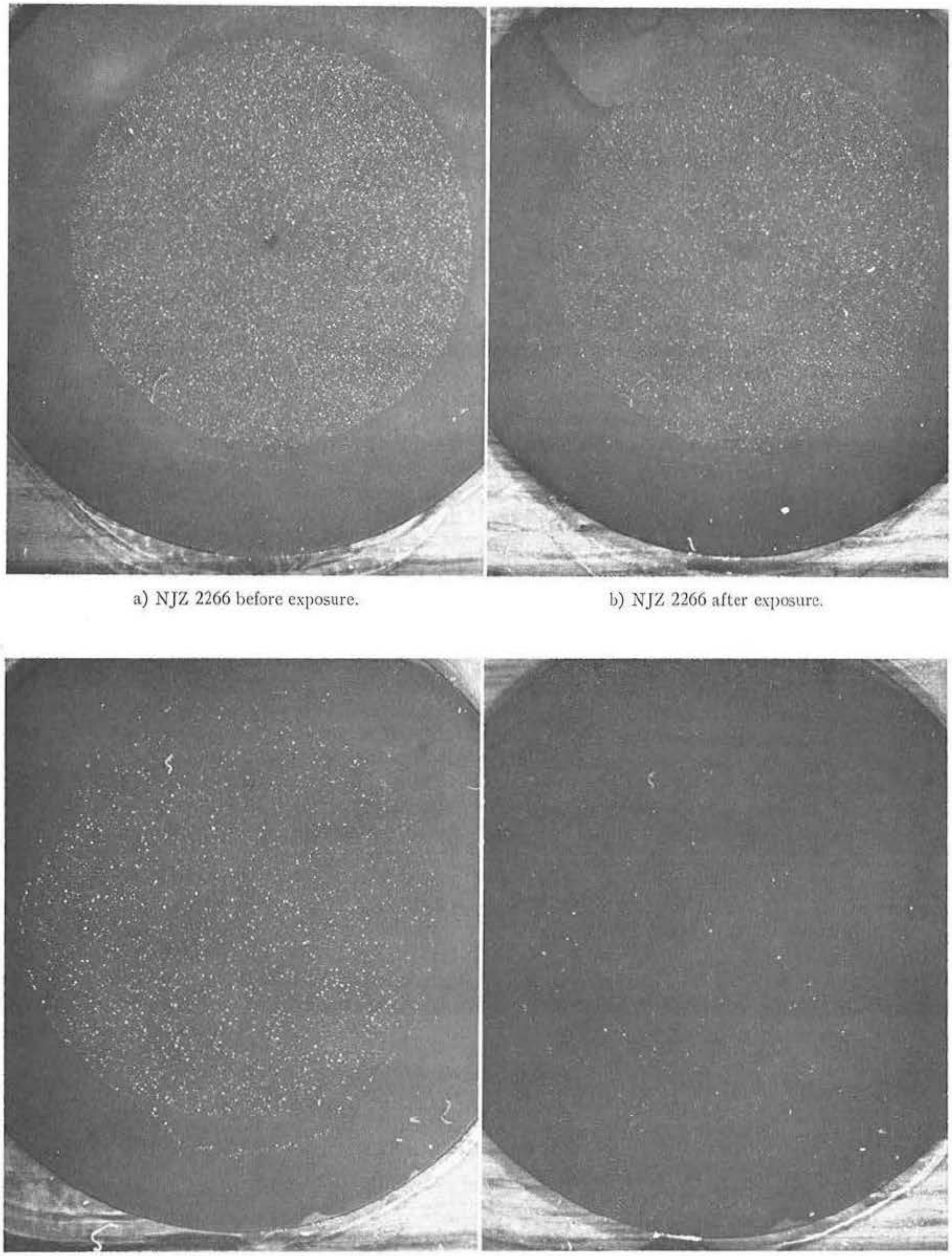
Comparison of columns A and B of Table 7 shows that increasing the illumination intensity during counting results in every case in an increase in particle loss. This is probably due to the fact that most of the unstable particles are small, and with increasing illumination the threshold of observable particle diameters is moved downward, thus bringing more of the unstable particles into the original count.

Decreasing the relative humidity during irradiation from 100% to 20% (Column C) decreased the percentage of particles lost with every material so tested. The apparent gain shown by three of the results in this column may be due either to the brightness increase which will be described below, or to the statistical variation involved in counting. In this series of tests the

TABLE 7. Effect of ultraviolet irradiation on particle counts.

Material	Lot No.	Particles per gram	% of particles below 1μ	Percentage reduction in particle counts for irradiation and counting conditions stated below. (G=Gain) A	B	C	D
NJZ 2266	8BG505	3.3×10^{10}	21	1.0	8.2	(7.4G)	7.1
USRC 2267	1339–2	1.7×10^{10}	12	2.0		(1.6G)	2.4
USRC 2267	WS-11	0.97×10^{10}		12.0		(2.7G)	16.0
USRC 2267	12–21	1.2×10^{10}	9	15.2	22.8		
USRC 3206	H324			26.7	26.8	7.1	4.1
USRC 2210	0067	1.35×10^{10}		10.8	14.1		
Derby 1318/10	8231		44	43.5	47.7	6.9	
Derby 1318/10	8336			30.7	37.3	4.4	

Irradiation and counting conditions:
A. 8 hours irradiation by UV at 1½X sunlight in air at 125F and 100% RH; counting by fields or traverses with standard microscope illumination.
B. Same as A except intense (PEK-109) microscope illumination.
C. Same as A except air during irradiation was at 20% RH.
D. 19 hours irradiation by sunlight on aspirated filters in ambient air, counting with standard illumination.



a) NJZ 2266 before exposure. b) NJZ 2266 after exposure.

c) Derby 1318/10 before exposure. d) Derby 1318/10 after exposure.

FIG. 11. Comparative fluorescence of NJZ 2266 and Derby 1318/10 before and after 8 hours of UV irradiation on membrane filters at an intensity of $1\frac{1}{3}$X sunlight. Throughout the irradiation period the filter surface was 125–130F and surrounding air was 100% relative humidity. Using standard counting procedures, the average loss in particle count as a result of irradiation was 1% for NJZ 2266 and 43.5% for Derby 1318/10. The darker backgrounds in the irradiated samples are due to an actual darkening of the filters; the rupture in the upper photographs also occurred during irradiation.

average number of particles counted per filter was 360, and three such counts were made on each filter before and after exposure. For a Poisson distribution the corresponding 90% confidence interval in the ratio of the mean counts is ±8.9%. All of the ratios obtained in the low humidity tests depart by less than this interval from unity, hence none of the materials tested showed a significant change. The same conclusion applies to three of the four materials which were exposed to sunlight for 19 hours (Column D of Table 7). In this case, only lot WS-11 showed a significant reduction in particle count, and this may have been due to obscuration by air pollution particulates which were deposited during the 19 hours of aspiration.

Measurements by photomultiplier of the fluorescent brightness, before and after UV irradiation, of 100 individual particles of NJZ 2266 and 100 of Derby 1318/10, mostly in the 1–5μ size range in each case, yielded the results shown in Table 8. The brightnesses recorded after irradiation may be somewhat high due to increased reflectivity of the filter material on which the particles were deposited, and particularly the apparent increase in brightness of the NJZ 2266 may be due to this effect. With this reservation, the data in Table 8 support the conclusion from the counting tests regarding the difference in fluorescent stabilities between the two materials.

6. Discussion

The zinc cadmium sulfide phosphors which are used as FP material are manufactured by a batch process in which there is considerable variability in the size range, the fluorescent hue, the intrinsic brightness, and the fluorescent stability under irradiation. For this reason, when it is proposed to use the tracer in accurately controlled and instrumented atmospheric diffusion experiments it is essential that the particle size distribution and the fluorescent properties of each lot of material be tested and judged satisfactory before it is put into use. By this procedure, it may be assured that the material is suitable for counting and that fluorescence loss will not be a significant source of error.

The evidence presented in the preceding sections indicates that for ground releases of tracer the losses by fallout and impaction may amount to from 1 to 10%

TABLE 8. Effect of ultraviolet irradiation on fluorescent brightness.

	Av. fluorescent brightness, picolumens		Brightness ratio
	NJZ 2266	Derby 1318/10	Derby 1318/10 / NJZ 2266
Before irradiation	4100	2500	0.62
After irradiation*	4400	1050	0.24

* 8 hours at $1\frac{1}{2}$X sunlight in air at 125F and 100% RH.

during the first few miles of travel, depending on the rate of rise of the cloud with turbulent mixing and the nature of the ground cover. For releases from aircraft, of course, there will be no losses from these sources until the cloud reaches the ground. For large travel distances, very little evidence is available on the rate of attrition by fallout and impaction. From Fig. 9, if the cloud height is above 100 meters the fallout loss should be below 2% per hour, and the observed decrease in fallout rate with increasing cloud height would appear to support this estimate.

The extent to which FP are removed from the atmosphere by rain has not been established. In two cases in which some rain fell during trials the dosages obtained did not appear to be significantly altered. Estimates based on the Langmuir accretion theory lead to the tentative conclusion that for particles of the size range and density of FP the amount of washout depends on the total precipitation rather than the intensity of rainfall (Vaughan and Perkins, 1961). For wettable particles of density 4, the computed losses for 25 mm of rain would be 10%, 78%, and 98% for particles of 1.5, 2, and 2.5μ diameter, respectively. For non-wettable particles the computed loss is negligible even for heavy rainfall. The wettability of the particles is, therefore, a critical factor, and for FP this remains to be determined.

In summary, the operational errors inherent in the FP technique in its present state of development set limits, in terms of 90% confidence intervals, of approximately ±5–10% for source strength determination with the blower generator, of ±10–12% (for 300 particles counted) for individual dosages determined by the Rotorod, and ±17–20% for those determined by the membrane filter sampler. Of the three behavioral aspects of FP which have been investigated, the effects of atypical diffusion on the validity of the method appear to be insignificant, and fluorescence losses may be controlled by proper selection of material. Fallout and impaction losses, on the other hand, may produce significant errors unless they are evaluated and a correction applied.

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APPENDIX B
SOURCE AND SAMPLER LOCATIONS

The source locations for the multicolor fluorescent particle (FP) tracer test was selected to simulate a existing source, of emissions, i.e., WODECO IV and the effects of ground-level and stack emissions from the proposed site in the Corral Canyon property. The green FP source was located near the north boundary as shown in Fig. 1 to simulate ground level emissions, the yellow FP source was located on the ridge east of the canyon, to simulate stack emissions which might go over this ridge and the red FP source was located on the stern of the drilling ship WODECO IV to simulate emissions from this source.

A relatively dense array of sampling stations was located along the perimeter of the Corral Canyon property and around the lower end of the canyon and the coast below the property in order to trace the airflow across the boundary lines and the down-canyon flow to the coastal area. A line of samplers was also placed across the canyon approximately half way between the north boundary and the coast. This line was selected to give a cross section of the down-canyon flow and to give a measure of its depth. These sampling stations are shown in Fig. 1. In addition to the samplers on the Corral Canyon property several samplers were lcoated in adjacent canyons east of the property including the Corral Canyon and one sampler (Station 23) was located on an adjacent ridge at about 550 ft. elevation.

The remainder of the land sampling stations were placed along the coast and also in the cities of Goleta and Santa Barbara. Samplers were placed at Refugio and El Capitan State Beaches and also on the Getty Oil property near Gaviota. In order to trace the air flow offshore samplers were placed on Platforms Hilda, Hazel, Hope, Heidi, Holly and on the drilling ships WODECO IV and Bluewater II. This large scale sampler array is shown in Fig. 2 with the area of the sampler array in Fig. 1 indicated.

For the test on 29 April 1971 (FE 164), a sequential drum pulsed sampler (DPS) was located at Station 46 at a small house west of the citrus and avocado orchards at the south end of the canyon in order to determine the time during which the FP tracer clouds passed this point. The second DPS was placed at Rotor Aids at Santa Barbara Airport, at Station 34, and a third at the Cliff Street Fire Station in Santa Barbara.
A detailed description of aerosol generation and sampler locations is given below and selected photographs taken at the aerosol generator locations and sampling stations are shown in the report.

A. Aerosol Generator Locations

For the multiple source FP tracer test, FE 164, three aerosol generators were used to simulate three types of sources:

1. Low-level source at site. The green FP generator was located on the road up the Corral Canyon just south of the fence at the north boundary.

2. Stack source. The yellow FP generator was located on the ridge east of Corral Canyon about 200 ft. south of the water tank at 550 ft. elevation.

3. Offshore source. The red FP generator was located on the stern of the drilling ship, WODECO IV which is located about 5 miles offshore at latitude 34°23'31" N and longitude 120°07'34" W.

B. Sampling Stations

1. Approximately 500 ft. west of road at bottom of Corral Canyon near fence at north boundary.

2. Approximately 30 ft east of the road near wind station at north boundary near fence.

3. Approximately 500 ft. southeast of Station 2, north boundary near fence at 300 ft. elevation.

4. Approximately 500 ft. southeast of Station 3, at north boundary near fence at 400 ft. elevation.

5. Approximately 700 ft. east northeast of Station 4, at about 550 ft. elevation.

6. At fence east of water tank on ridge east of Corral Canyon at 600 ft. elevation.

7. Approximately 800 ft. south of water tank at fence near first loop in road below water tank at 550 ft. elevation.

8. Approximately 1000 ft. southwest of water tank at fence near third loop in road below ridge at 400 ft. elevation.

9. Approximately 800 ft. west of Station 7 near Y in road at 350 ft. elevation.

10. Approximately 600 ft. west of Station 9, east of road near wells 1-34 and 1-48. Elevation 200 ft.

11. Approximately 600 ft. west of Station 10, near Y in road at bottom of canyon at 70 ft. elevation.

12. Approximately 500 ft. west of Station 11 near three wells on road up west side of canyon at 250 ft. elevation.

13. Near corral west of house near south end of canyon at 40 ft. elevation.

14. East of citrus orchard just below pepper tree beside road at south end of canyon about 500 ft. north of Highway 101.

15. At fence on east boundary of property about 600 ft. northeast of Station 14 at 120 ft. elevation.

16. Approximately 800 ft. north of Station 15 on post of old stair steps at 200 ft. elevation.

17. Through tunnel south of oil tanks on Mobile Oil Property and about 30 ft. east of abrupt rise in road along coast. Approximately 2000 ft. east of tunnel below Corral Canyon.

18. On beach at east side of drain near tunnel below Canada del corral.

19. On concrete wall along dirt road above beaches west of Corral Canyon between Anderson sign and palm tree. Approximately 0.7 miles west of Station 18.

20. Refugio Beach State Park on fence post at north boundary just west of entrance behind pepper trees.

21. Near road in Canada del Capitan. On opposite side of road from old water tank (on El Capitan Ranch).

22. In Canada del Capitan on fence post across road from corral.

23. On hill west of Canada del Capitan road at about 530 ft. elevation.

24. In Canada del Capitan on red and white fence post approximately 1000 ft. east of Station 23.

25. In bushes on north side of frontage road north of Highway 101 at El Capitan Beach State Park.

26. El Capitan Beach in gully approximately 100 ft. southwest of park store.

27. On fence post in canyon east of El Capitan Ranch sign.

27A. On fence post in canyon west of El Capitan Ranch sign.

28. Up canyon approximately 1000 ft. north of Station 27.

29. On Signal Oil property on coast near Eagle Canyon approximately midway between Corral Canyon and Goleta. Take road to right to railroad tracks. Walk to end of road and turn right. Near palm tree on sough side of road.

30, 31, 32. Not used. Selected locations were not readily accessible.

33. Goleta County Beach. On post behind tree near house and next to slough on north side of park.

34. On concrete slab outside Rotor Aids at Santa Barbara Airport.

35. North Fairview Ave., Goleta, near Via Lenora.

36. Cliff Drive Fire Station, Santa Barbara.

37. Modoc Fire Station, Santa Barbara.

38. Stanwood Drive Fire Station, Santa Barbara.

39. On coast of Getty Oil property on south side of Highway 101 near Gaviota.

40. Platform Hilda. Latitude 34°23'18" N., Longitude 119°35'42" W.

41. Platform Hazel. Latitude 34°22'56" N., Longitude 119°34'01" W.

42A. Platform Hope. Latitude 34°20'26" N., Longitude 119°31'49" W.

42B. Platform Heidi. Latitude 34°20'21" N., Longitude 119°31'06" W.

43. Platform Holly. Latitude 34°23'24" N., Longitude 119°54'19" W.

44. Drilling Ship Bluewater II, Well 183-1. Latitude 34°20'58" N., Longitude 120°18'35" W.

45. Drilling Ship WODECO IV, Well 188-4. Latitude 34°23'31" N., Longitude 120°07'34" W.

46. On north side of small house on west side of citrus and avocado orchards in lower end of Canada del Corral. Approximately 300 ft. west of large storage tank.

APPENDIX C
SANTA BARBARA METEOROLOGY

A. Site Location and Description

The proposed site lies within the Canada del Corral and Las Flores Canyon stream drainage systems as shown in Figs C-1 and C-2. Property boundaries extend from the Pacific Ocean on the south between Refugio and El Capitan Beach State Parks to approximately one mile inland. Two north-south ridges reaching a maximum of 848 feet above sea level from the eastern and western boundaries. The stream channels of Las Flores Canyon and Canada del Corral converge near the center of the property and the latter stream continues to the Pacific Ocean approximately one mile downstream.

The tentative plant site lies in a relatively flat meadow near the northern boundary of the property designated by a star in Fig. C-1. The Canada del Corral stream bed lies to the west of the site and rolling hills rise abruptly to the ridge on the east.

B. Meteorology

Meteorological measurements taken at the Corral Canyon site at the position indicated in Fig. C-1 and C-2 show a high degree of regularity in the diurnal flow patterns particularly when winds in the Santa Barbara area are light. A plot of wind frequencies and speeds is shown in Fig. C-3 for the periods 13 Nov. to 23 Dec. 1970. The high frequency of down-canyon flows from the north to northeast is due to the channeling of the airflow in the canyon as the air drains from the cooling slopes of the Santa Ynez Mountains from late afternoon to late morning during the winter season. The secondary maximum frequency occurs with south to southwest winds up the canyon. This flow occurs with the onset of the sea breeze and is accelerated by solar heating of the slopes. The up-canyon flows are weak and of short duration during the winter season but increase considerably and become more persistent during the summer season.

The wind frequencies at Santa Barbara Airport during the same period as the on-site measurements are shown in Fig. C-4 High frequencies of northeast and east winds are observed during the night and early morning hours. During the day the on-shore sea breezes are from a west southwest direction with a secondary maximum from the southeast. Comparison of winds at Santa Barbara Airport and at the site indicated that in most cases winds from the northwest and northeast quadrants at the airport correspond to down-canyon flow at the site and airport winds from the southeast and southwest quadrants correspond to up-canyon flow at the site. This comparison provides a means of converting climatological wind data obtained from Santa Barbara Airport observations to winds at the site.

A five year average wind frequency diagram at Santa Barbara Airport for December during the period 1960-1964 is shown in Fig.C-5. The frequencies are given to 16 compass points instead of 10 degree intervals as used in the observations. The wind frequencies in Fig.C-4 are similar to the 5-year average values except for a high frequency of easterly winds greater than 16 knots due to the unusually stormy periods in November and December 1970.

A tabulation of winds by Pasquill stability classes was obtained from the National Climatic Center at Asheville, North Carolina. These stability classes are determined from standard meteorological observations of wind speed and cloudiness and from the solar elevation angle which show a diurnal and seasonal variation*. Atmospheric stability and wind speed determine the dispersion of gaseous and particulate materials in the atmosphere and diffusion parameters have been derived by Pasquill for several stability classes. The Santa Barbara Airport data was grouped into six stability classes by months. These stability classes are defined as follows:

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* D. Bruce Turner, Journal of Applied Meteorology, February 1964

Stability Class	Definition
A	Extremely unstable
B	Unstable
C	Slightly unstable
D	Neutral
E	Slightly stable
F	Stable to extremely stable

Class A occurs with clear sunny days and light winds. Dispersion of airborne materials is very rapid under these conditions and concentration decreases rapidly with distance from the source. Class B and C also occur in daytime but with increasing cloudiness and/or stronger winds. Class D occurs day or night under overcast conditions or with broken cloudiness and moderate to strong winds. Classes E and F occur at night with the extreme stability of F occurring with light winds and clear skies.

The diffusion of airborne gases and particles decreases with increasing stability so that the concentration remains high for long distances from the source. The frequency of occurrence of stable conditions is of particular interest since this corresponds to a down-canyon flow from the site and off-shore flow along the coast. However, during transition periods the flow would parallel the coast and could cross the El Capitan area and Santa Barbara.

Table 1 shows the frequencies of the six stability classes by months and also on an annual basis. Classes C and D and F occur more than 75% of the time during all seasons of the year. Class F predominates during December and January and accounts for nearly 50% of the total because of the long nights and clear skies resulting in strong nocturnal cooling. The frequency of neutral conditions (Class D) increases to a maximum of nearly 50% in June while the frequency of Class F conditions decreases to 20% of the total hours. Neutral conditions can occur with both up-canyon and down-canyon flows and occasional cross-canyon

Table 1

MONTHLY AND ANNUAL FREQUENCIES OF STABILITY CLASSES
(5-Year Averages For 1960 - 1964)
STABILITY CLASS

	A		B		C		D		E		F	
Month	Hrs.	%	Hrs.	%	Hrs.	%	Hrs.	%	Hrs.	%	Hrs.	%
Jan.	0.2	0.05	51	6.8	100	13.4	191	25.6	52	7.0	350	47.1
Feb.	5	0.7	49	7.4	96	14.3	219	32.5	63	9.4	240	35.7
Mar.	3	0.4	57	7.7	96	13.0	273	36.7	74	9.9	240	32.3
Apr.	7	0.9	75	10.4	118	16.3	243	33.7	65	9.1	213	29.5
May	8	1.0	72	9.7	135	18.2	248	33.4	75	10.1	206	27.7
Jun.	7	1.0	69	9.5	111	15.4	340	47.2	45	6.2	149	20.6
Jul.	4	0.6	95	12.7	141	18.9	272	36.5	68	9.2	164	22.1
Aug.	3	0.3	80	10.7	129	17.3	274	36.8	70	9.4	190	25.5
Sep.	2	0.3	55	7.6	123	17.0	274	38.1	55	7.6	212	29.4
Oct.	1	0.1	47	6.4	115	15.5	272	36.5	58	7.8	251	33.7
Nov.	1	0.1	33	4.6	96	13.4	254	35.2	63	8.8	272	37.8
Dec.	0	0.0	38	5.1	113	15.1	190	25.6	48	6.5	355	47.7
Annual	41	0.5	720	8.2	1371	15.7	3049	34.8	737	8.4	2841	32.4

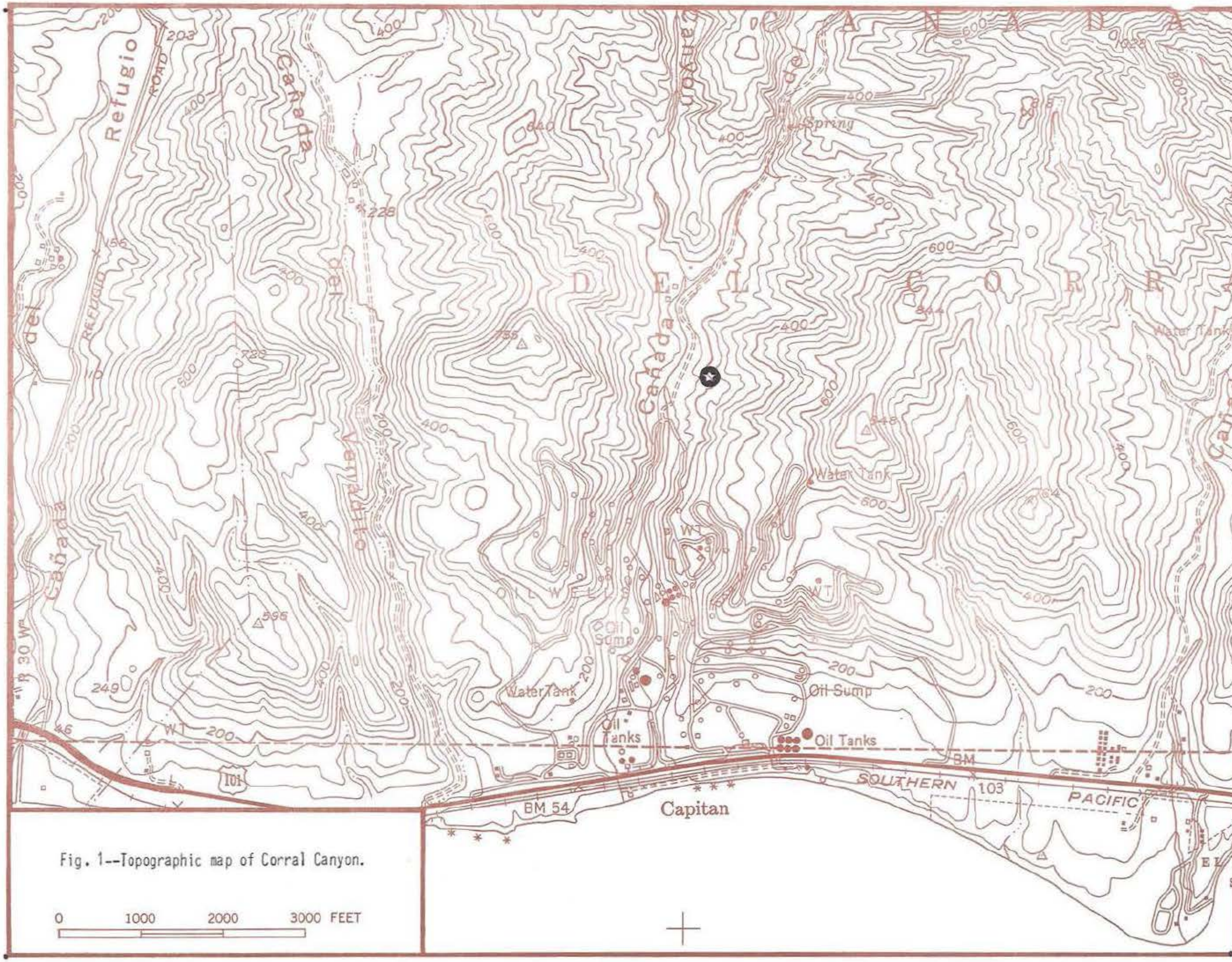


Fig. 1--Topographic map of Corral Canyon.

Fig. 2--Aerial photograph of Corral Canyon Site.

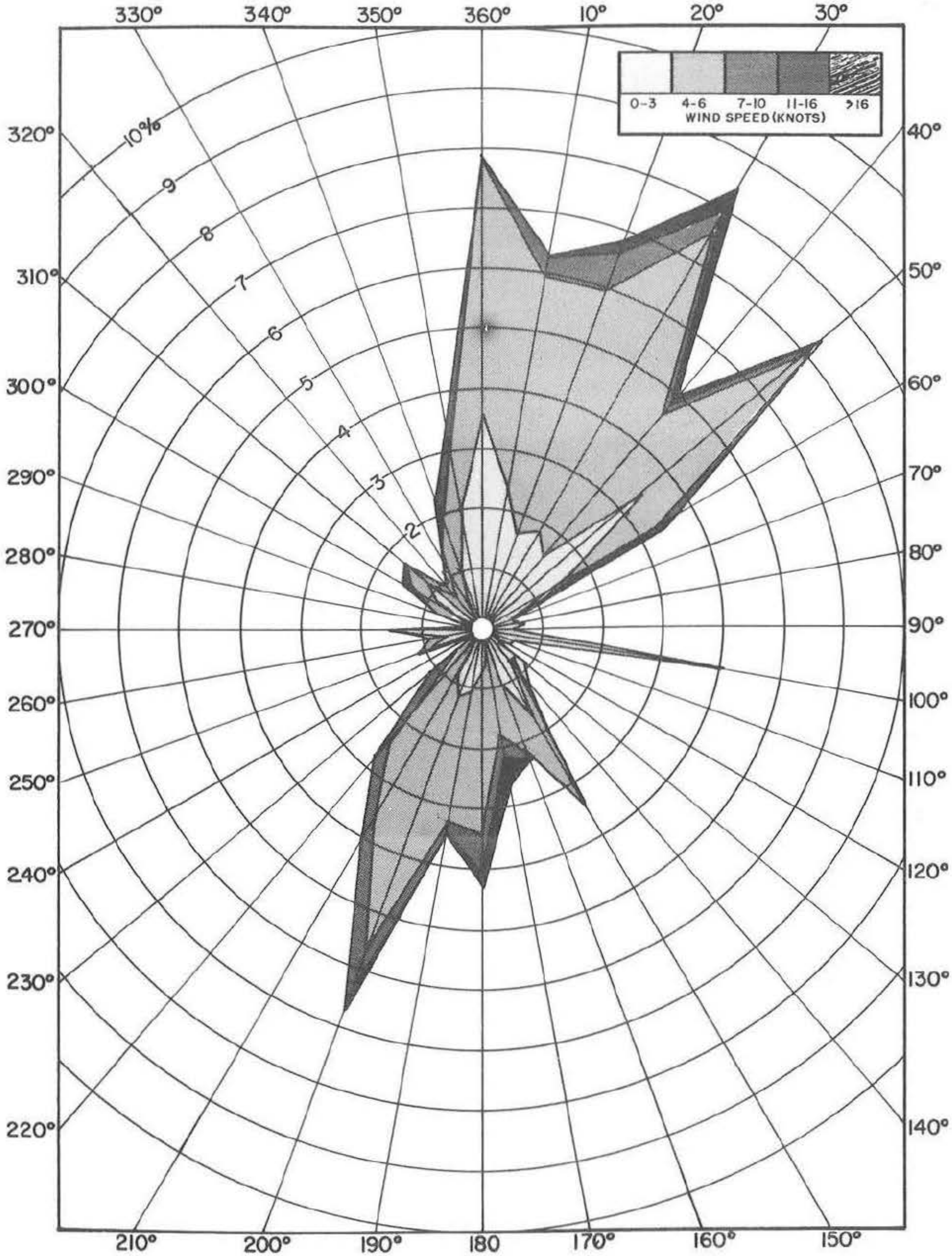


Fig. 3--Frequencies (%) of winds at site. (Nov. 13 - Dec. 23, 1970)

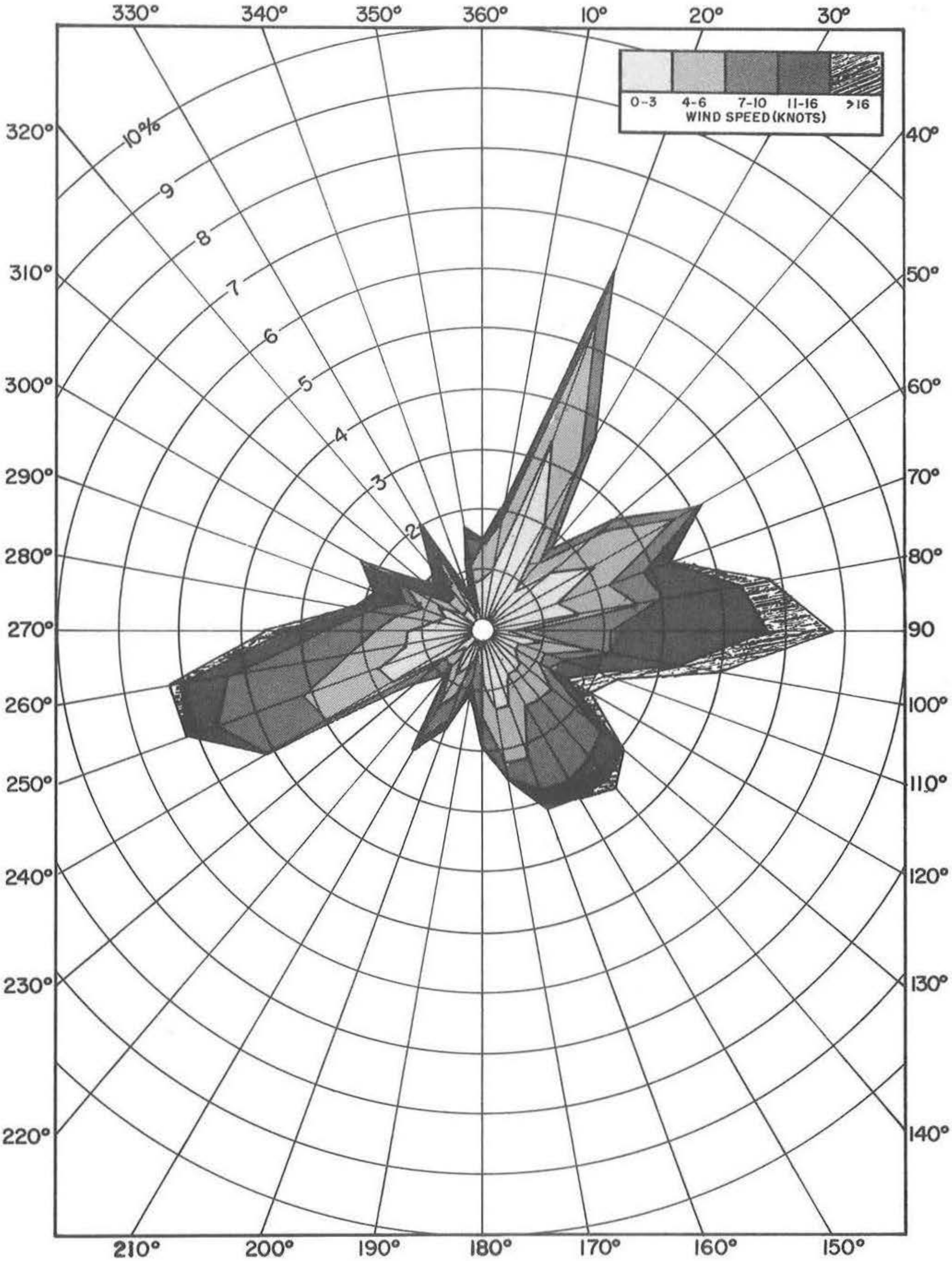


Fig. 4--Frequencies (%) of winds at Santa Barbara Airport. (Nov. 13 - Dec. 23, 1970)

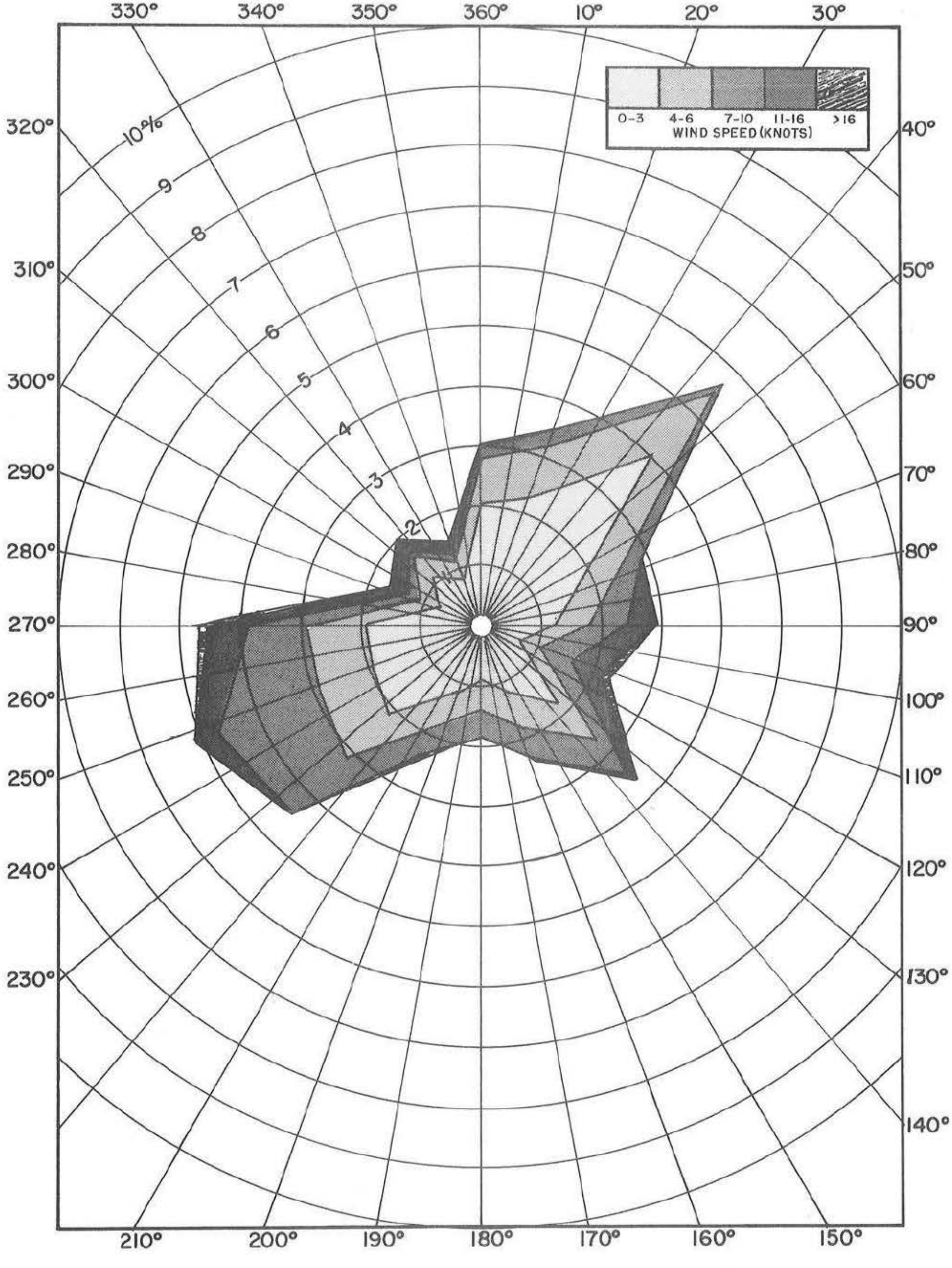


Fig. 5--Frequencies (%) of winds at Santa Barbara Airport. (5 year averages for December)

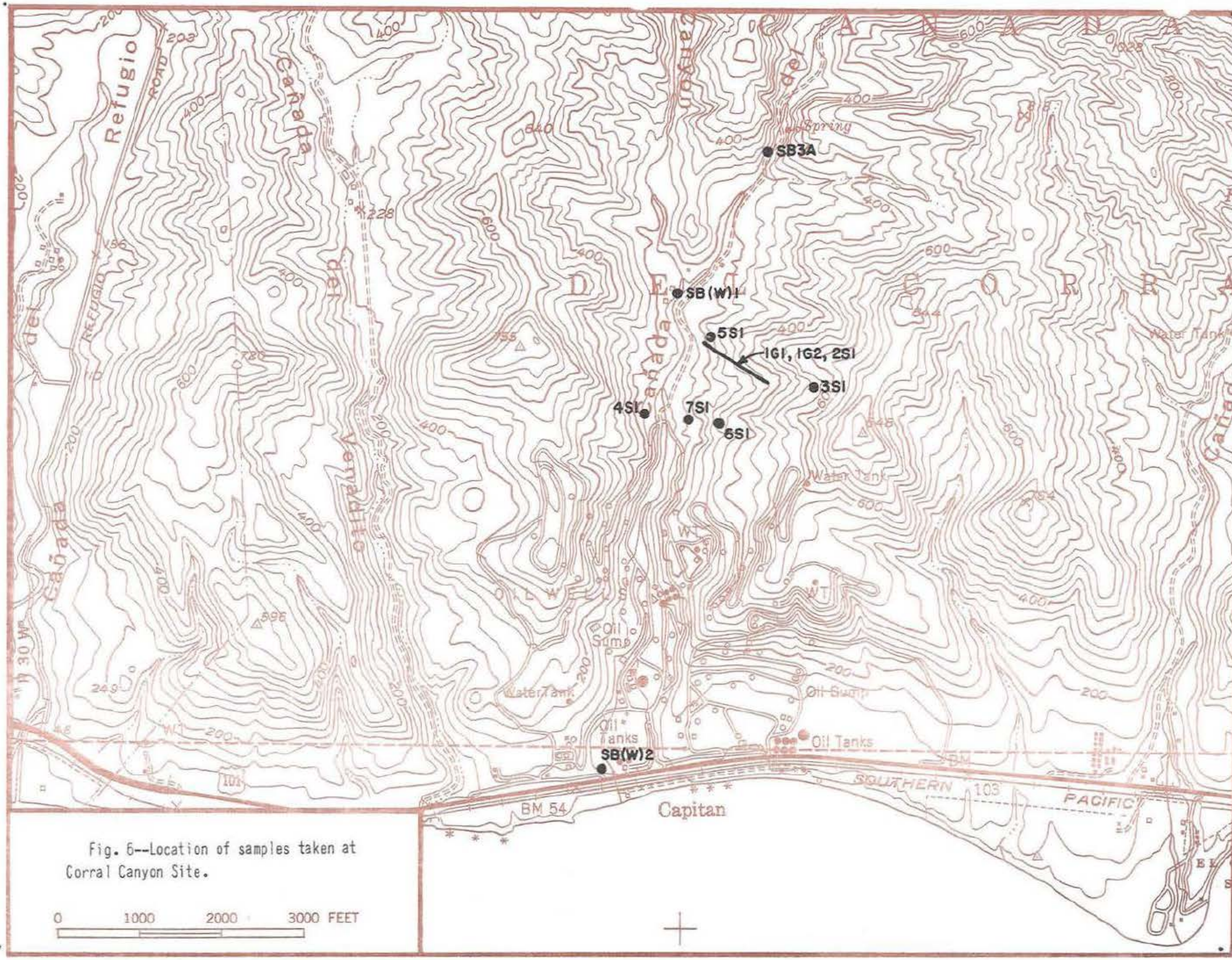


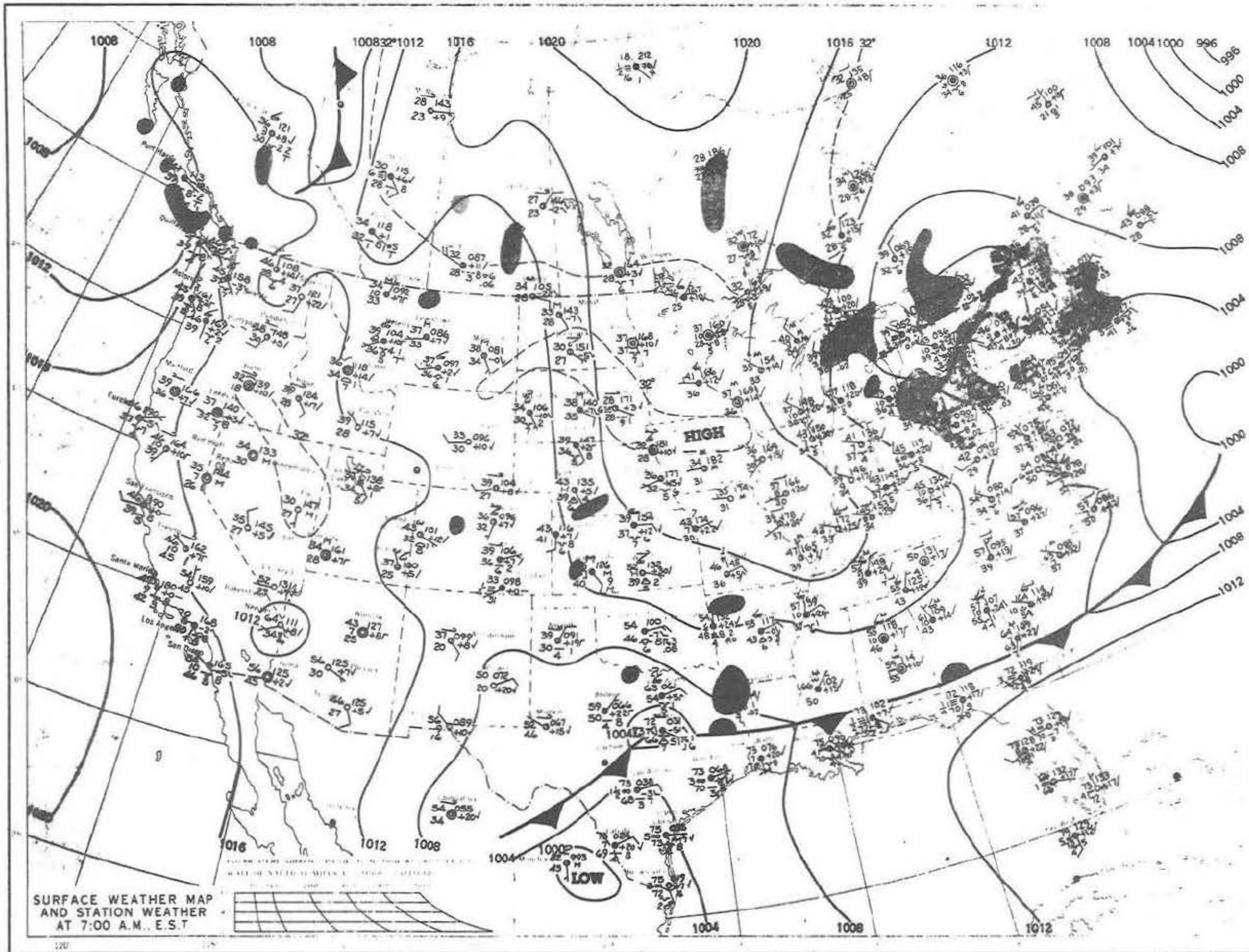
Fig. 6--Location of samples taken at Corral Canyon Site.

flows. Frequencies of Class A, B, and C also increase during the summer months and solar heating is increased then producing more favorable conditions for atmospheric diffusion of airborne materials.

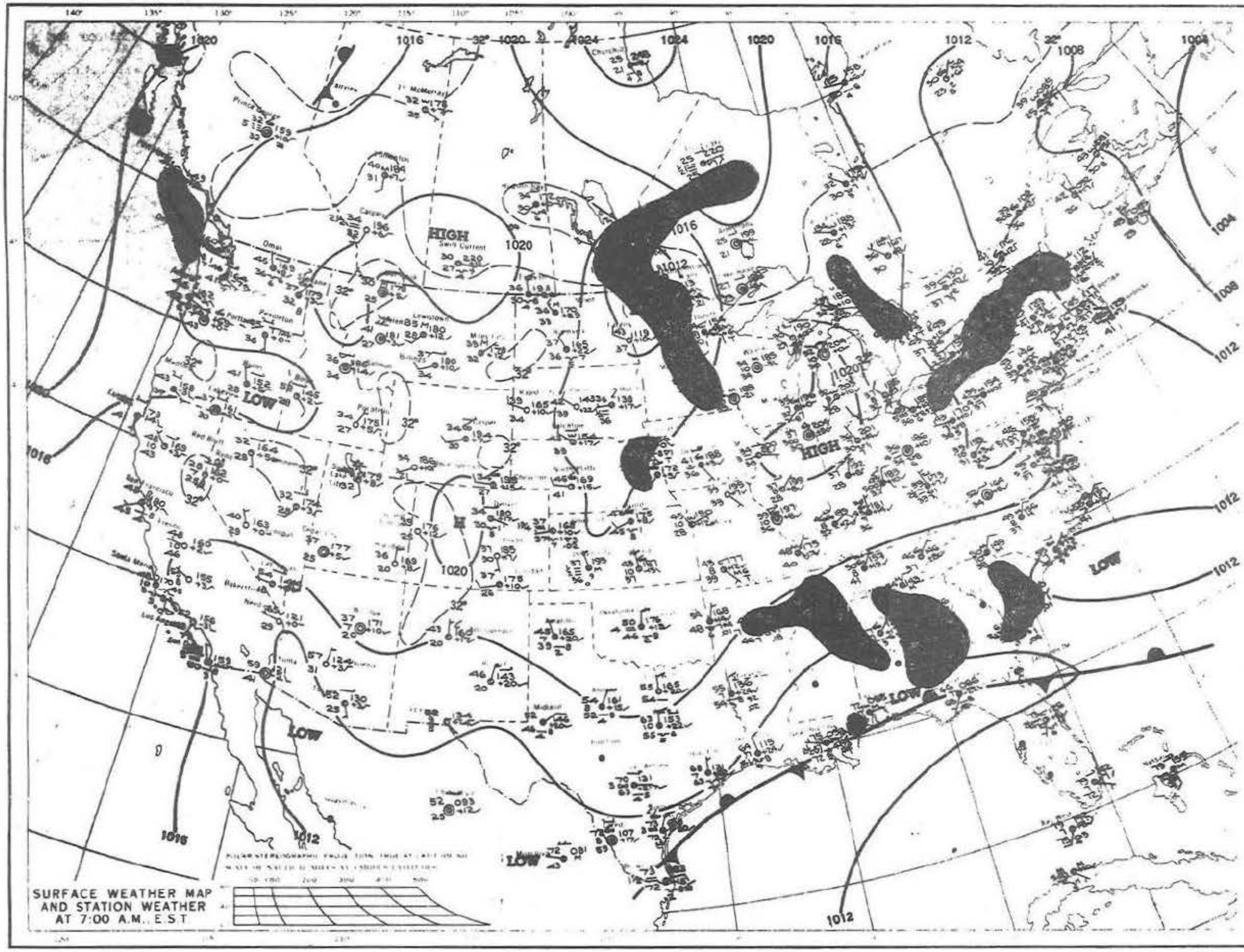
C. Meteorology During Air Tracer Test

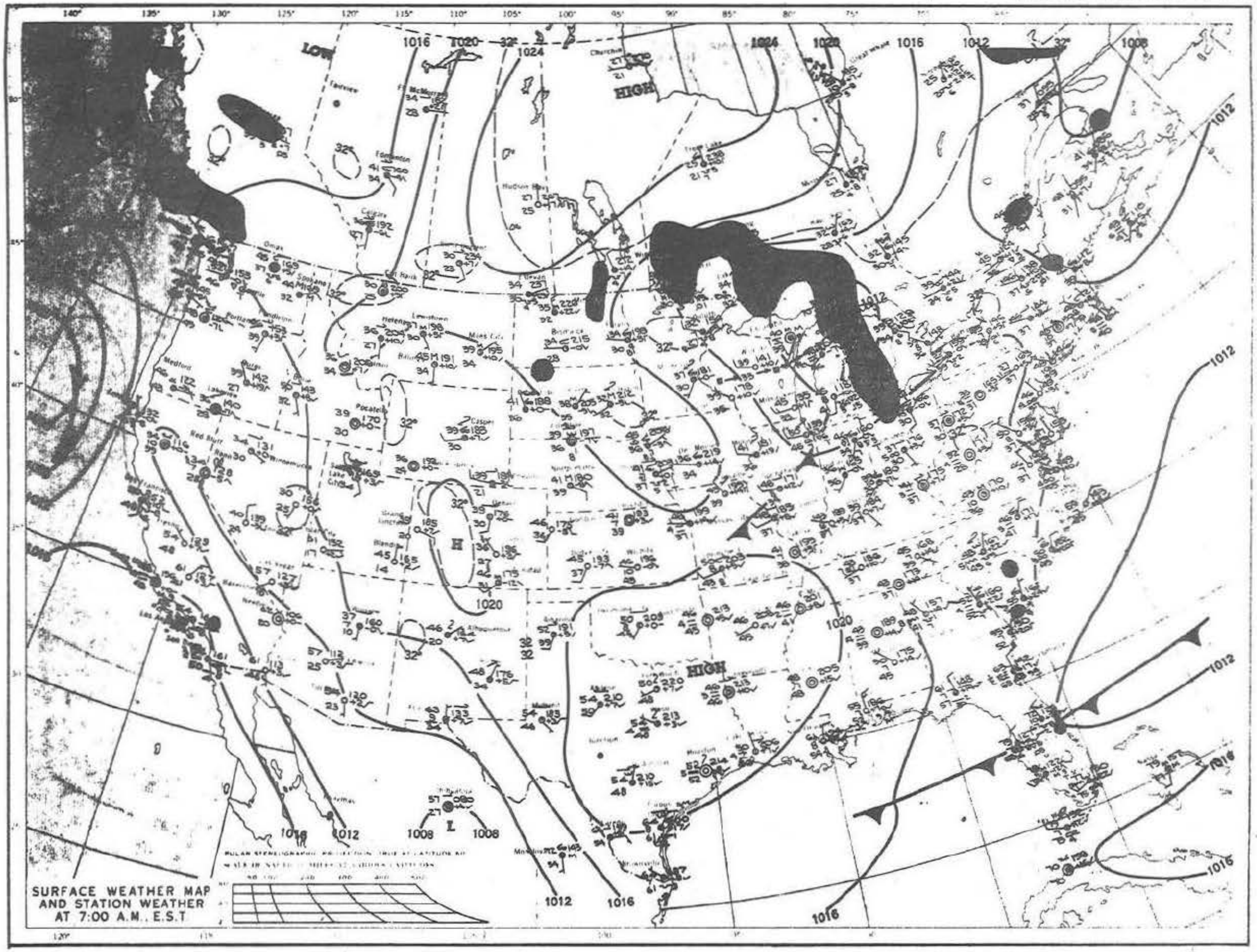
At 0500 PDT on Thursday morning, 29 April 1971 the Pacific high pressure area extended over the west coast region giving a northwesterly gradient flow in the Santa Barbara coastal region as shown in Fig. C-6. Surface winds were very light with drainage flows down the canyons along the coast and offshore over the Santa Barbara channel. Stratus clouds were present along the coast but were scattered in the Santa Barbara area because of the offshore flow. A ridge of high pressure aloft was centered over the California coast but shifted eastward during the next 24 hour period and was centered over the California-Nevada border at 0500 PDT 30 April as shown in Fig. C-7. The clear weather in the Santa Barbara area persisted through the night of the tracer test on 29 - 30 April and throughout the following day.

The period just following the transition from sea breeze to land breeze was selected for the tracer test because it was believed that this period would be most likely to produce measurable effluent concentrations along the coast and in the cities of Goleta and Santa Barbara. The meteorological conditions during the test were typical of the prevailing conditions in the Santa Barbara area during the spring season.


SURFACE WEATHER MAP
AND STATION WEATHER
AT 7:00 A.M., E.S.T.
HIGH
LOW
1008
1012
1016
1020
1004
1000
996

FRIDAY, APRIL 30, 1971




SURFACE WEATHER MAP
AND STATION WEATHER
AT 7:00 A.M., E.S.T.
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APPENDIX D

TEST CHRONOLOGY AND SAMPLER RECORDS

A. Multiple Source Test, FE 164

All aerosol generators and sampling equipment were moved to Santa Barbara on Tuesday, 27 April 1971. On Wednesday the aerosol generator sites were located and the sampling stations located and marked except for a few stations along the coast which were located on Thursday, 29 April. Rotorod samplers for the platforms, Hilda, Hazel and Hope were taken out by boat from the Standard Oil dock at Carpenteria starting at 1300 Thursday and the samplers were all running by 1406 PDT. The yellow FP aerosol generator was installed on the ridge east of Corral Canyon and the green FP aerosol generator was installed at the north boundary of the site in the canyon. The red FP aerosol generator and three Rotorod samplers were taken by Rotor Aids helicopter to Holly, WODECO IV, and Bluewater II. Starting at about 1400 the Rotorod samplers were installed on platform Holly and Bluewater II and the aerosol generator (AG) was installed on the hatch at the stern of WODECO IV. A Rotorod sampler was placed at the bow of the ship. The samplers were turned on at 1900 at the same time as all three aerosol generators were started.

Samplers within the Corral Canyon property and the Canada del Capitan property were turned on starting at 1315 and all samplers were running by 1837. The drum pulsed sampler at Station 46 was started at 1812 and set to take 2 minute samples at each drum index position.

Samplers along the coast were placed starting at 1210 and all samplers were running by 1910.

Samplers in Goleta and Santa Barbara were started beginning at 1815 and all were operating by 1917. The DPS at Cliff Street Fire Station was started at 1900 with a sampling interval of 5 minutes and the DPS at Rotor Aid was started at 1917 also with a sampling interval of 5 minutes.

All three aerosol generators were started at 1900, 29 April 1971 and the FP were dispersed at a uniform rate for approximately one hour.

Samplers within and around the Corral Canyon were turned off and samplers collected starting at 2107 and completed by 2146 with the exception of Station 1 through 5 and Station 12 which were picked up on Friday morning, 30 April.

Samplers in the adjacent canyon and Canada del Capitan were picked up Friday morning starting at 0830 and completed by 0900 PDT. Samplers along the coast and in Goleta and Santa Barbara were picked up starting at 0715 and completed by 0947.

Samplers on Platform Hilda, Hazel and Hope were turned off starting at 0822 PDT and completed by 0931. Samplers on Platform Holly and on WODECO IV were turned off at 0600. An additional sample was taken on WODECO IV from 0617 to 1020 PDT, 30 April. No sample was taken on Bluewater II between 0000 and 0600 PDT, 30 April but a sample was taken from 0617 to 1020 PDT.

B. Sampler Records

The location and type or types of samplers used at each sampling station are listed in Table D-1. The collector number and date and time (DTG) for starting and stopping the samplers is also indicated. The first two digits are the date and the last four are the time expressed on a scale of 24 hours. All DTG's are expressed in Pacific Daylight Time (PDT). The sequentially operated drum pulsed samplers (DPS) are rotated in 3 degree steps at preset intervals of time. The index number at start and stop for each drum are listed. The DPS time intervals for FE 164 were 2 minutes at Station 34 and 5 minutes at Stations 34 and 36.

Table D-1

SAMPLER RECORDS FOR FE 164

29 - 30 April 1971

Station	Type	Location	CR or Drum	Start Index	Start DTG	Stop Index	Stop DTG
1	RR	Canada del Corral - North Boundary West of Creek	0659		291325		300915
2	RR	Met Station	4800		291315		300920
3	RR	North boundary east slope	0660		291330		300925
4	RR	North boundary east slope	0661		291340		300932
5	RR	North boundary east slope	0662		291350		300938
6	RR	East ridge near water tank	1289		291837		292107
7	RR	East slope	3462		291835		292110
8	RR	East slope	3463		291830		292115
9	RR	East slope	3464		291825		292117
10	RR	East slope	3465		291820		292121
11	RR	Bottom of Canyon	3466		291815		292127
12	RR	West slope	5735		291405		300957
13	RR	West boundary near houses	0651		291615		292137
14	RR	East side of citrius orchard	0658		291610		292139
15	RR	Southeast boundary	0664		291510		292144
16	RR	Southeast boundary	0663		291506		292146
17	RR	Coast East of Capitan	1291		291715		300911
18	RR	Beach below site	1292		291726		300918
19	RR	Coast west of Capitan	2836		291740		300928

Table D-1 (continued)

				Start		Stop	
Station	Type	Location	CR or Drum	Index	DTG	Index	DTG
20	RR	Refugio State Park	3145		291747		300935
21	RR	Canada del Capitan near water tank	5729		291430		300842
22	RR	Canada del Capitan	5738		291435		300840
23	RR	Ridge west of Canada del Capitan	5740		291445		300900
24	RR	Canada del Capitan	5737		291455		300830
25	RR	Canada del Capitan (near Highway 101)	1288		291635		300854
26	RR	El Capitan Beach State Park	1290		291700		300847
27	RR	Canyon East of Site near highway	2681		291805		300856
28	RR	Canyon East of Site north of 27	3318		291817		300901
29	RR	Signal Property 1.5 mi East of Dos Palos Canyon	3283		291910		300947
30, 31, 33 Not used							
33	RR	Goleta Beach	3160		291610		300823
34	DPS	Rotor Aids	143	0	291917	68	300103
			137	68	300103	22	300715
	RR	Rotor Aids	B0525		291917		292210
			B0999		292210		300715
35	RR	Fairview Ave.	B0526		291815		300052
			B1001		300053		300740
36	DPS	1802 Cliff Fire Station	M204	0	291900	60	300015
			154	60	300015	22	300715
	RR	1802 Cliff Fire Station	0527		291900		300715
37	RR	Modoc Fire Stn.	B0529		291900		300830
38	RR	Stanwood Fire Stn.	B0528		291900		300033
			B1000		300033		300800

Table D-1 (continued)

Station	Type	Location	CR or Drum	Start Index	Start DTG	Stop Index	Stop DTG
39	RR	Getty, Gaviota	B0530		291250		300930
40	RR	Hilda	B1736		291354		300931
41	RR	Hazel	B1737		291406		300917
42	RR	Hope	B1735		291329		300822
43	RR	Holly	A5645		291900		292400
	RR	Holly	A5649		300001		300600
44	RR	Bluewater II	2675		291859		292400
	RR	Bluewater II	2901		300617		301020
45	RR	WODECO IV	B1656		291850		292355
			B1655		292356		300606
			B1651		300900		301230
46	DPS	Canada del Corral	203	0	291812	99	292132
	RR		0656		291812		292130

APPENDIX E
FP DOSAGES AND DOSAGE PATTERNS

The yellow, green and red FP dosages for the multiple source air tracer test, FE 164 were computed from the FP samples by dividing the total number of particles of each color in the sample by the sampler flow rate in liters per minute. The resulting dosages are given in Tables E-1 and E-2. The yellow FP source was located on the ridge east of Corral Canyon, the green FP source was located in Corral Canyon at the north boundary of the site and the red FP source was located offshore on the drilling ship WODECO IV approximately 6 miles southwest of Corral Canyon.

Dosage isopleths in particle liters per minute were drawn at levels differing by a factor of 10 as shown in Figs. E-1 through E-5. Fig. E-1 shows the dosage pattern from the yellow FP source in the Corral Canyon and surrounding areas and Fig. E-2 shows the extension of this pattern offshore and along the coast including Gaviota, Santa Barbara and Carpenteria. The major portion of the FP plume moved southwesterly down the ridge and offshore out the mouth of the Canyon. An eddy circulation producing an easterly wind along the shoreline carried a portion of the FP cloud westward to Gaviota and a portion was carried by westerly winds offshore toward the platforms Holly, Hilda, Hazel, Hope and Heidi as shown in Fig. E-2.

The green FP dosages were higher as expected than the yellow within Corral Canyon and on the beach below as shown in Fig. E-3. The dosage patterns were very similar, however, over the channel and along the coast as shown in Figs. E-2 and E-4 demonstrating that the two FP plumes became well mixed by the eddy circulation offshore.

The red FP source on the WODECO IV was emitted directly into the westerly winds offshore and the plume traveled eastward parallel to the coast as shown in Fig. E-5 with only a small portion caught in the eddy circulation giving traces at Gaviota and on Bluewater II.

TABLE E-1

FP DOSAGES FROM ROTOROD SAMPLERS, FE 164, 29 - 30 APRIL 1971
AT SANTA BARBARA, CALIFORNIA

Station	Collector	FP Dosage (part-min/liter) Yellow	Green	Red
1	0659	12.2	121	1.0
2	4800	0.5	7350	0.1
3	0660	7.3	1280	0.6
4	0661	11.8	23.0	0.4
5	0662	16.2	43.6	0.5
6	1289	0.3	0.1	0.1
7	3642	0.4	0.1	0.1
8	3463	0.1	0.1	0.1
9	3464	1980	0.0	0.0
10	3465	1370	0.8	0.1
11	3466	---	Excessive	---
12	5735	91	1020	0.5
13	0651	800	8700	0.0
14	0658	258	6840	0.0
15	0664	8.1	0.4	0.1
16	0663	0.1	0.4	0.1
17	1291	24.8	43.0	1.0
18	1292	256	975	0.1
19	2836	16.7	97.0	0.4
20	3145	15.7	45.4	0.7
21	5729	6.6	14.8	0.4
22	5738	8.6	19.3	0.2
23	5740	16.6	37.2	0.5
24	5737	9.8	20.2	0.1
25	1288	9.8	16.7	0.3
26	1290	18.0	28.8	0.6
27	2681	17.1	28.5	0.4
28	3318	24.7	28.3	0.7
29	3283	3.9	7.1	2.1
30	NOT USED	----	----	---

TABLE E-1 Continued

Station	Collector	FP DOSAGE (Part-min/liter) Yellow	Green	Red
31	NOT USED	---	---	---
32	NOT USED	---	---	---
33	3160	1.7	1.2	1.1
34	0525 0999	1.4	1.0	0.7
35	0526 1001	1.5	1.3	0.4
36	0527	1.6	2.0	0.8
37	0529	0.9	1.3	1.0
38	0528 1000	3.0	4.3	1.6
39	0530	58.0	82.0	0.2
40	1736	3.5	5.9	21.4
41	1737	3.2	5.3	12.9
42	1735	2.5	2.8	8.9
43	5645 5649	1.7	2.7	26.5
44	2675 2901	1.3	1.1	0.3
45	1656 1655 1651	35.8	77.0	2.5
46	0656	528	3290	0.1

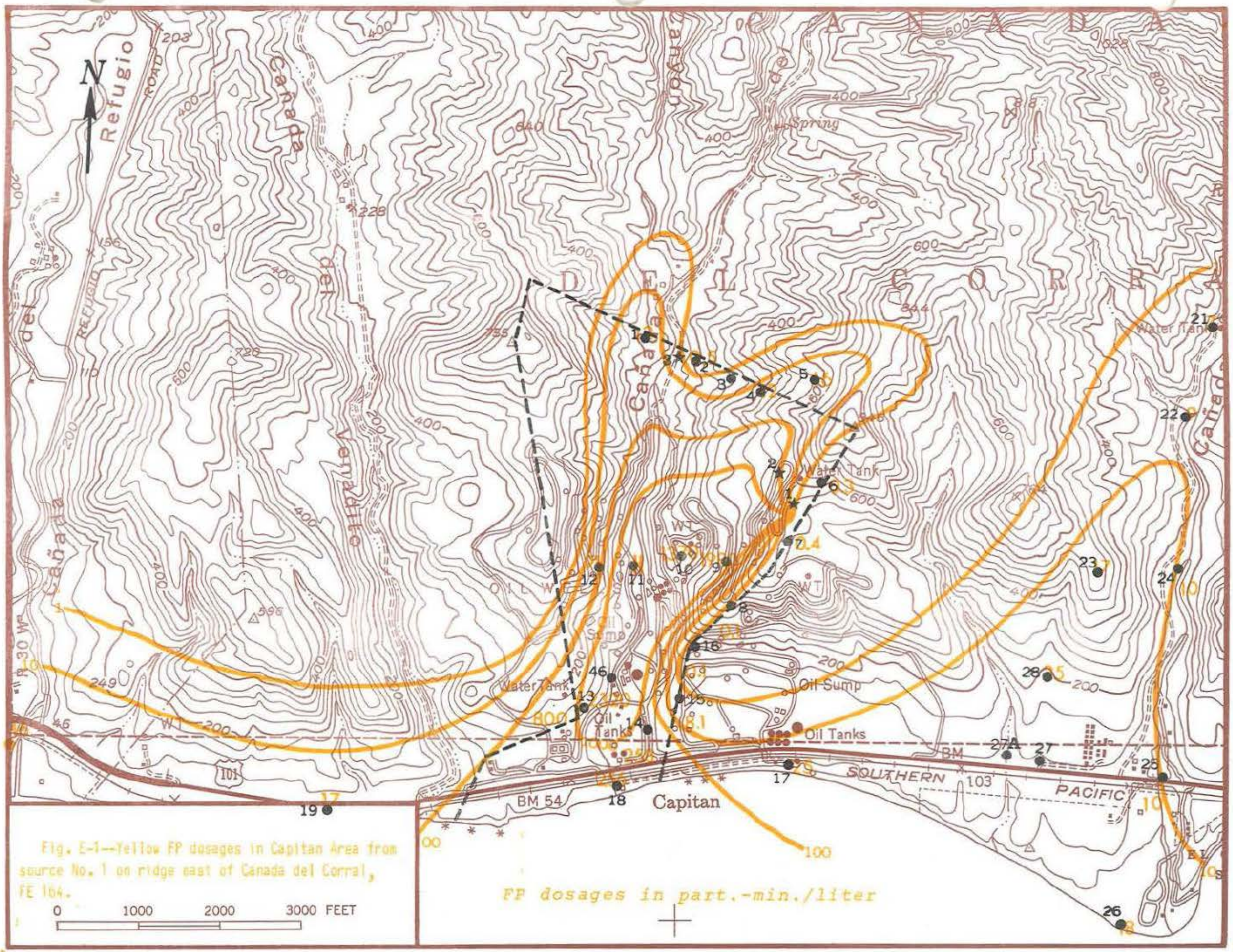

Fig. E-1--Yellow FP dosages in Capitan Area from source No. 1 on ridge east of Canada del Corral, FE 164.

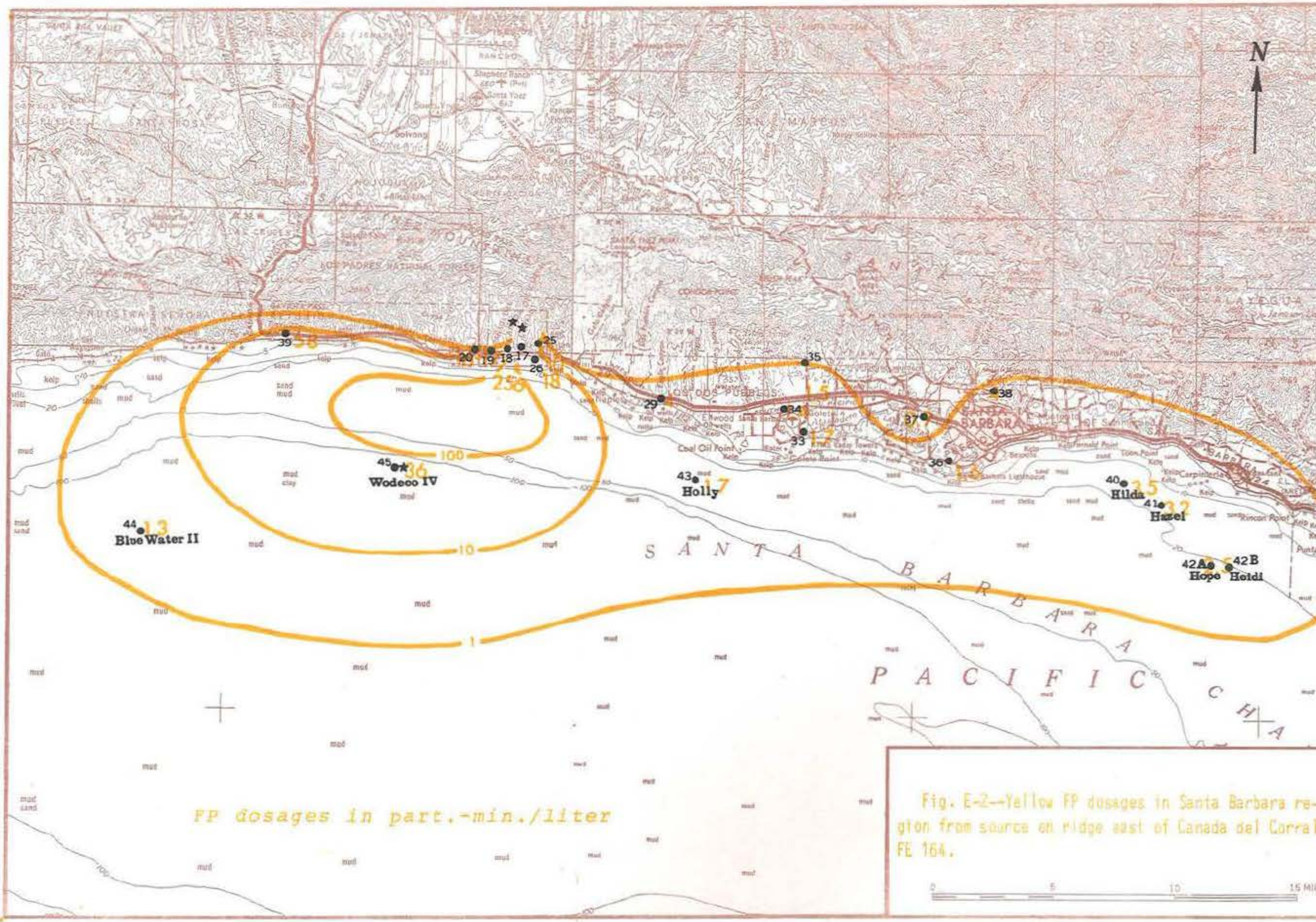

Fig. E-2--Yellow FP dosages in Santa Barbara region from source on ridge east of Canada del Corral, FE 164.

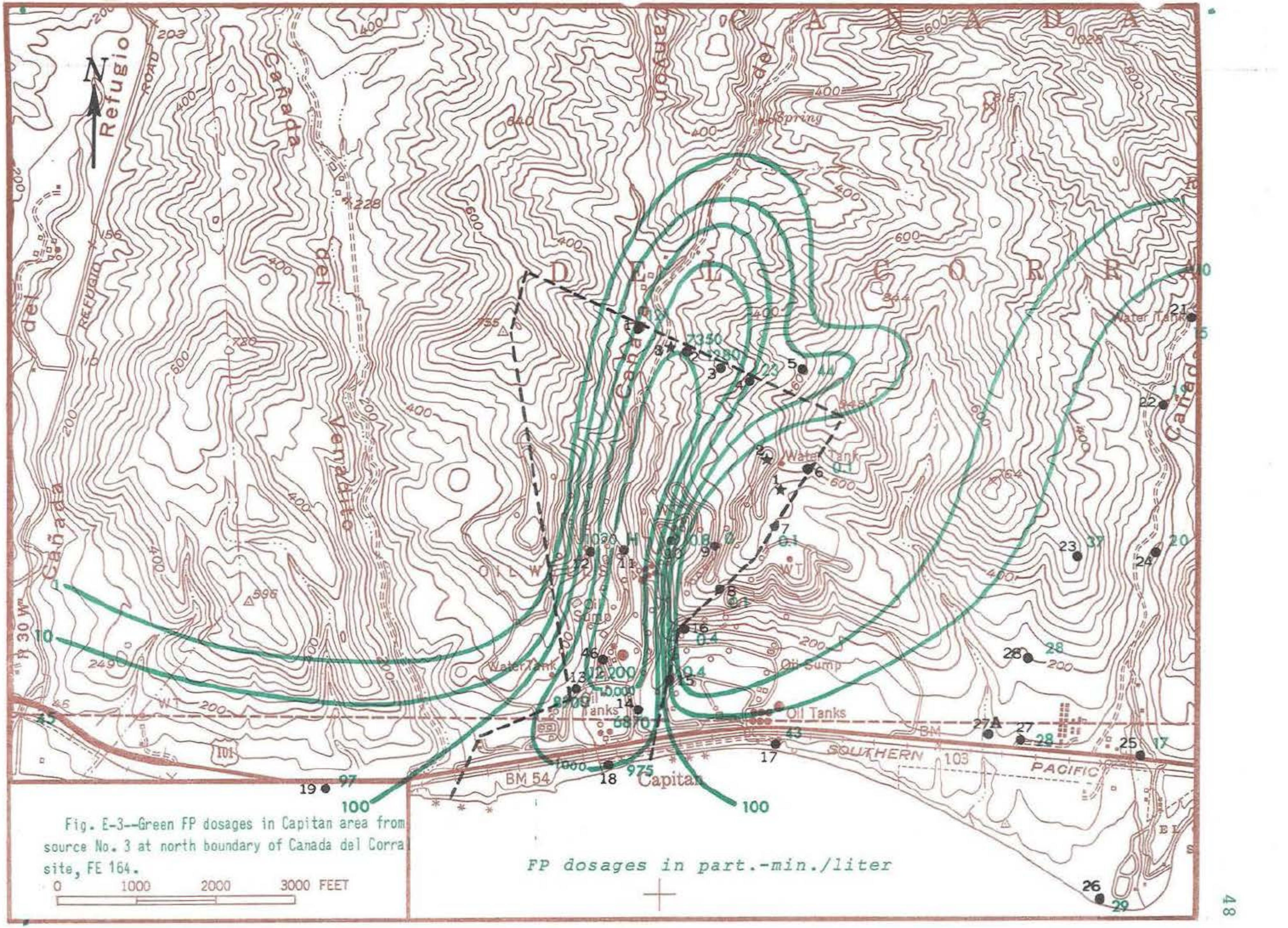

Fig. E-3--Green FP dosages in Capitan area from source No. 3 at north boundary of Canada del Corral site, FE 164.

FP dosages in part.-min./liter

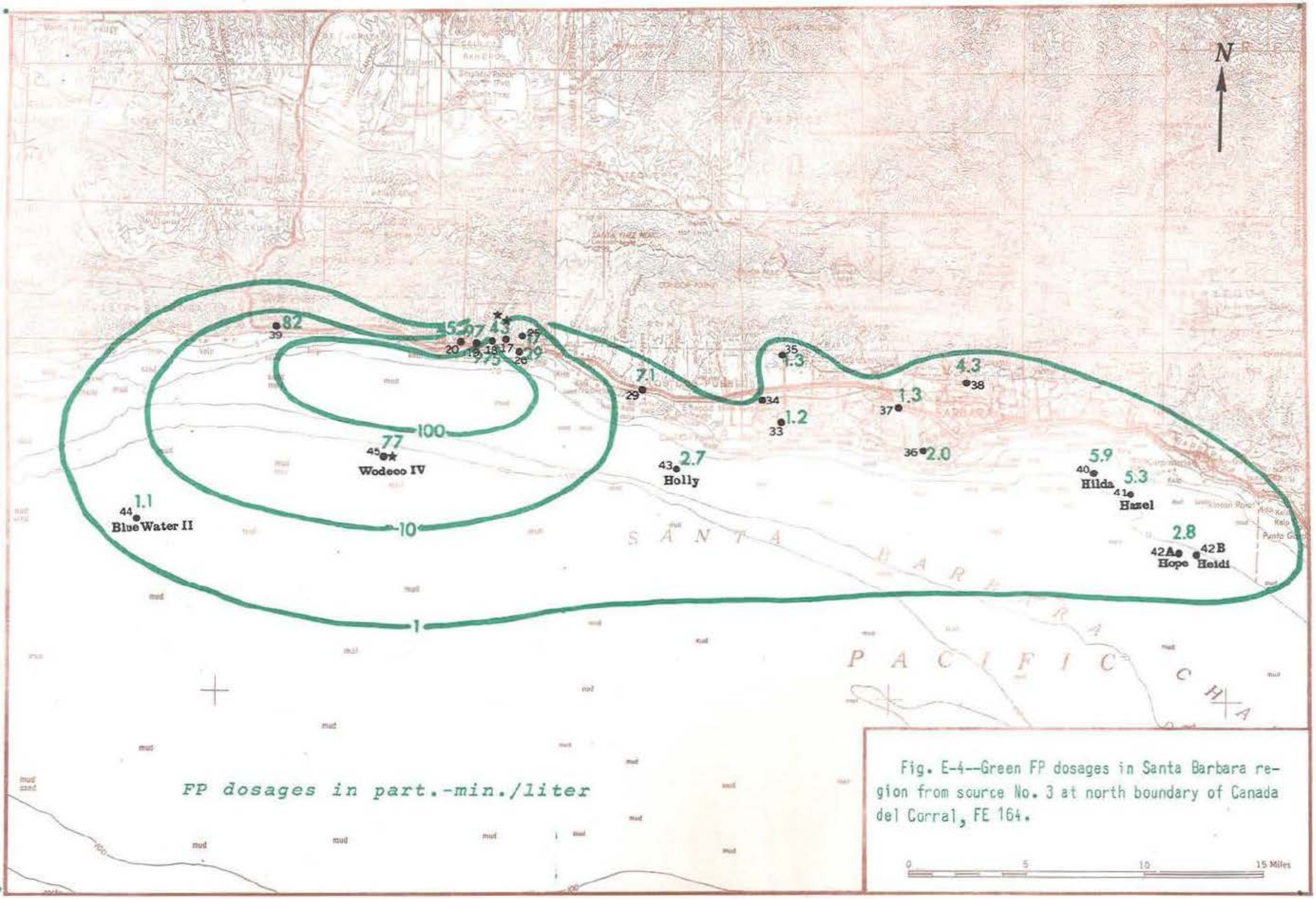

Fig. E-4--Green FP dosages in Santa Barbara region from source No. 3 at north boundary of Canada del Corral, FE 164.

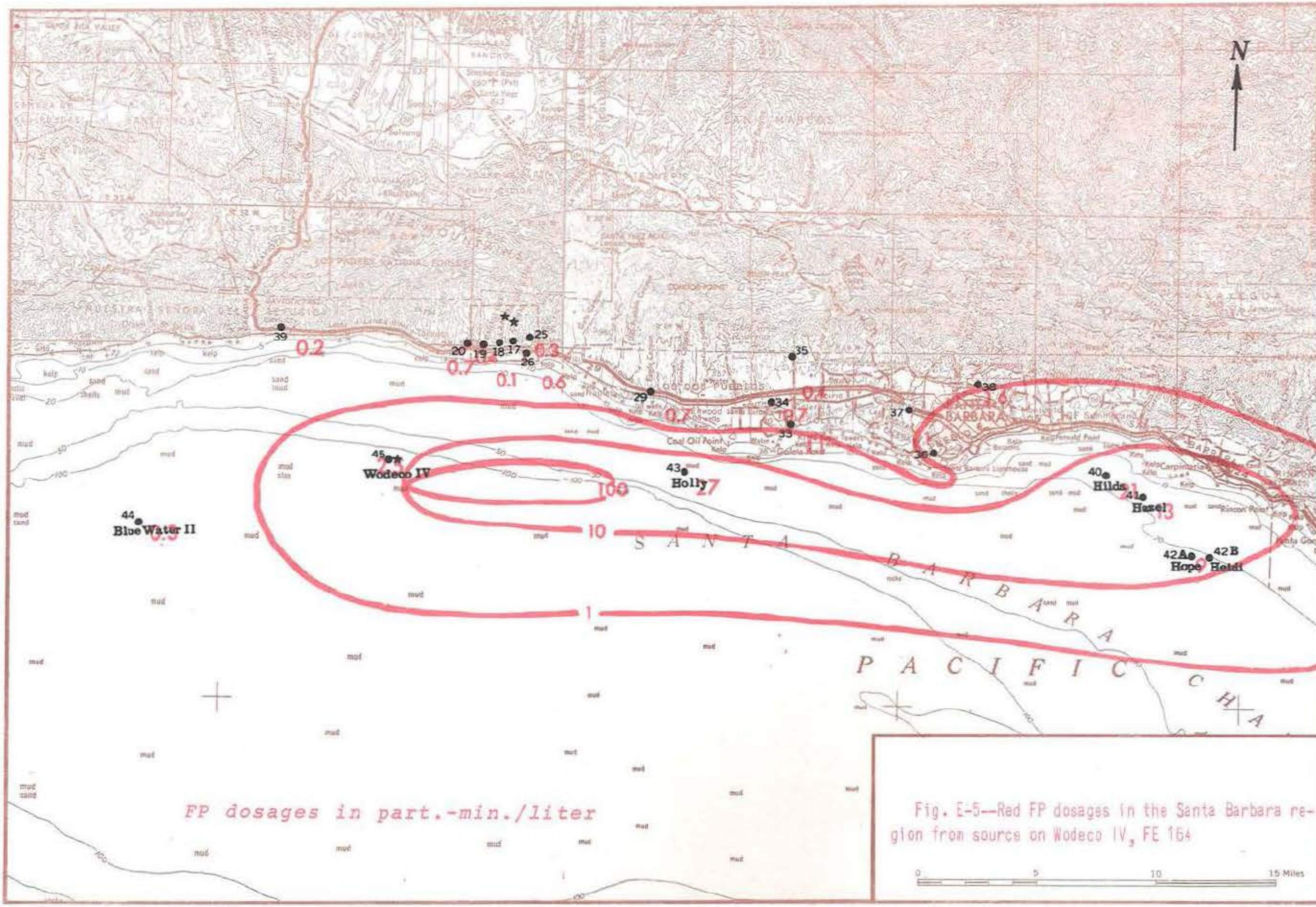

Fig. E-5--Red FP dosages in the Santa Barbara region from source on Wodeco IV, FE 164

Histograms of the FP data from the drum plused samplers are given in Figs. E-6, E-7 and E-8. Station 46 near the small house near the lower end of Corral Canyon received very heavy dosages of green FP and much smaller dosages of yellow FP as shown in Fig. E-6. The yellow FP cloud arrived approximately 25 minutes after the start of aerosol generation and continued for approximately 50 minutes. The green FP cloud arrived approximately 30 minutes after the aerosol generators were started and continued approximately 65 minutes with very small amounts arriving later up to 2 hours after the first arrival.

The histogram from the DPS at Rotor Aids, at Santa Barbara Airport, Fig. E-7, showed that FP from all three sources arrived at the same time, i.e., 2055 - 2100 PDT. The dosages were very small but the cloud persisted approximately 4 hours. It is apparent that the portion of the red FP cloud which reached this sampling station was caught in the eddy circulation which carried the green and yellow FP along the coast both east and west of Corral Canyon producing complete mixing of the three colors. The main portion of the red FP cloud undoubtedly missed this station because it was dispersed with a west wind of 17 mph which would have brought it to this station nearly an hour earlier.

The DPS at Station 36 at the Cliff Drive Fire Station in Santa Barbara also showed very low dosages with the red FP first arriving between 1925 and 1930 with yellow and green arriving between 1955 and 2005 PDT. Small numbers of particles continued to arrive periodically until the DPS samplers were turned off at 0715, 30 April. This indicated that the FP remained in the area for a considerable period of time.

A comparison of total dosages from Rotorod and DPS samplers is given in Table E-2. Both types were operated simultaneously over the same sampling period. At Stations 34 and 36 the dosages were of comparable magnitude considering the very low dosage

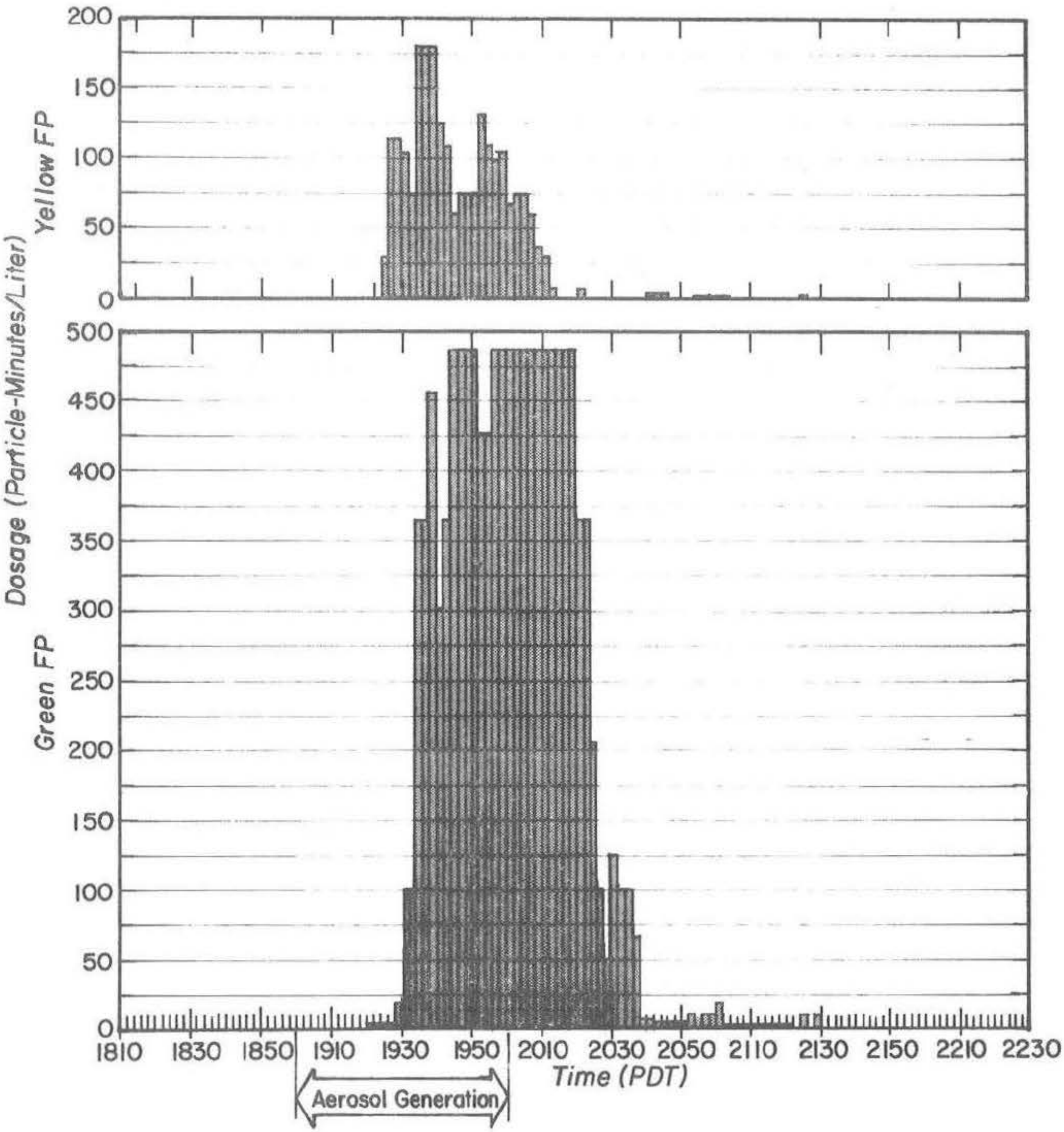

Fig. E-6--Histograms of FP dosages at Station 46 near small house in lower end of Canada del Corral, FE 164.

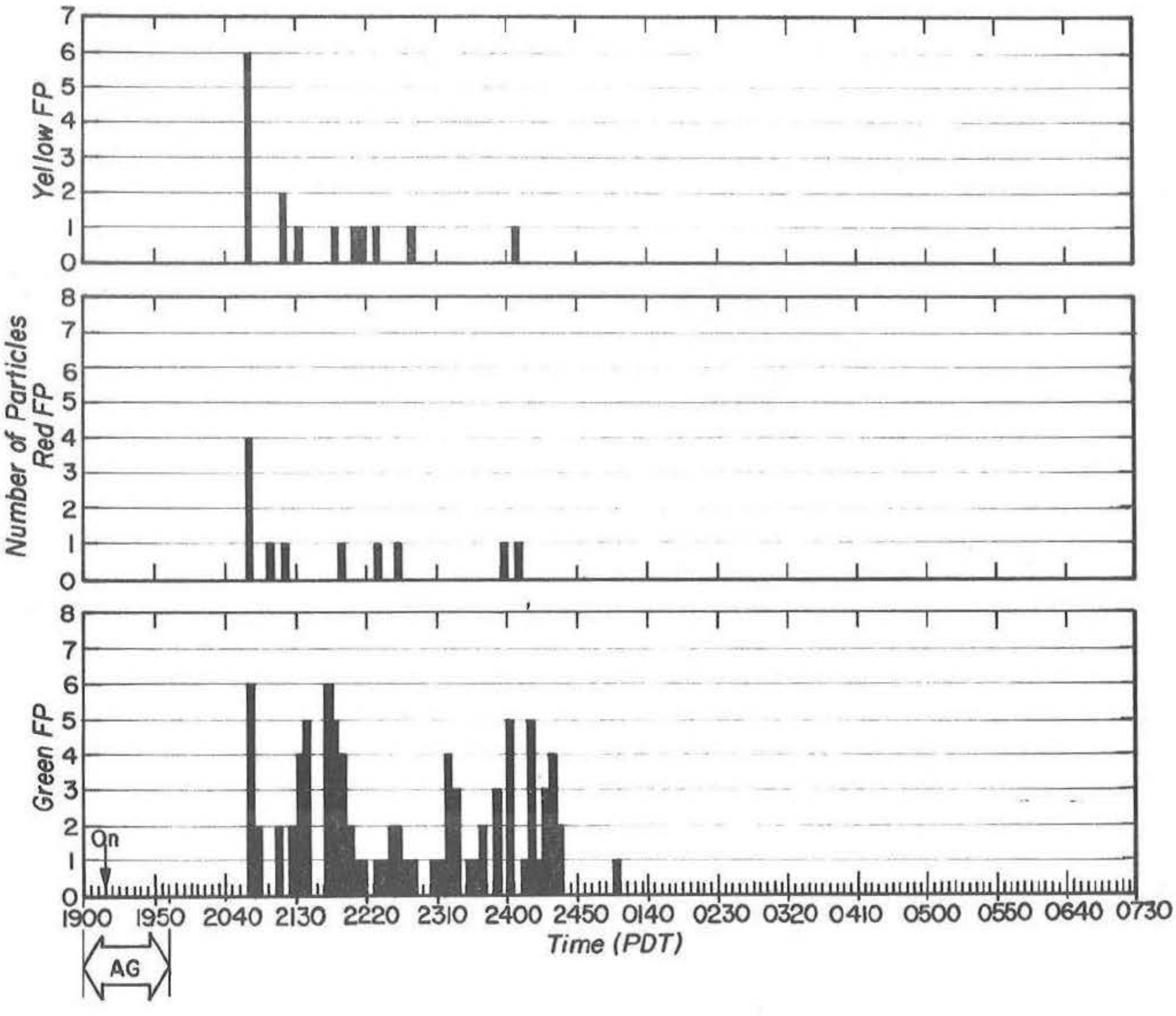

Fig. E-7--Histograms of FP Dosages at Station 34, Rotoraids, Santa Barbara Airport, FE 164.

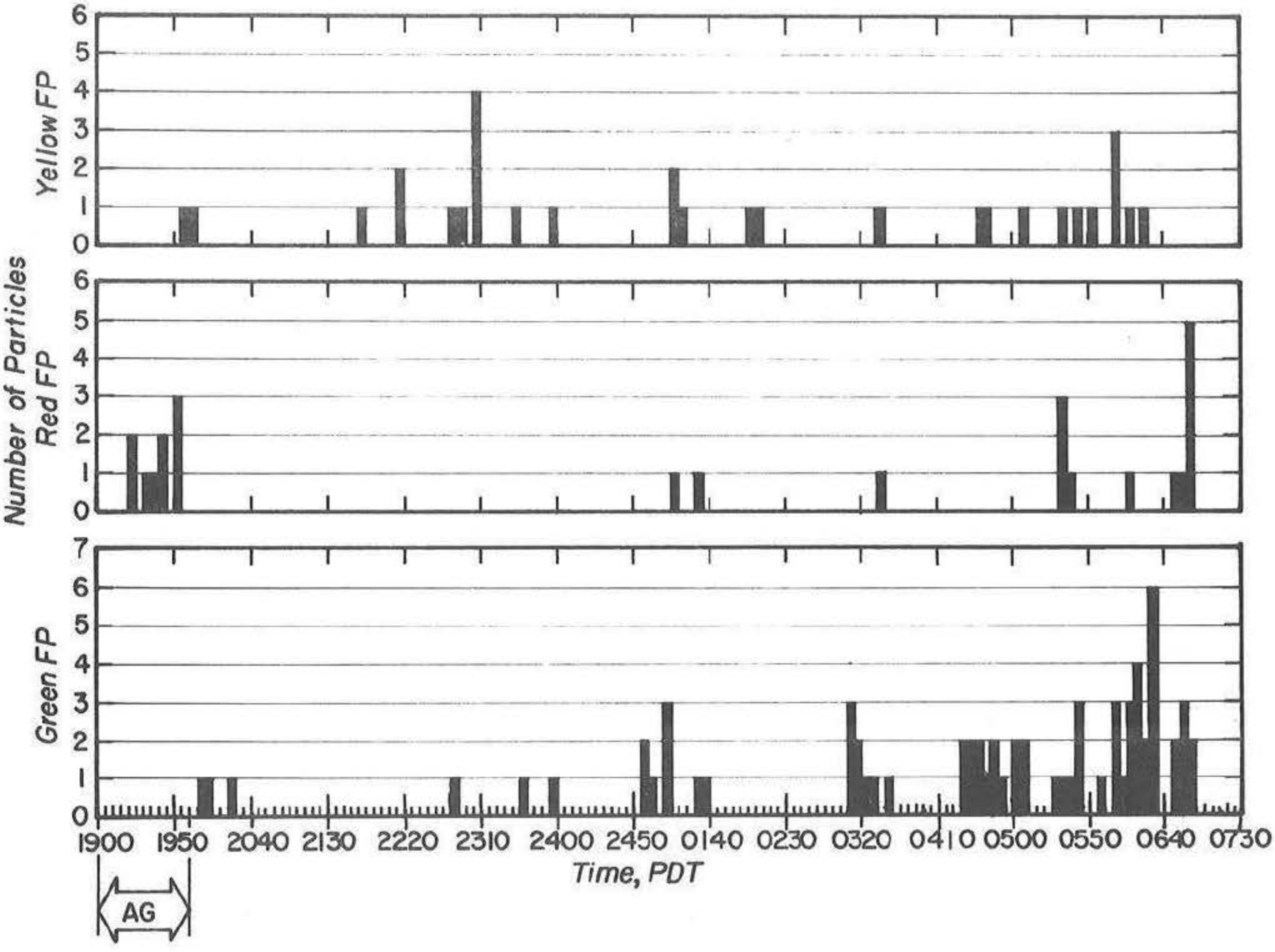

Fig. E-8--Histograms of FP dosages at Station 36, Fire Station, 1802 Cliff Drive, Santa Barbara, FE 164.

values. At Station 46 the DPS dosages were much higher than the Rotorod dosages. The DPS values were considered to be more accurate because the sample was spread out over a much larger collection area, while the Rotorod was so completely covered with FP that counting was very difficult. The DPS dosages at Station 46 were plotted in Figs. E-1 and E-3 instead of Rotorod dosages.

TABLE E-2

COMPARISON OF TOTAL DOSAGES FROM ROTOROD AND DRUM PULSED SAMPLERS (DPS), FE 164, 29 - 30 APRIL 1971 AT SANTA BARBARA, CALIFORNIA

Station	FP Dosage (part-min/liter) Yellow		Green		Red	
	RR	DPS	RR	DPS	RR	DPS
34	1.4	0.3	1.0	3.5	0.7	0.2
36	1.6	0.7	2.0	1.5	0.8	0.5
46	528	2320	3290	12200	0.1	0.0

APPENDIX F

POTENTIAL AIR POLLUTION SOURCES AND POLLUTANT CONCENTRATIONS

Although normal plant operations are not likely to produce detectable odors or pollutant concentrations in excess of the air quality standards set by the State of California, situations may occur which would release far more than normal amounts of pollutants into the atmosphere. The pollutant concentration in the vicinity of the plant and in the neighboring populated areas of Goleta and Santa Barbara are of primary concern under these conditions. Since the crude which will be processed contains appreciable amounts of sulfur, the possible concentrations of sulfur dioxide and hydrogen sulfide have been estimated from the potential source emissions and from the fluorescent particle (FP) dosages obtained during the air tracer tests during the night of 29 - 30 April 1971.

A. Potential Sources of Pollution

Some potential sources of pollutants are listed below:

1. Gas Plant Emissions

a. Normal operating conditions.

Under normal conditions only 1% of the sulfur would be emitted as SO_2 from the stack. This would amount to 192 lb per day giving an SO_2 concentration of 342 ppm in the stack. The stack exit temperature would be approximately 1000°F.

b. Tail Gas Clean-up Plant Shut Down

Under these conditions about 4% of the sulfur would be emitted from the stack or 1536 lb of SO_2 per day giving an SO_2 concentration of 2736 ppm in the stack.

c. Sulfur Plant Down.

In this case all the sulfur would go through the stack or 43,600 lb/day giving a concentration of 77,000 ppm in the stack.

d. Low-level Crude Spill from Rupture of a 110,000 bbl tank.

It was estimated that about 2000 lb of H_2S would be released during the first hour and another 2000 lb over a 24 hour period following the spill. The temperature of the crude would be about 95°F initially.

2. Offshore Sources

a. Gas from Offshore Wells

Gas containing H_2S is sometimes released during drilling operations. The largest gas flow reported in a memorandum from D. M. Griffiths was 3120 MCF per day of which 0.1% was H_2S. This gas was flared to convert H_2S to SO_2.

b. Crude Spill from Offshore Operations

This would result in considerable H_2S emissions. As an order of magnitude estimate it will be assumed that the H_2S emission will be equal to that from the 110,000 bbl tank rupture above.

B. Pollutant Concentrations Calculated from Air Tracer Test Under "Worst" Conditions

The worst condition for atmospheric dispersion of the emissions and for transporting the pollutants along the coast toward Santa Barbara occur during the early stages of the transition from sea breeze to land breeze during the evening hours from approximately 1800 to 2400 PST during the month of April. The three FP aerosol generators were operated from

1900 to 2000 PDT 29 April 1971. The FP dosages are given in Appendix E and the methods of converting FP dosages to equivalent pollutant concentrations for various source types are described in Appendix G.

1. Gas Plant Emissions

The calculated SO_2 concentrations from a simulated stack emission were based on the yellow FP source on the ridge east of Corral Canyon. The highest measured FP dosage occurred at Station 46 in the lower end of Corral Canyon The calculated SO_2 concentrations at this location for normal operating conditions were 0.00079 ppm, for the tail gas clean-up plant down it was 0.0063 ppm and for the sulfur plant down it was 0.179 ppm. Since only the last case with the sulfur plant down showed significant SO_2 concentrations the complete concentration patterns were determined only for this case and are shown in Figs. F-1 and F-2. No concentrations above the State 24-hour standard of 0.04 ppm (40 ppb) were indicated outside of the Canada del Corral property.

2. Low-level Crude Spill

Concentrations of H_2S from a low-level crude spill were based on green FP dosages from the aerosol generator located at the north boundary of the site in the Canada del Corral.

The concentrations resulting from a release of 2000 lbs of H_2S during the first hour are shown in Figs. F-3 and F-4. It is apparent that the State standard of 0.03 ppm (30 ppb) will be exceeded in the Corral Canyon and on the beach immediately below the canyon but Refugio and El Capitan beaches will have concentrations well below 30 ppb and concentrations in Goleta and Santa Barbara will be undetectable.

3. Offshore Emissions

Calculated concentrations for offshore emissions are based on the red FP dosages from the aerosol generator on WODECO IV.

a. Calculated H_2S or equivalent SO_2 emissions from flaring of gas during drilling operations offshore indicate that concentrations would be negligible from these sources.

b. Crude Spill Offshore

Concentrations from an offshore crude spill releasing H_2S at the rate of 2000 lb per hour are shown in Fig. F-5. The State standard of 0.03 ppm (30 ppb) would be exceeded only within the first 4 or 5 miles from the source.

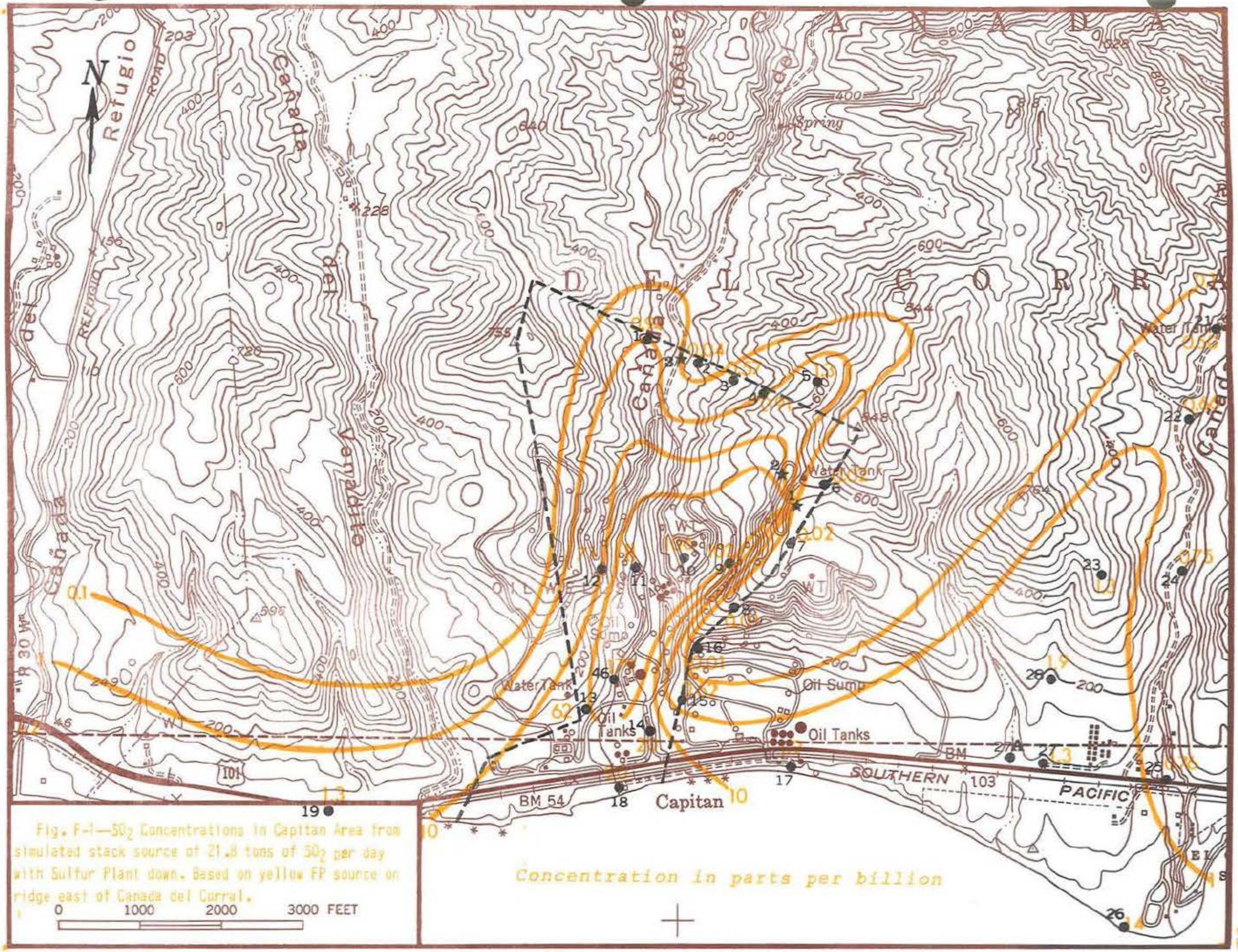

Fig. F-1—SO_2 Concentrations in Capitan Area from simulated stack source of 21.8 tons of SO_2 per day with Sulfur Plant down. Based on yellow FP source on ridge east of Canada del Corral.

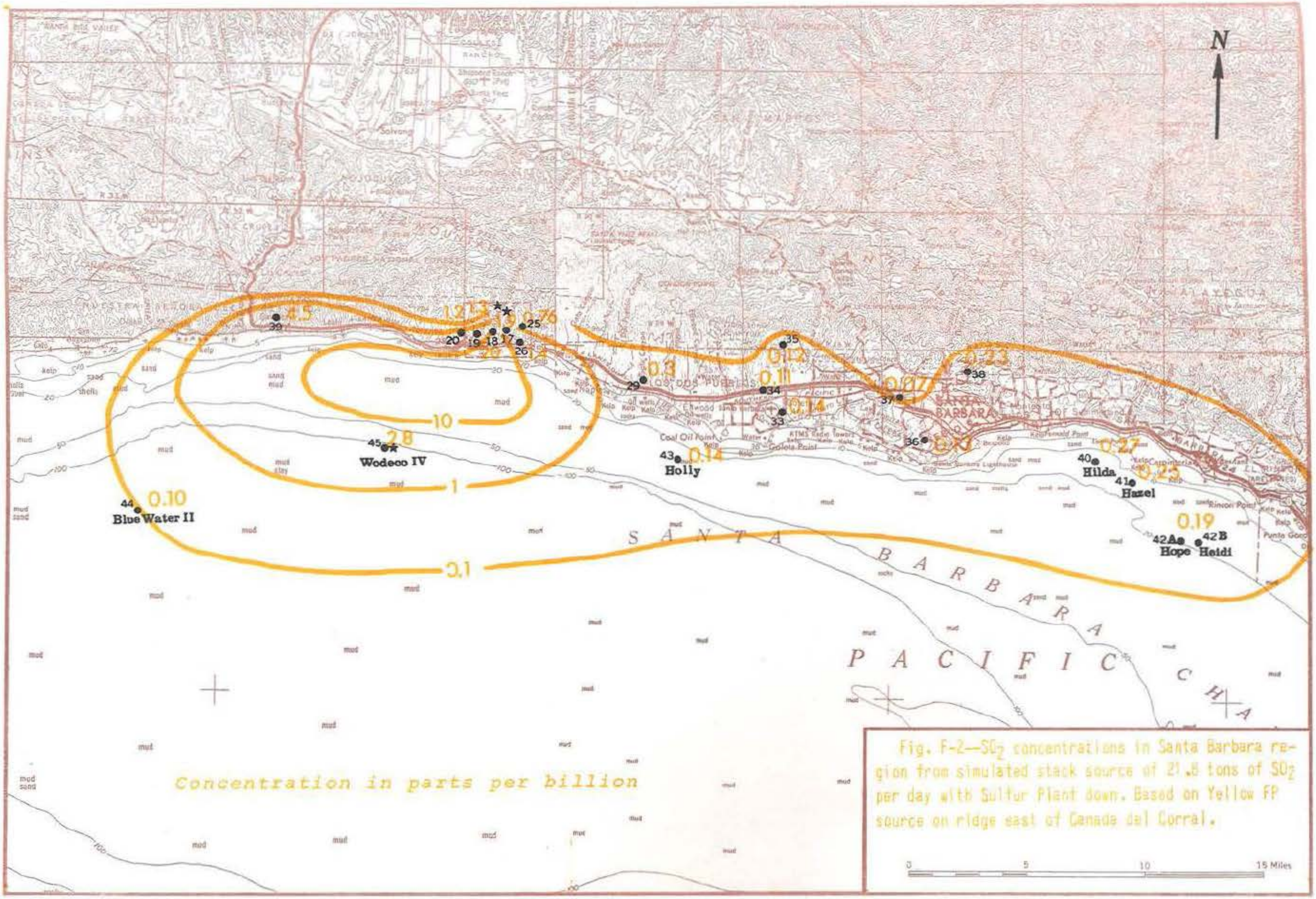

Fig. F-2—SO_2 concentrations in Santa Barbara region from simulated stack source of 21.8 tons of SO_2 per day with Sulfur Plant down. Based on Yellow FP source on ridge east of Canada del Corral.

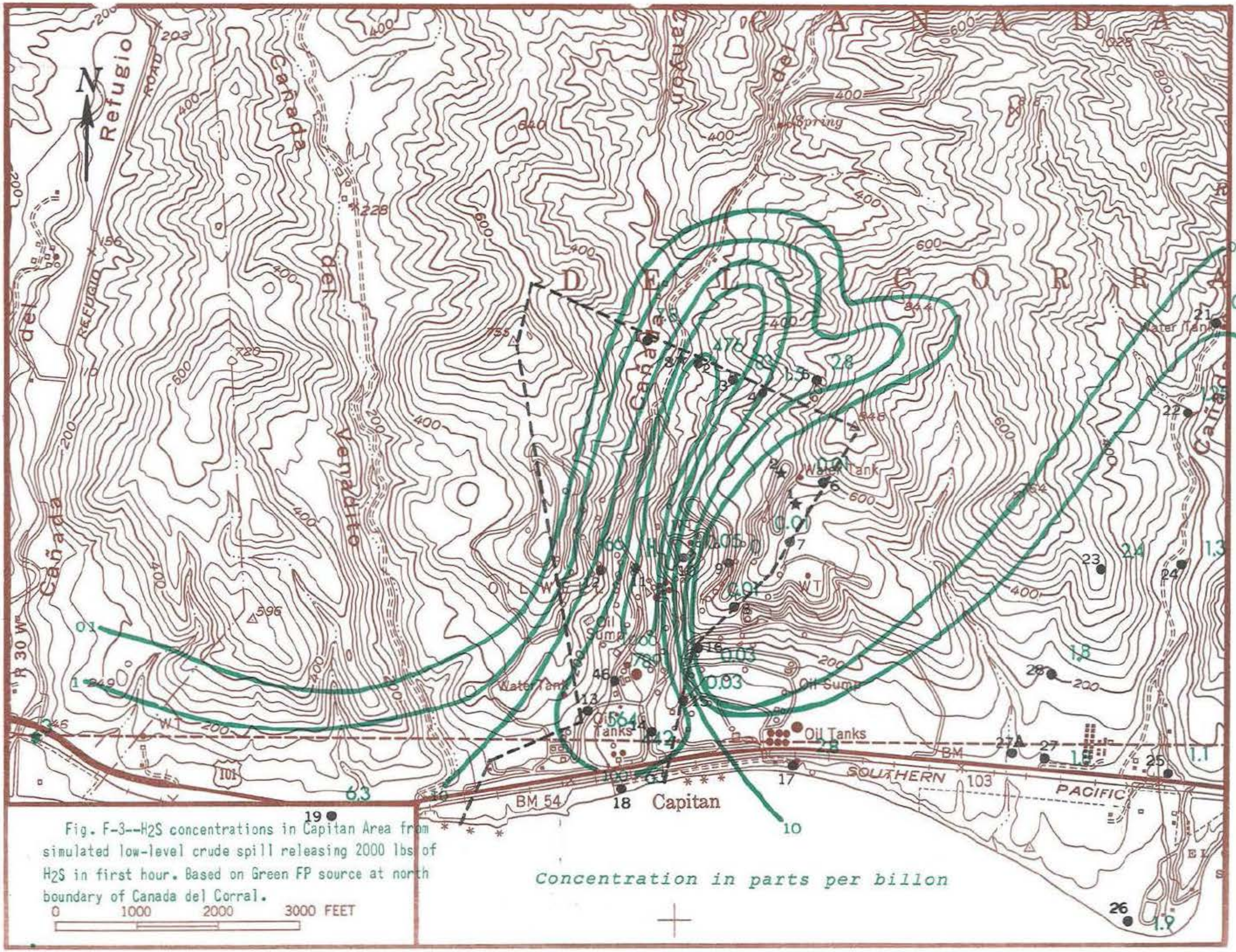

Fig. F-3--H2S concentrations in Capitan Area from simulated low-level crude spill releasing 2000 lbs of H2S in first hour. Based on Green FP source at north boundary of Canada del Corral.

0 1000 2000 3000 FEET

Concentration in parts per billon

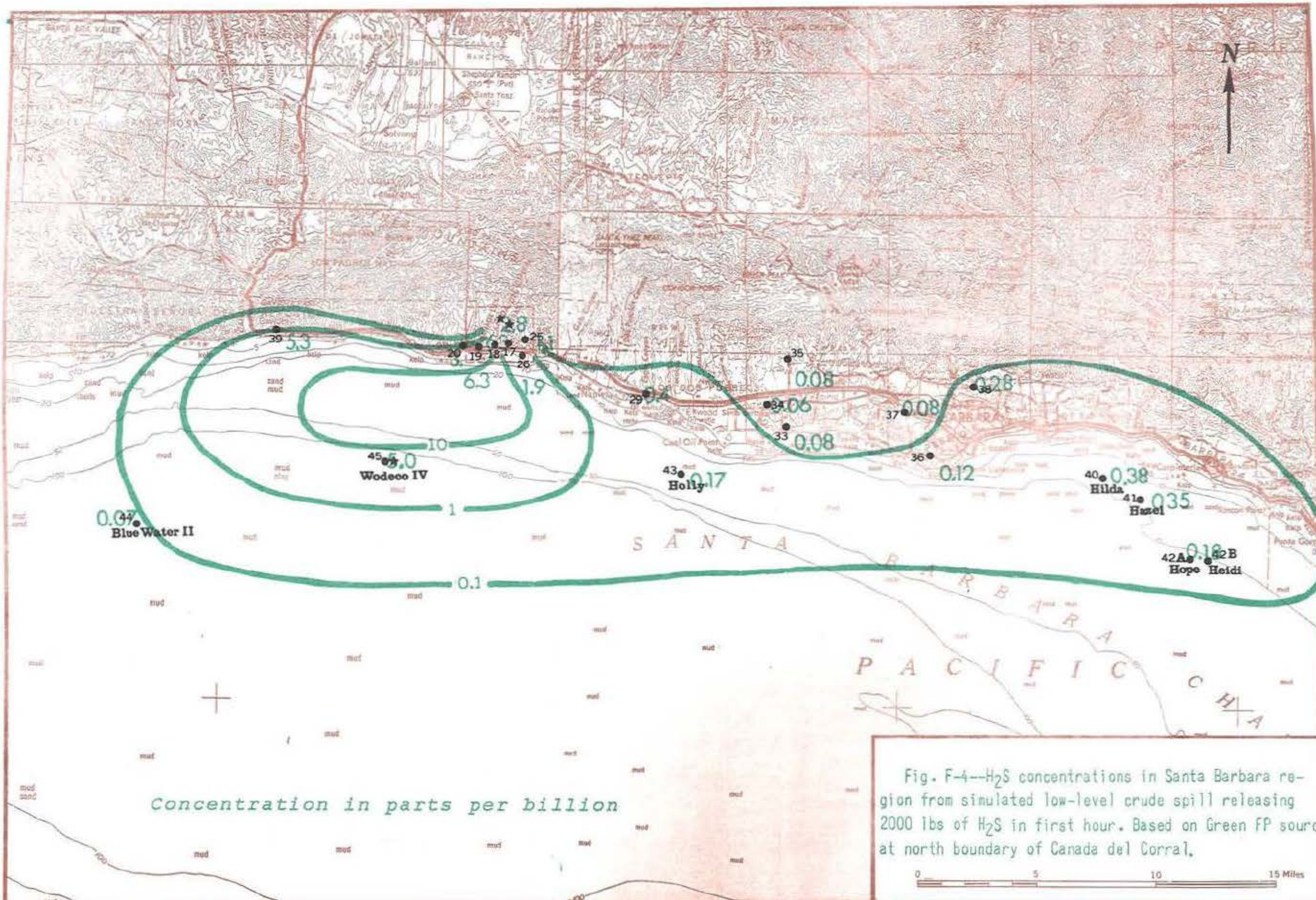

Fig. F-4--H_2S concentrations in Santa Barbara region from simulated low-level crude spill releasing 2000 lbs of H_2S in first hour. Based on Green FP source at north boundary of Canada del Corral.

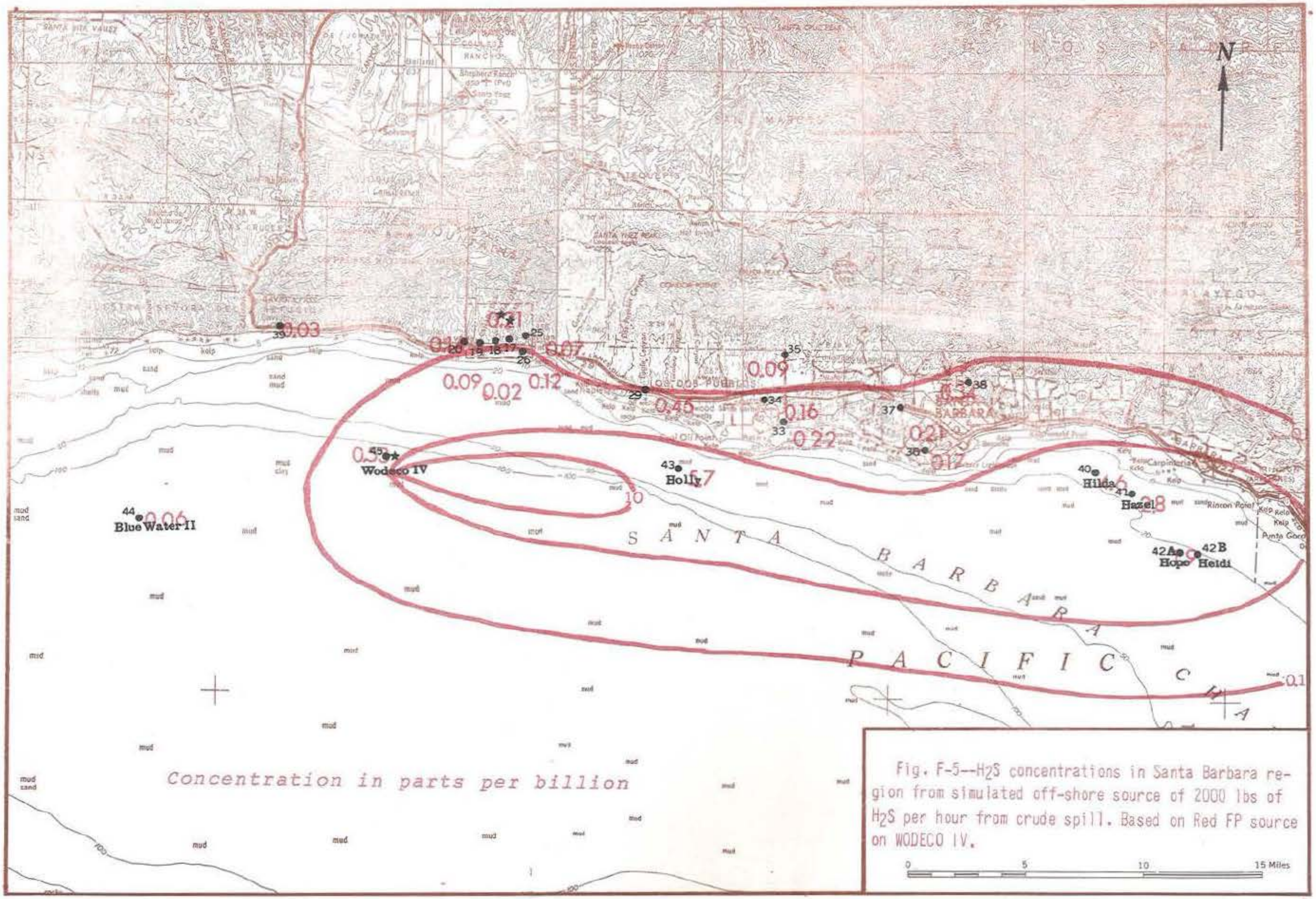

Fig. F-5--H_2S concentrations in Santa Barbara region from simulated off-shore source of 2000 lbs of H_2S per hour from crude spill. Based on Red FP source on WODECO IV.

APPENDIX G
CALCULATION OF POLLUTANT CONCENTRATIONS FROM FP TRACER MEASUREMENTS

Average concentrations of pollutants are readily calculated from the FP tracer measurements if the source emissions are known. The Rotorod Samplers are generally operated much longer than the period of FP dissemination in order to sample all FP which pass the sampling station. Since the variation of FP concentration with time is not determined by this type of measurement it is necessary to compute a maximized average concentration based on the assumption that the total number of FP collected is equal to that which would have been collected over a period equal to the period of FP dissemination. This approximation is accurate when the plume trajectory is relatively constant but becomes less exact when the trajectory is variable. However, the average concentration computed in this manner is not likely to be less than the average concentration from a continuous source from this same sampling period. The calculated value may thus be designated as a maximized average concentration.

Peak concentrations may be obtained by sequential samplers such as the Drum Pulsed Sampler (DPS) which is programmed to collect samples at successive intervals of a few minutes or less.

Calculations of maximized average pollution concentrations and peak concentrations from the FP tracer measurements are explained in the following sections for point, line and area sources.

1. Calculation of Average Concentration from Rotorod FP Data For an Assumed Pollutant Emission Rate.

During the course of an experiment, each Rotorod sampler was operated long enough, after the end of FP generation, to completely sample the FP cloud as it passed.

If we set the Rotorod sampling time equal to the dispersal time, the maximized average concentration at a given location is estimated by the following equation. Taking SO_2 as an example, we have:

$$X_{SO_2} = \left(\frac{D}{Q}\right)_{FP} q_{SO_2}$$

Where X_{SO_2} = maximized average SO_2 concentration at sampling location in g/l.

D = FP dosage in particle-min/l

$= \dfrac{\text{Number of FP collected}}{\text{Flow Rate (l/min) x Collection Efficiency}}$

$= \dfrac{Nc}{FE}$

Q = Total number of FP released

q_{SO_2} = SO_2 emission rate in g/min

X_{SO_2} can be expressed in ppm SO_2 (Vol. 20°C)

$$(X_{SO_2})\ \text{ppm} = (X_{SO_2})\ \text{g/l} \times 3.75 \times 10^5$$

For rotorod samplers, operating at the normal 2400 rpm:

F = 52.3 liters/min (H-rod FP collector)

E = 70% (for FP)

And for an emission rate of 40 tons of SO_2 per day:

$$q_{SO_2} = 40\ \text{tons/day} = 25{,}200\ \text{g/min}$$

Then:

$$X_{SO_2} = \left(\frac{D}{Q}\right)_{FP} (2.52 \times 10^4) \quad (3.75 \times 10^5)$$

$$= \left(\frac{D}{Q}\right)_{FP} (9.45 \times 10^9)\ \text{ppm}$$

In the case of the multicolor FP tracer experiment at Benicia, FE 163, 10 December 1970, 20 lb of yellow FP was released through the 465 ft main Refinery stack. For this particular batch of FP, the number of particles per gram was 0.71×10^{10}. Then:

$$Q = (453.6 \text{ g/lb})(20 \text{ lb})(0.71 \times 10^{10} \text{ particles/g})$$

$$= 6.44 \times 10^{13} \text{ particles released}$$

A Rotorod sampler operating downwind collected 1790 fluorescent particles, of which 857 were yellow. Since the Rotorod operates at 52.3 liters/min with the H-rod collector used for FP and the efficiency of this collector is 70%, the dosage at this station for yellow FP is then:

$$D = \frac{Nc}{FE}$$

$$= \frac{857 \text{ particles}}{52.3 \text{ (l/min)} (0.70)}$$

$$= 23.4 \text{ part-min/l}$$

The maximized SO_2 concentration at this location, for an assumed emission of 40 tons of SO_2 per day, is:

$$x_{SO_2} = \left(\frac{D}{Q}\right)_{FP} q_{SO_2}$$

$$= \frac{23.4 \text{ (part-min/l)}}{6.44 \times 10^{13} \text{ (particles)}} \times 25{,}200 \text{ (g/min)}$$

$$= 9.16 \times 10^{-9} \text{ g/l}$$

Expressed as ppm:

$$x'_{SO_2}(\text{ppm}) = x_{SO_2} \text{ (g/l)} \times 3.75 \times 10^5$$

$$= (9.16 \times 10^{-9})(3.75 \times 10^{5})$$
$$= 3.44 \times 10^{-3} \text{ ppm or } .003 \text{ ppm}$$

Similar calculations would be used for other color FP collected.

2. Calculation of Peak Concentrations from Time-Sequential FP Data.

Several time-sequential FP samplers (Metronics DPS Sampler) were used during FE 161 and 162. The DPS sampler collects FP by impaction on a sticky surface attached to a drum. The drum can be rotated incrementally through 3 degree steps to expose fresh collection surfaces.

To convert observed FP counts to concentration and taking SO_2 as an example, we have:

$$X_{SO_2} = \frac{d_{FP}}{q_{FP}} \times q_{SO_2}$$

where:

X_{SO_2} = instantaneous peak SO_2 concentration in grams/l.

$$d_{FP} = \frac{\text{Number FP collected}}{\text{(Flow rate)(Efficiency)(Collection Time)}} = \frac{Nc}{F\ E\ Tc}$$

q_{FP} = FP source strength per unit time

$$= \frac{\text{Number of FP dispersed}}{\text{Dispersal time}} = \frac{N_D}{T_D}$$

q_{SO_2} = SO_2 source strength in grams/minute

During FE 163, 20 lbs of yellow FP was released through the 465 foot main Refinery stack. A total of 6.44×10^{13} particles were released over a 4 hour period (see previous section). Then:

$$q_{FP} = \frac{N_D}{T_D}$$

$$= \frac{6.44 \times 10^{13}}{240 \text{ (min)}}$$

$$= 2.68 \times 10^{11} \text{ particles/min.}$$

The DPS Sampler has the following characteristics:

F = flowrate = 45 l/min

E = efficiency = 100%

T_c = collection time per sample = 5 min.

Then, for a 5 minute collection of 37 yellow particles (N_c = 37) we have:

$$d_{FP} = \frac{Nc}{F\ E\ Tc}$$

$$= \frac{37 \text{ (particles)}}{45 \text{ (l/min) (1) (5) (min)}}$$

$$= 0.164 \text{ particles/l}$$

For an assumed SO_2 emission of 40 ton/day:

$$q_{SO_2} = 25{,}200 \text{ g/min.}$$

Then:

$$x_{SO_2} = \frac{d_{FP}}{q_{FP}} \times q_{SO_2}$$

$$= \frac{0.164 \text{ (particles/l)}}{2.68 \times 10^{11} \text{ (particles/min)}} \times 25{,}200 \text{ g/min}$$

$$= 1.54 \times 10^{-8} \text{ g/l}$$

$$= 5.78 \times 10^{-3} \text{ ppm or } 0.006 \text{ ppm for 5 min.}$$

3. Estimation of SO_2 Source Strength at a Given Location From Time Sequential FP Data and Concurrent SO_2 Monitor Data.

This calculation assumes that all the SO_2 detected by the SO_2 monitor came from the same source as the FP. This need not be the case and usually is not.

From the preceeding section:

$$X_{SO_2} = \frac{d_{FP}}{q_{FP}} \; q_{SO_2} \; (3.75 \times 10^5)$$

Solving for q_{SO_2}:

$$q_{SO_2} = X_{SO_2} \frac{q_{FP}}{d_{FP}} \frac{1}{3.75 \times 10^5}$$

where:

q_{SO_2} = in grams/min

X_{SO_2} in ppm from monitor data

q_{FP} see preceeding section

d_{FP} from DPS data, same time and interval as X_{SO_2} above.

4. Calculation of Concentration from a Line Source of H_2S from Line Source FP Data.

The average concentration of H_2S from a line source is calculated from:

$$X_{H_2S} = \frac{d_{FP}}{q_{FP}L} \; q_{H_2S}L$$

where:

X_{H_2S} = average H_2S concentration at sampler location in g/l.

q_{H_2S} = average H_2S emitted per unit length of line source in g/min

d_{FP} = FP dosage in part-min/l

q_{FP} = FP released per unit length of line source

L = length of line source.

For the green FP source in FE 163 20 lbs of FP were released at a uniform rate along a five mile line. The number of particles per gram for this lot of FP was 1.75×10^{10}.

$$q_{FP} = \frac{20 \times 453.6 \times 1.75 \times 10^{10} \text{ part}}{5 \text{ miles}}$$
$$= 3.18 \times 10^{13} \text{ part/mile}$$

Station 11 received a green FP dosage of 390 part-min/liter from the green FP line source south of the Carquinez Straits during FE 163. Assuming an emission along this same 5 mile line of 40 tons of H_2S per day or 5040 g/min/mile, the corresponding H_2S concentration at Station 11 would be:

$$X_{H_2S} = \frac{390}{3.18 \times 10^{13} \times 5} (5.04 \times 10^3)(7.06 \times 10^5)(5)$$
$$= 0.044 \text{ ppm}$$

Although the total number of FP released could be used in the calculation instead of the product $q_{FP}L$, the length of the release line is important in determining the change in concentration with distance downwind from the source. For a crosswind line source the concentrations downwind from the center of the line decreases much more slowly than that from a point source until the distance downwind becomes large with respect to the length of the line source. The difference from a point source is due to the fact that the plumes from all points along the line overlap and lateral diffusion is effective in diluting the gas or tracer only near the ends of the line until the plume width from each point becomes comparable to the length of the line.

5. Calculation of Concentration of H_2S From an Area Source.

The average concentration of H_2S from an area source may be calculated directly from FP data provided that the FP source actually simulates the area source. This could be done either by moving the FP source at a uniform rate over the area or as an approximation by moving the FP source around the perimeter of the area at a uniform rate.

If a fixed point source of FP is used to provide the data for computing concentration from an area source it may be assumed that all points within the area source will produce the same concentration pattern as the FP source. Then the contribution at a given sampler location from each equal subarea of the area source can be computed by moving the entire concentration pattern so that the FP source point is located at the center of the subarea. This could be done by drawing the source point concentration pattern on a plastic overlay.

A simpler approach and the one used here is to let the centerline concentration downwind from the point source represent the maximum possible concentration from the area source. If the total emission of H_2S from an area source were concentrated into a point source the centerline concentration would always be greater near the source but would approach the same value at distances which are large with respect to the area source dimension.

The general formula for calculating H_2S concentrations from an area source from FP data is:

$$\chi_{H_2S} = \frac{d_{FP}}{q_{FP}A} \times q_{H_2S} A \times (7.06 \times 10^5)$$

X_{H_2S} = average H_2S concentration in ppm

d_{FP} = FP dosage in part min/l

q_{FP} = FP source strength per unit area in g/min

A = area of source

q_{H_2S} = H_2S source strength per unit area in g/min

Twenty pounds of red FP were dispersed from a point near the Humble waste water treatment ponds at Benicia. The red FP contained 0.89×10^{10} particles per gram. Then:

$$q_{FP} = 20 \times 453.6 \times 0.98 \times 10^{10} = 8.07 \times 10^{13} \text{ particles}$$

A red FP dosage of 688 part-min/l was obtained at Station 38. Assuming an H_2S emission of 1.4 g/min per square meter of pond area with a total area of 35,000 square meters the maximum H_2S concentration at Station 38 would be:

$$X_{H_2S} = \frac{688}{8.07 \times 10^{13}} \times (1.4 \times 7.06 \times 10^5) \times (3.5 \times 10^4)$$

$$= 0.296 \text{ ppm}$$

The total H_2S emission would be:

$$q_{H_2S} = 1.4 \times 3.5 \times 10^4 = 4.9 \times 10^4 \text{ g/min}$$

$$= 108 \text{ lb/min}$$

APPENDIX 4.3

SUPPLEMENTAL PLAN OF OPERATIONS

SANTA YNEZ UNIT

APPENDIX 4.3

Geotechnical Feasibility Investigation,

Proposed Petroleum Treating and Storage Facility,

Corral Canyon Site D, County of Santa Barbara, California

Geotechnical Consultants, Inc.

September, 1971

Engineering Geology,
Soil and Rock Engineering, Geohydrology

GEOTECHNICAL CONSULTANTS, INC.

Glendale, California
Santa Ana, California
Ventura, California
Las Vegas, Nevada

September 21, 1971

Our Job V1004

Geotechnical Feasibility Investigation
Proposed Petroleum Treating and
Storage Facility, Corral Canyon Site D
County of Santa Barbara, California
For Humble Oil and Refining Company

61 South California Street, Ventura, California 93001 • Phone (805) 643-8244

Engineering Geology,
Soil and Rock Engineering, Geohydrology

GEOTECHNICAL CONSULTANTS, INC.

Glendale, California
Santa Ana, California
Ventura, California
Las Vegas, Nevada

September 21, 1971

Humble Oil and Refining Company
Western Division
1800 Avenue of the Stars
Los Angeles, California 90067

Attention: Mr. D. M. Griffith — Our Job V1004

Subject: Geotechnical Feasibility Investigation
Proposed Petroleum Treating and
Storage Facility, Corral Canyon Site D
Santa Barbara County

Gentlemen:

The enclosed report presents the results of our geotechnical feasibility investigation of Site D.

It is our opinion that Site D can be utilized for the facility from a geotechnical standpoint. It is recommended that a detailed subsurface investigation coupled with laboratory testing and engineering analyses be performed prior to the final design of the layout and grading plan.

Very truly yours,

GEOTECHNICAL CONSULTANTS, INC.

Joseph M. Gonzalez
Principal

JMG:bd

61 South California Street, Ventura, California 93001 • Phone (805) 643-8244

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INTRODUCTION

PURPOSE

This report presents the results of our feasibility investigation of the Corral Canyon area approximately 20 miles west of the City of Santa Barbara, Santa Barbara County, for a suitable site for onshore petroleum treating and storage facilities. The general location of the investigated area is shown on Plate 1 - Location Map, and Plate 2 - Drainage Area Map.

SCOPE AND HISTORY OF INVESTIGATION

The initial scope of the investigation was set forth in our letter of January 28, 1971, "Proposal to Perform a Geotechnical Reconnaissance of the Proposed Humble Oil Company Onshore Facility." Initially, the area to be investigated comprised the lower part of Corral Canyon from the ocean to approximately one mile upstream. The scope was limited to delineation of earth materials and geologic structure as they relate to the apparent stability of potential sites.

Upon completion of our reconnaissance and subsequent meeting with the clients, the area of investigation was expanded to include an additional mile of Corral Canyon upstream from the original area of investigation. The purpose of the geotechnical investigation of the expanded area was for the purpose of finding alternative sites for the onshore facilities.

On March 24, 1971, we submitted a preliminary report covering the results of our investigation to that data. This report was titled "Geotechnical Reconnaissance, Proposed Humble

Oil Company Onshore Facility, Corral Canyon Area, County of Santa Barbara, California for Penfield and Smith."

In subsequent conferences with representatives of Humble Oil and Refining Company and various consultants, tentative grading plans for several alternate sites for the onshore facilities in Corral Canyon were discussed and evaluated. A decision was made to explore the feasibility of utilizing the lower part of Las Flores Canyon, a tributary of Corral Canyon, as a location for the onshore facilities.

This report is limited in scope to a general geologic dissertation of the lower Corral Canyon region and a geotechnical analysis of the proposed facilities site in Las Flores Canyon and the access way thereto. Subsurface exploration, sampling, and testing of earth materials were not included in the scope of this investigation.

PROPOSED FACILITIES SITE

GENERAL

A 15-acre site for the onshore treating and storage facilities is proposed for Las Flores Canyon, a tributary of Corral Canyon. See Plate 2. Vehicular and pipeline access will be via an access road through Corral Canyon from State Highway 101. The access road will follow the route of the existing unimproved road. This route originates at the freeway frontage road on the east side of the mouth of Corral Canyon. In the orchard area, the route traverses the valley floor alluvium on the east side of the channel of Corral Creek. In the narrow gorge-like area of the canyon, the present road is carved into the steep natural slopes on the west side a short distance above the stream channel. At the upstream end of the narrows, the route recrosses to the east side of the creek and continues up the open alluviated valley floor to the mouth of Las Flores Canyon. See Plate 2.

It is also proposed that the pipelines to the facilities will be buried beneath the roadway.

The proposed facilities at Site D will be distributed in linear fashion along the floor of Las Flores Canyon, approximately 700 to 2500 feet upstream from the confluence of Las Flores Canyon with Corral Canyon. It is proposed to provide room for the facilities by placing fill in the canyon bottom with a minimal amount of graded cuts. See Plate 3.2 - Geotechnical Map, Corral Canyon Site D, and Plates 6.1 and 6.2 - Panoramic Photographs.

GRADING

The maximum height of proposed cuts is approximately 100 feet at maximum slope inclinations of 2 horizontal to 1 vertical. Fill slopes will be constructed at maximum inclinations of 2 horizontal to 1 vertical and a maximum depth of 45 feet. The fill will extend across the drainage. See Plate 3.2. Surface waters originating upstream from the processing facilities will be diverted beneath the site through a 96-inch closed drainage culvert. See Plate 3.2

FINDINGS

GENERAL

The investigated area is within the Corral Canyon area on the south flank of the Santa Ynez Mountains. The Corral Canyon drainage area extends from the crest of the Santa Ynez Range to the ocean, a distance of approximately five miles. Only the lower two miles of the canyon were mapped in this investigation. All of the mapping that was done for this investigation is shown on Plate 4 - Geotechnical Photo Mosaic, Corral Canyon.

The geotechnical findings for Site D and its environs are provided on a topographic base as Plate 3.2 - Geotechnical Map, Corral Canyon Site D. Plate 3.2 also presents the proposed grading plan for Site D. The geotechnical findings pertaining to the access route to Site D are indicated on another topographic map, Plate 3.1 - Geotechnical Map, Lower Corral Canyon.

TOPOGRAPHY

Corral Canyon. The investigated area lies entirely within the foothill belt of the Santa Ynez Mountains except for a narrow marine terrace less than one thousand feet in width. The dominant topographic pattern of the foothill belt is one of relatively straight southerly-trending ridges and valleys.

The width of the valley floors and the configuration of the valley slopes are strongly influenced by the geotechnical properties of the underlying geologic formations. Where Corral Canyon crosses the marine terrace, it is approximately 100 feet deep with gently sloping sides and a broad alluviated floor.

In the Miocene formations, the canyon bottom generally lies from 400 to 600 feet below the ridge crests. In the Monterey formation, the slopes are as steep as 1 horizontal to 1 vertical in places, and the valley floor is approximately the width of the stream channel. See Plate 3.1. In the Rincon formation, the valley slopes tend to be gentler largely due to mass wasting processes. Narrow alluviated valley floors have been developed in the Rincon formation both in Corral Canyon and its tributary Las Flores Creek. Both creeks cross the Vaqueros formation via narrow slot-like gorges.

Site D. Site D is located on the floor of that part of Las Flores Canyon which extends across the lower part of the Rincon formation. See Plates 3.2, 6.1, and 6.2. The alluviated valley floor is 200 to 250 feet in width at this point. It is traversed by the meandering usually dry channel of Las Flores Creek. The channel is approximately ten feet deep and fifty feet wide.

The site is bordered on the east by the low terminal part of the intervening ridge between Las Flores and Corral Creeks. This ridge rises from 70 to 200 feet above the valley floor at the site location. It has natural slopes varying from 10 to 35 degrees from the horizontal. Site D is bordered on the west by the intervening ridge between Las Flores and Venadito

Canyons. See Plate 6.1. This ridge rises 240 to 320 feet above the valley floor at the proposed site location. Several short tributary valleys and intervening spur ridges descend from the main ridge crest to the floor of Las Flores Canyon. The natural slope gradients adjacent to the site on the west side of Las Flores Canyon range from 12 to 38 degrees from the horizontal.

LAND USE

Petroleum is produced from the Capitan field in the lower reaches of Corral Canyon. Lemon trees are cultivated on 9.2 acres of valley bottom adjacent to the highway. The remainder of the area is utilized only for cattle grazing.

IMPROVEMENTS

Oil wells, pipelines, storage tanks, and other petroleum facilities are present on the Capitan field part of the area. An occupied residence, several farm buildings, and water wells are present in the orchard area. An unoccupied residential building is situated on the floor of Corral Canyon approximately 6000 feet north of the highway.

A high pressure gas line traverses Corral Canyon adjacent to the highway. An underground telephone cable crosses the canyon in an east-west direction approximately 3500 feet north of the highway. Telephone and electric power service are available at the orchard area. No other improvements were observed in the area except for a few unpaved roads.

GEOLOGY

General. The site is situated on the south flank of the Santa Ynez Mountains, one of the east-west trending ranges of the Transverse Ranges Province of California. Generally, the Santa Ynez Range is a geo-anticline that has been complicated by faulting. Marine and continental sediments ranging from Cretaceous to Quaternary age are exposed in the Santa Ynez Mountains. However, only the upper part of the stratigraphic section consisting of Miocene and Quaternary rocks are pertinent to this investigation. See Plate 4 and Plate 5.3 - Geotechnical Sections, Corral Canyon.

Stratigraphy. The geologic units mapped in this investigation are listed in the following stratigraphic sequence:

Oligocene-Miocene	Sespe Formation	(Ts)
Miocene	Vaqueros Formation	(Tv)
	Rincon Formation	(Tr)
	Monterey Formation	(Tm)
Quaternary	Terrace	(Qt)
	Colluvium	(Qcol)
	Alluvium	(Qal)
	Landslides	(Qls)
	Mudflows	(Qmf)

Sespe Formation (Ts). The Sespe formation of Oligocene and/or early Miocene age crops out in the northern part of the investigated area. See Plate 4. It is of continental origin and consists of interbedded variegated silty sandstones, clayey siltstones, and silty claystones.

<u>Vaqueros Formation (Tv)</u>. The Vaqueros formation of early Miocene age conformably overlies the Sespe formation. See Plate 4. It is a well bedded, medium to coarse grained, hard, calcareous cemented, tan where weathered sandstone of marine origin. Typically, it forms cliffs and prominent hog-back ridges.

Generally, the Vaqueros formation has little to no soil cover, nevertheless, it generally supports a dense cover of chaparral and some oak trees. Corral and Las Flores Creek cross the Vaqueros formation via narrow, cliff-walled, slot-like gorges.

<u>Rincon Formation (Tr)</u>. The Rincon formation of early Miocene age and marine origin conformably overlies the Vaqueros formation. See Plate 4. It consists of very massive, brownish gray silty claystone and clayey siltstone. The lower member of the Rincon formation (Trlm) is approximately 60 feet thick.

From a surface examination only, the lower part Rincon formation appears to comprise the following units in stratigraphic order from older to younger:

> 60 feet basal member consisting of silty claystone, siltstone, and a few thin beds of interbedded sandstone. This unit appears to be relatively resistant to sliding.
>
> 300 feet massive bentonitic claystone. It is generally geomorphologically marked by extensive landslides, gentle hillside slopes, and saddles on the ridge crests. It forms very expansive soils, and it is very subject to mass wasting by creep, landslides, and mudflows.

600 feet relatively firmer claystone with some thin zones of calcareous concretions. This unit tends for form moderately prominent hog-back ridges. Although landslides are prevalent in this unit, it is somewhat less subject to mass wasting than the underlying bentonitic member.

The Rincon formation tends to weather deeply and it generally has a thick soil cover with a moderate to high organic content. Large desiccation cracks are common in the soil cover of the Rincon formation indicating its expansive nature. Typically, the Rincon formation exhibits a grass covered, gently rolling topography that is scarred by many landslide, mudflow, and soil creep features. Valley floors tend to be somewhat broader and more alluviated in the Rincon formation than in the other formations. The Rincon formation is approximately 960 feet thick. It crops out in a belt approximately 3200 feet wide in the vicinity of the junction of Corral and Las Flores Creeks. See Plate 4. It is also present in the lower slopes of Corral Creek in the vicinity of the orchard. See Plates 3.1 3.2 and 4.

Monterey Formation (Tm). The Monterey formation of middle and late Miocene age conformably overlies the Rincon formation. See Plates 3.1 and 4. It is well-bedded marine formation consisting dominantly of light gray, platy, siliceous shales and clay shales with some interbedded porcelanite, limestone, and fine to coarse grained sandstones. It also contains tuff beds, some of which are weathered to bentonite, in surface outcrop. Where Corral Creek crosses the Monterey formation, it has a narrow bottom with steep sides. This effect has been produced, in part, by large slides encroaching on the creek bottom from either side. See Plate 5.1 - Geotechnical Sections D-D' and E-E'.

Quaternary Terraces (Qt). A marine terrace caps the nearly flat shelf-like areas on either side of the mouth of Corral Creek. See Plates 3.1 and 4. For the most part, the terrace materials appear to be ten to twenty feet thick and to consist of sands and gravels.

Scattered rounded boulders on the valley slope west of Corral Creek suggest that a small fluviatile terrace may be present in that area.

Quaternary Colluvium (Qcol). Colluvium, as used in this report, refers to materials which have been transported by a combination of gravity and slope wash processes down the valley sides and deposited on the lower slopes and floor of the valley. It is distinct from the alluvium because it does not contain well-rounded gravels derived from upstream as does the alluvium. Instead, the materials in the colluvium reflect the nature of the upslope bedrock materials from which they are derived. Colluvium derived from Monterey shale consists of angular shale fragments. See Plate 5.1 - Geotechnical Section F-F'. Colluvium derived from the Rincon formation consists of clays and silts.

Alluvium (Qal). Alluvium consists of stream deposited materials which form the floors of Corral and Las Flores Canyons. It consists of gravel, sand, and boulders which have been transported into the area from upstream. Some of the boulders are several feet in diameter. Generally, the alluvium has a thick soil cover. The thickness of the alluvium could not be determined by surface examination.

From an examination of the cut banks of the channel of Las Flores Creek, the alluvium has a maximum thickness in excess of ten feet. It appears to consist of a five to ten feet thick layer of dark gray, organically rich clayey soil overlying hard, rounded gravels and boulders.

Quaternary Landslides (Qls) and Quaternary Mudflows (Qmf). Many landslides are present in the parts of the area that are underlain by the Monterey and Rincon formations. See Plates 3.1, 3.2, and 4. They vary in size from small to very large. They also vary in age from prehistoric to as recent as last winter.

The slides tend to fall into two categories depending upon whether they are in the Monterey formation or the Rincon formation.

The slides in the Monterey formation appear to be large bedding plane slides. See Plate 5.1. They have moved along dip components in the bedding into the canyon from either side. They have generally kept the valley floor narrowed and, in places, they have diverted the stream channel. A huge complex of multiple coalesced slides occurs on the eastern side of Corral Creek between 2000 and 3500 feet north of the highway. This slide complex, or "multislide," head near the crest of the ridge and descends by gently rounded, step-like stages to the valley floor. An attempt was made on Plates 3.1, 4, and 5.1 to delineate the various subsidiary slide units within the "multislide." Where exposed in graded cuts, the Monterey shale in the slides is badly broken up and chaotically disoriented.

The slides in the Rincon formation are not bedding plane slides. They occur against the dip and along the strike of the formation as readily as along the dip. See Plate 4. They originate as rotational slumps in the deeply weathered zone of the Rincon formation. In some cases, the slumped material moved downslope and out onto the alluviated valley floor as a viscous liquid mass. Where the liquidity of the displaced material appears to have been very high, they are called mudflows (Qmf); however, all gradations exist between simple rotational slumps and mudflows. Although some of the mudflow-shaped features may have been the result of slow movement, others certainly happened very suddenly. In some cases, the slumped material liquified and ran off downslope leaving empty, semi-circular slump scars behind. Several of the mudflows and accompanying slump scars are shown on Plate 4. The brows of the empty scars are indicated by hatchures.

A small shallow slide which occurred in the past year is present on the east slope of Las Flores Canyon opposite the oil processing facilities. This slide is noteworthy in that it occurred on a natural slope with a gradient of ten degrees to the horizontal. A larger slide also occurred on the west side of Las Flores Canyon. See Plates 4, 5.2, 6.1, and 6.2.

The large slide on the south side of Corral Canyon in the orchard area appears to be a hybrid type of slide. See Plates 3.1 and 4. Whereas most of the displaced mass is Monterey shale, the shale apparently collapsed due to a strength-of-materials failure in the underlying Rincon sediments.

GEOLOGIC STRUCTURE

General. In general, the geologic structure of the south flank of the Santa Ynez Mountains consists of a southerly dipping homocline. In the lower Corral Canyon area, the homoclinal pattern of the geologic structure has been modified by east-west trending folds and faults.

Faults. Two faults were recognized in the area. The northernmost fault is the Refugio fault. It crosses Las Flores Canyon approximately 1000 feet upstream from the proposed facilities. It strikes east-west and dips 33 degrees northerly. It has a stratigraphic separation of approximately 300 feet, and the direction of stratigraphic displacement indicates that it is a normal fault. See Plates 3.2, 4, and 5.3.

The other fault is the Erburu fault. It strikes approximately N75W and dips 41 to 47 degrees northerly. It crosses Corral Creek approximately 2000 feet north of the highway. It is also a normal fault. At the surface near the bottom of Corral Canyon, it juxtaposes the Monterey shale on the north side against Rincon claystone on the south side. See Plates 3.1, 4, and 5.1.

A third fault may be present midway up the west slope of Corral Canyon where flat-lying Monterey beds abut against overturned Monterey beds. The separating plane between these two structural units has an attitude of N67W 58E. Inasmuch as the beds further upslope appear to be undisturbed, we, at the present time, interpret these features as being caused by landsliding rather than faulting.

Both the Erburu and Refugio faults appear to be simple dip-slip normal faults without significant strike-slip components yet they occur in a geologic province where the faults generally have reverse and/or left lateral displacement. The Erburu and Refugio faults appear to be gravity or tensional in origin in a region that is actively undergoing tectonic compression. Also, both faults now have lower angles of dip than would be expected initially with gravity or tensional faults.

It appears likely that the Erburu and Refugio faults were formed before the present period of strong tectonic compression. Also, it is postulated that they were formed at a time when the beds were essentially flat before the period of regional folding. Thus, they probably were initially formed at angles approximately 70 degrees to the horizontal. They were probably rotated to their present low dip orientations by regional folding and tilting which was initiated along with and as a result of the present period of compression. Hence, it appears to be probable that the Erburu and Refugio faults are not only not active now but that they probably have not been active for a span of millions of years.

Folds. For most of the area upstream from the Erburu fault, the beds dip 20 to 30 degrees southerly; however, the axis of a westerly-trending, westerly-plunging syncline projects across Corral Creek approximately 600 feet north of the projected crossing of the Erburu fault. The westerly plunge of this syncline explains why landslides in the Monterey formation are more prevalent on the west-facing slopes of Corral Canyon (and Venadito Canyon to the west) than they are on the east-facing slopes. A subsurface anticline is present on the footwall side of the Erburu fault. It is from this anticline that the oil is being produced. A hint of this anticlinal structure is present at the surface on the south side of the Erburu fault.

SEISMICITY

Large magnitude earthquakes have occurred in the Santa Barbara area during the period of recorded history. Noteworthy of the larger earthquakes in the area are those of June 29, 1925, and July 1, 1941, with epicenters offshore of Santa Barbara. These earthquakes were of magnitudes 6.3 and 6.0, respectively, on the Richter scale. It is reasonable to expect, based upon the relatively short historical record available, that a magnitude 6.0 to 6.5 earthquake(s) will occur within 25 miles of the site during the useful life of the development.

WATER SUPPLY

General. A water supply within Corral Canyon has been obtained historically from diversion of surface water and from water wells. At present, the water supply for the home and lemon orchard at the mouth of the canyon is obtained from a water well located in the lemon orchard area in the lower Corral Canyon area.

Precipitation. The average rainfall for the study area ranges from approximately 18 inches at the coast to about 40 inches at Santa Ynez Peak. See Plate 2.

Rainfall occurs during the winter with nearly 85 percent of the annual total occurring from November through March while the summers are practically rainless. There is a marked variability in monthly and seasonal totals, and annual precipitation may range from less than a third of the normal to nearly three times normal; whereas, some customarily rainy months may be completely rainless or receive three to four times the average for the month.

Surface Water. A flowing stream was observed over the entire length of Corral Canyon in the spring of 1971. By August, the surface stream was dried up except for a few small pools of water. The stream flow originates in the upper reaches of the canyon. No surface flow was observed in Las Flores Canyon.

The surface flow near the confluence of Las Flores Canyon with Corral Canyon was estimated to be at least 250 gallons per minute on March 4, 1971. This stream reportedly runs most of the year.

Geohydrology. The Corral Canyon area as described in the preceding sections is underlain by limited areas of alluvium in the canyon areas and by a great thickness of consolidated sedimentary formations. These consolidated formations which underlie the area are not generally considered water-bearing because of their physical characteristics and inability to store or transmit water readily. However, some of the bedrock units do yield water stored in joints and fractures to water wells.

Water wells in areas nearby are drilled into the consolidated sedimentary rock of the Vaqueros sandstone. These wells range from 250 to 400 feet in depth and yield from 50 to 150 gallons per minute.

Ground Water Recharge. The only source of recharge to the ground water in the canyon areas is infiltration of rain that falls directly on the ground surface and storm runoff. Recharge to alluvium and bedrock storage from precipitation and runoff in mountain areas depends not only on the volume and time distribution of precipitation but also on the infiltration rate, soil moisture deficiency, and evapo-transpiration rate. For purposes of this reconnaissance study, we have assumed 24 inches of precipitation over the entire drainage with ten percent of this amount as the maximum available for ground water recharge.

The drainage areas are shown on Plate 2 - Drainage Area Map, and summarized below:

Area (1)	Upper Corral Canyon	2792±	Acres
Area (2)	Las Flores Canyon	680±	Acres
Area (3)	Lower Corral and Las Flores Canyons	778±	Acres
	Total	4250±	Acres

Utilizing the preceding areas and the estimated 0.2 foot of rainfall available for deep percolation, the following ground water inventory develops:

Area (1)	2792 acres x 0.2 feet =	588	acre-feet
Area (2)	680 acres x 0.2 feet =	136	acre-feet
Area (3)	778 acres x 0.2 feet =	156	acre-feet
	Total	850	acre-feet

Based on the foregoing, the total Corral Canyon-Las Flores Canyon catchment area has a maximum available recharge to the ground water reservoir of 850 acre-feet per year.

Ground Water Extractions. At the present time, approximately 9.2 acres of lemon trees at the mouth of Corral Canyon are irrigated with water extracted from water wells. It is estimated that approximately three feet of water per acre per year is applied to the grove for an estimated total of 27.6 acre-feet per year.

It is estimated that for all irrigation, domestic, and industrial purposes, the total present water demand from the Corral Canyon watershed is 35 acre-feet per year.

WATER QUALITY

Mineral analysis of ground water in adjacent areas indicate that ground water from water wells extracting from alluvium or from the Vaqueros formation will be calcium bicarbonate to sodium bicarbonate in character with total dissolved solids concentrations of 700 to 900 parts per million. The waters probably will meet the present permit requirements for drinking water as adopted by the California State Board of Public Health.

CONCLUSIONS AND RECOMMENDATIONS

1.0 GENERAL

The conclusions and recommendations presented herein are based upon our geologic mapping and engineering analysis based on engineering properties data and experience obtained on other projects in the coastal area of Santa Barbara County.

In our opinion, it is geotechnically feasible to locate the oil processing facilities within Las Flores Canyon as proposed. Our reconnaissance findings should be verified by a comprehensive subsurface geotechnical investigation based upon an improved topographic map prior to finalizing the site grading plans.

2.0 FAULTS

The Refugio fault is situated north of the site as shown on Plate 4. No evidence of movement along this fault during Holocene geologic time was discovered.

The Erburu fault corsses the access road approximately one mile south of the site as shown on Plate 4. There is no evidence of movement along this fault during Holocene geologic time.

3.0 SEISMICITY

From an engineering viewpoint, a realistic maximum value of expected ground acceleration for rock slope stability analysis at the site within the Vaqueros formation and unweathered Rincon formation would be 0.15 g.

4.0 SITE STABILITY

4.1 General. The proposed treating and storage facilities site is geologically stable as proposed. However, natural slopes encroaching on the site do exhibit some local instabilities which will require further study.

4.2 Natural Slopes. Two slides in the Rincon formation have been mapped within the site as shown on Plate 3.2.

The large slide on the west side of the Gas Processing Area encroaches into the proposed fill area with a relatively thick zone of slide debris. Placement of the proposed fill in the bottom of the canyon can be used to improve the stability of the slide mass. The stability of the slide mass and its relationship to the proposed fill can only be determined by subsurface geotechnical exploration and analysis.

A recent small slide on the east side of the Gas Processing Area is relatively shallow; however, it indicates that slope stabilization by engineering methods may be necessary in the area.

Generally, the natural canyon slopes within the Rincon formation are considered potentially unstable and some sliding or mudflows should be expected to encroach on the area during the life of the facility. The preliminary design provides for an access road around the perimeter of the site. This access road may also serve as a clean-up area for any eventual slide debris encroaching on the site.

The natural slopes of the Vaqueros formation are considered grossly stable.

5.0 EXCAVATION

5.1 General. All of the earth materials that will be encountered can be excavated with conventional equipment. Deep cuts in the Vaqueros sandstone and a few beds with concretions in the Rincon shales may require heavy ripping.

5.2 Cut Slopes. The preliminary grading plan includes only two significant cut slopes, both located at the north end of the site.

The south-facing slope will be completely in the Vaqueros formation. It will have a maximum height of approximately 100 feet with an inclination of 2 horizontal to 1 vertical, which is approximately the inclination of the bedding dip of the Vaqueros formation in this area.

Stability analyses utilizing assumed peak shear strength values (across bedding $\phi = 40°$, c = 1000 psf; along bedding $\phi = 40°$, c = 0 psf) indicate tentative factors of safety against sliding of 1.75 for a static condition and 1.30 with a seismic force equal to 0.15 g. The slope is considered grossly stable as designed.

The east-facing slope will be completely in the Rincon formation. It will have a maximum height of 130 feet with an inclination of 3 horizontal to 1 vertical. Stability analyses utilizing assumed peak shear strength values ($\phi = 28°$, c = 200 psf) indicate factors of safety against sliding of 2.40 for a static condition and 1.40 with a seismic acceleration force equal to 0.15 g. The slope is considered grossly stable as designed.

Both slopes have a 50-foot wide bench approximately 25 feet above the toe. The Vaqueros formation sandstone is considered nonerodible, and the cut slope in this formation will not require planting against erosion.

The Rincon claystone is erodible and the proposed 3 horizontal to 1 vertical cut slope should be protected against erosion with a lightweight, deeply rooted plant cover.

The excavated material can be used in compacted fills if free of organics or other deleterious materials.

6.0 COMPACTED FILLS

6.1 General. The existing ground will satisfactorily support compacted fills provided that the ground has been prepared in accordance with the provisions of the local grading code and accepted practice.

Fills placed on natural slopes steeper than 5 horizontal to 1 vertical must be provided with horizontal keyways and benches into firm natural ground. It is important that the keyways and benches penetrate any mudflows, slides, and/or weathered zones, especially in the Rincon formation.

Fill should be placed in thin layers, six to eight inches thick, and compacted to at least 90 percent relative compaction, relative to the maximum dry density determined by standard test method ASTM D1557-70T, modified to three layers.

We recommend that wherever possible, fills be topped off with sandy materials from the Vaqueros formation. This will significantly improve the engineering properties of the fill and provide substantial savings in structural road sections.

6.2 Fill Slopes. The preliminary grading plan indicates fill slopes inclined at 2 horizontal to 1 vertical and 3 horizontal to 1 vertical. Maximum height of fill slopes is approximately 50 feet. Paved benches have been provided as required by the County Grading Ordinance.

The fill slopes are considered grossly stable as designed.

7.0 DRAINAGE

7.1 Subdrains. Canyon fills and sidehill fills placed against slopes with water seeps must be provided with subdrain systems to prevent build-up of hydrostatic pressure.

7.2 Slope Drainage. All fill and cut slopes should be protected against erosion by proper drainage, away from slopes, by properly constructed brow berms or brow ditches.

7.3 Surface Drainage. Water originating within Las Flores Canyon upstream from the site will be diverted beneath the site through an engineered culvert.

8.0 STRUCTURAL ROAD SECTIONS

Structural road sections should be designed in accordance with the County of Santa Barbara road standards based on estimated traffic index and the R-value of the subgrade materials.

The R-values should be determined when the rough grading is completed. We estimate that the sandstone from the Vaqueros formation has an R-value of approximately 50, while the Rincon claystone is expected to show an R-value in the 5 to 10 range. In addition to the low R-value, the claystone is highly expansive which also will influence the structural section.

We recommend that wherever possible, road fills be topped off with two feet of sandstone from the Vaqueros formation thus reducing the required thickness of aggregate base.

9.0 EARTHWORK FACTOR

Both the Rincon and Vaqueros formations have natural densities ranging from 85 to 100 percent of maximum laboratory densities. We recommend using a shrinkage factor of 5 percent from cut to fill when compacting the earth material to 90 percent relative compaction.

Compaction to a higher density will increase the shrinkage factor correspondingly.

10.0 FOUNDATION DESIGN

The tanks and other oil treating facilities can be satisfactorily supported on conventional footings.

The four crude oil storage tanks will have a capacity of 110,000 barrels each with a diameter of 130 feet and a height of 48 feet. All of the tanks will be in cut areas. Three of these tanks will probably be situated on the Vaqueros sandstone. One large tank and the three smaller tanks will probably be situated on the Rincon claystone.

At the present, we do not possess accurate information regarding the exact location of the contact between the Vaqueros and Rincon formations and alluvium in the canyon bottom. We, therefore, cannot provide detailed recommendations regarding foundation preparation until this area has been explored by subsurface borings.

Tentatively, we believe that no foundation preparation will be required for the tanks situated on the Vaqueros sandstone.

The Rincon formation beneath any of the tanks should be overexcavated and backfilled with approximately ten feet of compacted fill derived from the Vaqueros sandstone.

Surge and rerun tanks and all other oil treating facilities will be located on fill. To provide adequate foundations for these facilities, we recommend that the fill be topped off with ten feet of sandy material from the Vaqueros formation.

11.0 ACCESS ROAD AND PIPELINE

The proposed access road will follow an existing road in Corral Canyon to the site. It is anticipated that the road will be widened to twenty feet and improved to handle heavy loads. The existing road traverses several possible slide areas. We recommend that these areas be investigated by deep borings to evaluate eventual stability problems.

The existing roadway alignment can be used for the pipeline to the facility if no serious geologic instability is encountered during exploration. In the event instabilities that could threaten this route are found, other safe pipeline routes can be located within the Corral Canyon area.

12.0 GEOTECHNICAL INVESTIGATION

All conclusions and recommendations set forth in this report should be confirmed by geologic mapping on an improved topographic map, subsurface exploration, laboratory testing, and geotechnical analysis.

13.0 GRADING CONTROL

13.1 General. Grading for development of Site D should be performed under the control of qualified geotechnical personnel. All fill should be placed and tested under the control of a soils engineer to assure that proper compaction is being obtained.

13.2 Grading Specifications. It is recommended that grading operations be performed in accordance with the Santa Barbara

County Grading Ordinance and Geotechnical Consultant's "Standard Grading Specifications."

14.0 WATER SUPPLY

14.1 Ground Water Extractions. At the present time, it is estimated that the total ground water demand on the area is 35 acre-feet per year. We estimate that an additional 35 acre-feet per year could be extracted from additional water wells in the watershed without adversely affecting the existing water well or the natural vegetation in Corral Canyon.

14.2 Water Well Locations. Water wells can be located in either Corral Canyon or Las Flores Canyon within Site D.

The wells should be drilled in the vicinity of the Rincon-Vaqueros formation contact. The wells should be a minimum of 12 inches in diameter and extend through the Vaqueros sandstone, approximately 450$\pm$ feet. It may be possible to complete a well in the Vaqueros sandstone without casing except for a 50-foot surface (sanitary seal) casing. Wells should be drilled without bentonite muds. If possible, it would be desirable to drill wells in this formation by percussion methods.

15.0 WATER QUALITY

The mineral quality of ground water will probably meet California State Board of Health requirements. The waters will have total dissolved concentrations of 700 to 900 parts per million.

16.0 SEWAGE DISPOSAL

A leach line system in the alluvial area downstream from Site D should suffice for disposal of sewage effluent from the facility. Tentatively, the system should be designed for a percolation rate of one to two gallons per day per square foot.

The attachments which complete this report are listed in the Table of Contents.

Respectfully submitted,
GEOTECHNICAL CONSULTANTS, INC.

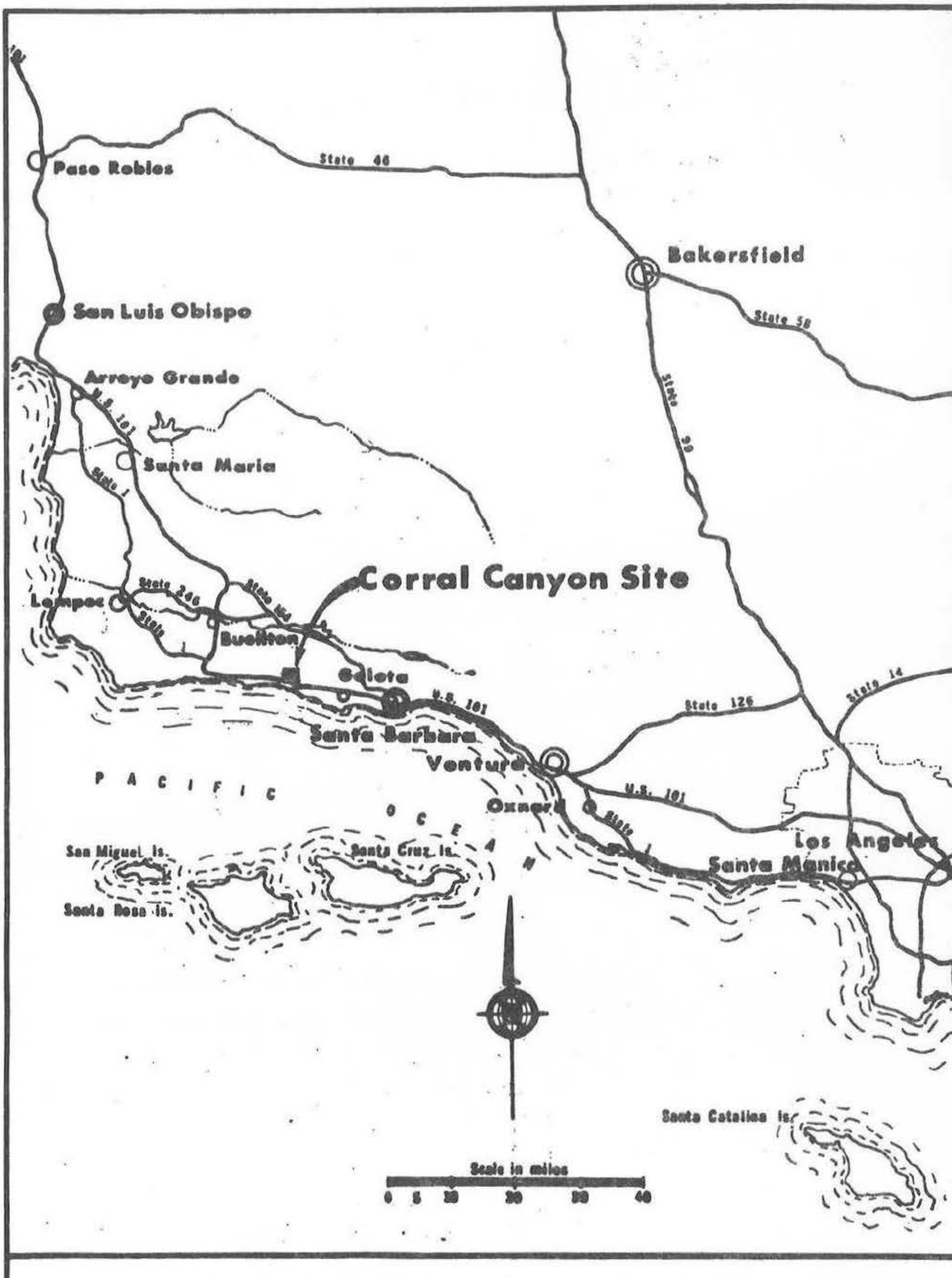
George L. Quick
Engineering Geologist 548

Joseph M. Gonzalez
Engineering Geologist 562

Ivar Staal
Civil Engineer 16483

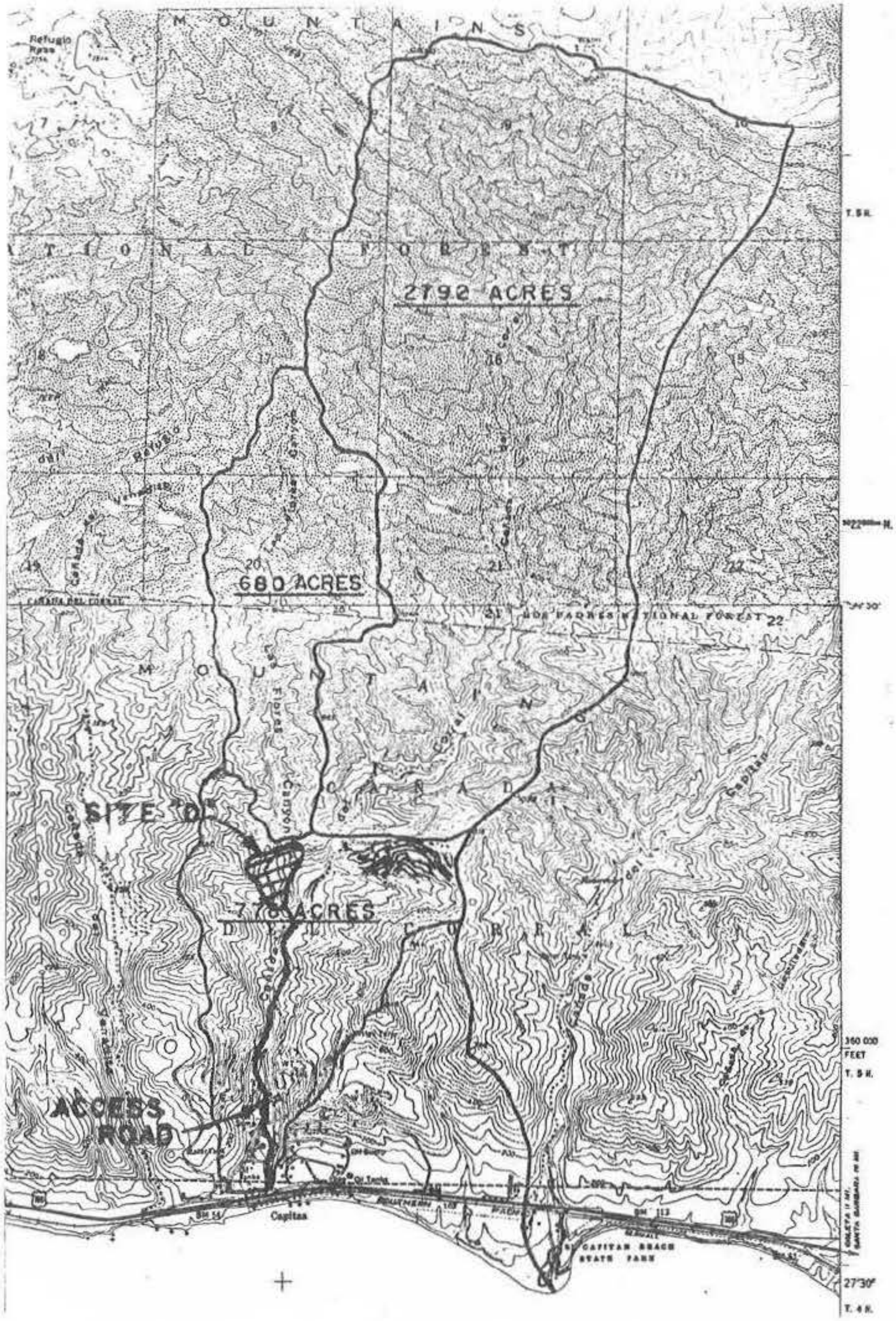
IS:JMG:GLQ:bd

DATE 2-14-71 GEOL. J.M.G DRW. H.P.Z. CHKD. ______ TYP. ______
ENG. I.S.



LOCATION MAP
HUMBLE OIL AND REFINING COMPANY

JOB V1004 GEOTECHNICAL CONSULTANTS, INC. PLATE 1

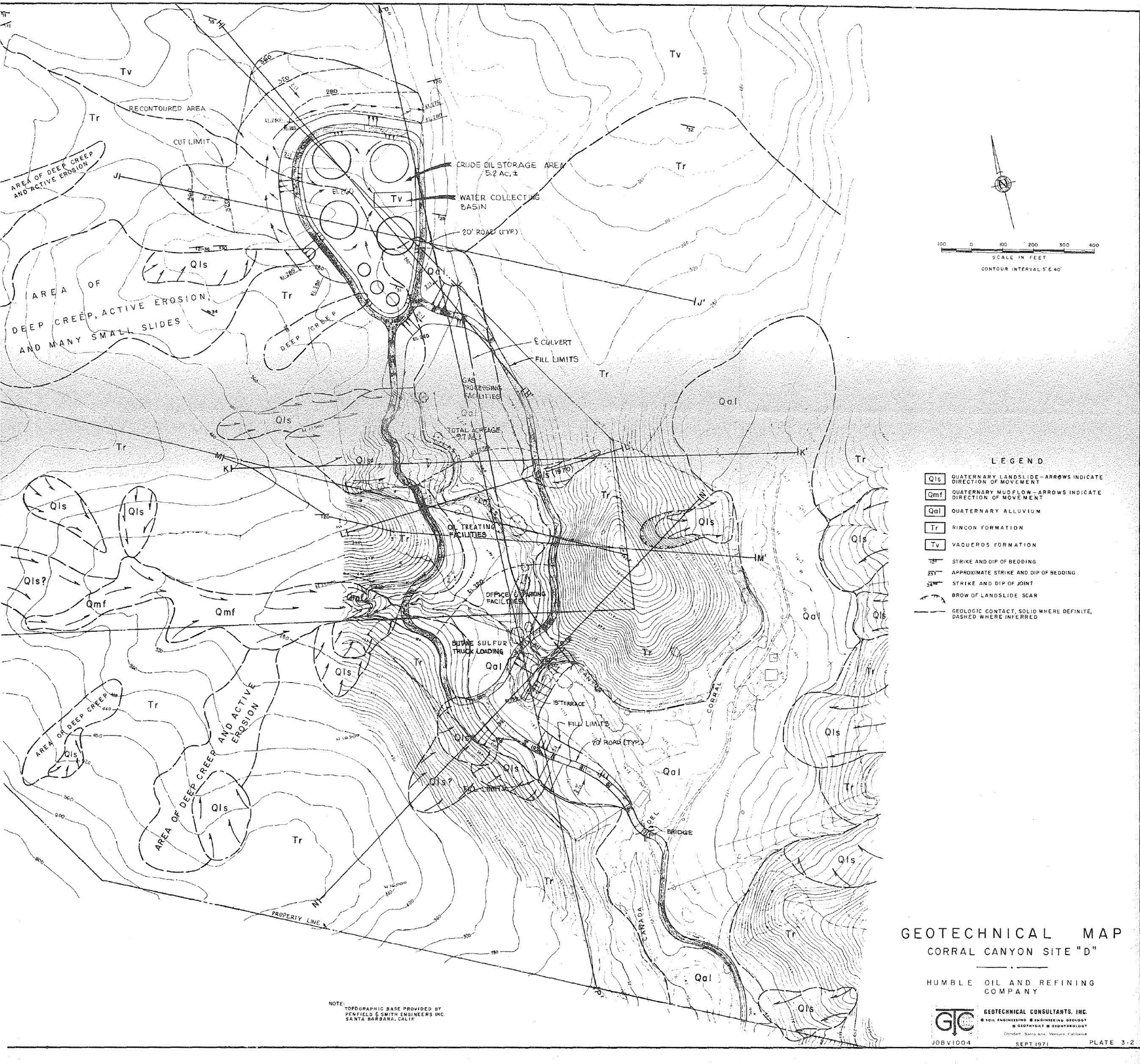


DRAINAGE AREA MAP

HUMBLE OIL AND REFINING COMPANY

JOB V1004 | GEOTECHNICAL CONSULTANTS, INC. | PLATE 2

DATE 9-14-71 GEOL. DRW. TYP. B.D. CHKD. ENG. I.S.



GEOTECHNICAL MAP
CORRAL CANYON SITE "D"
HUMBLE OIL AND REFINING COMPANY

GEOTECHNICAL MAP

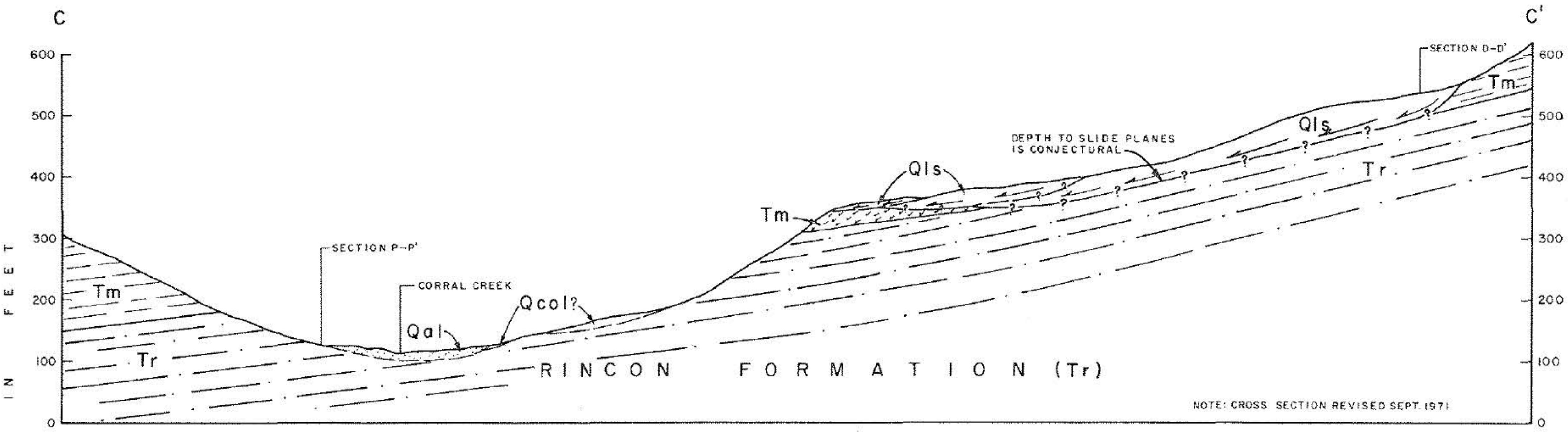
LOWER CORRAL CANYON

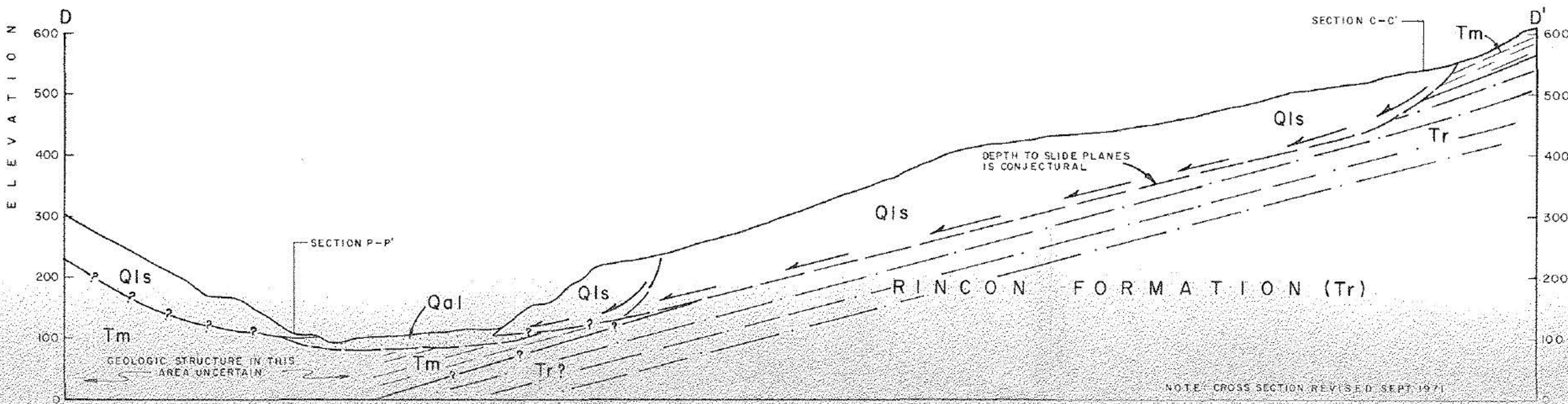
HUMBLE OIL AND REFINING COMPANY

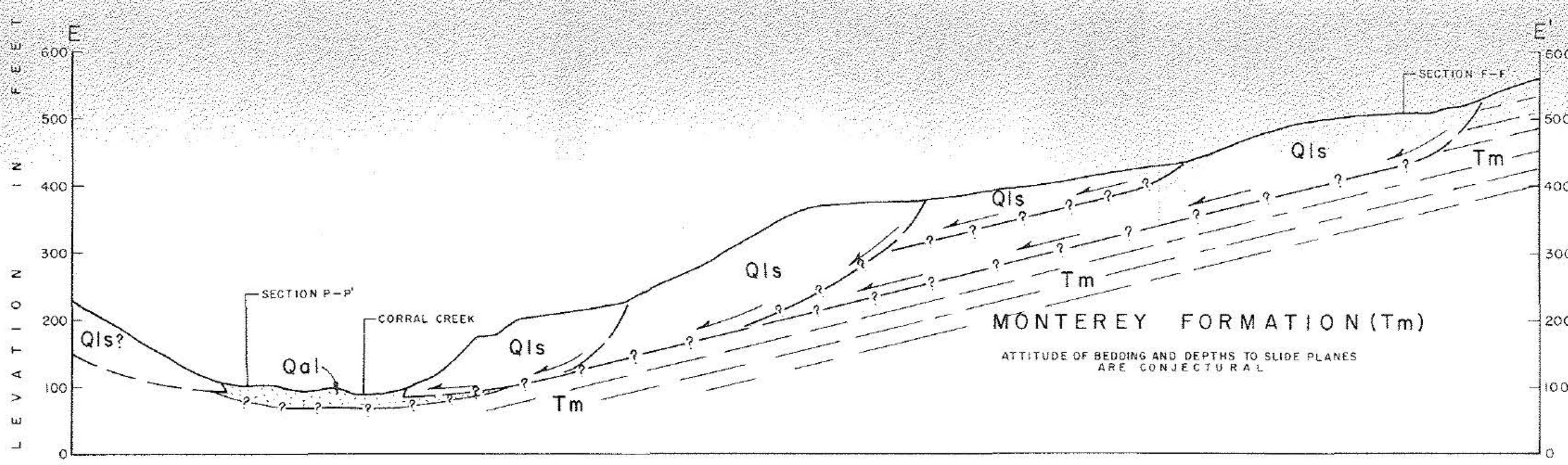
GEOTECHNICAL CONSULTANTS, INC.
SOIL ENGINEERING ■ ENGINEERING GEOLOGY ■ GEOPHYSICS ■ GEOHYDROLOGY
Glendale, Santa Ana, Ventura, California

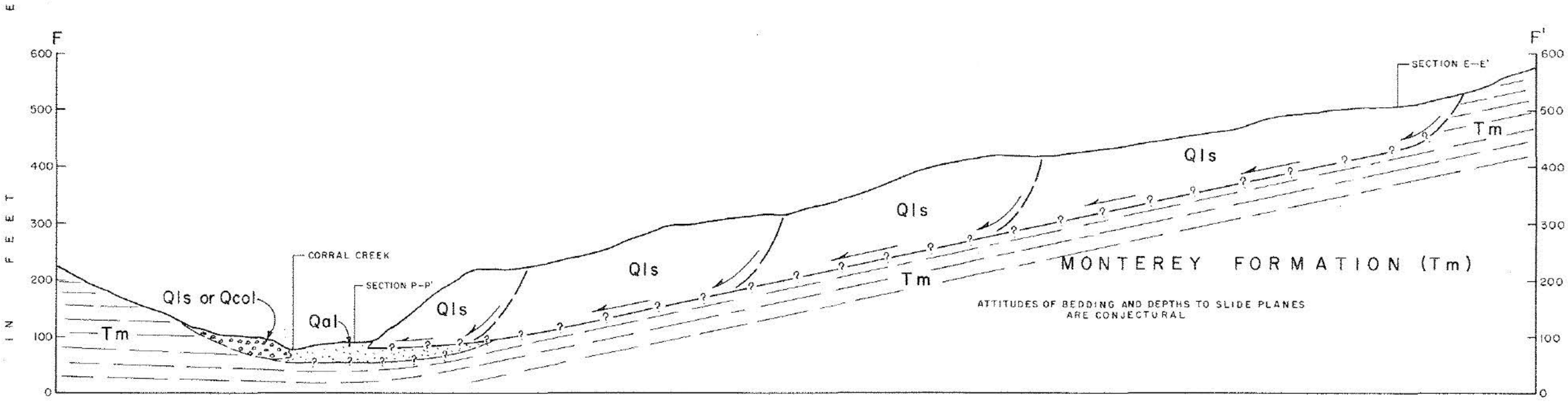
JOB V1004

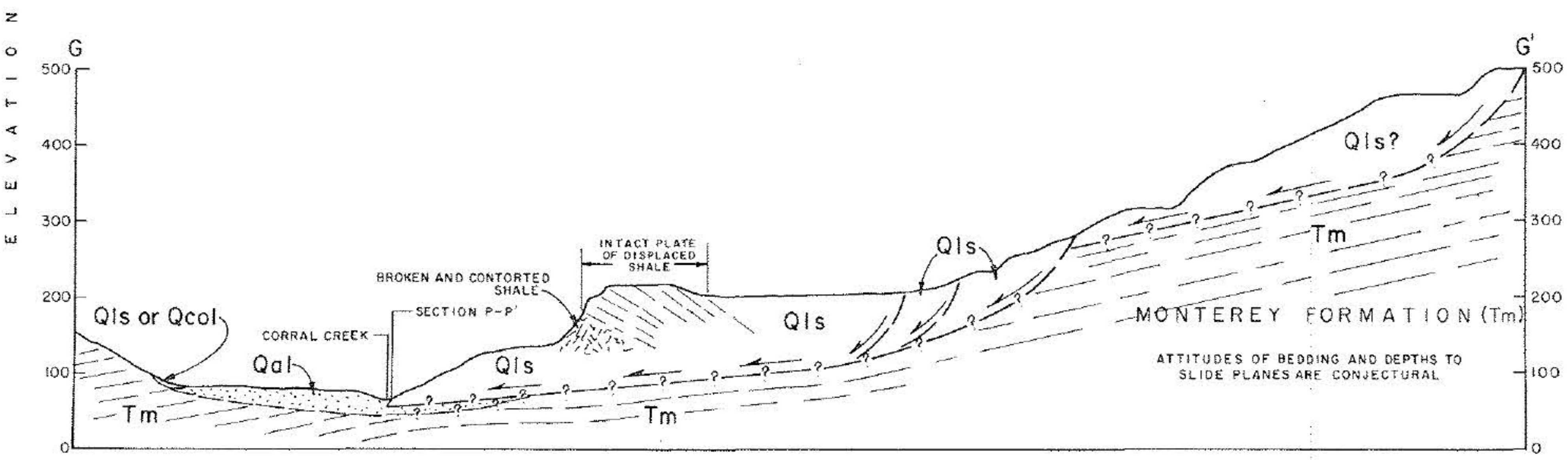
PLATE 3-1











SEE PLATE 3-1 FOR LOCATION OF SECTIONS AND GEOLOGIC LEGEND

100 0 100 200 300 400
SCALE IN FEET
HORIZONTAL & VERTICAL SCALE

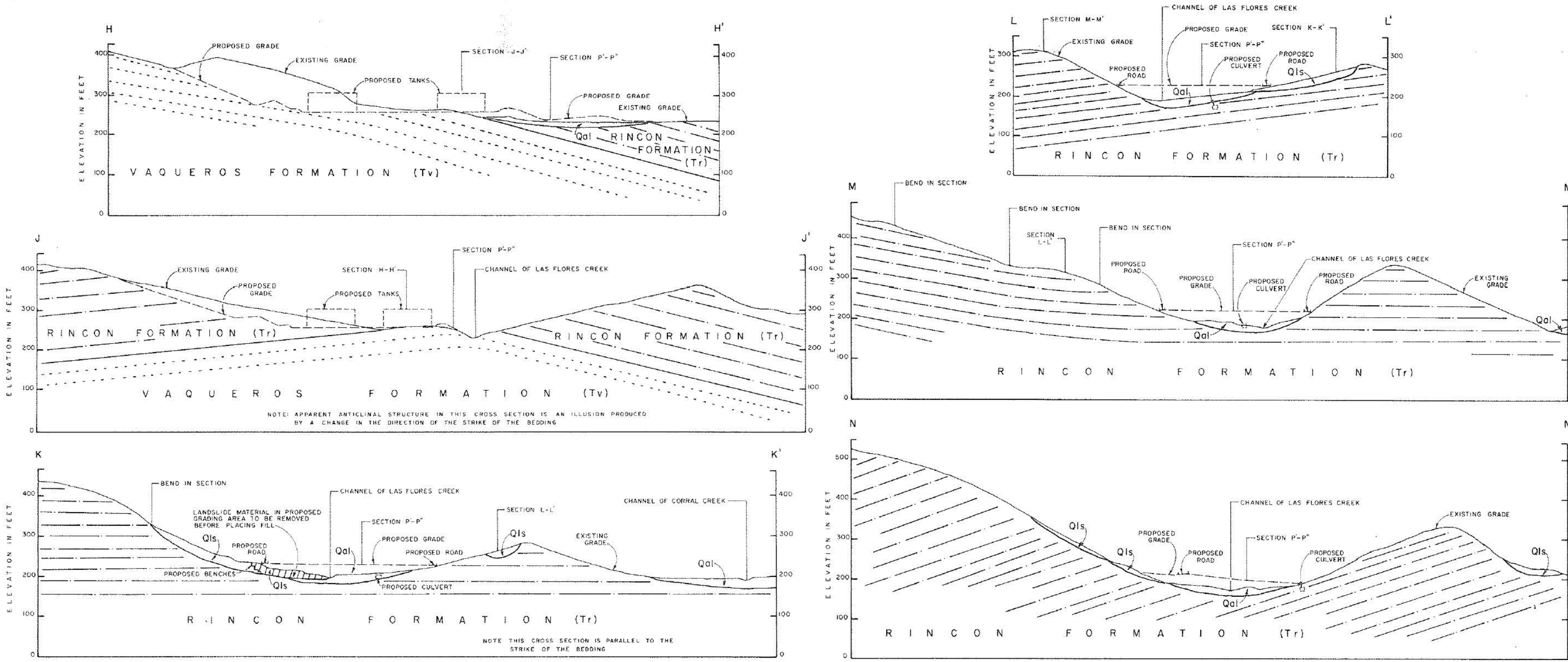
GEOTECHNICAL SECTIONS
C-C', D-D', E-E', F-F', G-G'

LOWER CORRAL CANYON

HUMBLE OIL AND REFINING COMPANY

GEOTECHNICAL CONSULTANTS, INC.
■ SOIL ENGINEERING ■ ENGINEERING GEOLOGY
■ GEOPHYSICS ■ GEOHYDROLOGY
Glendale Santa Ana Ventura California

JOB V1004 SEPT. 1971 PLATE 5-1



GEOTECHNICAL SECTIONS H-H' J-J', K-K', L-L', M-M', N-N'

CORRAL CANYON SITE "D"

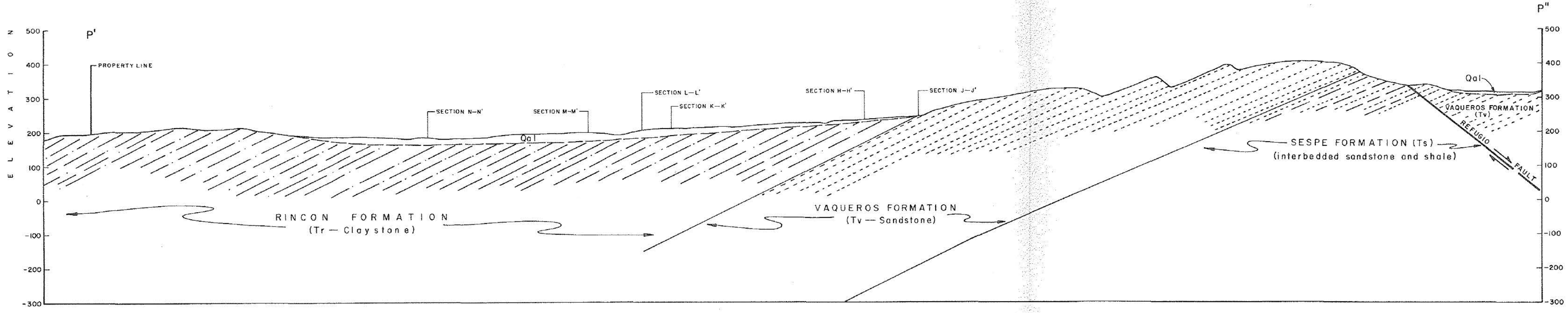
HUMBLE OIL AND REFINING COMPANY

100 0 100 200 300 400
SCALE IN FEET
HORIZONTAL & VERTICAL SCALE

SEE PLATE 3-2 FOR LOCATION OF SECTIONS AND GEOLOGIC LEGEND

GEOTECHNICAL CONSULTANTS, INC.
SOIL ENGINEERING · ENGINEERING GEOLOGY · GEOPHYSICS · GEOHYDROLOGY
Glendale, Santa Ana, Ventura, California

JOB V1004 SEPT., 1971 PLATE 5-2



100 0 100 200 300 400

SCALE IN FEET
HORIZONTAL & VERTICAL SCALE

GEOLOGIC LEGEND ON PLATES 3-1, 3-2, 4

GEOTECHNICAL SECTION P-P'-P"
CORRAL CANYON

HUMBLE OIL AND REFINING COMPANY

GEOTECHNICAL CONSULTANTS, INC.
SOIL ENGINEERING ■ ENGINEERING GEOLOGY ■ GEOPHYSICS ■ GEOHYDROLOGY
Glendale, Santa Ana, Ventura, California

JOB V1004 SEPT. 1971 PLATE 5-3

VIEW SOUTHWESTERLY SHOWING LAS FLORES CANYON. INTERVENING RIDGE BETWEEN LAS FLORES AND CORRAL CREEK IS AT LEFT END OF PHOTO. VENADITO CANYON IS SITUATED BEYOND RIDGE ALONG TOP OF PHOTO. PHOTO ALSO SHOWS VAQUEROS FORMATION (SANDSTONE) AT RIGHT END. THE RINCON FORMATION OCCUPIES MAIN PORTION OF PHOTO, WITH THE MONTEREY FORMATION SHOWING IN THE UPPER LEFT IN THAT PORTION OF THE PHOTO MARKED BY A BRUSH LINE. THE FORMATIONS ARE DIPPING FROM RIGHT TO LEFT.

PANORAMIC PHOTOS		
JOB V1004	GEOTECHNICAL CONSULTANTS, INC.	PLATE 6-1

VIEW SOUTHEASTERLY SHOWING INTERVENING RIDGE BETWEEN LAS FLORES AND CORRAL CANYON AT CENTER LEFT OF PHOTO. THE CONFLUENCE OF THESE CANYONS IS NEAR THE BARN AT CENTER RIGHT. THE PACIFIC OCEAN IS AT THE UPPER RIGHT, AND THE RIDGE ALONG TOP OF PHOTO MARKS THE EASTERLY PROPERTY LINE OR LIMIT OF STUDY AREA.

VIEW NORTH SHOWING LAS FLORES CANYON. FACILITIES WOULD BE LOCATED IN THE CANYON BOTTOM FROM THE RIGHT FOREGROUND TO THE TREE MARKED RESISTANT RIDGE AT CENTER OF PHOTO. THIS RIDGE MARKS THE VAQUEROS FORMATION. BRUSH COVERED AREAS IMMEDIATELY BEYOND ARE UNDERLAIN BY THE SESPE FORMATION. THE GRASS COVERED AREAS IN FOREGROUND OF PHOTO ARE UNDERLAIN BY RINCON FORMATION.

THE LANDSLIDE ON THE WEST SIDE OF SITE "D" IS DELINEATED BY CANYON-LIKE FEATURE INTERSECTING THE INTERMEDIATE RIDGE IN CENTER LEFT OF PHOTO.

A SMALL RECENT LANDSLIDE OCCURRED IN THE SADDLE SHOWN AT CENTER RIGHT.

CREST OF SANTA YNEZ MOUNTAIN RANGE IS SHOWN ALONG UPPER EDGE OF PHOTO.

PANORAMIC PHOTOS		
JOB VI004	GEOTECHNICAL CONSULTANTS, INC.	PLATE 6-2

APPENDIX 4.4

SUPPLEMENTAL PLAN OF OPERATIONS

SANTA YNEZ UNIT

APPENDIX 4.4

Site Improvement Report, Humble Oil & Refining Co.

Onshore Facilities - Corral Canyon, Site "D"

Penfield & Smith Engineers Inc.

September, 1971

Site Improvement Report

SITE "D"

Humble Oil & Refining Co.
Onshore Facilities Corral Canyon

County Of Santa Barbara, Calif.
1971

PENFIELD & SMITH
ENGINEERS INC.

111 E. VICTORIA ST. • SANTA BARBARA, CALIF. 93102
966-7156 AREA CODE 805
MAILING ADDRESS: P. O. BOX 98

CIVIL ENGINEERS
SURVEYORS
PLANNERS

September 13, 1971

Humble Oil and Refining Company
Western Division
1800 Avenue of the Stars
Los Angeles, California 90067

Gentlemen:

Transmitted herewith is our engineering report of the investigation of Site D for Humble Oil and Refining Company's proposed onshore petroleum treating and storage facilities in the Corral Canyon area.

A Preliminary Grading Plan for this site has been included in this report.

We believe that the information in this report, in conjunction with data currently in your files, will enable you to select the site best suited for the stated purposes.

Respectfully submitted,

PENFIELD & SMITH ENGINEERS, INC.

By Jerry D. Smith
Jerry D. Smith

JDS:ga
Enc.

TABLE OF CONTENTS

TABLE OF CONTENTS, CONT'D.

SECTION I

INTRODUCTION

PURPOSE

The purpose of this report is to discuss the proposed improvement of Site D for onshore facilities for final crude treatment and storage.

ACKNOWLEDGMENTS

Information on the geology and soil conditions in the area of Site D was provided by Geotechnical Consultants, Inc., and their findings are set forth in a separate report. Joe Gonzalez and Ivar Strahl of that company were of special assistance in working out the details of the site plans.

SECTION II

SUMMARY AND CONCLUSIONS

SUMMARY

Site D could be developed in the Las Flores Canyon by excavating in the northern portion of the site and using this material to fill across Las Flores Creek. A culvert would be required to conduct the drainage in Las Flores Creek under the filled area. Approximately 500,000 cubic yards of material would be moved.

Our opinion of some of the advantages and disadvantages of Site D are listed as follows:

Advantages

1. The site would hold all necessary facilities.
2. Corral Creek would not be disturbed.
3. It is geotechnically feasible to develop the site.
4. The site is approximately 6,500 feet from U.S. Highway 101 and not in clear view from the highway.

Disadvantages

1. The property is not owned by Humble Oil & Refining Company.
2. Scattered oak trees in the northern portion of the site would be destroyed.
3. Las Flores Creek through the site would be filled over and replaced with a concrete culvert.

CONCLUSIONS

It is not the intent of this report to select Site D as the most suitable for the Humble Oil and Refining Co.

facility. Subjects beyond the scope of this report such as land costs and pipe line costs would have to be considered in such a determination.

However, we believe that prime consideration should be given to the site that can hold all facilities in one location, have the least effect on the ecology and environment of the area, be least in view to the general public, and, therefore, have the greatest chance for approval by residents and County Officials of the County of Santa Barbara.

It is our opinion that Site D comes nearer to providing these assurances than any of the other previously studied sites.

SECTION III

SITE D COMMENTS

LOCATION

Corral Canyon is located in the southern foothills of the Santa Ynez Mountains approximately 20 miles West of Santa Barbara. It lies in the immediate proximity of El Capitan Beach State Park, a public camping and swimming area, which is heavily used by both local residents and tourists. The orientation of the canyon is North-South, making it almost perpendicular to U.S. 101, which traverses its seaward end. The upper reaches of the canyon are presently in a generally natural state and show only moderate effects of human intrusion. The lower area, that fronting U.S. 101 and the coastline, is presently occupied by a citrus orchard and a small petroleum operation. The orchard serves only minimally to buffer the tanks and other facilities now located there. Site D is located approximately 6,500 feet northerly of U.S. Highway 101 up Corral Canyon in a small canyon branching to the northwest called Las Flores Canyon. Site D is located on portions of three properties - Assessor's Parcels 81-220-06, 81-230-01 and 81-220-01. See Vicinity Map - Plate 1 and Key Map - Plate 2.

PREVIOUS SITE INVESTIGATIONS AND REPORTS

Several sites have been investigated in the Corral Canyon area to establish those believed to be the best suited for the proposed development.

A previous site improvement report was prepared by this office and submitted to Humble Oil & Refining Co. on July 21, 1971. That report set forth our findings on Sites A, B, & C, in the Corral Canyon area.

Information on the geology and soil conditions in the area was provided by Geotechnical Consultants, Inc., and their findings are set forth in a report dated June 14, 1971.

SELECTION OF "SITE D" FOR STUDY

The recently completed studies by Stearns-Roger Corporation have determined that a much smaller area is required for the treating and storage facilities than was believed necessary at the time Sites A, B, & C, were being considered.

Several meetings with Humble Oil & Refining Co. and consultants led to the opinion that a site not situated in the main Corral Canyon would be more desirable for environmental reasons.

Hence Site D located in the small canyon branching to the northwest called Las Flores Canyon was selected for study.

TOPOGRAPHY

Corral Canyon and Las Flores Canyon are generally relatively narrow canyons bordered by steeply sloping hillsides. Both Corral Canyon and Las Flores Canyon contain streams fed by springs and runoff from the upper reaches of the seaward slope of the Santa Ynez Mountains. The contributory area of this drainage basin approximates 4,250 acres. See the Drainage Map - Plate 3.

A topographic map of the canyon area from U.S. 101 to the North boundary of the property owned by Humble Oil, was prepared by Mark Hurd Aerial Surveys, Inc. at a scale of 1" = 100'. Ground control was provided by this office and was accomplished by triangulation and measurement of base line distances using an electrotape. This map was included in the previous report.

No accurate topographic map of the Site D area is available. The plan of Site D has been prepared on a topographic map by Mark Hurd Aerial Surveys, Inc., showing 5' contours of relative accuracy only. Vertical control was determined solely by interpolation from U.S.G.S. contours. In areas not covered by the Mark Hurd contours, forty foot contours have been added from enlargements of U.S.G.S. maps and are approximate only. Accurate topography will be necessary for preparation of final engineering drawings.

Natural vegetation is sparse along the sides of the canyon. However, heavy brush and many trees flourish along the creeks. The significant trees are either live oak or sycamore.

GEOLOGICAL CONDITIONS

Information concerning the geology and soils conditions in the general area was provided by Geotechnical Consultants, Inc. Their findings are set forth in a separate report dated June 14, 1971 and entitled "Geotechnical Reconnaissance, Proposed Humble Oil Company Onshore Facility, Corral Canyon Area, County of Santa Barbara, California, For Penfield and Smith." A supplementary report is being prepared by Geotechnical Consultants, Inc. relating specifically to Site D and will be submitted directly by the authors.

Geotechnical Consultants, Inc. also provided additional information and consultation during the development of the site plan which is the subject of this report.

Particular emphasis is placed upon this section of our study since the geotechnical considerations for site development present the greatest physical problems. Grading and drainage design must not only provide the required surface area, but must also consider the problems of stabilizing landslides.

EXISTING LAND USE AND IMPROVEMENTS

The most southerly parcel in Corral Canyon is presently occupied by the Shell Oil Company and is being utilized for orchards, oil well production and oil storage. A few small structures exist on the property. Humble Oil & Refining Co. has an option to purchase this property. The adjacent property to the North is used for oil well production and grazing land. Humble Oil & Refining Co. owns this property, however, the oil wells and associated production facilities are currently owned and operated by the Shell Oil Co.

The most northerly property owned by G. M. Williams and Louise M. Erro is used exclusively for cattle grazing. Two old unoccupied buildings exist on the property.

GENERAL PLAN AND ZONING

The Santa Barbara County General Plan was adopted August 17, 1965 by the Board of Supervisors of Santa Barbara County. GP-1, a portion of said adopted plan, shows symbolically an "oil field" at this location, extending northerly from Highway 101 to the vicinity of the fork in the canyon. The area surrounding is shown on GP-1 as "open and grazing." See Plate 7.

The property is presently zoned "U" - Unlimited agricultural. The Santa Barbara County Zoning Ordinance 661 sets forth the allowable uses in this zone.

GRADING

In general, Site D would be constructed by excavating in the Vaqueros and Rincon formations located in the northerly portion of the site to create a level surface for the major storage tanks. The excavated material would be used to fill across Las Flores Creek, buttressing the natural slopes on both sides and creating additional usable area for the rest of the facilities. See the Preliminary Grading Plan on Plate 4.

Approximately 500,000 cubic yards of normal excavation would be required to develop the site. An estimated additional 50,000 cubic yards of loose slide material under the proposed fill must be over-excavated and recompacted.

Before final engineering can be completed for this site, additional geotechnical information must be obtained from borings penetrating the slide mass and an accurate topographic map must be prepared.

Ordinance No. 1795 regulates the excavation, grading and filling of land within the County of Santa Barbara.

Detailed final grading plans must be checked and approved by the County Public Works Director.

Plans must be supported by detailed soils and geological data to assure that sites will be stable after grading operations are complete.

A soils engineer must provide continuous soils inspection, take compaction tests, and generally supervise the grading operation.

It is anticipated that all grading operations will be accomplished by standard methods. Material will be excavated and transported by bulldozers and tractor scraper units to areas to be filled, placed in layers, watered to optimum moisture content, and compacted to a minimum of 90 percent of maximum density with sheepsfoot rollers pulled by bulldozers.

DRAINAGE

Las Flores Canyon drainage must be conducted through Site D in a closed conduit. The contributory drainage area to this culvert would be approximately 680 acres, and the time of concentration is estimated as 24 minutes. Rainfall intensity from County Flood Control Data would be 2.6 inches per hour with a runoff coefficient of 0.62. Using the rational method where $Q = ciA$, the amount of drainage to be conducted by the culvert equals $0.62 \times 2.6 \times 680 = 1096$ cubic feet per second.

A 96 inch reinforced concrete pipe or a 7' x 8' reinforced concrete box culvert would be needed to conduct this drainage through the site.

Drainage from the slopes adjacent to the site should be intercepted, conducted around the site, and disposed of into Las Flores Creek by ditches and conventional storm drains.

All drainage facilities must be checked and approved by the Santa Barbara County Flood Control Engineer.

FIRE PROTECTION

We have met with Chief Gordon, Assistant Santa Barbara County Fire Chief, to determine any special requirements or codes which would pertain to treating facilities in this area.

It was determined that Ordinance No. 1924 adopts the Uniform Fire Code, 1967 Edition, with amendments.

Article 15 of the Uniform Fire Code applies to the storage, handling and use of flammable and combustible liquids, such as crude oil. Sections of Article 15 refer to sections in the National Fire Code - N.F.P.A. No. 30.

Article 20 of the Uniform Fire Code applies to the storage, handling and transportation of liquified petroleum gas, such as propane and butane. Sections of Article 20 refer to sections in the National Fire Code, N.F.P.A. No. 58 and No. 59.

In addition to complying with the codes mentioned above, the importance of good access roads, wide clearance areas around the perimeter of facilities, and sufficient water supply for fire fighting must not be overlooked in design of the installation.

Earth dikes restricted to an average height of 6 feet above the interior grade are to be provided around the major storage tanks, crude surge tanks, rerun tanks, and slop oil tanks in accordance with Section 15.206 of the Uniform Fire Code.

Graded ditches at a minimum slope of one percent must take drainage to a nearby collecting basin. Any oil must be separated from the water at the collection basin and clean water may then be directed into the creek by a conventional storm drain.

Calculation of the major storage tank area to provide the required volumetric capacity to comply with Section 15.206 of the Uniform Fire Code, Paragraph C, subparagraph (2) is as follows:

Total Facilities - 4-110,000 Barrel Tanks

130 Ft. Diameter and 48 Ft. in Height

Let C = Capacity Required
Let A = Gross Area Required to the Midpoint of the Dike Slopes

$$C = 110{,}000 \text{ bbls.} \times 5.6 \frac{\text{Cu. Ft.}}{\text{bbl.}} = 616{,}000 \text{ Cu. Ft.}$$

$$C = 616{,}000 \text{ Cu. Ft.} = (6A) - (110{,}000 \times \frac{6}{48} \times 5.6 \times 4)$$

$$A = 154{,}000 \text{ S.F.} = 3.6 \text{ Ac.}$$

If two 10,000 bbl. crude surge tanks and a 10,000 bbl. re-run tank is included in the major storage tank area, the required area would be increased to 3.7 acres.

AREAS REQUIRED

General area requirements for preliminary planning purposes were obtained from typical rectangular facility layouts prepared by Stearns-Roger Corporation and calculated areas to provide minimum volumetric diked capacity complying to fire codes.

The areas tabulated in Table 1 are estimated, approximate minimum area requirements, to accommodate all facilities including access roads. The final area requirements will be dictated by the shape of the graded area and the spacing of the facilities.

TABLE 1

Facility	Area
Diked Major Storage Tank Area Including Crude Surge, and Rerun Tanks	5.0 Ac.
Crude Oil Treating Area	2.5 Ac.
Gas Processing Area	3.0 Ac.
Pump Area	0.6 Ac.
Butane & Propane Loading Area	1.6 Ac.
Sulfur Loading	0.6 Ac.
Office Facilities & Parking	0.5 Ac.
TOTAL	13.8 Ac.

The plan for Site D provides for approximately 15 acres of usable area.

ROADS

All access roads to and through the site should be approximately 20 feet in width and could generally follow the route of the existing road up Corral Canyon. Some improvements to the alignment and grade of the existing road could be accomplished with minor grading.

A sound structural road bed should be constructed for all existing and new roads to withstand heavy truck loads with little maintenance.

The access road will cross Corral Creek three times. It is recommended that a culvert large enough to pass a 25 year frequency storm be constructed at these crossings. Drainage during a larger storm would be allowed to flow over the roadbed. A double 12' x 10' reinforced concrete box culvert would be needed.

WATER SUPPLY

General: Water for the proposed facilities will be needed for the following uses: Domestic, landscaping, treating facility, and fire protection. Domestic needs can be estimated at 50 gallons per capita per day maximum. Ten full time employees at the site has been estimated for design purposes, and the domestic water requirement would be 500 gal./day or approximately 0.6 acre-feet per year.

Since the landscaping planned for the facility is mostly native trees and shrubs, the water requirements after they become established would be low. This water need is estimated as 10 acre-feet per year.

A 20,000 bbl. tank is planned for fire storage. Assuming the tank is filled once a year, three acre-feet peryear would be needed to fill the tank. Pressure for fire flow would be developed by pumps. Some water would be needed for use in the treating facility. This amount is estimated to be less than 5 acre-feet per year.

The total demand for all needs is estimated at approximately 20 acre-feet per year.

There are four possible sources of supply for water. These are local ground water, local surface water, imported water and effluent water. All four of these sources have been studied, and it has been concluded that the most logical and feasible source is local ground water.

Ground Water: Wells drilled to a depth of 250 to 400 feet in Vaqueros sandstone formation should yield from 50 to 150 gallons per minute. The only source of ground water recharge is infiltration of rainfall within the watershed area, and the maximum available recharge to the ground water reservoir in the Corral Canyon catchment area near Site D has been estimated by Geotechnical Consultants, Inc. at 558 acre-feet per year and 136 acre-feet per year in the Las Flores Canyon catchment area. Mineral analysis of ground water from adjacent wells indicates a total content of dissolved solids in the range of 700 to 900 parts per million, which is near the limit of permit requirements for drinking water as adopted by the California State Board of Public Health. In any case, the water is treatable if necessary. Treatment could consist of aeration, filtration, demineralization by electrodialysis, and chlorination. Only that portion of the water supply used for domestic purposes need be treated. Raw water recovered from the wells will be satisfactory for fire protection uses and landscaping.

Local Surface Water: While the surface flow from Corral Canyon reportedly flows all year, it is our opinion that this may not always be the case. Therefore, surface water sources are not believed to be reliable enough for permanent planning.

Imported Water: Since the nearest municipal water supply is in the Goleta Valley, the only practical consideration of imported water is for domestic uses. This could mean simply bottled drinking water or tank storage for potable supplies.

Effluent Water: Salt water will be separated from the crude oil stream by the oil treating facility, but it is believed that the quality of this water is such that it is unsuitable for project uses.

ELECTRICAL AND TELEPHONE SERVICE

Electrical power lines belonging to Southern California Edison Company, and telephone lines belonging to General Telephone Company of California exist along U.S. Highway 101. Electrical service lines and telephone lines should be constructed underground to the proposed site along the same route as the other pipe lines.

SEWAGE DISPOSAL

There is only one practical method for sewage disposal, and that is the use of septic tanks and subsurface leaching.

Until percolation rates of the soils are determined by tests it will not be possible to design the system. Subsurface disposal could utilize either leach fields or dry wells.

Installation of the system will require approval by the County Health Department

PROFILE - LINE OF SIGHT

A profile showing a line of sight from U.S. Highway 101 is shown on Plate 6.

Most of the site would not be visible from U.S. Highway 101 due to the natural hillsides. Even a line of sight directly up Corral Canyon is partially blocked by existing trees approximately 1400 feet from the highway.

LANDSCAPING

A preliminary landscaping plan and cost estimate for Site D has been prepared by Richard Taylor and Associates. See Plate 5 and Table 2.

The landscape development consists of a landscape irrigation system, screen planting of large trees to conceal the facilities, erosion control planting and naturalistic groupings of native shrubs and trees to blend with the surrounding natural slope cover.

All cut and fill slopes (except interior slopes of dikes) will be planted to closely approximate the natural vegetation. In all cases, drought tolerant plant material generally considered as fire resistant will be utilized. The irrigation system will insure the maintenance of healthy growth and provide a further fire deterrent. All native brush will be removed within 50 ft. of the road surrounding the facilities and replaced with fire resistant groundcover, trees and shrubs, watered by a sprinkler system. For additional protection, a separate system of impact sprinkler heads will be installed on the periphery of the planted areas surrounding the facilities. This would allow the wetting down of an additional buffer area around the facilities in case of emergency.

Plantings being considered include:

Baccharis pilularis (prostrate coyote bush) for the basic groundcover, live oaks and pines. Native shrub groupings include Rhus integrifolia (lemonade berry), Heteromeles arbutifolia (toyon, or native holly), and Prunus lyoni (catalina cherry).

Screen planting at the narrow entrance to the facilities in Flores Canyon and the intermediate screen planting for the storage tanks consist of 25 ft. tall Monterey and Aleppo pines, backed up by 5 gallon Eucalyptus globulus. Native shrubs provide a lower, fill-in screen to augment the trees.

All slopes will be stabilized by hydromulching with a slurry consisting of water, mulch, stabilizer (silva-fibre, or equal), plus some seeds of drought tolerant native flowering plants such as Mimulus (monkey flower), etc.

It is estimated that the water requirements for the plantings (included in the total domestic water requirements) will be 12 - 14 inches per year for the planted areas on a continuing basis. However, the first year water requirement for establishing the plantings would be approximately double this figure.

Landscape maintenance would consist of operating, adjusting and repairing the irrigation system; replacement of plants as required; and weeding, maintenance of basins, etc. An important continuing maintenance operation would be to remove any native chapparal and sage each year which invade the planted slopes and which would otherwise constitute a fire hazard.

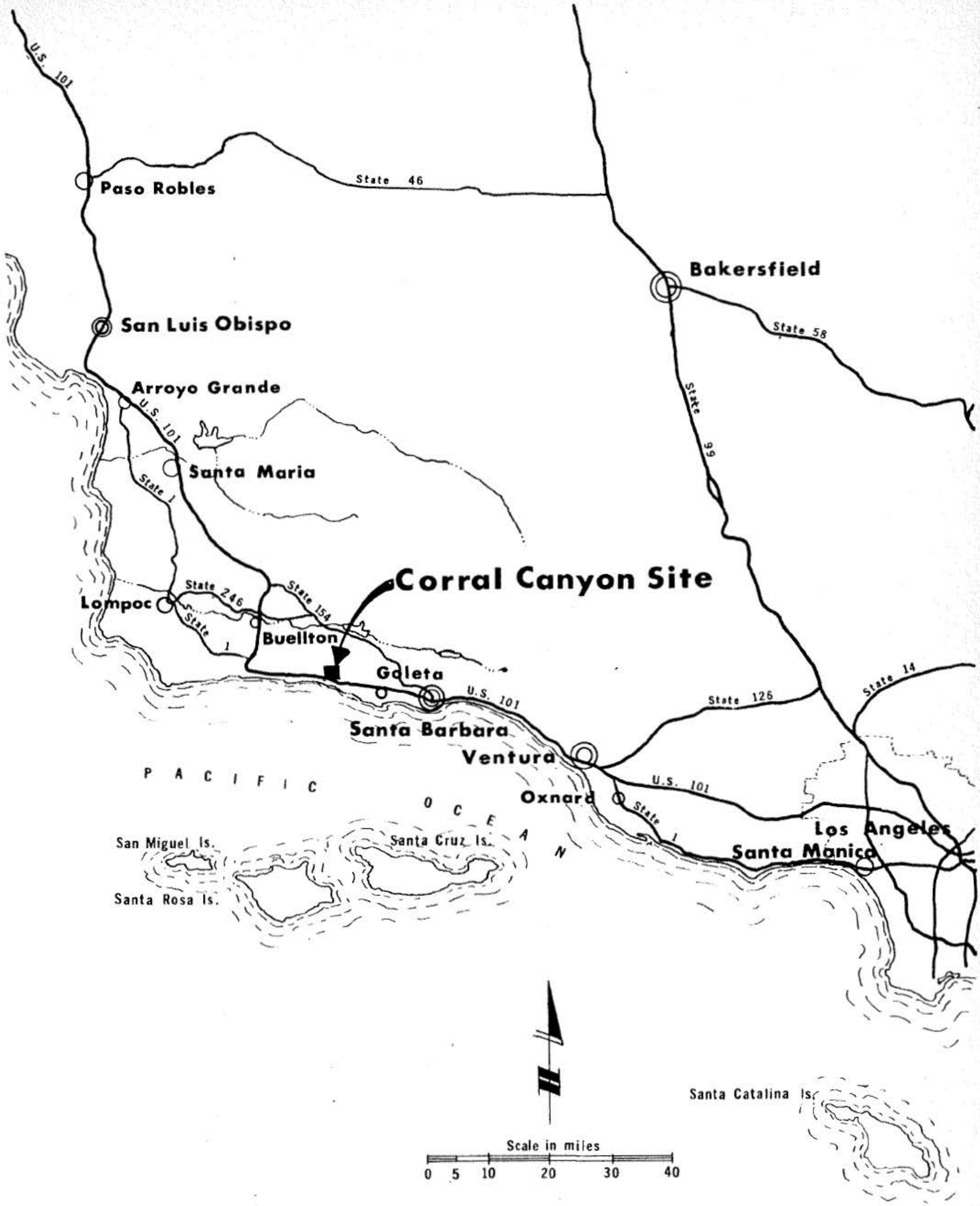
The general effect then will be to visually isolate the facility in an unimportant, mostly dry side canyon, leaving the main canyon, Corral Creek, untouched. Graded slopes will not exceed 2:1 and will be planted to harmonize with the existing natural plant cover.

TABLE 2

PRELIMINARY COST ESTIMATE

SITE "D"

	Quantity	Unit Cost	Unit Total	Total
Site Clearing and Demolition (Removal of exist. vegetation for fire protection)			$ 2,000.	$ 2,000.
25 ft. tall Monterey or Aleppo pines	200	$ 850.00 ea.	$170,000.	
15 gal. trees	80	$ 45.00 ea.	$ 3,600.	
5 gal. trees	50	$ 9.00 ea.	$ 450.	
5 gal. shrubs	150	$ 8.50 ea.	$ 1,275.	
1 gal. shrubs	350	$ 3.00 ea.	$ 1,050.	
Groundcover	499,145 sq.ft.	$ .04/sq.ft.	$ 19,965.	
Hydromulching	499,145 sq.ft.	$ .02-1/2 sq.ft.	$ 12,478.	
Total Planting				$210,818.
Sprinkler system			$ 70,000.	$ 70,000.
TOTAL COST				$280,818.
		10% contingency		$ 28,081.
				$308,899
		1.5% bonds		$ 4,633.
				$313,532.
		Estimated fee		$ 15,000.
TOTAL COST				$328,532.



Humble Oil & Refining Co.
Corral Canyon Site

Vicinity Map
Plate 1

PENFIELD & SMITH ENGINEERS INC.

Penfield & Smith Engineers Inc.
111 E. Victoria Street
Santa Barbara, California

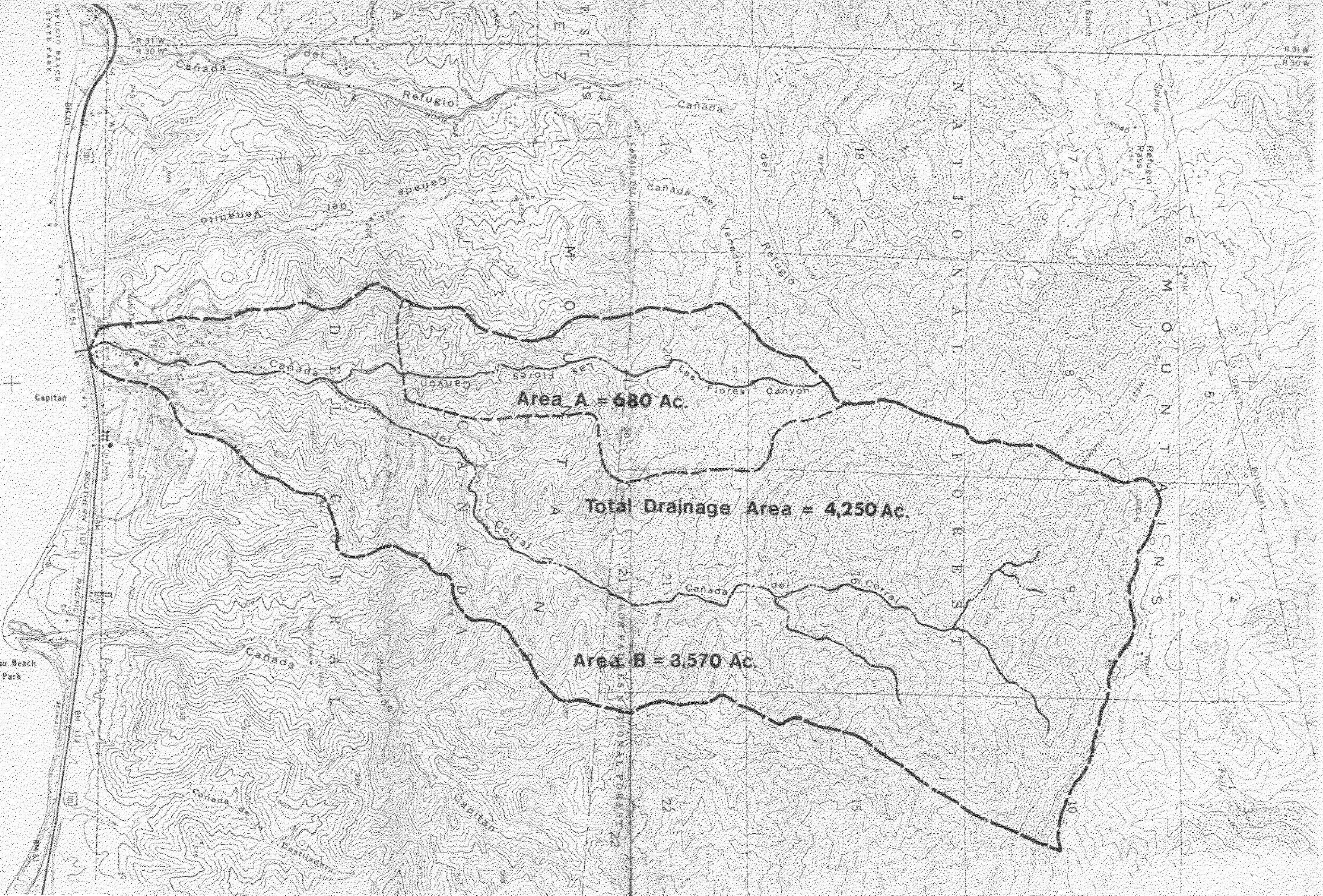
Scale: 1" = 450' ±

Humble Oil & Refining Co.
Corral Canyon Site

Key Map

Plate 2

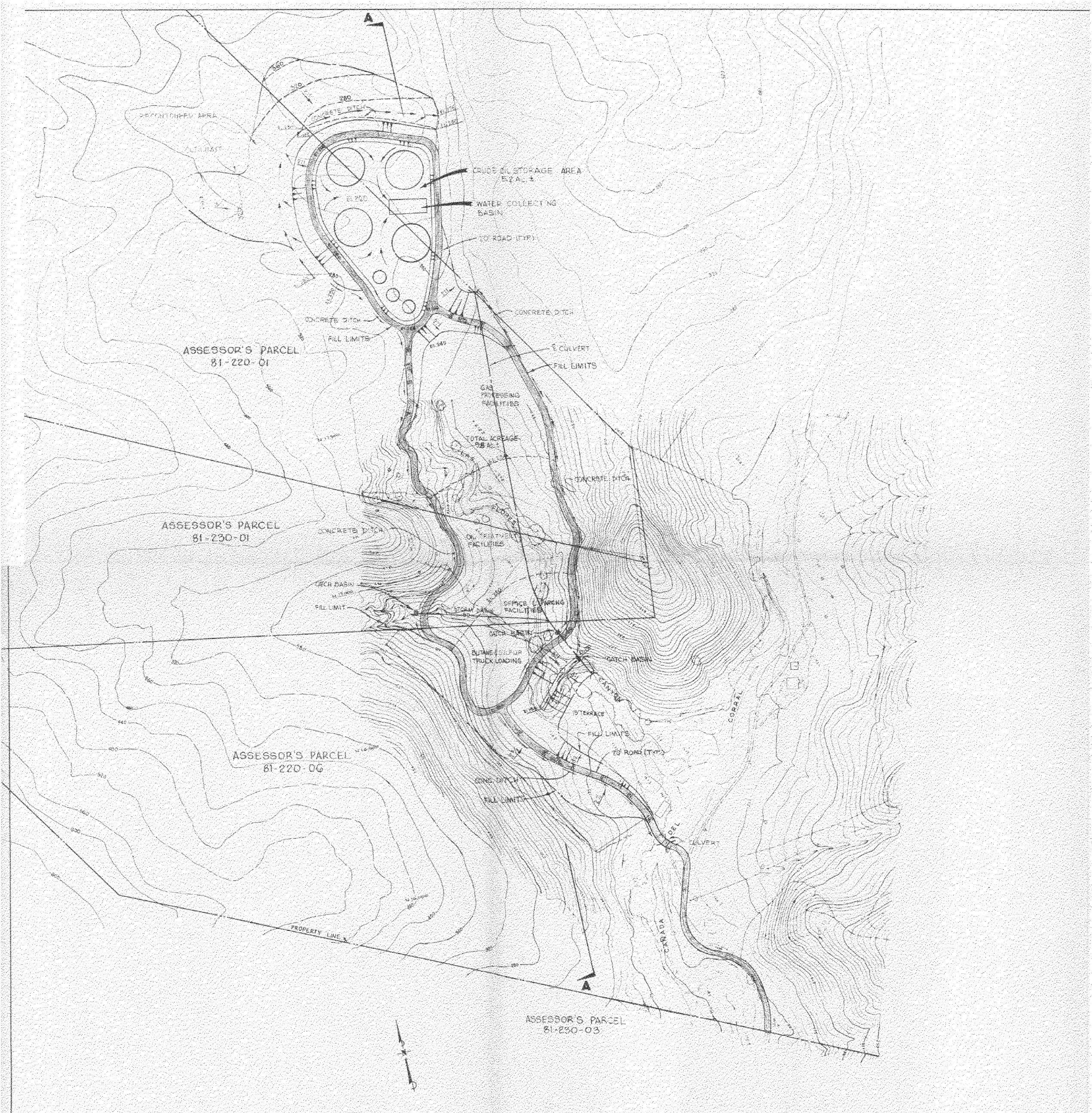
Penfield & Smith Engineers Inc.



Scale in feet
0 2000 4000

Humble Oil & Refining Co.
Corral Canyon Site

Drainage Map
Plate 3



PENFIELD & SMITH
ENGINEERS INC.

Photography date 1/26/71

This map was compiled at 1"=80' and was photographically reduced to 1"=200'

This planning map was prepared with vertical control interpolated from U.S.G.S. map contours. Do not use for Engineering purposes.

Mark Hurd

SCALE 1"=200'

0 100 200 300

CONTOUR INTERVAL 5'±

PRELIMINARY GRADING PLAN

CORRAL CANYON SITE "D"

HUMBLE OIL & REFINING CO.

COUNTY OF SANTA BARBARA, CALIFORNIA

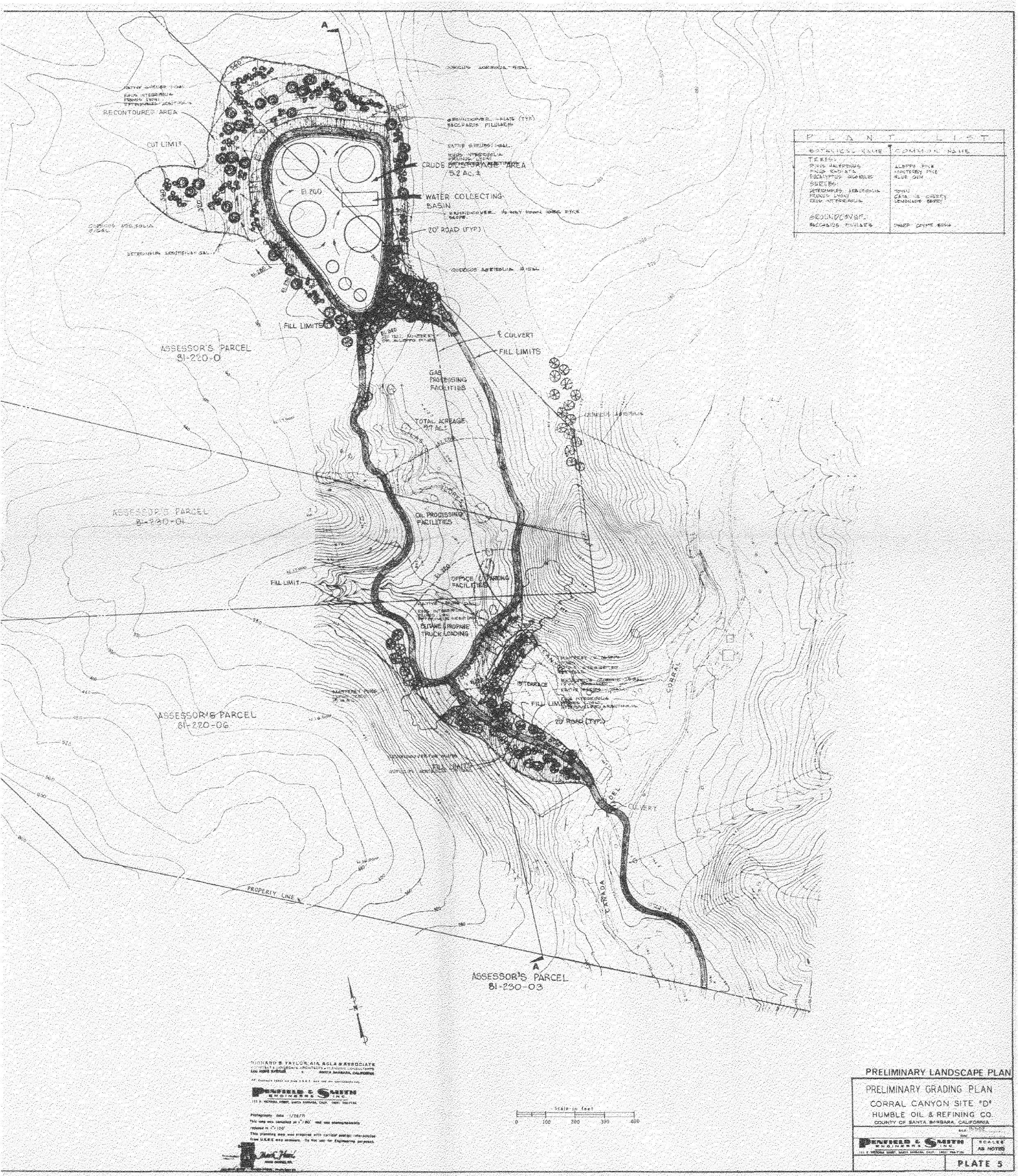
15502

Sept. 14-1971

PENFIELD & SMITH ENGINEERS INC.

SCALES AS NOTED

PLATE 4



PRELIMINARY LANDSCAPE PLAN

PRELIMINARY GRADING PLAN
CORRAL CANYON SITE "D"
HUMBLE OIL & REFINING CO.
COUNTY OF SANTA BARBARA, CALIFORNIA

PENFIELD & SMITH ENGINEERS INC.

SCALES AS NOTED

PLATE 5

Scale: Horiz. 1"=200'
Vert. 1"=200'

Humble Oil & Refining Co.
Corral Canyon Site

Profile A-Line of sight through SITE D from U.S. Highway 101

Penfield & Smith
111 E. Victoria Street
Santa Barbara, California

Plate 6

C E R T I F I C A T I O N

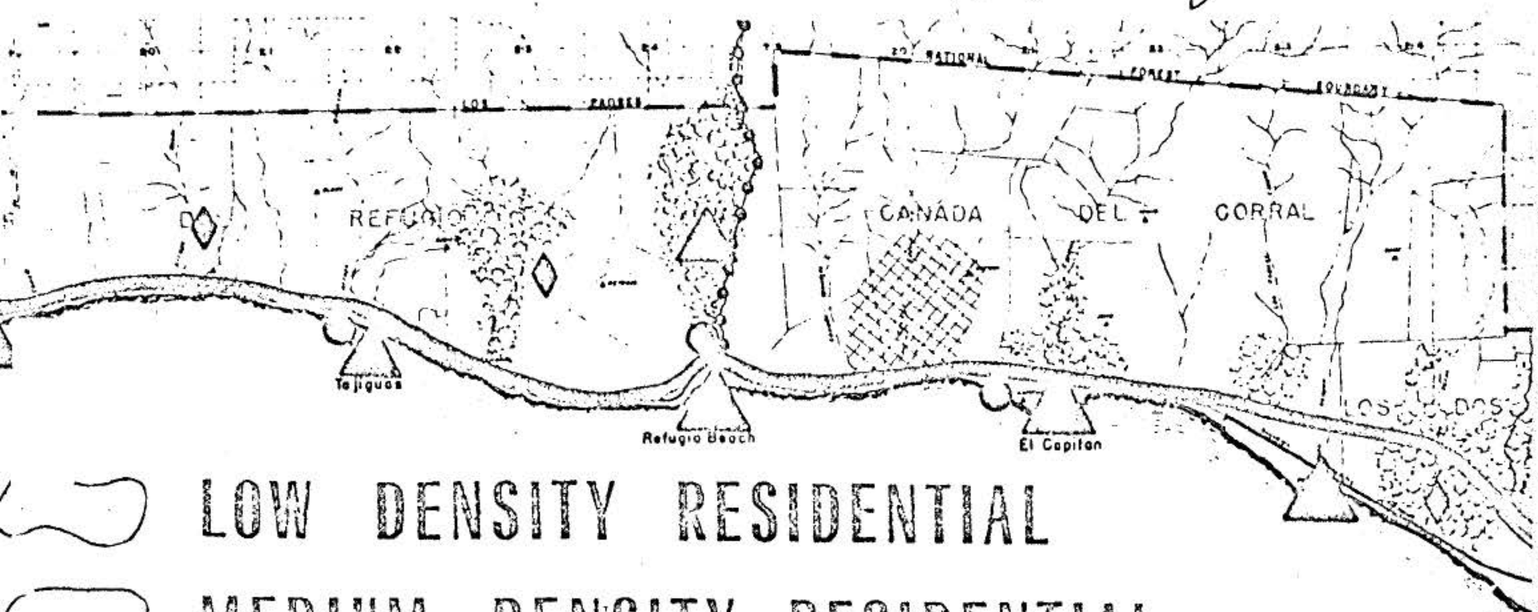
WE HEREBY CERTIFY THAT THIS MAP IS PART OF THE *GENERAL PLAN* WHICH WAS ADOPTED, RECOMMENDED, AND CERTIFIED TO THE BOARD OF SUPERVISORS OF THE COUNTY OF SANTA BARBARA BY RESOLUTION NO. 65-50 OF THE *PLANNING COMMISSION* ON THE 4th DAY OF AUGUST, 1965

• SECRETARY, PLANNING COMMISSION • CHAIRMAN, PLANNING COMMISSION

WE HEREBY CERTIFY THAT THIS MAP IS A PART OF THE *GENERAL PLAN* WHICH WAS ADOPTED BY RESOLUTION NO 24908 OF THE *BOARD OF SUPERVISORS* ON THE 17th DAY OF AUGUST 1965

• COUNTY CLERK • CHAIRMAN, BOARD OF SUPERVISORS

Scale: 1" = 8000'



LOW DENSITY RESIDENTIAL

MEDIUM DENSITY RESIDENTIAL

HIGH DENSITY RESIDENTIAL

COMMERCIAL INDUSTRIAL

AIRPORT OIL FIELD

AGRICULTURAL LAND

OPEN AND GRAZING

RECREATION AREA (PUBLIC OR PRIVATE)

HISTORICAL SITE

GP-1

SANTA BARBARA COUNTY GENERAL PLAN

Plate 7

APPENDIX 4.5

SUPPLEMENTAL PLAN OF OPERATIONS

SANTA YNEZ UNIT

APPENDIX 4.5

Engineering Study for Crude Oil
Treating and Storage Facility, Santa Barbara Channel

Stearns-Roger Corporation

August, 1971

HUMBLE OIL AND REFINING COMPANY

LOS ANGELES, CALIFORNIA

ENGINEERING STUDY

for

CRUDE OIL TREATING AND STORAGE FACILITY
SANTA BARBARA CHANNEL

PREPARED BY

STEARNS-ROGER INCORPORATED

DESIGN BASIS

C-10140
August 1971

HUMBLE OIL AND REFINING COMPANY
CRUDE OIL TREATING AND STORAGE FACILITY
SANTA BARBARA CHANNEL

DESIGN BASIS

In requesting this study, covering the design of onshore Crude Oil Treating and Storage Facilities for the Santa Barbara Channel area, certain basic data, requirements, and design criteria were set forth by Humble to be used as a basis for design. This information is summarized below:

SITE LOCATION

The Crude Oil Treating and Storage Facilities are to be located about 6-7000 feet north of the highway (US-101) in Los Flores Canyon, just north of its junction with Cañada del Corral. Contour maps of the area were furnished to aid in plant layouts.

BASIC DATA

Offshore Platform Crude Handling

Primary Separator,	Pressure	100 psia
	Temperature	60-120 °F
Crude Storage Tank,	Pressure	14.7 psia
	Temperature	105-120 °F

Onshore Crude Treating and Storage

Produced Crude Oil Properties

Composition	Mol Percent
Methane	.08
Carbon Dioxide	.06
Ethane	.38
Hydrogen Sulfide	.08
Propane	1.67
i-Butane	.53
n-Butane	3.61
i-Pentane	.67
n-Pentane	.84
Hexanes	3.98
Heptanes	4.08
Octanes	4.59

BASIC DATA - continued

Onshore Crude Treating and Storage

Nonanes	3.61
Decanes	5.03
171 MWT Fraction	12.91
238 MWT Fraction	8.25
303 MWT Fraction	49.63
Total	100.0

Sulfur Content, Maximum 4 weight percent
(Including light Mercaptans)

Specific Gravity @ 60°F 0.92-0.945

Crude Oil Rates

Phase I	40,000 B/D of ST Oil (Initial)
Phase II	+20,000 B/D of ST Oil (First Addition)
Phase III	+20,000 B/D of ST Oil
Total	80,000 B/D of ST Oil (Ultimate)

Produced Water Properties

Specific Gravity @ 60°F 1.019
Salinity 19,800 mg/liter (NaCL)

Produced Water Rates

Volume contained in Emulsion to Shore

Phase I	0-10,000 B/D (Initial)
Phase II	+ 5,000 B/D (First Addition)
Phase III	+ 5,000 B/D
Total	20,000 B/D (Ultimate)

Utilities

Electric Power - Purchased power available
Fuel Gas - Purchased gas available.

FACILITY REQUIREMENTS

The Crude Oil Facilities shall be designed so that the treating and storage operation will be odor free and have a minimum hazard for accidental water or air pollution. The final offshore oil separation is at 0 psig with a minimum of 105°F which should allow the onshore facilities to contain the remaining crude oil vapors.

The facilities should include Crude Oil Storage for approximately 5 days production. Automatic switching of inlet crude flow to oil treaters or to storage shall be included, along with necessary pumps, valving, and storage for rerunning oil from major storage to the treaters.

AIR QUALITY CRITERIA

The facility is to be odor free. No hydrogen sulfide is to be vented without incineration to sulfur dioxide. Average sulfur dioxide emissions from the onshore crude oil facilities shall be less than 2.0 Lbs/Hr. In addition, the facility shall be designed to meet the anticipated rules and regulations (4-8-71 draft) of the Air Pollution Control District of Santa Barbara County.

WATER QUALITY CRITERIA

Any open discharge of water from the facility will meet Regional Water Control Board standards, Environmental Protection Agency regulations, California Fish and Game regulations, and the 1965 Federal Water Pollution Control Act for discharge of produced water to the Pacific Ocean.

Any sub-surface discharge of water from the facility will be clarified, cleaned and treated before sub-surface injection.

OTHER DESIGN CRITERIA

The facilities shall be designed to meet the compatibility criteria of the Santa Barbara County Oil Policy Statement (April 12, 1967). Applicable local, state, and national codes and regulations shall be followed.

FACILITY DESIGN

C-10140
August 1971

HUMBLE OIL AND REFINING COMPANY
CRUDE OIL TREATING AND STORAGE FACILITY
SANTA BARBARA CHANNEL

FACILITY DESIGN

This study covers the design of a Crude Oil Treating and Storage Facility for the initial conditions of crude oil flow rates and composition given in the "Design Basis" section of this report. The facility is more fully described in the other sections of this report where a description, equipment lists and specifications, flow diagrams, and layouts will be found.

The initial facility will be expanded in two subsequent construction phases to an ultimate crude oil processing rate outlined in the "Design Basis" section of this report. For purposes of this report the initial facility has been referred to as "Phase I", with the two subsequent additions referred to as "Phases II and III". Additions of equipment necessary to accomplish Phases II and III are described in the section on "Facility Description".

Certain process and facility requirements and other criteria as outlined in the "Design Basis" dictated some of the design philosophy. The effects of these requirements on the design are discussed below.

DESIGN FOR AIR QUALITY CRITERIA

In designing the facility to be odor free and to meet the anticipated rules and regulations of the Air Pollution Control District of Santa Barbara County (APCD), several areas of the facility must be examined. The primary potential sources of potential air contamination are from the tank and equipment vent systems and the drain system. No sources of air pollution are anticipated for the Crude Oil Treating and Handling Facility. The design of the facility from an air quality standpoint is discussed below.

Drain Systems - Since the major source of odors in a crude oil facility is miscellaneous venting and accidental liquid spills of crude and produced brine, every effort must be made in the design to control these seemingly minor items.

DESIGN FOR AIR QUALITY CRITERIA

Drain Systems - continued

For this reason, all items such as gauge glasses and liquid level controls, which are routinely blown-down in the normal course of operations, have been connected into closed drain systems.

All vessels and other equipment which would normally be drained for maintenance purposes are also connected into these closed drain systems. Vapors from these drain systems, released at essentially atmospheric pressure, are collected and incinerated.

Vent Gas Handling - The Crude Oil Facility is designed to allow no discharge of vapors onshore. Design includes an offshore crude degassing step for vapor stabilization at 105° - 120°F at atmospheric pressure. Onshore treating pressures are maintained at all times sufficiently above the crude vapor pressure to prevent formation of a vapor phase. The crude surge and storage tanks are cone roof type equipped with internal floating roofs. This type of tank design is well proven in suppressing vapor evolution. All tanks and vessels are vented to a closed system with discharge through a vent vapor incinerator prior to release to the atmosphere. Sulfur emissions are less than 2.0 Lbs/Hr as sulfur dioxide equivalent during operation.

Fuel and Combustion Equipment - All fuel consumed in the facility will be sweet commercial natural gas. Total sulfur content of the fuel gas will be not more than 20 grains/100SCF, well below the maximum of 50 grains/100SCF allowed in the APCD regulations. Fuel gas will be used in direct fired crude heaters, and as well as for the vent gas incinerator. A total ultimate fuel gas consumption of 1,450 MSCF/D is anticipated.

DESIGN FOR WATER QUALITY CRITERIA

In designing the unit to meet water quality regulations, several factors are involved. No cooling water is required, and produced brine is disposed of by ground injection.

All cooling is accomplished by using aerial coolers so that no water cooling tower is required.

DESIGN FOR WATER QUALITY CRITERIA - continued

Heating requirements are handled by direct fired heaters. The two major heating requirements are the crude treaters and the vent vapors incinerator. No steam is used for heating.

All produced brine carried into the treating system is separated from the crude oil, treated in an air-tight closed system, and injected into brine disposal wells by high-pressure pumps. This brine disposal system serves as the ultimate disposal point for all waste liquids originating in the facility. The entire system is designed to prevent any surface or stream discharge of brines.

All waste drain streams originating from treating units or brine and crude storage vessels are collected in a closed drain system. This drain system discharges into a closed settling basin which is vented to the vent vapor disposal system. Any aqueous material collected in the settling basin is passed to the brine disposal system for ultimate injection into wells. Hydrocarbon material from the settling basin is collected and recycled. This settling basin also receives a small quantity of liquid waste material from adjacent Gas Processing Facility. This material is combined with the crude waste and disposed of to the brine wells.

The operating areas of the facility, which might be subject to accidental spills of hydrocarbons or lubricating oil from equipment, will be provided with curbs. All surface drainage from these areas will be routed to skimming facilities where any oil and hydrocarbons can be separated from the water before discharge to the creek. Any skimmed material will be collected and prevented from discharging to ditches or to the creek.

Sewage Disposal - Proper sanitary facilities, as required by codes and ordinances, will be provided for personnel in the office/shop/warehouse area and in the control building. The type of soil at the plantsite, as determined by a soil investigation, will have a great deal to do with the selection of the method of sewage disposal. If the resulting soil is a granular type (sand, gravel, etc.) with a relatively high degree of porosity, ideal for natural percolation, a conventional septic tank system with a disposal or leaching field will be recommended. If the soil is a highly compacted clay type impervious to liquid percolation, an alternate system, such as "Extended Aeration", will be proposed. Both systems mentioned above will be "odor free" with proper periodic maintenance.

OTHER DESIGN CRITERIA

Certain general factors such as codes, safety requirements, control and protection systems, and special materials have entered into the design of the facilities. These factors are discussed below.

Equipment Codes - All equipment in the facility will be of types usually used in oil and gas facilities. The following are the codes which will be used in the design and fabrication of the major items of equipment:

ASME Boiler and Pressure Vessel Code

Standards of Tubular Exchanger Manufacturers Association (TEMA Standards)

Standards of the Hydraulic Institute (Pumps)

American Petroleum Institute (API) various standards for tanks.

Building Codes - Numerous other codes, standards, regulations, etc. will be used in the design and installation of this facility, including but not limited to those listed below:

1. Uniform Building Code, as published by the International Conference of Building Officials.

2. California Administrative Code, Title 24, State Building Standards, Parts 1A and 2, Basic Building Regulations.

3. Concrete and Foundations

   a. ACI Building Code - American Concrete Institute.
   b. CRSI Design Handbooks - Concrete Reinforcing Steel Institute.
   c. ASTM Standards - American Society for Testing Materials.

4. Structural Steel

   a. AISC Manual of Steel Construction - American Institute of Steel Construction.
   b. AWS Standards - American Welding Society.
   c. ASTM Standards - American Society for Testing Materials.

OTHER DESIGN CRITERIA

Building Codes - continued

5. Piping

   a. Standard Codes for Pressure Piping as published by ASME (American Society of Mechanical Engineers).

      (1) ANSI B31.3 Petroleum Refinery Piping - American National Standards Institute.
      (2) ANSI B31.4 Liquid Petroleum Transportation Piping Systems.
      (3) ANSI B31.8 Gas Transmission and Distribution Piping Systems.

   b. Miscellaneous API (American Piping Institute) designations on material and other requirements.
   c. Miscellaneous ASTM Specifications or Standards.

6. Electrical

   a. NEC - National Electrical Code
   b. California Administrative Code, Title 24, State Building Standards, Part 3, Basic Electrical Regulations
   c. API, RP-500A - Area Classifications

7. Instrumentation

   a. ISA Standards and Practices for Instrumentation - Instrument Society of America.
   b. API Standards and Recommended Practices.
   c. AGA Orifice Metering of Natural Gas.
   d. "Flow Meter Engineering" by Spink.
   e. ASME Boiler and Pressure Vessel Code for Relief Valves.

8. General

   a. "General Industry Safety Orders", issued by the Division of Industrial Safety, State of California.
   b. "Petroleum Safety Orders - Refining, Transportation, and Handling", issued by the Division of Industrial Safety, State of California.
   c. Occupational Safety and Health Standards for General Industry, as published by the Department of Labor, Occupational Safety and Health Administration.

OTHER DESIGN CRITERIA

Building Codes

8. General - continued

   d. Safety and Health Regulations for Construction, as published by the Department of Labor, Bureau of Labor Standards.
   e. All applicable local codes - Santa Barbara County and State of California.

9. All design calculations and drawings on foundations, structures, buildings, etc. will be stamped by an engineer registered in the State of California.

Foundation Design - A complete soil investigation of the entire site by a qualified soils engineering and materials testing firm will be required.

The results and recommendations from the soil investigation, along with earthquake design criteria, will then establish the criteria for the design of all foundations for buildings, structures, tanks, and other equipment and material. It is felt at this time that either spread footings or some form of concrete piling (drilled and cast-in-place) will be suitable for most requirements.

SPECIAL MATERIALS OF CONSTRUCTION

It is anticipated that because the crude oil itself is not extremely sour in nature, no special materials of construction are required for that piping and equipment contacting de-emulsified crude oil. It is likely that special measures will have to be taken, either in extra corrosion allowance or use of modified carbon steel alloys for that piping and equipment exposed to brine or sour crude. Carbon steels have proven adequate in handling sea water and brines at temperatures of under 180°F; twenty year service is not unusual with adequate corrosion allowance. Cathodic protection of brine storage vessels is anticipated.

EQUIPMENT SPARES AND REDUNDANCY

Normal design practice with respect to spare equipment will be followed. In general, rotating equipment such as pumps will be spared, if failure of the item would cause a shutdown. Equipment such as heat exchangers and pressure vessels will not be spared.

EQUIPMENT SPARES AND REDUNDANCY - continued

In the ultimate as well as the initial facility, major units will be installed as multiple trains of equipment. Thus, a major upset or breakdown of a single train will result in the loss of only partial capacity.

FIRE PROTECTION SYSTEM

A firewater system with tank, pump, hydrants, and monitor nozzles is provided. The system is interconnected with the fire water loop in the Gas Processing Facilities, so that the fire pump in either facility can provide protection to both facilities.

The crude oil storage tank area is provided with mechanical foam generation facilities. It is anticipated that a system of foam hydrants with foam-nozzle monitors located around the perimeter of the dyked area will allow foam-blanketing of the dyked area in the event of a fire emergency. These stationary monitors will be supported by mobile hose-equipped foam monitors that would be supplied from the foam hydrants.

The crude treater area itself would be protected by two wheeled dry chemical extinguishers with 350 pounds of "Purple-K" or equal agent. These are effective at up to a 40-foot range and can easily be handled by one man.

In addition to the above mentioned systems, hand extinguishers of the carbon dioxide or dry chemical type will be located throughout the facility to provide protection from electrical fires and other lesser hazard situations not requiring foam.

CENTRAL CONTROL AND EMERGENCY SYSTEMS

A central control room will be provided to control the facilities. Operating variables such as pressures, temperatures, flow rates, and levels from the various units will be transmitted to the control room where they will be displayed and used as input to controllers. The operator thus has a complete picture before him of the current status of the operation and can make whatever adjustments are necessary. Alarm points and automatic shutdown are also displayed in the control room.

Emergency shutdown, if required, can be initiated by the operator from the control room. In addition to total shutdown, certain units and individual pieces of equipment have their own safety shutdown systems. These would include flame failure shut-

CENTRAL CONTROL AND EMERGENCY SYSTEMS - continued

down systems on fired equipment, vibration shutdowns on fans for aerial coolers, and pump shutdowns on low level in suction vessels. The various shutdown systems are described more fully on drawing 00-1-15.

NOISE AND VIBRATION FACTORS

Proper silencing of equipment, air intakes, and vents will be provided to keep operating noise from the facility at an acceptable level in accordance with the Occupational Safety and Health Standards for General Industry.

Because very little reciprocating equipment, of relatively small sizes, has been used in the design, there will be no measurable vibration of the earth at the boundaries.

MATERIAL AND UTILITY BALANCES

C-10140
August 1971

HUMBLE OIL AND REFINING COMPANY
CRUDE OIL TREATING AND STORAGE FACILITY
SANTA BARBARA CHANNEL

FACILITY MATERIAL BALANCE

MATERIAL BALANCE

	PHASE I	PHASE II	PHASE III
Inlet (BPD):			
Emulsified Crude	50,000	75,000	100,000
Outlet (BPD):			
Treated Crude Oil	40,000	60,000	80,000
Produced Brine	10,000	15,000	20,000
Total	50,000	75,000	100,000

C-10140
August 1971

HUMBLE OIL AND REFINING COMPANY
CRUDE OIL TREATING AND STORAGE FACILITY
SANTA BARBARA CHANNEL

FACILITY FUEL AND ELECTRICAL DEMAND SUMMARY

FUEL [1]

	PHASE I	PHASE II	PHASE III
Normal (MSCFD):			
Crude Oil Treaters	715.7	1073.5	1501.8
Incinerator	21.8	21.8	21.8
Total Normal	737.5	1095.3	1523.6
Intermittent Fuel (MSCFH):			
Incinerator Heatup	18.2	18.2	18.2
Tank Blanketing	2.4	3.6	4.8
Filter Flush	12.0	18.0	24.0
Total Intermittent	32.6	39.8	47.0

ELECTRICAL [2]

	I	II	III
Electrical Drives	502.3	831.0	1159.8
Treaters	32.0	48.0	64.0
Other	2.5	2.5	2.5
Total Process	536.8	881.5	1226.3

Notes: (1) Based upon 1100 LHV.
(2) See plant electrical operating load sheets for detail.

Form No. [illegible]

PLANT ELECTRICAL OPERATING LOAD

ESTIMATE OR JOB NO. C-10140

CUSTOMER HUMBLE OIL AND REFINING COMPANY

DATE 8/16/71

PROJECT CRUDE OIL PROCESSING AND STORAGE

PHASE I LOAD

BY RWC

ITEM NO.	SERVICE	NO. IN-STALLED	NO. OPERA-TING	MOTOR HP	MOTOR RPM	MOTOR VOLTS	ONE MOTOR LOAD B.HP	ONE MOTOR % LOAD B.HP/HP	FROM TABLES KW	FROM TABLES KVAR	TOTAL OPERATING KW	TOTAL OPERATING KVAR	REMARKS
A-1	TREATER BLOWOFF COOLER	1	1	20			18	90	13.4		13.4		
A-2	TREATED OIL COOLER	4	4	50			45	90	33.6		134.4		
C-1	INSTRUMENT AIR COMP.	2	1	10			7	70	5.2		5.2		
C-2	UTILITY AIR COMP.	1	1	10			7	70	5.2		5.2		
H-1	INCINERATOR (BLOWER)	1	1	5			3	60	2.2		2.2		
P-1	CRUDE OIL TRANSFER PUMP	3	2	125			105	84	78.3		156.6		
P-2	FILTER FEED PUMP	2	1	30			22	73	16.4		16.4		
P-3	RERUN PUMP	1	1	50			44	88	32.8		32.8		
P-4	WATER TRANSFER PUMP	1	1	7½			5	67	3.7		3.7		
P-5	INJECTION PUMP	2	2	100			72	72	53.7		107.4		
P-6	RECYCLE BRINE PUMP	2	1	3			2.5	83	1.9		1.9		
P-7	OIL RETURN PUMP	2	1	3/4			0.5	67	0.4		0.4		
P-8	BACKWASH BRINE PUMP	2	1	7½			4.3	57	3.2		3.2		
P-9	CHEMICAL ADDITION PUMP	1	1	½			0.2	40	0.2		0.2		
P-10	CORROSION INHIBITOR P.	2	1	½			0.2	40	0.2		0.2		
P-11	DE-EMULSIFIER PUMP	2	1	½			0.2	40	0.2		0.2		
P-12	SKIMMED OIL PUMP	1	1	2			1.7	85	1.3		0.2		
P-14	BLOWOFF PUMP	1	1	30			25	83	18.7		18.7		
	TOTALS												

PLANT KVA $=\sqrt{\text{TOTAL KW}^2 + \text{TOTAL KVAR}^2}$ =

PLANT P.F. = TOTAL KW/TOTAL KVA =

Form No. 301

PLANT ELECTRICAL OPERATING LOAD

ESTIMATE OR JOB NO. C-10140

CUSTOMER HUMBLE OIL AND REFINING COMPANY

DATE 8/16/71

PROJECT CRUDE OIL PROCESSING AND STORAGE — PHASE I LOAD

BY

ITEM NO.	SERVICE	NO. INSTALLED	NO. OPERATING	MOTOR HP	MOTOR RPM	MOTOR VOLTS	ONE MOTOR LOAD B.HP	ONE MOTOR % LOAD B.HP/HP	FROM TABLES KW	FROM TABLES KVAR	TOTAL KW	TOTAL KVAR	REMARKS
S-1	ELECTRIC TREATER	4	4								32		
U-1	INSTRUMENT AIR DRYER	1	1								2.5		
	TOTAL PHASE I										536.8		
	TOTALS												

PLANT KVA = $\sqrt{\text{TOTAL KW}^2 + \text{TOTAL KVAR}^2}$ =

PLANT P.F. = TOTAL KW/TOTAL KVA =

Form No .301

PLANT ELECTRICAL OPERATING LOAD

ESTIMATE OR JOB NO. C-10140 PAGE 3 OF 4

CUSTOMER HUMBLE OIL AND REFINING COMPANY DATE 8/16/71

PROJECT CRUDE OIL PROCESSING AND STORAGE PHASE III LOAD BY RWC

ITEM NO.	SERVICE	NO. IN-STALLED	NO. OPERA-TING	MOTOR HP	MOTOR RPM	MOTOR VOLTS	ONE MOTOR LOAD B.HP	ONE MOTOR % LOAD B.HP/HP	FROM TABLES KW	FROM TABLES KVAR	TOTAL OPERATING KW	TOTAL OPERATING KVAR	REMARKS
A-1	TREATER BLOWOFF COOLER	1	1	20			18	90	13.4		13.4		
A-2	TREATED OIL COOLER	8	8	50			45	90	33.6		268.6		
C-1	INSTRUMENT AIR COMP.	2	2	10			8	80	5.2		10.4		
C-2	UTILITY AIR COMP.	1	1	10			7	70	5.2		5.2		
H-1	INCINERATOR (BLOWER)	1	1	5			3	60	2.2		2.2		
P-1	CRUDE OIL TRANSFER PUMP	5	4	125			105	84	78.3		313.2		
P-2	FILTER FEED PUMP	4	3	30			22	73	16.4		49.2		
P-3	RERUN PUMP	1	1	50			44	88	32.8		32.8		
P-4	WATER TRANSFER PUMP	1	1	7½			5	67	3.7		3.7		
P-5	INJECTION PUMP (A & B)	2	2	100			72	72	53.7		107.4		
P-5	INJECTION PUMP (C, D, E)	3	3	200			144	72	[illegible]		322.2		
P-6	RECYCLE BRINE PUMP	3	2	3			2.5	83	1.9		3.8		
P-7	OIL RETURN PUMP	2	1	3/4			0.5	67	0.4		0.4		
P-8	BACKWASH BRINE PUMP	3	2	7½			4.3	57	3.2		6.4		
P-9	CHEMICAL ADDITION PUMP	2	1	½			0.3	60	0.3		0.3		
P-10	CORROSION INHIBITOR PUMP	2	1	½			0.3	60	0.3		0.3		
P-11	DE-EMULSIFIER PUMP	2	1	½			0.3	60	0.3		0.3		
P-12	SKIMMED OIL PUMP	1	1	2			1.7	85	1.3		1.3		
P-14	BLOWOFF PUMP	1	1	30			25	83	18.7		18.7		
	TOTALS												

PLANT KVA $=\sqrt{\text{TOTAL KW}^2 + \text{TOTAL KVAR}^2} =$

PLANT P.F.=TOTAL KW/TOTAL KVA =

Form No ..501

PLANT ELECTRICAL OPERATING LOAD

ESTIMATE OR JOB NO. C-10140

PAGE 4 OF 4

CUSTOMER HUMBLE OIL AND REFINING COMPANY

DATE 8/16/71

PROJECT CRUDE OIL PROCESSING AND STORAGE

PHASE III LOAD

BY RWC

ITEM NO.	SERVICE	NO. IN-STALLED	NO. OPERA-TING	MOTOR HP	MOTOR RPM	MOTOR VOLTS	ONE MOTOR LOAD B.HP	ONE MOTOR % LOAD B.HP/HP	FROM TABLES KW	FROM TABLES KVAR	TOTAL KW	TOTAL KVAR	REMARKS
S-1	ELECTRIC TREATER	8	8								64		
U-1	INSTRUMENT AIR DRYER	1	1								2.5		
	TOTAL PHASE III										1226.0		
	TOTALS												

PLANT KVA = $\sqrt{\text{TOTAL KW}^2 + \text{TOTAL KVAR}^2}$ =

PLANT P.F. = TOTAL KW/TOTAL KVA =

FACILITY DESCRIPTION

C-10140
August 1971

HUMBLE OIL AND REFINING COMPANY
CRUDE OIL TREATING AND STORAGE FACILITY
SANTA BARBARA CHANNEL

FACILITY DESCRIPTION

Outlined below are descriptions of the individual processing units that comprise the Crude Oil Treating and Storage Facility. Within each section, specific reference is made to the number and type of equipment items present in the initial design and the two subsequent additions. In certain cases, the initial unit (or units) are either designed for the ultimate facility or the initial item is of sufficient capacity to prove adequate for the ultimate case.

Reference is made to the major controls and safeguards in several instances where these have been designed for safe operation and containment of material released in any conceivable operating upset.

INLET FACILITIES

The inlet crude facility consists of an inlet 10,000 barrel crude surge tank, Item T-1 shown on mechanical flow diagram 00-1-10. This initial tank is supplemented in Phase III by an additional identical 10,000 barrel unit. The inlet crude surge tanks are API-650 welded cone roof oil storage tanks equipped with internal floating roofs.

All crude storage and surge tanks are equipped with internal floating roofs. Air is admitted into each tank in the space between the floating and fixed roof during tank emptying and is vented to the closed vent system during tank filling. This provision has been successfully utilized in oil storage to reduce vapor emissions to a fraction of conventional cone roofed storage tanks.

A mixture of emulsified crude oil and free brine is delivered to the inlet crude surge tank after passing through the pipeline extending from the shoreline to the facility. Supply pressure on the inlet crude is assumed adequate to maintain full level in the surge tanks. A free brine-crude oil interface is maintained in the bottom region of each inlet tank by an oil/water interface level control system. Free brine is drawn off the tank by the Water Transfer Pump, Item P-4. This centrifugal pump is sized for a delivery of 50 gallons per minute at a discharge pressure of 26 psig. An interface level switch performs a dual purpose of starting and stopping the Water Transfer Pump and also opening or closing a

INLET FACILITIES - continued

remotely-operated valve placed in the discharge line of P-4. The level of crude oil in T-1 is measured by a local tank gauge equipped with a signal transmitter. Tank level readings are continuously transmitted to a panel-mounted level indicator. High and low tank levels initiate level alarms in the central control room with an additional low/low level alarm and causing shutdown of discharge pump P-4. The automatic shutdown is provided to prevent emulsified crude oil from being accidentally drawn off in the brine discharge line in the event of abnormally low liquid levels in the inlet surge tanks. Phase II and III of operation will require two inlet surge tanks operating in parallel and connected by a level equalizing line.

CRUDE TREATING

The overall crude treating system is depicted on mechanical flow diagram 00-1-10. Initially, this system is centered around four horizontal electrical-type crude treaters with each vessel 144" in diameter by 65' 0" in length. Phases II and III of the operation require the addition of two identical units at the onset of each phase in addition to the four operating initially.

Crude oil is supplied from the inlet crude tanks by three 800 GPM rotary pumps. These positive-displacement pumps are rated at 105 BHP each at a differential pressure of 85 psi. Initially, two pumps will be in operating service with a third common spare. One additional pump is added for each additional phase providing for a single common spare at all times.

After exchange of heat with the treated crude in the crude oil exchanger, Item E-1, the crude oil emulsion is fed to the electric treaters. Each treater is designed for a maximum working pressure of 100 psig and a maximum operating temperature of 180°F. Normally the treaters will operate at the minimum temperature sufficient to obtain good emulsion breaking. Emulsion breaking is brought about by the combined effect of elevated temperatures, chemical addition, and the electrostatic field provided within the treater between metallic grid elements. Electric treaters were chosen over conventional heater-treaters as it is felt that the electrostatic feature will allow more efficient emulsion breaking at a lower operating temperature. This potentially will result in substantial fuel gas savings. Final heating of the crude oil emulsion is carried out by firetube heater bundles located in the end of each treater. Each fire tube bundle is rated for a heat transfer rate of 6.00 MMBtu/Hr., sufficient for the maximum operating temperature of 180°F.

CRUDE TREATING - continued

Each treater is operated at a pressure of 75 psia in order to prevent the formation of a vapor phase. The crude oil is degassed prior to on-shore treating at 105° - 120°F at atmospheric pressure to produce a crude oil vapor pressure of approximately 20 psia at 180°F. Therefore, at the treater operating pressure of 75 psia, vapor evolution will be prevented.

The initial four parallel treaters are fed at identical flow rates through an interrelated control network. Overall combined flow rate from the Crude Oil Transfer Pumps is controlled by a master control station with a manual set point. The output signal from this central controller resets the set point for the individual flow controllers associated with each treater. Therefore, in normal operation, each treater is fed at an equal rate. Back pressure sufficient to maintain the 75 psig operating pressure is maintained by a pressure control valve placed in each treater crude discharge line.

Crude oil leaves the treater at a temperature of 180°F and is cooled by heat exchange with the crude feed in crude oil exchanger E-1. These exchangers are two-shell, shell and tube units with 5844 sq. ft. of effective surface area per shell. Initial thermal rating of each unit is 3.825 MMBtu/Hr. Upon leaving this exchanger the crude is further cooled to 95°F storage temperature by the Treated Oil Coolers (Item A-2). Each cooler unit is comprised of 4 cells connected in parallel, with an extended surface heat transfer area of approximately 208,000 sq. ft. per unit.

Initially four (4) crude oil exchangers and a single crude cooler will be required for crude oil heat exchange. At the onset of each additional plant phase, two additional E-1 units will be added. The single Phase I Treated Oil Cooler will be supplemented by similar two cell units for Phase II and III.

Brine discharge from each treater is controlled by a liquid dump valve regulated by interface controllers allowing a design brine discharge rate for each treater of 2,500 barrels per day. This produced brine is diverted to the brine treating area.

Pressure relief has been provided for each electric treater. Under normal operation, there is no flow through the pressure relief line, but in the event of over-pressurization of the treater, vapor and liquid will flow through the relief to the Treater Blow-Off Cooler, item A-1. This aerial cooler prevents excessive vapor flash caused by treater over-pressurization. The unit is designed for a thermal duty of 800,000 Btu/Hr.

CRUDE TREATING - continued

The treater blow-off flows from the blow-off cooler to the Blow-Off drum, Item V-1. The drum volume is sufficient to provide over 15 minutes holdup of liquid accumulated during blow of the treater pressure relief valve. A backpressure controller for this vessel maintains slight positive pressure in the blow-off drum during any emergency. Any vapors generated during blow-off will enter the crude treating vent gas disposal system. Backup to this pressure control valve is maintained by a pressure relief valve set to open at a few ounces above the controlled vessel pressure.

A temperature switch in the blow-off drum actuates the fan motors in the blow-off cooler and sets off a temperature alarm in the control process control building. A centrifugal pump (Item P-14) is used for removal of liquid blowoff from V-1. During an emergency blowoff period, operators must start the Blowoff Pump to prevent accumulation of crude oil in the Blowoff Drum and open a valve in the blowoff line to the Rerun Tank, Item T-3.

The entire blowoff handling system is designed to prevent any release of vapors to the atmosphere during an emergency situation. Fail-open control valves have been provided on the crude inlet and outlet lines surrounding each treater to prevent accidental blocking-in of a treater due to control valve failure. In addition, a "no-flow" of crude oil to any treater will cause immediate shutoff of fuel gas to the treater fired heater, minimizing the possibility of over-pressurization of the treater due to residual heat in the tube bundle. Due to the safeguards that have been provided, over-pressurizing of a treater is a remote operating possibility.

It is possible to route the crude oil collected in the inlet surge tank directly to the crude storage area without passing through the electric treaters. Two block valves, designed to operate together through a system of mechanical linkage, allow shunting of the crude around the treater train. Brine, coalesced in each treater, is drawn off the bottom through a liquid dump valve which is regulated to maintain a proper oil-water interface level. Collected brine from all treaters flows to the brine treating area.

BRINE TREATING

The brine treating facility is depicted on mechanical flow diagram 00-1-12. Inherent in the design of the brine disposal system is complete containment of all vapors associated with storage and handling of the sour brine. The subsurface injection system for disposal of produced brine will comply with California Department of Oil and Gas and Santa Barbara County regulations.

BRINE TREATING - continued

The ultimate disposition of the produced brine, by subsurface injection will be preceded by cleaning and treating. This treating will be carried out in an oxidant free system to prevent contact with air or other oxidants which would cause precipitation of solids which would make subsequent filtration very difficult.

All tanks and vessels in the Brine Treating System are closed and operated under a natural gas blanket. Vapors displaced from equipment during treating are released to a closed vent system and eventually pass through the Vent Vapor Incinerator before being released to the atmosphere. Blanket gas is provided from the fuel gas system to these tanks.

All drains from tanks, vessels and pumps are piped to a closed drain system which discharges into the Brine Settling Basin. This is provided to permit recycle of all brines back into the Brine Treating System without contact with air. This closed system eliminates the discharge of brines and/or sour crude oil into the surface storm drain system and thereby removes a potential source of pollution.

Separated brine from the Crude Storage Tank (T-1) and the Electric Treaters (S-1) flows to the Dirty Brine Storage Tank (T-4). This is a 10,000 barrel closed tank equipped with oil skimming lines at various levels. The tank as designed provides sour brine surge capacity as well as acting as a gravity-type oil-water separator. Periodic drawoff of any accumulated free oil is accomplished by manipulation of the proper skimming line or lines. The brine phase from this tank would be expected to have 200-300 ppm total oil. A non-oxidizing biocide is metered by pump P-9 to the tank influent to prevent bacterial growth, if needed.

Filter Feed Pumps take suction on the Dirty Brine Storage Tank and pump the dirty brine to the Filter-Coalescer (S-2). This is an upflow, sand filled vessel in which entrained oil is coalesced and suspended solids are trapped in the bed. An oil-brine phase separation is made at the top of the vessel yielding an oil phase and a brine phase containing small quantities of oil and particular matter. In similar units, turbidities of the treated brines have been reported as low as 1 ppm. The quality of this brine is suitable for injection. Probable turbidity level should be less than 5 ppm with a mean particle size of 5 microns. The oil phase flows to the Brine Settling Basin (S-3) and the brine phase flows to the Injection Brine Storage Tank (T-6).

Periodic washing of the filter is required. This is accomplished by the use of increased filter feed rate (20 GPM/FT^2) and the simul-

BRINE TREATING - continued

taneous addition of "scrubbing" gas to the system (5 SCFM/Ft^2 @ 10 psig). The turbulence caused by this combined brine-gas flow removes oil and solids held in the bed. During the washing cycle, the oil release line is closed and the effluent brine-gas stream is diverted to the Backwash Brine Holding Tank (T-5). After the washing cycle is complete, a prerun cycle at filtration conditions, but with the effluent brine still diverted to T-5, is required to reset the filter media.

The Injection Brine Storage Tank (T-6) is a 1000 barrel closed tank. The Brine Injection Pumps (P-5) take suction on T-6 and discharge into the injection line at 1500 psig. A recycle line from the injection pump discharge back to the storage tank is provided. The flow of this recycle is controlled by the level in T-6. This system is proveded to avoid the necessity of shutting down and restarting the Injection pumps as the supply of brine fluctuates with the discontinuous operation of the filter. The brine is metered prior to injection.

The Backwash Brine Holding Tank (T-5), a 1500 barrel closed tank with a cone bottom, is provided so that a steady flow of brine can be sent to the Brine Settling Basin. The brine is pumped on flow control from the holding tank by the Backwash Brine Pumps (P-8). Recycle from the P-8 discharge back to the bottom of T-5 is provided to prevent settling of solids in this tank.

Backwash brine from T-5, coalesced oil from S-2, skimmed oil from T-4, and all streams which enter the closed drain system are fed to the Brine Settling Basin (S-3). This is a covered basin operating under a gas blanket. Settling of backflush solids is carried out in this basin as well as skimming of any surface oil. Brine is pumped out of the basin by the Recycle Brine Pumps (P-6) to the Dirty Brine Storage Tank for reprocessing. This flow is controlled by an oil-brine interface level controller. Oil accumulated in the brine basin overflows an internal weir into an oil sump and is pumped from this sump to the Rerun Tank (T-3) by the Oil Return Pump (P-7). Solids which accumulate at the bottom of the basin are periodically removed by a vacuum truck and trucked to solids disposal.

CRUDE STORAGE AND RERUN

The Crude Storage and Rerun Facilities are shown on Mechanical Flow Diagram 00-1-11. The Major Storage Tanks, Item T-2, are 110,000 barrel cone roof tanks with internal floating roofs. Each tank is equipped with a locally mounted level gauge equipped with transmitter for level display in the central control room. High and low liquid level alarms are actuated from the tank level gauge. As a back-up

CRUDE STORAGE AND RERUN - continued

to this alarm system, independent level switches are utilized to initiate "high-high" and "low-low" liquid level alarms. The "low-low" alarm function includes an automatic shutdown of the crude shipping pumps.

Each Crude Storage Tank is equipped with an atmospheric air breathing valve with vent vapors directed to the vent gas disposal system. In this system, no tank breathing vapors are emitted to the atmosphere without passing through the incinerator. Initially two storage tanks are required with single identical additions at Phases II and III.

The Rerun Tank, Item T-3, is also shown on Mechanical Flow Diagram 00-1-11. This 10,000 Barrel tank has been provided to allow rerun of wet crude from any of the major storage tanks through Rerun Pump P-3. This tank also can receive treated crude directly allowing for an additional 10,000 Barrels of crude storage. Relief from the crude shipping pumps is directed to the Rerun Tank in the event of over-pressurization of the shipping system. The Rerun Pump, P-3 is a horizontal rotary type capable of a discharge rate of 250 GPM at a discharge pressure of over 100 psig.

FIRE PROTECTION

The fire protection system consists primarily of a 20,000 Barrel fresh water storage tank which supplies firewater to the Crude Oil Facility. A 2,000 GPM engine-driven centrifugal Firewater Pump (P-13) is used to boost pressure for supply of 125 psi firewater to the firewater loop. The engine driver for this pump is dual-carburated, allowing operation with supply of fuel either from the fuel gas system or from gasoline storage. The location of water hydrants and water monitors is shown on Drawing 00-2-02. The fire-water loop is supplemented by foam generation facilities located to allow foam blanketing of the dyked crude storage area.

Additional discussion of the overall fire protection system can be found in the report section on "Facility Design".

VENT GAS DISPOSAL AND DRAINS

The Vent Gas Disposal System is described on Mechanical Flow Diagram 00-1-14. This system is designed to collect tank breathing vapors and vessel vent gas for ultimate disposal to the Vent Vapor Incinerator, Item H-1. Two collection headers collect vapors from the crude storage tanks and the gas-blanketed brine tanks. In addition, blow-off vapors from Blowoff Drum V-1 are released to the air vent header

VENT GAS DISPOSAL AND DRAINS - continued

for incineration. Essentially all items of equipment are piped to the Vent Gas Disposal System. This includes all pumps, vessels, basins, and other equipment.

The vent vapor incinerator is a forced draft 50 foot unit with an external fuel gas supply. Waste gases from the two vent supply headers are received at the incinerator burner at a pressure of 1-2 inches of water. Under normal operating conditions, no more than 2.0 Lb/Hr. of equivalent sulfur dioxide will be emitted from the incinerator. This unit is designed for the complete thermal oxidation of hydrocarbons and hydrogen sulfide vapors prior to release to the atmosphere. Safety and control monitors are included with this unit to allow efficient automatic combustion.

GENERAL UTILITIES

Utilities are shown on Mechanical Flow Diagram 00-1-13. Fuel gas from a commercial pipeline is received by the Inlet Fuel Gas Scrubber, Item V-4. Two pressure regulators, operating in parallel reduce the pressure of the pipeline fuel gas from 800 psi to 50 psi plant fuel gas pressure. Condensate collected in the Inlet Fuel Gas Scrubber is drained to the closed plant drain system. A separate blanket gas header has been provided for supply of gas to the brine treating tanks. The pressure in this supply header is maintained at about 5 psi.

INSTRUMENT AIR

The instrument air system, shown on Mechanical Flow Diagram 00-1-13, consists of two reciprocating, non-lubricated, single stage air compressors with a common air aftercooler and instrument air receiver. In normal operation, one unit will be in service and one unit will be used as a spare. The first unit will operate on start-stop and the second will start automatically in the event of unusual demand. A lead-lag transfer switch will allow each machine to be switched periodically to equalize wear on the two machines.

The instrument Air Dryer, Item U-1, is of the automatic regeneration type utilizing electrical power for regeneration.

UTILITY AIR

The Utility Air Compressor, Item C-2, supplies 125 psi utility air for shop and maintenance requirements. This compressor is a reciprocating, lubricated, single stage unit with an air-cooled aftercooler.

ELECTRICAL

Purchased power has been assumed available for supply to the Crude Oil Facility at high or medium voltage. No emergency power generator has been supplied as part of the plant utility system. Underground wiring will be used from the utility company meter.

EMERGENCY SHUTDOWN

An emergency shutdown system has been provided to allow orderly shutdown in the event of any emergency. The system has been designed to provide local equipment shutdowns while allowing as much as possible of the facility to remain in service.

Alarms have been provided in many instances to call operator attention to abnormal operation. The alarmed units are set to allow attending operators sufficient time to determine the proper action necessary to either diagnose the abnormality or to proceed on an orderly facility or unit shutdown.

The Emergency Shutdown System function is detailed on Mechanical Flow Diagram 00-1-15. Listed on this sheet are the alarm units, the events causing shutdown, and the actions taken during an emergency.

C-10140
August 1971

HUMBLE OIL AND REFINING COMPANY
CRUDE OIL TREATING AND STORAGE FACILITY
SANTA BARBARA CHANNEL

EQUIPMENT LIST

	No. of Units Added/Phase		
	I	II	III
A-1 Treater Blowoff Cooler 15' x 8' x 14,300 sq. ft. cooler w/1-20 HP motor; 12,300#	1	0	0
A-2 Treated Oil Cooler 24' x 80' x 209,000 sq. ft. cooler w/4-50 HP motors; 180,000#	1	1/2	1/2
C-1 Instrument Air Compressor 50 CFM @ 100 psi w/1-10 HP motor; 940# (w/o motor)	2	0	0
C-2 Utility Air Compressor 40 CFM @ 125 psi w/1-10 HP motor; 1310# (w/o motor)	1	0	0
E-1 Crude Oil Exchanger 45 x 240 type BEU/2 shells per unit w. 5844 sq. ft/shell; 97,000#	4	2	2
H-1 Vent Vapors Incinerator 1-50', 1.0 MM Btu/Hr waste Gas Incinerator w/3 HP forced air blower, 29,213#	1	0	0
P-1 Crude Oil Transfer Pump 800 gpm horizontal rotary w/125 HP motor, 2600# (w/o motor)	3	1	1
P-2 Filter Feed Pump 379 gpm horizontal centrigugal w/30 HP motor;	2	0	2

C-10140
August 1971

EQUIPMENT LIST	No. of Units Added/Phase I	II	III
P-3 Rerun Pump 250 gpm horizontal rotary with 50HP motor; 1150# (w/o motor)	1	0	0
P-4 Water Transfer Pump 50 gpm horizontal centrifugal with 7½ HP motor; 350#	1	0	0
P-5 Injection Pump Phase I - 76.9 gpm w/100 HP motor Phase II - 152.6 gpm w/200 HP motor Phase III - 152.6 gpm w/200 HP motor	2	1	2
P-6 Recycle Brine Sump Pump 60 gpm vertical sump pump w/3 HP motor; 475# (w/o motor)	2	1	0
P-7 Oil Return Pump 5 gpm vertical sump pump w/3/4 HP motor; 400# (w/o motor)	2	0	0
P-8 Backwash Brine Pump 100 gpm horizontal centrifugal w/7½ HP motor; 485# (w/o motor)	2	0	1
P-9 Chemical Addition Pump Diaphragm metering w/½ HP motor	1	0	1
P-10 Corrosion Inhibitor Pump Reciprocating metering injection w/½ HP motor	2	0	0
P-11 De-emulsifier Addition Pump Reciprocating metering w/½ HP motor	2	0	0
P-12 Skimmed Oil Pump Vertical sump w/2 HP motor	1	0	0
P-13 Fire Water Pump 2000 gpm horizontal centrifugal with dual carb. engine driver @ 225 BHP	1	0	0

C-10140
August 1971

EQUIPMENT LIST	No. of Units Added/Phase I	II	III
P-14 Blowoff Pump 250 gpm Horizontal centrifugal with 30 HP motor	1	0	0
S-1 Electric Treater 144" x 65'0" x 100# MWP horizontal vessel; 95,000#	4	2	2
S-2 Filter/Coalescer 7' O.D. x 10' H x 75# MWP vertical vessel, 10,000#	1	0	2
S-3 Brine Settling Basin 24'0" L x 8'0" W x 10'0" D concrete basin	1	0	0
T-1 Crude Surge Tank 42'6" D x 40'0" H; 10,000 Bbl With internal floating roof	1	1	0
T-2 Major Storage Tank 130'0" D x 48'0" H; 110,000 Bbl. With internal floating roof	2	1	1
T-3 Rerun Tank 42'6" D x 40'0" H; 10,000 Bbl. With internal floating roof	1	0	0
T-4 Dirty Brine Storage Tank 42'6" D x 40'0" H; 10,000 Bbl.	1	0	1
T-5 Backwash Brine Holding Tank 26'0" D x 16'0" H; 1,500 Bbl.	1	0	1
T-6 Injection Brine Storage Tank 21'3" D x 16'0" H; 1,000 Bbl.	1	0	1
T-7 Fire Water Tank 60'0" x 40'0"; 20,000 Bbl.	1	0	0

C-10140
August 1971

EQUIPMENT LIST	No. of Units Added/Phase		
	I	II	III
U-1 Instrument Air Dryer 50 ACFM @ 100 psig	1	0	0
V-1 Blowoff Drum 84" x 21'0" 14# MWP vertical vessel 10,800#	1	0	0
V-2 Instrument Air Receiver 24" x 7'0" 130# MWP 1000#	1	0	0
V-3 Utility Air Receiver 48" x 15'0", 200# MWP vertical vessel 6100#	1	0	0
V-4 Fuel Gas Scrubber 24" x 8'0" 75# MWP vertical vessel 2000#	1	0	0
X-1 Air Vent Flame Arrestor	1	0	0
X-2 Gas Vent Flame Arrestor	1	0	0

EQUIPMENT SPECIFICATIONS

Form 1.62

Stearns-Roger

AERIAL COOLERS

STUDY DATA SHEET

ITEM NO. A-1

ACC'T. PAGE

CUSTOMER HUMBLE OIL AND REFINING COMPANY S-R JOB C-10140

PROJECT CRUDE OIL TREATING AND STORAGE FACILITY

LOCATION SANTA BARBARA CHANNEL DATE August 1971

REV. BY J.W. / R.C. REV

SERVICE TREATER BLOWOFF COOLER

REVISION DATE: a BY : b BY : c BY

NO REQ'D 1 MANUFACTURER SOURCE: QUOTE OF

MODEL & TYPE

CONDITIONS OF SERVICE

CONDITIONS SHOWN FOR TOTAL REQUIRED SERVICE: TOTAL OPERATING UNITS REQUIRED AND SPARE UNITS

FLUID, INSIDE TUBES CRUDE OIL	TEMPERATURE, °F IN 180 OUT 100
LIQUID, #/HR IN OUT	STEAM, #/HR IN OUT
SP. GR. @60° IN OUT	WATER, #/HR IN OUT
MWT IN OUT	VISCOSITY @ °F 10,000 Cps @ 60°F
VAPOR, #/HR IN OUT	OPERATING PRESURE, PSIG 75 IN
MWT IN OUT	ALLOW. PRESS. DROP PSI 30 REQ'D. MWP, PSIG

FLUID OUTSIDE TUBES ATMOSPHERIC AIR TEMPERATURE, °F 77 ELEVATION FT. 0

TOTAL DUTY, BTU/HR 800,000 REQ'D. DESIGN WIND LOAD

PERFORMANCE (OF SINGLE UNIT UNLESS NOTED)	CONSTRUCTION DETAILS
DESIGN DUTY, BTU/HR 800,000	CELLS/UNIT ONE SECTIONS/CELL
AIR TEMP. RISE, °F PRESS DROP, PSI	FANS/UNIT ONE FANS/CELL
AIR QUANT./UNIT, #/HR SCFM/FAN	UNIT SIZE, FT., IN. L 15 : W 8 : H 15
MTD, °F CORR. MTD, °F 49	DESIGN WIND LOAD
FOULING FACTOR 0.001	UNIT SHIPPING WT.
CLEAN TRANS RATE, BTU/HR/SQ FT/°F BARE FIN'D	FABRICATED STEEL STRUCTURE ASSEMBLED BY
SER. TRANS. RATE, BTU/HR/SQ. FT/°F BARE FIN'D 1.2	SHOP FINISH

TUBE SECTIONS

SIZE	TUBES: TYPE
CONNECTED IN	SIZE 1" O.D. x 12 BWG x 16' LONG
BARE SURFACE/SECTION, SQ. FT.	NO/SECT. ROWS/SECT.
FINNED SURFACE/SECTION, SQ. FT. 14,300	SPACING
F.S./UNIT, SQ FT TOTAL F.S., SQ. FT.	MATERIAL STEEL
NO. OF PASSES/SECTION	FINS: MATERIAL Aluminum
DESIGN PRESSURE 125 PSIG @ 250 °F	HEIGHT 5/8" THICKNESS
CODE ASME SEC VIII	SPACING 9 PER INCH
INLET NOZZLES	HEADERS: TYPE Box
OUTLET NOZZLES	MATERIAL A-285-C OR EQ.
	PLUGS

MECHANICAL EQUIPMENT

FANS: NO./UNIT ONE	DRIVE: TYPE V-BELT
TYPE FORCED DRAFT	MFG'R.
DIAMETER BLADES/FAN	MODEL
PITCH: SET AT MAX. MIN.	RATIO
BLADE MAT'L. MAX OP. °F	AGMA RATING
HUB MAT'L	NO. & TYPE BELTS
FAN RING	DIAM. SHEAVE: FAN DRIVER
RPM TIP FPM	SUPPORT
BHP/FAN (AT SHAFT) 18	
TOTAL BHP UNIT 18	FAN GUARD

AUXILIARIES: LADDER (W/CAGE): WALKWAY: [redacted]

REMARKS:

DRIVER SUPPLIED BY MOUNTED BY

ELECTRIC MOTOR NO. REQ'D ONE MFG'R GE. OR EQ. HP 20 RPM 3600 FRAME NO

TYPE TEFC BEARINGS LUBRICATION VOLTS 460 PH. 3 - 60 CY.

TORQUE/THRUST OTHER DRIVER TYPE REF PAGE

Stearns-Roger

AERIAL COOLERS
STUDY DATA SHEET

ITEM NO. A-2
ACC'T. PAGE

CUSTOMER HUMBLE OIL AND REFINING COMPANY — S-R JOB C-10140
PROJECT CRUDE OIL TREATING AND STORAGE FACILITY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA — DATE August 1971
REV. — BY RWC — REV.

SERVICE TREATED OIL COOLER

REVISION DATE: a BY ; b BY ; c BY

NO REQ'D MANUFACTURER — SOURCE: QUOTE OF

MODEL & TYPE

CONDITIONS OF SERVICE — PHASE I (DESIGN)

CONDITIONS SHOWN FOR TOTAL REQUIRED SERVICE: TOTAL OPERATING UNITS REQUIRED AND SPARE UNITS

FLUID, INSIDE TUBES CRUDE OIL	TEMPERATURE, °F IN 115.8 OUT 95.0
LIQUID, #/HR IN 564,472 OUT 564,472	STEAM, #/HR IN OUT
SP.GR. @60° IN 0.92 OUT 0.92	WATER, #/HR IN OUT
MWT IN OUT	VISCOSITY @ °F 1250 cps @ 60°F
VAPOR, #/HR IN OUT	OPERATING PRESURE, PSIG IN
MWT IN OUT	ALLOW. PRESS. DROP, PSI ~20 REQ'D. MWP, PSIG 75
FLUID OUTSIDE TUBES ATMOSPHERIC AIR TEMPERATURE, °F 77.0	ELEVATION FT. 0
TOTAL DUTY, BTU/HR 4,696,400	REQ'D. DESIGN WIND LOAD

PERFORMANCE (OF SINGLE UNIT UNLESS NOTED)	CONSTRUCTION DETAILS
DESIGN DUTY, BTU/HR 4,696,400	CELLS/UNIT 4 SECTIONS/CELL 2
AIR TEMP. RISE, °F PRESS DROP, PSI	FANS/UNIT 4 FANS/CELL 1
AIR QUANT. /UNIT, #/HR SCFM/FAN	UNIT SIZE, FT, IN. L 24' : W 80' : H 15'
MTD, °F CORR. MTD, °F 15.0	DESIGN WIND LOAD
FOULING FACTOR 0.003	UNIT SHIPPING WT. 180,000 (EST.)
CLEAN TRANS RATE, BTU/HR/SQ FT/°F BARE FIN'D	FABRICATED STEEL STRUCTURE ASSEMBLED BY
SER. TRANS. RATE, BTU/HR/SQ. FT/°F BARE 23.5 FIN'D 1.5	SHOP FINISH

TUBE SECTIONS

SIZE	TUBES: TYPE FINNED
CONNECTED IN	SIZE 1" O.D. x 14 BWG x 24' LONG
BARE SURFACE/SECTION, SQ. FT.	NO/SECT. 184 ROWS/SECT. 4
FINNED SURFACE/SECTION, SQ. FT.	SPACING 2 5/16"
F.S./UNIT, SQ FT 209,000 TOTAL F.S. SQ. FT.	MATERIAL C.S.
NO. OF PASSES/SECTION 2	FINS: MATERIAL ALUMINUM
DESIGN PRESSURE 125 PSIG @ 250 °F	HEIGHT 5/8" THICKNESS
CODE ASME SEC. VIII	SPACING 9 PER INCH
INLET NOZZLES	HEADERS: TYPE BOX
OUTLET NOZZLES	MATERIAL C.S.
	PLUGS OPPOSITE TUBES

MECHANICAL EQUIPMENT

FANS: NO./UNIT 4	DRIVE: TYPE
TYPE INDUCED	MFG'R
DIAMETER ~14' BLADES/FAN	MODEL
PITCH: SET AT MAX. MIN.	RATIO
BLADE MAT'L. MAX OP. °F	AGMA RATING
HUB MAT'L	NO. & TYPE BELTS
FAN RING	DIAM. SHEAVE: FAN DRIVER
RPM TIP FPM	SUPPORT
BHP FAN (AT SHAFT) 45 (EST.)	
TOTAL BHP UNIT 180	FAN GUARD

AUXILIARIES: LADDER (W/CAGE): WALKWAY: HAIL SCREENS: LOUVERS: LOUVER OPERATOR (3-15# AIR): SIDE/END PANELS

REMARKS: DESIGN IS APPROXIMATE – TO BE CONFIRMED BY VENDORS.

DRIVER SUPPLIED BY — MOUNTED BY

ELECTRIC MOTOR NO REQ'D FOUR MFG'R — HP 50 — RPM — FRAME NO

TYPE TEFC — BEARINGS — LUBRICATION — VOLTS 460 — PH. 3 — CY. 60

TORQUE THRUST — OTHER DRIVER TYPE — REF PAGE

Stearns-Roger

AIR COMPRESSOR
STUDY DATA SHEET

ITEM NO. C-1
ACC'T. ____ PAGE ____
S.R JOB C-10140

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT CRUDE OIL TREATING AND STORAGE FACILITY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA DATE August 1971 BY RWC

SERVICE Instrument Air Compressor NO. REQ'D. Two (2)
REVISIONS: a BY :b BY :c BY :d BY
MANUFACTURER SOURCE: QUOTE OF

Two (2) - Motor driven recriprocating, air cooled, non lubricated, oil free compressors - one (1) operating and (1) spare for the following service:

Capacity: 50 ACFM

Suction Pressure: 14.7 PSIA

Discharge Pressure: 100 PSIG

Temperature @ Suction: 85°F

Driven (Electric Motor)

Estimated BHP required 7 Hp
Motor Size 10 Hp

Auxiliaries

Air cooled aftercooler

Estimated weight: 940 lb

REV. REV

Stearns-Roger

AIR COMPRESSOR
STUDY DATA SHEET

ITEM NO. C-2
ACC'T. PAGE
CUSTOMER HUMBLE OIL AND REFINING COMPANY S.R JOB C-10140
PROJECT CRUDE OIL TREATING AND STORAGE FACILITY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA DATE August 1971 BY RWC

SERVICE Utility Air Compressor NO. REQ'D. One (1)
REVISIONS: a BY : b BY : c BY : d BY
MANUFACTURER SOURCE: QUOTE OF

One (1) Motor driven reciprocating air cooled air compressor for the following service:

Capacity: 40 ACFM

Suction Pressure: 14.7 psia

Discharge Pressure: 125 PSIG

Temperature @ Suction: 85°F

Driven (Electric Motor)

Estimated motor size Req'd: 10 Hp

RPM: 1750

Other

Air cooled aftercooler

Estimated weight (less motor) 1310 lb.

Form 1.21

Stearns-Roger

HEAT EXCHANGERS

STUDY DATA SHEET

CUSTOMER HUMBLE OIL AND REFINING COMPANY

PROJECT CRUDE OIL TREATING & STORAGE FACILITY

LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

ITEM NO. E-1

ACCT. PAGE

JOB NO. C-10140

DATE August, 1971 BY RWC

REV. a BY

b

c

d

SERVICE CRUDE OIL EXCHANGER

MANUFACTURER

PROPOSAL OF

NO. OF UNITS FOUR SHELLS PER UNIT 2 ARRANGEMENT 2 SERIES

SIZE 45 X 240 TYPE BEU POSITION HORIZONTAL

SURFACE PER UNIT 11,688 SURFACE PER SHELL 5844

PERFORMANCE OF ONE UNIT - INITIAL PHASE I

	SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED (PER UNIT)	CRUDE OIL + BRINE		TREATED CRUDE OIL	
VAPOR #/HR.	IN	OUT	IN	OUT
MOLECULAR WEIGHT				
LIQUID #/HR.	178,335	178,335	141,118	141,118
GRAVITY LB/FT³	58.57 AVE.		56.03 AVE.	
VISCOSITY CPS	2979 AVE.		31.2 AVE.	
STEAM #/HR.				
WATER #/HR.				
NON-CONDENSABLES #/HR.				
SP. HEAT	0.526 AVE.		0.40 AVE.	
TEMPERATURE IN °F.	60.0		180.0	
TEMPERATURE OUT °F.		107.8		100.6
OPERATING PRESSURE P.S.I.	90		75	
NUMBER OF PASSES PER SHELL	ONE		FOUR	
VELOCITY FT./SEC.	0.219		1.062	
PRESSURE DROP P.S.I.	ALLOWED	32.9 CALC.	ALLOWED	19.60 CALC
FOULING RESISTANCE	0.002		0.0013	

HEAT EXCHANGED-B.T.U./HR. 4,479,500 PER UNIT M.T.D. (CORRECTED) 49.55

TRANSFER RATE-SERVICE 7.74

CONSTRUCTION - EACH SHELL

	SHELL SIDE	TUBE SIDE
DESIGN PRESSURE P.S.I.	125	125
TEST PRESSURE P.S.I.	CODE	CODE
DESIGN TEMPERATURE °F.	500	500
CORROSION ALLOWANCE	1/8" MIN.	

CODE REQUIREMENTS ASME SEC VIII TEMA CLASS

TUBES A-179 C.S. SEAMLESS NO. 1416 O.D. 3/4" BWG. 14 LENGTH 20' PITCH 1.0" SQ.

SHELL A-285-C I.D. 45" O.D. THICKNESS

SHELL COVER C. STEEL FLOATING HEAD COVER

CHANNEL C. STEEL CHANNEL COVER

TUBE SHEETS-STATIONARY C.S. FLOATING

BAFFLES-CROSS C.S TYPE SEG. THICKNESS

BAFFLE-LONG — TYPE THICKNESS

BAFFLE-IMP'T. C.S GASKETS

TUBE SUPPORTS C.S THICKNESS

CONNECTIONS-SHELL-IN 12" OUT 12" SERIES 150 # R.F.

CHANNEL-IN 8" OUT 8" SERIES 150 # R.F.

WEIGHTS-EACH SHELL AND BUNDLE 48500 lb. BUNDLE ONLY FULL OF WATER

OVERALL LENGTH

(S.R.) INDICATES STRESS RELIEVING & (X.R.) INDICATES RADIOGRAPHING

REMARKS:-

Stearns-Roger

STUDY DATA SHEET

ITEM NO. H-1
ACC'T. ______ PAGE ______
CUSTOMER HUMBLE OIL AND REFINING COMPANY — S.R JOB C-10140
PROJECT CRUDE OIL TREATING AND STORAGE FACILITY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA — DATE August 1971 BY RWC

SERVICE VENT VAPORS INCINERATOR — NO. REQ'D. One (1)
REVISIONS: a ______ BY ______ : b ______ BY ______ : c ______ BY ______ : d ______ BY ______
MANUFACTURER ______ SOURCE: QUOTE OF ______

ONE (1) 50 foot, vertical, cylindrical, self-supported, vent vapor incinerator for the complete combustion of vent gas. Design shall be forced draft.

CAPACITY

Component	Rate Lb./Hr.
CH_4	253.4
Air	4040.0
SO_2	2.0

UTILITIES

	Normal	Maximum
Fuel, MMBTU/Hr.	1.0	10.0
Power (110 V) KW	0.5	1.5
Power (440 V) Hp	3.0	3.0

COMBUSTION

1400°F @ 25% excess air

BURNER

One combination fuel gas waste burner to be supplied. Features shall include:

- Raw gas burner
- Waste gas annular burner
- Ignitor
- Gas pilot
- Burner tile
- Air control registers

CONTROLS

A flame safeguard and temperature control system shall be provided with attendant instrumentation.

FAN

A combustion air fan of 3.0 Hp with driver shall be provided. Enclosure type shall be TEFC.

CODES

Unit shall conform toaall applicable law, regulations, and codes of the State of California and the Federal Government.

FORM 1.55
REV.

Stearns-Roger

ROTARY PUMPS
STUDY DATA SHEET

ITEM NO. P-1
ACC'T. ______ PAGE ______
CUSTOMER HUMBLE OIL AND REFINING COMPANY — S.R JOB C-10140
PROJECT CRUDE OIL TREATING AND STORAGE FACILITY
LOCATION SANTA BARBARA CHANNEL — DATE August 1971 — BY RW

SERVICE CRUDE OIL TRANSFER PUMP — NO. REQ'D. 3/1/1
REVISIONS: a ______ BY ______ : b ______ BY ______ : C ______ BY ______ : d ______ BY ______
MANUFACTURER ______ SOURCE: QUOTE OF ______
MODEL & TYPE HORIZ. / GEAR OR SCREW — TURBINE DRIVEN ______ MOTOR DRIVEN ✓

CONDITIONS OF SERVICE

CONDITIONS SHOWN FOR TOTAL REQUIRED SERVICE — TOTAL OPERATING PUMPS REQUIRED AND SPARE PUMPS

PUMPING TEMP. 100 °F	SUCTION 0 PSIG	NPSH AVAIL. 7' — NSPH REQ'D (WATER) ______
CAPACITY @ P.T. 800 GPM	DISCHARGE 85.0 PSIG	RPM 1150 — EFF. ______
SPEC. GR. ~~@ P.T.~~ 0.92-0.945 @ 60°	DIFFERENTIAL 85.0 PSI	BHP @ RATING 105 — MAX. BHP FOR FRAME ______
VISCOS. @ P.T. 1500 CP ______ SSU	HEAD 207.5 FT.	RECOMMENDED HP DRIVEN ______
V.P. @ P.T. 11 PSIA	HYDRAULIC HP 40	FLUID EMULSIFIED CRUDE OIL

MATERIALS		GRINNELL HARDNESS	CONSTRUCTION
OUTER CASE	CAST STEEL		CASE SWP 150 PSIG @ 100 °F — HYD. TEST (MAX.) ______ PSIG
SIDE PLATE			MIN. THICKNESS ______ IN. — CORR. ALLOW. ______
LINER	NONE		SUPPORT TYPE ______ SPLIT (HORIZ.)(VERT.) ______
ROTOR OR GEARS	CAST IRON		ROTOR OR GEAR OVERHUNG (YES)(NO) ______
ROTATING VANE			DIAMETER SIZE ______ IN. TYPE ______
IDLER			TYPE GEAR __(SPUR)__(HELICAL)__(HERRING BONE) ______
TIMING GEAR	ALLOY STEEL (H.T.)		ROTATION FACING PUMP CPLG. (CW:CCW) ______
GASKETS			RELIEF VALVES (INT.)(EXT.) PRESS. SETTING ______ PSIG
STUDS & NUTS			CLEARANCE (DIAM.) ______ IN. SIDE PLATE ______ IN.
SHAFT	ALLOY STEEL		COUPLING MTR. THOMAS / EQ. (SINGLE)(SPACER) GUARD ______
SHAFT SLEEVES			STUFFING BOXES BORE ______ IN. DEPTH ______
STUFFING BOX			JACKETED (YES)(NO) ______ SMOTHERING GLAND (YES)(NO) ______
PACKING GLAND			PACKING NO. RINGS ______ SIZE ______ IN. SQ. ______ IN. I.D. ______
GLAND STUDS			MECH. SEAL MAKE & TYPE JOHN CRANE OR EQ.
LANTERN RING			MAT'L. ROT. FACE ______ STAT. FACE ______ SEAL GASK. ______
THROAT BUSHING			BASE PLATE TYPE EXTENDED

BEARINGS

THRUST (BALL: ~~SLEEVE~~) (OIL GREASE) (INT EXT) TYPE ______
RADIAL (BALL: ~~SLEEVE~~) (OIL GREASE) (INT EXT) TYPE ______

CONNECTIONS

NOZZLES	SIZE	RATING	FACING	LOCATION
SUCTION		150#		
DISCH.		150#		
VENTS				
DRAINS				
COOL. WTR.				

SPEED REDUCER

MAKE NONE REQ'D
CASE MAT'L. ______ GEAR MAT'L. ______
TYPE ______ CLASS ______
SPEED RATIO ______ SERVICE FACTOR ______

COOLING WATER

THRUST BRG. (YES)(NO) ______ GPM ______
RADIAL BRG. (YES)(NO) ______ GPM ______
STUFF. BOX (YES)(NO) ______ GPM ______

DRIVER

MOTOR	TURBINE
MAKE GE. OR EQ.	MAKE ______
ENCLOSURE TEFC	TYPE ______
FRAME NO. ______	HP ______ RPM ______
HP 125 RPM 1150	PRESS. @ THROTTLE ______ PSIG
VOLTS 440 PHASE 3 CYCLES 60	TEMP. ______ °F
START (LOW VOLT: X LINE) ______	EXHAUST PRESS. ______
BRG. TYPE ______	WATER RATE ______
BRG. LUBE ______	NO. HAND VALVES ______

DRAWINGS

SERIAL NUMBER ______
PERFORMANCE CURVE ______
OUTLINE DRAWING ______
CROSS SECT. DWG. OR BULLETIN # & PAGE # ______

TESTING

WITNESS PERF. TEST (YES)(NO) — CERTIFIED CURVE (YES)(NO) ______
WITNESS HYDRO TEST (YES)(NO) — TEST. PRESS. ______ PSIG
SUBMERGENCE TEST (YES)(NO) — SHOP INSP. ______
WTS. PUMP 2600 LBS. BASE ______ LBS. DRIVER ______ LBS.

REMARKS: SOUR SERVICE METALLURGY REQ'D.

Form 1.34
REV. 9-69

REV.

Stearns-Roger

CENTRIFUGAL PUMP

STUDY DATA SHEET

TAG NO. P-2

ACC'T.

CUSTOMER HUMBLE OIL AND REFINING COMPANY

S.R JOB C-10140

PROJECT CRUDE OIL TREATING AND STORAGE FACILITY

PAGE 1 OF 1

LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

DATE August 1971 BY RFS

SERVICE FILTER FEED AND BACKWASH PUMP (PHASE I DESIGN) NO. OPERATING 1 SPARE 1

REVISIONS: a ____ BY ____ : b ____ BY ____ : c ____ BY ____ : d ____ BY ____

MANUFACTURER ____ MODEL ____ SIZE ____ TYPE ____

SOURCE: ____ QUOTATION NO: ____ DATE: ____

LIQUID CHARACTERISTICS

LIQUID SOUR BRINE

PT °F 180 SP GR @ 60°F/@PT 1.026 / 0.98

VIS (CP) @ 180 °F/@PT — / 0.53

VAP. PRESS. PSIA @ 180 °F/@PT — / 7.5

BAROMETRIC PRESS. PSIA 14.7

OTHER ____

CONDITIONS OF SERVICE-EACH PUMP

	CALCULATED	RATED	MIN / MAX
USGPM @ 60°F	—	362	— / —
USGPM @ PT *	—	379	— / —
DIS PRESS PSIG	—	70	
SUC PRESS PSIG	—	0	
DIFF HEAD FT.	—	165	
NPSHA FT (SUC FLG)	—	AMPLE	—

AVAILABLE SUMP DEPTH FT —

CONSTRUCTION REQUIREMENTS

CUST. SPECS ____

TYPE: API 610 ☐ AVS ☐ OTHER ____

SUPPORT: CENTERLINE ☐ BASE ☐ IN-LINE ☐ VERTICAL ☐

CASE SPLT: RADIAL ☐ AXIAL ☐ CORROSION ALLOW ____ IN

CPLG & GUARD BY ____ DRIVER HALF MTD. BY ____

COUPLING MFG ____ MODEL ____

☒ MECH. SEAL: MFG ____ MODEL ____

SINGLE ☐ DOUBLE ☒ TANDEM ☐ BAL. ☐ UNBAL. ☐

☐ PACKING: MFG & TYPE ____

BASEPLATE: CI ☐ FAB STL ☐ DRIP LIP ☐ EXTENDED ☐

AUXILIARY CONNECTIONS

SERVICE	SIZE	LIQUID	GPM	°F	PSIG	PIPED BY
FLUSHING INLET						
FLUSHING OUTLET						
COOLING INLET						
COOLING OUTLET						
QUENCHING INLET						
QUENCHING OUTLET						
CLG. JKT - SEAL						
CLG. JKT-BEARING						
CLG. JKT-PEDESTAL						
OTHER						

TOTAL EXTERNAL COOLING WATER ____ GPM @ ____ °F

CASING VENT ____ CASING DRAIN ____ GAGE CONN'S ____

WTS: PUMP ____ BASE ____ DRIVER ____

PERFORMANCE & CONSTRUCTION

RATED RPM ____ ROTATION (FACING PUMP CPLG) ____

NO. OF STAGES ____ MIN CONT FLOW GPM ____

MIN SUBMER REQ'D ____ FT IMPELLER TYPE ____

MAX ALLOW CASE WP 125 PSIG @ 250 °F

	RATED	MIN/MAX
NPSHR FT	@SUC FLG	
EFF %		/
BHP		/
IMP DIA		/

CONNECTIONS	SIZE	ASA	FACE	POSITION
SUCTION				
DISCHARGE				

DRIVER: FURNISHED BY ____ MTD BY ____

MFG. ____ ENC TEFC FRAME ____

HP 30 RPM ____ VOLTS/PHASE/HZ 460/3/60

SEE DRIVER SPEC ____

AUXILIARY PIPING & ACCESSORIES

MECH SEAL FLUSH PLAN (API 610 APP C) ____

	BY S-R	BY MFG.		BY S-R	BY MFG
PIPE	☐	☐	TUBING	☐	☐
HEAT EXCHANGER	☐	☐	STRAINER	☐	☐
ORIFICE	☐	☐	SEPARATOR	☐	☐

OTHER ____

MATERIALS:

PUMP		SEAL	
CASING	NI-RESIST	ROT FACE	CARB-24
IMPELLER	NI-RESIST	STAT FACE	T.C.
SHAFT	316 SS	SPRINGS	316 SS
SLEEVE	316 SS	SHAFT SEAL	TEFLON
IMP WEAR RINGS	316 SS	STAT SEAL	VITON
CASE WEAR RINGS	316 SS	AUX. SEAL	
STATIC SEALS		PIPE/TUBING	
BUSHINGS		OTHER	

TESTING & INSPECTION (W INDICATES WITNESSED)

CERTIFIED SHOP TESTS:

____ PERFORMANCE ☐ ____ HYDRO ☐ @ ____ PSIG

____ NPSHR (ON WATER) ☐ NONE ☐ OTHER ____

INSPECTION:

☐ NONE ☐ OTHER ____

CERT PERF CURVE (MIN/MAX HD, FLOW, EFF, BHP, NPSHR) ☒

PERF CURVE NO. ____

BEARINGS: PLAIN ☐ ANTIFRICTION ☐

LUBRICATION: GREASE ☐ OIL RING ☐ FORCE FEED ☐ OTHER ☐

REMARKS: * RATE DETERMINED BY BACKWASH OPERATION

ALL VENTS TO CLOSED VENT SYSTEM AT 0 PSIG

ALL DRAINS TO CLOSED DRAIN SYSTEM AT 0 PSIG

FORM 1.33
REV.

Stearns-Roger

ROTARY PUMPS
STUDY DATA SHEET

ITEM NO. P-3
ACC'T. ______ PAGE ______
S-R JOB C-10140
DATE August 1971 BY RWC

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT CRUDE OIL TREATING AND STORAGE FACILITY
LOCATION SANTA BARBARA CHANNEL

SERVICE Rerun Pump NO. REQ'D. One (1)
REVISIONS: a ______ BY ______ : b ______ BY ______ : c ______ BY ______ : d ______ BY ______
MANUFACTURER ______ SOURCE: QUOTE OF ______
MODEL & TYPE HORIZ. / GEAR OR SCREW TURBINE DRIVEN ______ MOTOR DRIVEN ✓

CONDITIONS OF SERVICE

CONDITIONS SHOWN FOR TOTAL REQUIRED SERVICE — TOTAL OPERATING PUMPS REQUIRED AND SPARE PUMPS

PUMPING TEMP. 100 °F	SUCTION 0 PSIG	NPSH AVAIL. 7' NSPH REQ'D (WATER) ______
CAPACITY @ P.T. 250 GPM	DISCHARGE 95.3 PSIG	RPM 1150 EFF. ______
SPEC. GR. ~~@ P.T.~~ 0.92-0.945 @ 60°F	DIFFERENTIAL 95.3 PSI	BHP @ RATING 44 MAX. BHP FOR FRAME ______
VISCOS. @ P.T. 1500 CP SSU	HEAD 232 FT.	RECOMMENDED HP DRIVEN ______
V.P. @ P.T. 11 PSIA	HYDRAULIC HP 13.9	FLUID EMULSIFIED CRUDE OIL

MATERIALS

		GRINNELL HARDNESS
OUTER CASE	CAST STEEL	
SIDE PLATE		
LINER	NONE	
ROTOR OR GEARS	CAST IRON	
ROTATING VANE		
IDLER		
TIMING GEAR	ALLOY STEEL (H.T.)	
GASKETS		
STUDS & NUTS		
SHAFT	ALLOY STEEL	
SHAFT SLEEVES		
STUFFING BOX		
PACKING GLAND		
GLAND STUDS		
LANTERN RING		
THROAT BUSHING		

CONSTRUCTION

CASE SWP 150 PSIG @ 100 °F HYD. TEST (MAX.) ______ PSIG
MIN. THICKNESS ______ IN. CORR. ALLOW. ______
SUPPORT TYPE ______ SPLIT (HORIZ.)(VERT.)
ROTOR OR GEAR OVERHUNG (YES)(NO) ______
DIAMETER SIZE ______ IN. TYPE ______
TYPE GEAR ___ (SPUR) ___ (HELICAL) ___ (HERRING BONE) ______
ROTATION FACING PUMP CPLG. (CW:CCW) ______
RELIEF VALVES (INT.)(EXT.) PRESS. SETTING ______ PSIG
CLEARANCE (DIAM.) ______ IN. SIDE PLATE ______ IN.
COUPLING MTR. Thomas / EQ. (SINGLE)(SPACER) GUARD ______
STUFFING BOXES BORE ______ IN. DEPTH ______
JACKETED (YES)(NO) ______ SMOTHERING GLAND (YES)(NO) ______
PACKING NO. RINGS ______ SIZE ______ IN. SQ. ______ IN. I.D. ______
MECH. SEAL MAKE & TYPE JOHN CRANE OR EQ.
MAT'L. ROT. FACE ______ STAT. FACE ______ SEAL GASK. ______
BASE PLATE TYPE EXTENDED

BEARINGS

THRUST (BALL: ~~SLEEVE~~) (OIL GREASE) (INT EXT) TYPE ______
RADIAL (BALL: ~~SLEEVE~~) (OIL GREASE) (INT EXT) TYPE ______

CONNECTIONS

NOZZLES	SIZE	RATING	FACING	LOCATION
SUCTION		150#		
DISCH.		150#		
VENTS				
DRAINS				
COOL. WTR.				

SPEED REDUCER

MAKE ______
CASE MAT'L. ______ GEAR MAT'L. ______
TYPE ______ CLASS ______
SPEED RATIO ______ SERVICE FACTOR ______

COOLING WATER

THRUST BRG. (YES)(NO) ______ GPM ______
RADIAL BRG. (YES)(NO) ______ GPM ______
STUFF. BOX (YES)(NO) ______ GPM ______

DRIVER

MOTOR	TURBINE
MAKE G.E. OR EQUAL	MAKE ______
ENCLOSURE TEFC	TYPE ______
FRAME NO. ______	HP ______ RPM ______
HP 50 RPM 1150	PRESS. @ THROTTLE ______ PSIG
VOLTS 440 PHASE 3 CYCLES 60	TEMP. ______ °F
START (LOW VOLT: X LINE) ______	EXHAUST PRESS. ______
BRG. TYPE ______	WATER RATE ______
BRG. LUBE ______	NO. HAND VALVES ______

DRAWINGS

SERIAL NUMBER ______
PERFORMANCE CURVE ______
OUTLINE DRAWING ______
CROSS SECT. DWG. OR BULLETIN # & PAGE # ______

TESTING

WITNESS PERF. TEST (YES)(NO) ______ CERTIFIED CURVE (YES)(NO) ______
WITNESS HYDRO TEST (YES)(NO) ______ TEST. PRESS. ______ PSIG
SUBMERGENCE TEST (YES)(NO) ______ SHOP INSP. ______
WTS. PUMP 2025 LBS. BASE ______ LBS. DRIVER ______ LBS.

REMARKS: ______

Form 1.31
REV. 9-69

Stearns-Roger

CENTRIFUGAL PUMP
STUDY DATA SHEET

TAG NO. P-4
ACC'T.
S.R JOB C-10140
Page 1 OF 1
DATE August 1971 BY RTG/

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT CRUDE OIL TREATING AND STORAGE FACILITY
LOCATION SANTA BARBARA CHANNEL

SERVICE WATER TRANSFER PUMP — NO. OPERATING 1 SPARE 0
REVISIONS: a ___ BY ___ : b ___ BY ___ : c ___ BY ___ : d ___ BY ___
MANUFACTURER ___ MODEL ___ SIZE ___ TYPE HORIZ.
SOURCE: ___ QUOTATION NO: ___ DATE: ___

LIQUID CHARACTERISTICS

LIQUID SOUR BRINE
PT °F 60 SP GR @ 60°F/@PT 1.019 / 1.019
VIS (CP) @ ___ °F/@PT / 1.12
VAP. PRESS. PSIA @ ___ °F/@PT / 0.26
BAROMETRIC PRESS. PSIA 14.7
OTHER

CONDITIONS OF SERVICE-EACH PUMP

	CALCULATED	RATED	MIN / MAX
USGPM @ 60°F			/
USGPM @ PT		50	
DIS PRESS PSIG		25.3	
SUC PRESS PSIG		0	
DIFF HEAD FT.		59	
NPSHA FT(SUC FLG)		25	

AVAILABLE SUMP DEPTH FT

CONSTRUCTION REQUIREMENTS

CUST. SPECS
TYPE: API 610[ ] AVS[ ] OTHER
SUPPORT: CENTERLINE [ ] BASE [ ] IN-LINE[ ] VERTICAL[ ]
CASE SPLT: RADIAL[ ] AXIAL[ ] CORROSION ALLOW ___ IN
CPLG & GUARD BY ___ DRIVER HALF MTD. BY ___
COUPLING MFG ___ MODEL ___
X MECH. SEAL: MFG ___ MODEL ___
SINGLE[ ] DOUBLE[X] TANDEM[ ] BAL.[ ] UNBAL.[ ]
PACKING: MFG & TYPE JOHN CRANE OR EQ.
BASEPLATE: CI[ ] FAB STL[ ] DRIP LIP[ ] EXTENDED[ ]

AUXILIARY CONNECTIONS

SERVICE	SIZE	LIQUID	GPM	°F	PSIG	PIPED BY
FLUSHING INLET						
FLUSHING OUTLET						
COOLING INLET						
COOLING OUTLET						
QUENCHING INLET						
QUENCHING OUTLET						
CLG. JKT - SEAL						
CLG. JKT-BEARING						
CLG. JKT-PEDESTAL						
OTHER						

TOTAL EXTERNAL COOLING WATER ___ GPM@ ___ °F
CASING VENT ___ CASING DRAIN ___ GAGE CONN'S ___
WTS: PUMP ___ BASE ___ DRIVER ___

PERFORMANCE & CONSTRUCTION

RATED RPM 3550 ROTATION(FACING PUMP CPLG) ___
NO. OF STAGES ___ MIN CONT FLOW GPM ___
MIN SUBMER REQ'D ___ FT IMPELLER TYPE ___
MAX ALLOW CASE WP ___ PSIG @ ___ °F

	RATED	MIN/MAX
NPSHR . FT	@SUC FLG	
EFF %		
BHP		
IMP DIA		

CONNECTIONS	SIZE	ASA	FACE	POSITION
SUCTION				
DISCHARGE				

DRIVER: FURNISHED BY ___ MTD BY ___
MFG. GE OR EQ ENC TEFC FRAME ___
HP 7½ RPM 3600 VOLTS/PHASE/HZ ___
SEE DRIVER SPEC ___

AUXILIARY PIPING & ACCESSORIES

MECH SEAL FLUSH PLAN (API 610 APP C) ___

	BY S-R	BY MFG.		BY S-R	BY MFG
PIPE	[ ]	[ ]	TUBING	[ ]	[ ]
HEAT EXCHANGER	[ ]	[ ]	STRAINER	[ ]	[ ]
ORIFICE	[ ]	[ ]	SEPARATOR	[ ]	[ ]

OTHER ___

MATERIALS: PUMP / SEAL

CASING CAST STEEL — ROT FACE CARBON 24
IMPELLER C.I. — STAT FACE TUNG. CARB.
SHAFT 4140 H.T. — SPRINGS 316 SS
SLEEVE 11-13 CR — SHAFT SEAL TEFLON
IMP WEAR RINGS CI — STAT SEAL VITON
CASE WEAR RINGS CI — AUX. SEAL ___
STATIC SEALS ___ PIPE/TUBING ___
BUSHINGS ___ OTHER ___

TESTING & INSPECTION(W INDICATES WITNESSED)

CERTIFIED SHOP TESTS:
___ PERFORMANCE[ ] ___ HYDRO[ ]@ ___ PSIG
___ NPSHR(ON WATER)[ ] NONE[ ] OTHER ___
INSPECTION:
[ ]NONE [ ]OTHER
CERT PERF CURVE(MIN/MAX HD, FLOW, EFF, BHP, NPSHR) [ ]
PERF CURVE NO. ___

BEARINGS: PLAIN[ ] ANTIFRICTION[ ]
LUBRICATION: GREASE[ ] OIL RING[ ]
FORCE FEED[ ] OTHER[ ]

REMARKS:

FORM 1.82

REV.

Stearns-Roger

RECIPROCATING PUMPS

STUDY DATA SHEET

ITEM NO. P-5

ACC'T. ____ PAGE ____

S.R JOB C-10140

CUSTOMER HUMBLE OIL AND REFINING COMPANY

PROJECT CRUDE OIL TREATING & STORAGE FACILITY

LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

DATE August 1971 BY RES

SERVICE BRINE INJECTION PUMP (PHASE I DESIGN) NO. REQ'D. 2

REVISIONS :a ____ BY ____ :b ____ BY ____ :c ____ BY ____ :d ____ BY ____

MANUFACTURER ____ SOURCE: QUOTE OF ____

MODEL, TYPE & SIZE ____

CONDITIONS OF SERVICE

CONDITIONS SHOWN FOR TOTAL REQUIRED SERVICE: TOTAL OPERATING PUMPS REQUIRED AND ____ SPARE PUMPS ____

FLUID SOUR BRINE	REQ'D. — GPM @ 60° 72.9
PUMPING TEMPERATURE, °F 180	— GPM @ P.T., NORM. 76.3 DESIGN 76.3
SP. GR. @ 60°F 1.026 @ P.T. 0.98	SUCT. PRESS., PSIG — 0
VISCOSITY @ P.T. 0.53 cp	DISCH. PRESS., PSIG — 1500
VAPOR PRESSURE, PSIA 7.5 @ 180 °F	DIFF. PRESS., PSIG — 1500
BAROMETRIC PRESSURE, PSIA 14.7	DRIVING MEDIUM MOTOR
NPSH AVAILABLE @ SUCT. FLG., FT. OF FLUID AMPLE	PRESSURE, PSIG SUPPLY — EXHAUST —
	SUPPLY TEMP. °F — QUALITY % —

PERFORMANCE (OF SINGLE UNIT UNLESS NOTED)

NPSH REQ'D. @ SUCT. FLG., FT. OF FLUID ____	DESIGN EFFICIENCY, % VOLUMETRIC ____ MECH. ____
DESIGN ____ GPM EACH PUMP ____ TOTAL ____	DESIGN HYDRAULIC HORSEPOWER, HHP ____
DESIGN PISTON SPEED, FPM ____ RPM ____	BHP (POWER PUMPS) DESIGN ____ MAX. ____
MAX. ALLOW. PISTON SPEED, FPM ____ RPM ____	STEAM CONSUMPTION, LB/HHP/HR ____
STALLING PRESSURE, PSIG ____ @ 100% M.E.	LB/HR ____
WITH ____ PSIG SUPPLY, ____ PSIG EXH.	STEAM CHEST PRESS. @ DESIGN RATE, PSIG ____

MATERIALS AND DESIGN

LIQUID END: CYLINDER 316 SS HARD	LIQUID END: VALVES 316 SS HARD
CYLINDER LINER NONE	VALVE SEATS 316 SS HARD
TYPE ____	VALVE SPRINGS 316 SS
PISTON/PLUNGER 316 SS HARD	SUCT. VALVES, NO. & SIZE ____ SQ. IN. ____
PISTON PACKING TFE	VELOCITY, FPM DESIGN ____ MAX. ____
PISTON ROD ____	DISCH. VALVES, NO. & SIZE ____ SQ. IN. ____
ROD PACKING ____	VELOCITY, FPM DESIGN ____ MAX. ____
STUFFING BOX ____	COOLING WATER ____ @ ____ °F & ____ PSIG
LANTERN RING ____	____ GPM TO ____
PACKING GLAND ____	____ GPM TO ____
STEAM JACKET ____	VENTS ____ DRAINS ____
MAX. ALLOW. W.P. ____ PSIG @ ____ °F	SUCT. NOZZLE ____
CORR. ALLOW., IN. ____ HYD. TEST, PSIG ____	DISCH. NOZZLE ____
STEAM END: CYLINDER ____	POWER: FRAME TYPE ____
PISTON ROD ____	MAINSHAFT RPM ____ GEARSHAFT RPM ____
PACKING ____	GEAR RATIO ____ LUBRICATION ____
TYPE VALVE ____	DRIVE TYPE ____
MAX. ALLOW. W.P., ____ PSIG @ ____ °F TEST PSIG ____	GUARD ____
SUPPLY NOZZLE ____	BASEPLATE ____
EXHAUST NOZZLE ____	DRIVER MOUNTING ____

LUBRICATOR ____ LAGGING ____ REVOLUTION COUNTER ____

REMARKS: ALL VENTS TO CLOSED VENT SYSTEM AT 0 PSIG
ALL DRAINS TO CLOSED DRAIN SYSTEM AT 0 PSIG

DRIVER

FURNISHED BY ____ MOUNTED BY ____

ELECTRIC MOTOR NO. REQ'D. 2 MFG'R. ____ OTHER DRIVER TYPE & REF. PG. ____

HP 100 RPM ____ FRAME ____ TYPE ____ BEARINGS ____

VOLTS ____ PH ____ CY ____ LUBRICATION ____ TORQUE/THRUST ____

Form 1.34
Rev. 9-69

CENTRIFUGAL PUMP

STUDY DATA SHEET

Stearns-Roger

TAG No. P-6
Acc'T.
S.R Job C-10140
PAGE 1 OF 1
DATE August 1971 BY RFS

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT CRUDE OIL TREATING AND STORAGE FACILITY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

SERVICE RECYCLE BRINE SUMP PUMP NO. OPERATING 1 SPARE 1

REVISIONS: a BY : b BY : c BY : d BY

MANUFACTURER MODEL SIZE TYPE

SOURCE: QUOTATION NO: DATE:

LIQUID CHARACTERISTICS

LIQUID SOUR BRINE

PT °F 180 SP GR @ 60°F/@PT 1.026 / 0.98

VIS (CP) @ 180 °F/@PT — / 0.53

VAP. PRESS. PSIA @ 180 °F/@PT — / 7.5

BAROMETRIC PRESS. PSIA 14.7

OTHER —

CONDITIONS OF SERVICE-EACH PUMP

	CALCULATED	RATED	MIN / MAX
USGPM @ 60°F	52.2	63	— / —
USGPM @ PT	54.7	66	/
DIS PRESS PSIG	—	40	/
SUC PRESS PSIG	—	0	/
DIFF HEAD FT.	—	94.2	/
NPSHA FT (SUC FLG)	—	—	/ —

AVAILABLE SUMP DEPTH FT 5.0

CONSTRUCTION REQUIREMENTS

CUST. SPECS

TYPE: API 610☐ AVS☐ OTHER

SUPPORT: CENTERLINE☐ BASE☐ IN-LINE☐ VERTICAL☐

CASE SPLT: RADIAL☐ AXIAL☐ CORROSION ALLOW ____ IN

CPLG & GUARD BY ____ DRIVER HALF MTD. BY ____

COUPLING MFG ____ MODEL ____

☒ MECH. SEAL: MFG ____ MODEL ____

SINGLE☐ DOUBLE☒ TANDEM☐ BAL.☐ UNBAL.☐

☐ PACKING: MFG & TYPE

BASEPLATE: CI☐ FAB STL☐ DRIP LIP☐ EXTENDED☐

AUXILIARY CONNECTIONS

SERVICE	SIZE	LIQUID	GPM	°F	PSIG	PIPED BY
FLUSHING INLET						
FLUSHING OUTLET						
COOLING INLET						
COOLING OUTLET						
QUENCHING INLET						
QUENCHING OUTLET						
CLG. JKT - SEAL						
CLG. JKT-BEARING						
CLG. JKT-PEDESTAL						
OTHER						

TOTAL EXTERNAL COOLING WATER ____ GPM@ ____ °F

CASING VENT ____ CASING DRAIN ____ GAGE CONN'S ____

WTS: PUMP ____ BASE ____ DRIVER ____

PERFORMANCE & CONSTRUCTION

RATED RPM ____ ROTATION (FACING PUMP CPLG) ____

NO. OF STAGES ____ MIN CONT FLOW GPM ____

MIN SUBMER REQ'D ____ FT IMPELLER TYPE ____

MAX ALLOW CASE WP ____ PSIG @ ____ °F

	RATED	MIN/MAX
NPSHR FT	@SUC FLG	
EFF %		/
BHP		/
IMP DIA		/

CONNECTIONS	SIZE	ASA	FACE	POSITION
SUCTION				
DISCHARGE				

DRIVER: FURNISHED BY ____ MTD BY ____

MFG. ____ ENC TEFC FRAME ____

HP 3 RPM ____ VOLTS/PHASE/HZ ____

SEE DRIVER SPEC ____

AUXILIARY PIPING & ACCESSORIES

MECH SEAL FLUSH PLAN (API 610 APP C) ____

	BY S-R	BY MFG.		BY S-R	BY MFG
PIPE	☐	☐	TUBING	☐	☐
HEAT EXCHANGER	☐	☐	STRAINER	☐	☐
ORIFICE	☐	☐	SEPARATOR	☐	☐

OTHER ____

MATERIALS: PUMP / SEAL

PUMP		SEAL	
CASING	NI-RESIST	ROT FACE	
IMPELLER	NI-RESIST	STAT FACE	
SHAFT	316SS	SPRINGS	
SLEEVE	316SS	SHAFT SEAL	
IMP WEAR RINGS	316SS	STAT SEAL	
CASE WEAR RINGS	316SS	AUX. SEAL	
STATIC SEALS		PIPE/TUBING	
BUSHINGS		OTHER	

TESTING & INSPECTION (W INDICATES WITNESSED)

CERTIFIED SHOP TESTS:

____ PERFORMANCE☐ ____ HYDRO☐@ ____ PSIG

____ NPSHR (ON WATER)☐ NONE☐ OTHER ____

INSPECTION:

☐NONE ☐OTHER ____

CERT PERF CURVE (MIN/MAX HD, FLOW, EFF, BHP, NPSHR) ☒

PERF CURVE NO. ____

BEARINGS: PLAIN☐ ANTIFRICTION☐

LUBRICATION: GREASE☐ OIL RING☐ FORCE FEED☐ OTHER☐

REMARKS:

Form 1.34
REV. 9-69

Stearns-Roger

CENTRIFUGAL PUMP

STUDY DATA SHEET

VAG NO. P-7
ACC'T.
S.R JOB C-10140
PAGE 1 OF 1
DATE August 1971 BY R.F.S.
REV.

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT CRUDE OIL TREATING AND STORAGE FACILITY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

SERVICE OIL RETURN SUMP PUMP — NO. OPERATING ONE — SPARE ONE

REVISIONS: a ___ BY ___ : b ___ BY ___ : c ___ BY ___ : d ___ BY ___

MANUFACTURER ___ MODEL ___ SIZE ___ TYPE ___

SOURCE: ___ QUOTATION NO: ___ DATE: ___

LIQUID CHARACTERISTICS

LIQUID CRUDE OIL (SOUR)
PT °F 180 SP GR @ 60°F/@PT 0.93 / 0.88
VIS (CP) @ 180 °F/@PT — / 14
VAP. PRESS. PSIA @ 180 °F/@PT — / 7.2
BAROMETRIC PRESS. PSIA 14.7
OTHER —

CONDITIONS OF SERVICE-EACH PUMP

	CALCULATED	RATED	MIN / MAX
USGPM @ 60°F	—	—	— / —
USGPM @ PT	—	5	— / —
DIS PRESS PSIG	—	40	
SUC PRESS PSIG	—	0	
DIFF HEAD FT.	—	105	
NPSHA FT (SUC FLG)	—	—	/ —

AVAILABLE SUMP DEPTH FT 5.0

CONSTRUCTION REQUIREMENTS

CUST. SPECS ___
TYPE: API 610 ☐ AVS ☐ OTHER ___
SUPPORT: CENTERLINE ☐ BASE ☐ IN-LINE ☐ VERTICAL ☐
CASE SPLT: RADIAL ☐ AXIAL ☐ CORROSION ALLOW ___ IN
CPLG & GUARD BY ___ DRIVER HALF MTD. BY ___
COUPLING MFG ___ MODEL ___
☒ MECH. SEAL: MFG ___ MODEL ___
SINGLE ☐ DOUBLE ☒ TANDEM ☐ BAL. ☐ UNBAL. ☐
☐ PACKING: MFG & TYPE ___
BASEPLATE: CI ☐ FAB STL ☐ DRIP LIP ☐ EXTENDED ☐

AUXILIARY CONNECTIONS

SERVICE	SIZE	LIQUID	GPM	°F	PSIG	PIPED BY
FLUSHING INLET						
FLUSHING OUTLET						
COOLING INLET						
COOLING OUTLET						
QUENCHING INLET						
QUENCHING OUTLET						
CLG. JKT - SEAL						
CLG. JKT-BEARING						
CLG. JKT-PEDESTAL						
OTHER						

TOTAL EXTERNAL COOLING WATER ___ GPM @ ___ °F
CASING VENT ___ CASING DRAIN ___ GAGE CONN'S ___
WTS: PUMP ___ BASE ___ DRIVER ___

PERFORMANCE & CONSTRUCTION

RATED RPM ___ ROTATION (FACING PUMP CPLG) ___
NO. OF STAGES ___ MIN CONT FLOW GPM ___
MIN SUBMER REQ'D ___ FT IMPELLER TYPE ___
MAX ALLOW CASE WP ___ PSIG @ ___ °F

	RATED	MIN/MAX
NPSHR FT	@SUC FLG	
EFF %		/
BHP		/
IMP DIA		/

CONNECTIONS	SIZE	ASA	FACE	POSITION
SUCTION				
DISCHARGE				

DRIVER: FURNISHED BY ___ MTD BY ___
MFG. ___ ENC TEFC FRAME ___
HP 3/4 RPM ___ VOLTS/PHASE/HZ ___
SEE DRIVER SPEC ___

AUXILIARY PIPING & ACCESSORIES

MECH SEAL FLUSH PLAN (API 610 APP C) ___

	BY S-R	BY MFG.		BY S-R	BY MFG
PIPE	☐	☐	TUBING	☐	☐
HEAT EXCHANGER	☐	☐	STRAINER	☐	☐
ORIFICE	☐	☐	SEPARATOR	☐	☐

OTHER ___

MATERIALS: PUMP / SEAL

CASING CAST STEEL — ROT FACE ___
IMPELLER C.I — STAT FACE ___
SHAFT 4140 HT — SPRINGS ___
SLEEVE 11-13 CR — SHAFT SEAL ___
IMP WEAR RINGS CI — STAT SEAL ___
CASE WEAR RINGS CI — AUX. SEAL ___
STATIC SEALS ___ PIPE/TUBING ___
BUSHINGS ___ OTHER ___

TESTING & INSPECTION (W INDICATES WITNESSED)

CERTIFIED SHOP TESTS:
___ PERFORMANCE ☐ ___ HYDRO ☐ @ ___ PSIG
___ NPSHR (ON WATER) ☐ NONE ☐ OTHER ___
INSPECTION:
☐ NONE ☐ OTHER ___
CERT PERF CURVE (MIN/MAX HD, FLOW, EFF, BHP, NPSHR) ☒
PERF CURVE NO. ___

BEARINGS: PLAIN ☐ ANTIFRICTION ☐
LUBRICATION: GREASE ☐ OIL RING ☐ FORCE FEED ☐ OTHER ☐

REMARKS:

Form 1.84
REV. 9-69

Stearns-Roger

CENTRIFUGAL PUMP
STUDY DATA SHEET

TAG No. P-8 Rev.
Acc't.
CUSTOMER HUMBLE OIL AND REFINING COMPANY S.R JOB C-10140
PROJECT CRUDE OIL TREATING AND STORAGE FACILITY PAGE 1 OF 1
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA DATE August 1971 BY RES

SERVICE BACKWASH BRINE PUMP (PHASE I & II DESIGN) NO. OPERATING TWO SPARE
REVISIONS: a BY : b BY : c BY : d BY
MANUFACTURER MODEL SIZE TYPE
SOURCE: QUOTATION No: DATE:

LIQUID CHARACTERISTICS

LIQUID SOUR BRINE
PT °F 180 SP GR @ 60°F/@PT 1.026 / 0.98
VIS (CP) @ 180 °F/@PT — / 0.53
VAP. PRESS. PSIA @ 180 °F/@PT — / 7.5
BAROMETRIC PRESS. PSIA 14.7
OTHER —

CONDITIONS OF SERVICE-EACH PUMP

	CALCULATED	RATED	MIN / MAX
USGPM @ 60°F	95.5	114.6	— / —
USGPM @ PT	100	120	— / —
DIS PRESS PSIG	-	30	
SUC PRESS PSIG	-	0	
DIFF HEAD FT.	-	70.6	
NPSHA FT (SUC FLG)	-	AMPLE	/ —

AVAILABLE SUMP DEPTH FT —

CONSTRUCTION REQUIREMENTS

CUST. SPECS
TYPE: API 610☐ AVS☐ OTHER
SUPPORT: CENTERLINE☐ BASE☐ IN-LINE☐ VERTICAL☐
CASE SPLT: RADIAL☐ AXIAL☐ CORROSION ALLOW ____ IN
CPLG & GUARD BY ____ DRIVER HALF MTD. BY
COUPLING MFG ____ MODEL
☒ MECH. SEAL: MFG ____ MODEL
SINGLE☐ DOUBLE☒ TANDEM☐ BAL.☐ UNBAL.☐
☐ PACKING: MFG & TYPE
BASEPLATE: CI☐ FAB STL☐ DRIP LIP☐ EXTENDED☐

AUXILIARY CONNECTIONS

SERVICE	SIZE	LIQUID	GPM	°F	PSIG	PIPED BY
FLUSHING INLET						
FLUSHING OUTLET						
COOLING INLET						
COOLING OUTLET						
QUENCHING INLET						
QUENCHING OUTLET						
CLG. JKT - SEAL						
CLG. JKT-BEARING						
CLG. JKT-PEDESTAL						
OTHER						

TOTAL EXTERNAL COOLING WATER ____ GPM@ ____ °F
CASING VENT ____ CASING DRAIN ____ GAGE CONN'S
WTS: PUMP ____ BASE ____ DRIVER

PERFORMANCE & CONSTRUCTION

RATED RPM ____ ROTATION (FACING PUMP CPLG) ____
NO. OF STAGES ____ MIN CONT FLOW GPM
MIN SUBMER REQ'D ____ FT IMPELLER TYPE
MAX ALLOW CASE WP ____ PSIG @ ____ °F

	RATED	MIN/MAX
NPSHR FT	@SUC FLG	
EFF %		/
BHP		/
IMP DIA		/

CONNECTIONS	SIZE	ASA	FACE	POSITION
SUCTION				
DISCHARGE				

DRIVER: FURNISHED BY ____ MTD BY
MFG. ____ ENC TEFC FRAME
HP 7½ RPM ____ VOLTS/PHASE/HZ
SEE DRIVER SPEC

AUXILIARY PIPING & ACCESSORIES

MECH SEAL FLUSH PLAN (API 610 APP C)

	BY S-R	BY MFG.		BY S-R	BY MFG
PIPE	☐	☐	TUBING	☐	☐
HEAT EXCHANGER	☐	☐	STRAINER	☐	☐
ORIFICE	☐	☐	SEPARATOR	☐	☐

OTHER

MATERIALS:

PUMP		SEAL	
CASING	NI-RESIST	ROT FACE	CARB-24
IMPELLER	NI-RESIST	STAT FACE	T.C.
SHAFT	316SS	SPRINGS	316SS
SLEEVE	316SS	SHAFT SEAL	TEFLON
IMP WEAR RINGS	316SS	STAT SEAL	VITON
CASE WEAR RINGS	316SS	AUX. SEAL	
STATIC SEALS		PIPE/TUBING	
BUSHINGS		OTHER	

TESTING & INSPECTION (W INDICATES WITNESSED)

CERTIFIED SHOP TESTS:
____ PERFORMANCE☐ ____ HYDRO☐ @ ____ PSIG
____ NPSHR (ON WATER)☐ NONE☐ OTHER
INSPECTION:
☐ NONE ☐ OTHER
CERT PERF CURVE (MIN/MAX HD, FLOW, EFF, BHP, NPSHR) ☒
PERF CURVE NO.
BEARINGS: PLAIN☐ ANTIFRICTION☐
LUBRICATION: GREASE☐ OIL RING☐ FORCE FEED☐ OTHER☐

REMARKS: ALL VENTS TO CLOSED VENT SYSTEM AT 0 PSIG
ALL DRAINS TO CLOSED DRAIN SYSTEM AT 0 PSIG

FORM 1.34

METERING PUMPS

Stearns-Roger CORPORATION

ITEM NO. P-9
ACC'T. ______ PAGE 1
S-R JOB C-10140

CUSTOMER HUMBLE OIL AND REFINING CO
PROJECT CRUDE OIL TREATING & STORAGE FACILITY
LOCATION SANTA BARBARA CHANNEL, CALIF.

DATE AUGUST, 1971 BY RF

SERVICE CHEMICAL ADDITION PUMP NO. REQ'D. 1

REVISIONS :a ______ BY ____ :b ______ BY ____ :c ______ BY ____ :d ______ BY ____

MANUFACTURER ______ SOURCE: QUOTE OF ______

TYPE PUMP: PLUNGER [ ] DIAPHRAGM [X] DIRECT ACTING [ ] POWER FRAME [ ]

METERING HEADS: SIMPLEX [ ] DUPLEX [ ] TRIPLEX [ ] * HEAD GANG [ ]

* USE SEPARATE DATA SHEET FOR EACH LIQUID END

MATERIALS

LIQUID END ______
PLUNGER ______
CROSS HEAD ______
CONN. ROD ______
CRANK ______
GEAR (DRIVER) ______
GEAR (DRIVEN) ______
GEAR HOUSING ______
FRAME ______
VALVES ______
VALVE SEATS ______
VALVE BODY ______
PACKING ______ MAX. TEMP. °F ______
GASKETS ______
DIAPHRAGM ______ MAX. TEMP. °F ______
GLAND ______
LANTERN RING ______
VALVE CAPS ______

CONNECTIONS

	SIZE	TYPE	RATING
SUCTION			
DISCHARGE			
DRAINS			
FLUSHING			

AIR OR GAS PURGING YES [ ] NO [ ]
VALVES REPLACEABLE YES [ ] NO [ ]

LIQUID END

LIQUID END BODY: TYPE (PLUNGER) (DIAPHRAGM) (REMOTE) (SUBMERGED)
PLUNGER DIAM. ______ STROKE ______
STROKES/MIN/CYLINDER ______
S.W.P. ______ W/QUOTED DRIVER SWP ______ W/MAX. DRIVER

VALVES	SUCTION	DISCHARGE
TYPE		
NUMBER		
AREA $IN.^2$		

PLUNGER SUPPORT ______ (PACKING) ______ (CROSS HEAD) ______
PACKING SIZE ______ TYPE ______
SPECIAL SEALS ______

LUBRICATION

PACKING ______ DRIVER BRGS. ______
CONN. ROD BRGS. ______
CROSS HEAD ______ GEARING ______
POWER CYLINDER ______
HYDRAULIC FLUID (DIAPHRAGM PLUNGER PUMP) ______

STROKE ADJUSTMENT

MANUAL [X] AUTO [ ] WHILE RUNNING [ ] OR STOPPED [ ]
REMOTE [ ] LOCAL [ ]
SIGNAL: PNEUMATIC [ ] ELECTRIC [ ] HYDRAULIC [ ]

AUXILIARY FEATURES

JACKETED [ ] STROKE COUNTER [ ]
TIMER & MULTIPORT VALVE [ ] SPARE PACKING [ ]

DRIVE

ELECTRIC [X] GAS [ ] AIR [ ] BHP ______
MAKE ______ CONSTANT SPEED [ ] VAR. SPEED [ ]
RPM ______ PHASE 1 CYCLES 60 VOLTS 110
ENCLOSURE TEFC FRAME NO. ______
FULL LOAD CURRENT ______ LOCKED ROTOR CURRENT ______
POWER CYLINDER: DIAM. ______ STROKE ______
GAS PRESS. SUPPLY ______ EXHAUST ______
GAS CONSUMPTION ______ SCFM @ MAX. SPEED

SPEED CONTROL ELECT. [ ] PNEUMATIC [ ] MANUAL [X]
AUTOMATIC [ ] NONE [ ]
SPEED REDUCER: MFR. ______ INTEG. [ ] SEPARATE [ ]
MODEL ______ RATIO ______ CLASS. ______
COUPLING: MAKE ______ TYPE ______
GUARDS: COUPLING [ ] CRANK [ ]
SPEED INDIC. YES [ ] NO [ ] REMOTE [ ] LOCAL [ ]

SERVICE CONDITIONS

LIQUID END NO. ______ LIQ. BIOCIDE (~~[illegible]~~) (BASIC)
PUMPING TEMP. 100 °F. VAPOR PRESS. @ P.T. —
VISCOSITY 6.0 C.P. SPECIFIC GRAVITY 1.0
CORROSION OR EROSION FACTORS ______
CAPACITY GPH: MAX. — MIN. — NORM. 0.10
SUCT. PRESS. PSIG: MAX. — MIN. — NORM. 0
DISCH. PRESS. PSIG: MAX. — MIN. — NORM. 40
NPSH AVAILABLE AMPLE REQ'D. —
BHP @ RATING ______
BASE PLATE ______
TEST: HYD. [ ] PERF. [ ] WITNESSED [ ] NOT WITNESSED [ ]

REMARKS:

1. Pump shall be designed for the continuous injection 0.10 Gpm of Chemical biocide agent. Capacity rating approx. - to be confirmed by additive supplier.

REV. FORM 1.34 REV.

METERING PUMPS

STUDY DATA SHEET

Stearns-Roger CORPORATION

ITEM NO. P-10
ACC'T. ______ PAGE ______

CUSTOMER HUMBLE OIL AND REFINING COMPANY S-R JOB C-10140
PROJECT CRUDE OIL TREATING AND STORAGE FACILITY
LOCATION SANTA BARBARA CHANNEL DATE August 1971 BY RWC

SERVICE Corrosion Inhibitor Pump NO. REQ'D. 1 OP. / 1 SPARE
REVISIONS :a ______ BY ______ :b ______ BY ______ :c ______ BY ______ :d ______ BY ______
MANUFACTURER ______ SOURCE: QUOTE OF ______

TYPE PUMP: PLUNGER [X] DIAPHRAGM [ ] DIRECT ACTING [ ] POWER FRAME [ ]
METERING HEADS: SIMPLEX [X] DUPLEX [ ] TRIPLEX [ ] * HEAD GANG [ ]
* USE SEPARATE DATA SHEET FOR EACH LIQUID END

MATERIALS

LIQUID END Steel
PLUNGER 316 SS
CROSS HEAD ______
CONN. ROD ______
CRANK ______
GEAR (DRIVER) ______
GEAR (DRIVEN) ______
GEAR HOUSING ______
FRAME ______
VALVES ______
VALVE SEATS 316 SS
VALVE BODY Steel
PACKING ______ MAX. TEMP. °F ______
GASKETS ______
DIAPHRAGM ______ MAX. TEMP. °F ______
GLAND ______
LANTERN RING ______
VALVE CAPS ______

CONNECTIONS

	SIZE	TYPE	RATING
SUCTION			
DISCHARGE			
DRAINS			
FLUSHING			

AIR OR GAS PURGING YES [ ] NO [X]
VALVES REPLACEABLE YES [X] NO [ ]

LIQUID END

LIQUID END BODY: TYPE (PLUNGER) (DIAPHRAGM) (REMOTE) (SUBMERGED)
PLUNGER DIAM. ______ STROKE ______
STROKES/MIN/CYLINDER ______
S.W.P. ______ W/QUOTED DRIVER SWP ______ W/MAX. DRIVER

VALVES	SUCTION	DISCHARGE
TYPE	Ball	Ball
NUMBER		
AREA IN.^{2}		

PLUNGER SUPPORT ______ (PACKING) ______ (CROSS HEAD) ______
PACKING SIZE ______ TYPE ______
SPECIAL SEALS ______

LUBRICATION

PACKING Grease DRIVER BRGS. ______
CONN. ROD BRGS. Grease
CROSS HEAD Grease GEARING ______
POWER CYLINDER ______
HYDRAULIC FLUID (DIAPHRAGM PLUNGER PUMP) ______

STROKE ADJUSTMENT

MANUAL [X] AUTO [ ] WHILE RUNNING [ ] OR STOPPED [ ]
REMOTE [ ] LOCAL [ ]
SIGNAL: PNEUMATIC [ ] ELECTRIC [ ] HYDRAULIC [ ]

AUXILIARY FEATURES

JACKETED [ ] STROKE COUNTER [ ]
TIMER & MULTIPORT VALVE [ ] SPARE PACKING [ ]

DRIVE

ELECTRIC [X] GAS [ ] AIR [ ] BHP 1/2
MAKE G.E. or E.Q. CONSTANT SPEED [X] VAR. SPEED [ ]
RPM 1750 PHASE 1 CYCLES 60 VOLTS 110
ENCLOSURE TEFC FRAME NO. ______
FULL LOAD CURRENT ______ LOCKED ROTOR CURRENT ______
POWER CYLINDER: DIAM. ______ STROKE ______
GAS PRESS. SUPPLY ______ EXHASUT ______
GAS CONSUMPTION ______ SCFM @ MAX. SPEED

SPEED CONTROL ELECT. [ ] PNEUMATIC [ ] MANUAL [ ]
AUTOMATIC [ ] NONE [ ]
SPEED REDUCER: MFR. ______ INTEG. [ ] SEPARATE [ ]
MODEL ______ RATIO ______ CLASS. ______
COUPLING: MAKE ______ TYPE ______
GUARDS: COUPLING [ ] CRANK [ ]
SPEED INDIC. YES [ ] NO [ ] REMOTE [ ] LOCAL [ ]

SERVICE CONDITIONS

LIQUID END NO. ______ LIQ. ______ (ACID) (BASIC)
PUMPING TEMP. 77 °F. VAPOR PRESS. @ P.T. ______
VISCOSITY ______ C.P. SPECIFIC GRAVITY ______
CORROSION OR EROSION FACTORS ______
CAPACITY GPH: MAX. 8.0 MIN. 2.0 NORM. 4.0
SUCT. PRESS. PSIG: MAX. ______ MIN. ______ NORM. 0
DISCH. PRESS. PSIG: MAX. 90.0 MIN. ______ NORM. 50.0
NPSH AVAILABLE ______ REQ'D. ______
BHP @ RATING ______
BASE PLATE ______
TEST: HYD. [ ] PERF. [ ] WITNESSED [ ] NOT WITNESSED [ ]

REMARKS:
CAPACITY RATING APPROX. - TO BE CONFIRMED BY INHIBITOR ADDITIVE SUPPLIER.

FORM 1.34

METERING PUMPS

STUDY DATA SHEET

Stearns-Roger CORPORATION

ITEM NO. P-11
ACC'T. ______ PAGE ______
S-R JOB C-10140

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT CRUDE OIL TREATING AND STORAGE FACILITY
LOCATION SANTA BARBARA CHANNEL
DATE August 1971 BY RWC

SERVICE DE-EMULSIFIER ADDITION PUMP NO. REQ'D. 1 OP./1 SPARE
REVISIONS :a ______ BY ______ :b ______ BY ______ :c ______ BY ______ :d ______ BY ______
MANUFACTURER ______ SOURCE: QUOTE OF ______

TYPE PUMP: PLUNGER [X] DIAPHRAGM [ ] DIRECT ACTING [ ] POWER FRAME [ ]
METERING HEADS: SIMPLEX [X] DUPLEX [ ] TRIPLEX [ ] * HEAD GANG [ ]
* USE SEPARATE DATA SHEET FOR EACH LIQUID END

MATERIALS

LIQUID END STEEL
PLUNGER 316 SS
CROSS HEAD ______
CONN. ROD ______
CRANK ______
GEAR (DRIVER) ______
GEAR (DRIVEN) ______
GEAR HOUSING ______
FRAME ______
VALVES ______
VALVE SEATS 316 SS
VALVE BODY STEEL
PACKING ______ MAX. TEMP. °F ______
GASKETS ______
DIAPHRAGM ______ MAX. TEMP. °F ______
GLAND ______
LANTERN RING ______
VALVE CAPS ______

CONNECTIONS

	SIZE	TYPE	RATING
SUCTION	1/2"	NPT	
DISCHARGE	1/2"	NPT	
DRAINS			
FLUSHING			

AIR OR GAS PURGING YES [ ] NO [X]
VALVES REPLACEABLE YES [X] NO [ ]

LIQUID END

LIQUID END BODY: TYPE (PLUNGER) (DIAPHRAGM) (REMOTE) (SUBMERGED)
PLUNGER DIAM. ______ STROKE ______
STROKES/MIN/CYLINDER ______
S.W.P. ______ w/QUOTED DRIVER SWP ______ w/MAX. DRIVER

VALVES	SUCTION	DISCHARGE
TYPE	BALL	BALL
NUMBER		
AREA IN.^{2}		

PLUNGER SUPPORT ______ (PACKING) ______ (CROSS HEAD) ______
PACKING SIZE ______ TYPE ______
SPECIAL SEALS ______

LUBRICATION

PACKING GREASE DRIVER BRGS. ______
CONN. ROD BRGS. GREASE
CROSS HEAD GREASE GEARING ______
POWER CYLINDER ______
HYDRAULIC FLUID (DIAPHRAGM PLUNGER PUMP) ______

STROKE ADJUSTMENT

MANUAL [X] AUTO [ ] WHILE RUNNING [ ] OR STOPPED [ ]
REMOTE [ ] LOCAL [ ]
SIGNAL: PNEUMATIC [ ] ELECTRIC [ ] HYDRAULIC [ ]

AUXILIARY FEATURES

JACKETED [ ] STROKE COUNTER [ ]
TIMER & MULTIPORT VALVE [ ] SPARE PACKING [ ]

DRIVE

ELECTRIC [X] GAS [ ] AIR [ ] BHP 1/2
MAKE G.E. OR EQ. CONSTANT SPEED [ ] VAR. SPEED [ ]
RPM 1750 PHASE 1 CYCLES 60 VOLTS 110
ENCLOSURE TEFC FRAME NO. ______
FULL LOAD CURRENT ______ LOCKED ROTOR CURRENT ______
POWER CYLINDER: DIAM. ______ STROKE ______
GAS PRESS. SUPPLY ______ EXHAUST ______
GAS CONSUMPTION ______ SCFM @ MAX. SPEED

SPEED CONTROL ELECT. [ ] PNEUMATIC [ ] MANUAL [ ]
AUTOMATIC [ ] NONE [ ]
SPEED REDUCER: MFR. ______ INTEG. [ ] SEPARATE [ ]
MODEL ______ RATIO ______ CLASS. ______
COUPLING: MAKE ______ TYPE ______
GUARDS: COUPLING [ ] CRANK [ ]
SPEED INDIC. YES [ ] NO [ ] REMOTE [ ] LOCAL [ ]

SERVICE CONDITIONS

LIQUID END NO. ______ LIQ. ______ (ACID) (BASIC)
PUMPING TEMP. 77 °F. VAPOR PRESS. @ P.T. ______
VISCOSITY ______ C.P. SPECIFIC GRAVITY ______
CORROSION OR EROSION FACTORS ______
CAPACITY GPH: MAX. 8.0 MIN. 2.0 NORM. 4.0
SUCT. PRESS. PSIG: MAX. ______ MIN. ______ NORM. 0
DISCH. PRESS. PSIG: MAX. 90.0 MIN. ______ NORM. 50.0
NPSH AVAILABLE ______ REQ'D. ______
BHP @ RATING ______
BASE PLATE ______
TEST: HYD. [ ] PERF. [ ] WITNESSED [ ] NOT WITNESSED [ ]

REMARKS:
RATING CAPACITY APPROX. - TO BE CONFIRMED BY ADDITIVE SUPPLIER.

Form 1.34
Rev. 9-69

CENTRIFUGAL PUMP
STUDY DATA SHEET

Stearns-Roger

TAG No. P12
Acc'T. ____
S.R Job C-10140
Page ____ Of ____
Date August 1971 By ____

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT CRUDE OIL TREATING AND STORAGE FACILITY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

SERVICE SKIMMED OIL SUMP PUMP — NO. OPERATING 1 SPARE 0
REVISIONS: a ____ By ____ : b ____ By ____ : c ____ By ____ : d ____ By ____
MANUFACTURER ____ MODEL ____ SIZE ____ TYPE ____
SOURCE: ____ QUOTATION No: ____ DATE: ____

LIQUID CHARACTERISTICS

LIQUID OIL OR WATER *
PT °F 80 SP GR @ 60°F/@PT 0.93 / 0.92
VIS (CP) @ 80 °F/@PT ____ / 4.0
VAP. PRESS. PSIA@ 80 °F/@PT — / —
BAROMETRIC PRESS. PSIA 14.7
OTHER ____

CONDITIONS OF SERVICE-EACH PUMP

	CALCULATED	RATED	MIN / MAX
USGPM @ 60°F	—	—	— / —
USGPM @ PT	—	50	— / —
DIS PRESS PSIG	—	167	/
SUC PRESS PSIG	—	0	/
DIFF HEAD FT.	—	42	/
NPSHA FT(SUC FLG)	—	AMPLE	/ —

AVAILABLE SUMP DEPTH FT ____

CONSTRUCTION REQUIREMENTS

CUST. SPECS ____
TYPE: API 610☐ AVS☐ OTHER ____
SUPPORT: CENTERLINE☐ BASE☐ IN-LINE☐ VERTICAL☐
CASE SPLT: RADIAL☐ AXIAL☐ CORROSION ALLOW ____ IN
CPLG & GUARD BY ____ DRIVER HALF MTD. BY ____
COUPLING MFG ____ MODEL ____
☐ MECH. SEAL: MFG ____ MODEL ____
SINGLE☐ DOUBLE☐ TANDEM☐ BAL.☐ UNBAL.☐
☒ PACKING: MFG & TYPE ____
BASEPLATE: CI☐ FAB STL☐ DRIP LIP☐ EXTENDED☐

AUXILIARY CONNECTIONS

SERVICE	SIZE	LIQUID	GPM	°F	PSIG	PIPED BY
FLUSHING INLET						
FLUSHING OUTLET						
COOLING INLET						
COOLING OUTLET						
QUENCHING INLET						
QUENCHING OUTLET						
CLG. JKT - SEAL						
CLG. JKT-BEARING						
CLG. JKT-PEDESTAL						
OTHER						

TOTAL EXTERNAL COOLING WATER ____ GPM@ ____ °F
CASING VENT ____ CASING DRAIN ____ GAGE CONN'S ____
WTS: PUMP ____ BASE ____ DRIVER ____

PERFORMANCE & CONSTRUCTION

RATED RPM ____ ROTATION(FACING PUMP CPLG) ____
NO. OF STAGES ____ MIN CONT FLOW GPM ____
MIN SUBMER REQ'D ____ FT IMPELLER TYPE ____
MAX ALLOW CASE WP ____ PSIG @ ____ °F

	RATED	MIN/MAX
NPSHR FT	@SUC FLG	
EFF %		/
BHP		/
IMP DIA		/

CONNECTIONS	SIZE	ASA	FACE	POSITION
SUCTION				
DISCHARGE				

DRIVER: FURNISHED BY ____ MTD BY ____
MFG. ____ ENC TEFC FRAME ____
HP 2 RPM ____ VOLTS/PHASE/HZ ____
SEE DRIVER SPEC ____

AUXILIARY PIPING & ACCESSORIES

MECH SEAL FLUSH PLAN (API 610 APP C) ____

	BY S-R	BY MFG.		BY S-R	BY MFG
PIPE	☐	☐	TUBING	☐	☐
HEAT EXCHANGER	☐	☐	STRAINER	☐	☐
ORIFICE	☐	☐	SEPARATOR	☐	☐

OTHER ____

MATERIALS:

PUMP		SEAL	
CASING	C.I.	ROT FACE	
IMPELLER	C.I.	STAT FACE	
SHAFT	STEEL	SPRINGS	
SLEEVE	C.I.	SHAFT SEAL	
IMP WEAR RINGS	C.I.	STAT SEAL	
CASE WEAR RINGS	C.I.	AUX. SEAL	
STATIC SEALS		PIPE/TUBING	
BUSHINGS		OTHER	

TESTING & INSPECTION (W INDICATES WITNESSED)

CERTIFIED SHOP TESTS:
____ PERFORMANCE☐ ____ HYDRO☐@ ____ PSIG
____ NPSHR (ON WATER)☐ NONE☐ OTHER ____
INSPECTION:
☐NONE ☐OTHER ____
CERT PERF CURVE(MIN/MAX HD, FLOW, EFF, BHP, NPSHR) ☐
PERF CURVE NO. ____

BEARINGS: PLAIN☐ ANTIFRICTION☐
LUBRICATION: GREASE☐ OIL RING☐ FORCE FEED☐ OTHER☐

REMARKS: SPECIFICATIONS GIVEN FOR CONTROLING CASE - OIL FLOW

Stearns-Roger

CENTRIFUGAL PUMP
STUDY DATA SHEET

ITEM No. P-13
ACC'T. ______ PAGE ______
S.R JOB C-10140

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT CRUDE OIL TREATING AND STORAGE FACILITY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA
DATE August 1971 BY RWC

SERVICE Fire Water Pump NO. REQ'D. 1

REVISIONS: a ______ BY ______ : b ______ BY ______ : c ______ BY ______ : d ______ BY ______

MANUFACTURER ______ SOURCE: QUOTE OF ______

One (1) Engine driven horizontal centrifugal fire water pump of discharge capacity of 2000 rpm at a minimum discharge pressure of 125 psig. Pump shall be of a design approved by the Fire Underwriters Association and shall meet all applicable standards issued by the FUA.

Pump

Fluid:	Fresh Water
Suction Pressure:	30 psig
No. of Stages:	1
Discharge Pressure:	125 psig
Pumping Temperature:	77°F
Seals:	Packing
Support:	Base Mounted

Engine

Type:	Internal combustion/dual Carburetion
Fuel:	Natural gas or gasoline
Manufacturer:	Waukesha or equal

Accessories

Automatic air release valve for pump, compound suction and discharge gauges, dual batteries, cables, and connectors. Battery trickle charger.

Form 1.34
Rev. 9-69

Stearns-Roger

CENTRIFUGAL PUMP
STUDY DATA SHEET

TAG No. P-14
Acc'T.
S.R Job C-10140
Page 1 of 1
Date August 1971 By RWC

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT CRUDE OIL TREATING AND STORAGE FACILITY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

SERVICE BLOWOFF PUMP NO. OPERATING 1 SPARE 0
REVISIONS: a ___ BY ___ :b ___ BY ___ :c ___ BY ___ :d ___ BY
MANUFACTURER ___ MODEL ___ SIZE ___ TYPE HORIZ.
SOURCE: ___ QUOTATION No: ___ DATE:

LIQUID CHARACTERISTICS

LIQUID EMULSIFIED CRUDE OIL
PT °F 180 SP GR @ 60°F/@PT ___ / 0.900
VIS (CP) @ 100 °F/@PT 1,400 / 50
VAP. PRESS. PSIA@ 105°F/@PT 14.7 / 20.0
BAROMETRIC PRESS. PSIA 14.7
OTHER

CONDITIONS OF SERVICE-EACH PUMP

	CALCULATED	RATED	MIN / MAX
USGPM @ 60°F			/
USGPM @ PT		250	/
DIS PRESS PSIG		95.3	
SUC PRESS PSIG		0.0	
DIFF HEAD FT.		238	
NPSHA FT(SUC FLG)		5	

AVAILABLE SUMP DEPTH FT

CONSTRUCTION REQUIREMENTS

CUST. SPECS
TYPE: API 610☐ AVS☐ OTHER
SUPPORT: CENTERLINE☐ BASE☐ IN-LINE☐ VERTICAL☐
CASE SPLT: RADIAL☐ AXIAL☐ CORROSION ALLOW ___ IN
CPLG & GUARD BY ___ DRIVER HALF MTD. BY
COUPLING MFG ___ MODEL
☒ MECH. SEAL: MFG JOHN CRANE MODEL OR EQ.
SINGLE☐ DOUBLE☒ TANDEM☐ BAL.☐ UNBAL.☐
☐ PACKING: MFG & TYPE
BASEPLATE: CI☐ FAB STL☐ DRIP LIP☐ EXTENDED☐

AUXILIARY CONNECTIONS

SERVICE	SIZE	LIQUID	GPM	°F	PSIG	PIPED BY
FLUSHING INLET						
FLUSHING OUTLET						
COOLING INLET						
COOLING OUTLET						
QUENCHING INLET						
QUENCHING OUTLET						
CLG. JKT - SEAL						
CLG. JKT-BEARING						
CLG. JKT-PEDESTAL						
OTHER						

TOTAL EXTERNAL COOLING WATER ___ GPM@ ___ °F
CASING VENT ___ CASING DRAIN ___ GAGE CONN'S
WTS: PUMP 200 BASE ___ DRIVER

PERFORMANCE & CONSTRUCTION

RATED RPM 3550 ROTATION(FACING PUMP CPLG)
NO. OF STAGES ___ MIN CONT FLOW GPM
MIN SUBMER REQ'D ___ FT IMPELLER TYPE
MAX ALLOW CASE WP 125 PSIG @ 250 °F

	RATED	MIN/MAX
NPSHR FT	@SUC FLG	
EFF %		/
BHP		/
IMP DIA		/

CONNECTIONS	SIZE	ASA	FACE	POSITION
SUCTION				
DISCHARGE				

DRIVER: FURNISHED BY ___ MTD BY
MFG. GE. OR EQ. ENC TEFC FRAME
HP 30 RPM 3600 VOLTS/PHASE/HZ
SEE DRIVER SPEC

AUXILIARY PIPING & ACCESSORIES

MECH SEAL FLUSH PLAN (API 610 APP C)

	BY S-R	BY MFG.		BY S-R	BY MFG
PIPE	☐	☐	TUBING	☐	☐
HEAT EXCHANGER	☐	☐	STRAINER	☐	☐
ORIFICE	☐	☐	SEPARATOR	☐	☐

OTHER

MATERIALS: PUMP / SEAL

PUMP		SEAL	
CASING	CAST STEEL	ROT FACE	
IMPELLER	C.I.	STAT FACE	
SHAFT		SPRINGS	
SLEEVE		SHAFT SEAL	
IMP WEAR RINGS	C.I.	STAT SEAL	
CASE WEAR RINGS	C.I.	AUX. SEAL	
STATIC SEALS		PIPE/TUBING	
BUSHINGS		OTHER	

TESTING & INSPECTION(W INDICATES WITNESSED)

CERTIFIED SHOP TESTS:
___ PERFORMANCE☐ ___ HYDRO☐@ ___ PSIG
___ NPSHR(ON WATER)☐ NONE☐ OTHER
INSPECTION:
☐NONE ☐OTHER
CERT PERF CURVE(MIN/MAX HD, FLOW, EFF, BHP, NPSHR) ☐
PERF CURVE NO.

BEARINGS: PLAIN☐ ANTIFRICTION☐
LUBRICATION: GREASE☐ OIL RING☐ FORCE FEED☐ OTHER☐

REMARKS:

Form 1.01

REV.

Stearns-Roger

SEPARATORS

STUDY DATA SHEET

ITEM NO. S-1

ACC'T. PAGE

CUSTOMER HUMBLE OIL AND REFINING COMPANY S.R JOB C-10140

PROJECT CRUDE OIL TREATING AND STORAGE FACILITY

LOCATION SANTA BARBARA CHANNEL DATE August 1971 BY D/G

SERVICE Chemelectric Treaters (Onshore - Case 1 & 2) NO. REQ'D.

REVISIONS: a BY :b BY :c BY :d BY

MANUFACTURER National Tank Company SOURCE: QUOTE OF

Four (4) National-Petreco Type VFH - Chemelectric Treaters. Each unit is 12' dia. x 65' long, designed for 100 psig MWP with 1/8" corrosion allowance and ASME code stamped. An internal corrosion resistant coating is provided. Aproximate weight is 95,000#.

Each unit has 2 - 30" stress relieved fire tubes rated 6 MM Btu/Hr. and equipped with flame arrestors. The units are provided with standard controls for level and temperature. Interface sludge dumps are provided.

Each unit is provided with a 50 KVA transformer for 440 volt 60 cycle 3 phase power.

Each unit is designed to treat 10,000 BPD of 15° API crude oil at 180°F.

BRINE FILTER-COALESCER
STUDY DATA SHEET

Stearns-Roger

ITEM NO. S-2
ACC'T. ______ PAGE ______
S.R JOB C-10140

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT CRUDE OIL TREATING AND STORAGE FACILITY
LOCATION SANATA BARBARA CHANNEL, CALIFORNIA
DATE August 1971 BY RFS

SERVICE Brine Filter-Coalescer NO. REQ'D. 1
REVISIONS: a ______ BY ______ : b ______ BY ______ : c ______ BY ______ : d ______ BY ______
MANUFACTURER ______ SOURCE: QUOTE OF ______

One (1) - Filter coalescer unit to treat 292 GPM of sour brine containing 200-300 PPM oil. Effluent brine is to contain less than 10 PPM suspended oil and solids. This unit will operate at 180°F and 40 PSIG.

This unit is to be a "Roberts-Boze Inc., Oil Claire" package unit, or equal, complete with:

(a) Filter coalescer with internals. 7'-0" x 10'-0" high
(b) Initial charge of filter material
(c) Instrumentation to control both process and backwashing operations.

Maximum working pressure shall be 75 psig. Unit shall be supplied with all required valves, piping, timer-controls, tubing fittings, and filter media.

Stearns-Roger

SEPARATORS

STUDY DATA SHEET

ITEM NO. 5-3

ACC'T. ______ PAGE 1

S.R JOB C-10140

CUSTOMER HUMBLE OIL AND REFINING COMPANY

PROJECT CRUDE OIL TREATING AND STORAGE FACILITY

LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

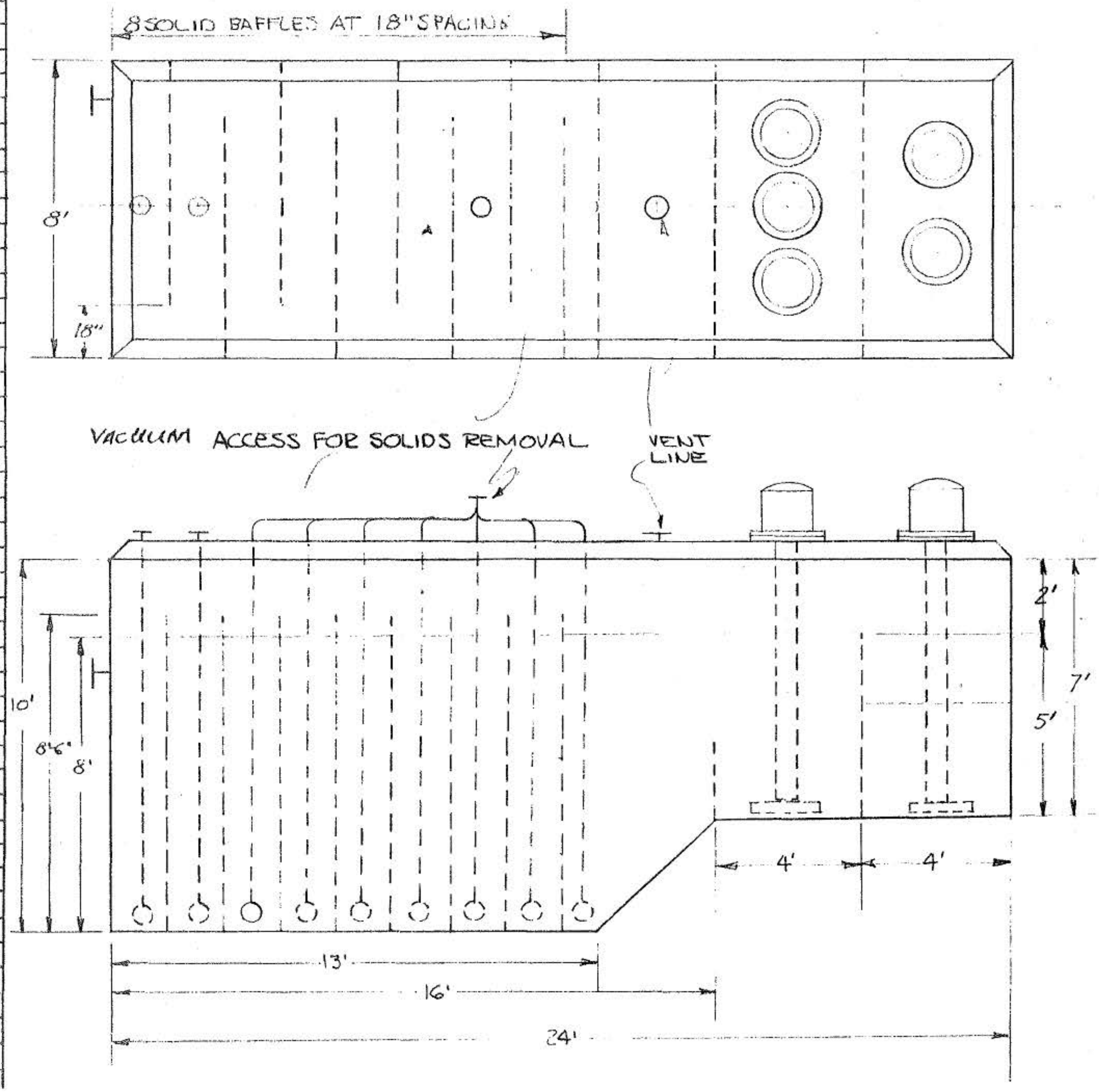
DATE August 1971 BY R.F.S.

SERVICE BRINE SETTLING BASIN NO. REQ'D. 1

REVISIONS: a ______ BY ______ :b ______ BY ______ :c ______ BY ______ :d ______ BY ______

MANUFACTURER ______ SOURCE: QUOTE OF ______

ONE (1) - ENCLOSED SETTLING BASIN TO HANDLE 200 GPM OF SOUR BRINE CONTAINING SUSPENDED OIL AND SOLIDS. THIS BASIN WILL OPERATE AT 180°F AND 0 PSIG. SUMP PUMPS SPECIFIED SEPARATELY.



The following storage tanks by the Chicago Bridge and Iron Co., (or equal Manufactur) designed to conform with API-650 standards. Each tank is field fabricated of pickeled and primed plates to be placed upon foundations by others. No field paint is included. Where indicated below, tanks to be of the CB and I "Weathermaster" type with internal floating roof and external cone-roof cover. Design pressure for all tanks (both air and gas blanketed) to be 2 oz. at 150°F. All tanks to be designed for sour fluid storage (Ex. T-7).

T-1 Crude Surge Tank (Crude)

1 - Phase I
2 - Phase III
10,000 Bbl Weathermaster, 42'-6" dia. X 40' high

T-2 Major Storage Tank (Crude)

2 - Phase I
3 - Phase II
4 - Phase III
110,000 Bbl Weathermaster, 130'-0" dia. X 48'-0" high

T-3 Rerun Tank (Crude)

1 - Phase I
1 - Phase III
10,000 Bbl Weathermaster, 42'-6" dia. X 40' high

T-4 Dirty Brine Storage Tank (Brine)

1 - Phase I
2 - Phase III
10,000 Bbl Cone Roof Tank, 42'-6" dia. X 40' high

T-5 Backwash Brine Holding Tank (Brine)

1 - Phase I
2 - Phase III
1500 Bbl Cone Roof and Cone Botton Tank, 26'-0" dia. X 16'-0" high

T-6 Injection Brine Storage Tank (Brine)

1 - Phase I
2 - Phase III
1000 Bbl Cone Roof Tank, 21'-3" dia. X 16'-0" high

REV.

STORAGE TANKS
STUDY DATA SHEET

Stearns-Roger

ITEM No. See Below
ACC'T. ____ PAGE 2 of 2
S-R JOB C-10140

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT CRUDE OIL TREATING AND STORAGE FACILITY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA
DATE August 1971 BY RWC

SERVICE Storage Tanks NO. REQ'D. See Below
REVISIONS: a ____ BY ____ : b ____ BY ____ : c ____ BY ____ : d ____ BY ____
MANUFACTURER ____ SOURCE: QUOTE OF ____

T-7 Firewater Storage Tank (Fresh Water)

1 - Phase I
1 - Phase III
20,000 Bbl Cone Roof Tank, 60'-0" X 40'-0" high

REV.

DRYER STUDY DATA SHEET

Stearns-Roger

ITEM No. U-1
ACC'T. ______ PAGE ______
S.R JOB C-10140

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT CRUDE OIL TREATING AND STORAGE FACILITY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA
DATE August 1971 BY RWC

SERVICE Instrument Air Dryer NO. REQ'D. One
REVISIONS: a ______ BY ______ : b ______ BY ______ : c ______ BY ______ : d ______ BY ______
MANUFACTURER ______ SOURCE: QUOTE OF ______

One (1): Instrument air dryer sized for 50 SCFM continuous operation at 75 psia operating pressure.

Specifications

Pressure Drop	3.0 PSI
Purge Flow	4 SCFM
Electrical Heat Regen.	110 V
Electrical Code	NEMA 1
Effluent Conditions:	
Exit Dew Point	-10°F @ 50 PSIA

NO. VESSELS REQ'D. (~~HORIZ~~.-VERT.) ONE
SHELL DIA. I.D.-~~O.D.~~ 84"
SHELL THICKNESS 3/8"
HEADS THICKNESS S.E.-~~ELLIP~~. 3/8"
SHELL & HEAD THICKNESS INCLUDE C.A.
SHELL LENGTH (SEAM TO SEAM) 21'0"
SUPPORT SKIRT

DESIGN CONDITIONS

CODE ASME STAMP NO

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	0	14	
TEMP. (°F)	180	250	

CORR. ALLOW. SHELL 1/8" HEADS 1/8"
X-RAY STRESS RELIEF
WINDLOAD

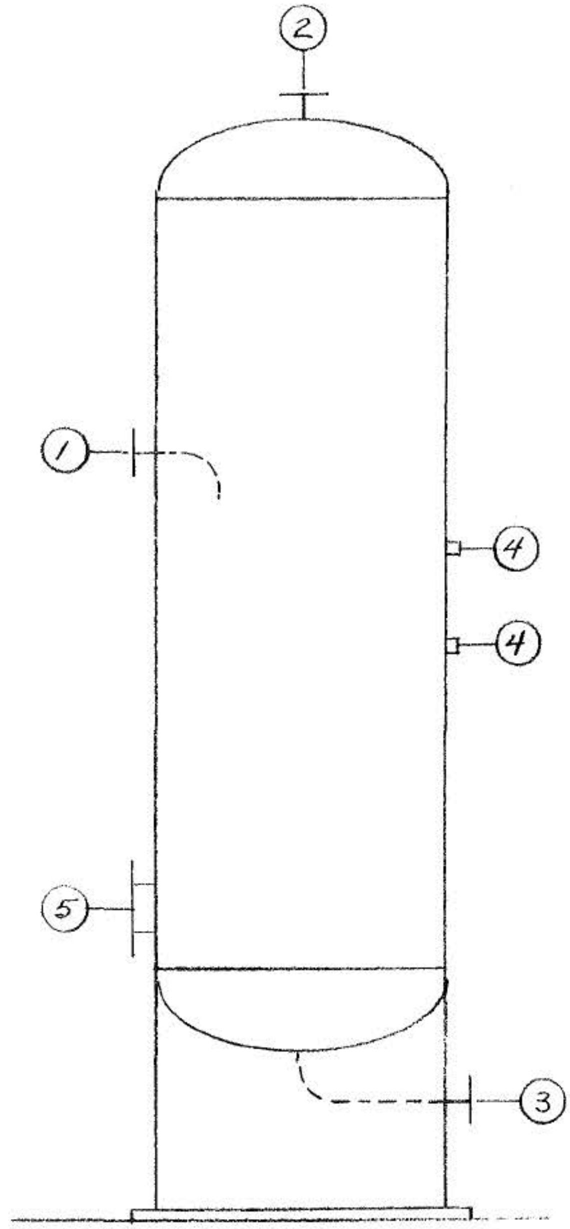
MATERIALS

HEADS SA-515
SHELL SA-515
NOZZLES & FLANGES
GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. INLET	1	6" 150# R.F.
2. VAPOR OUTLET	1	4" 150# R.F.
3. LIQUID OUTLET	1	6" 150# R.F.
4. LEVEL ALARM	2	1" COUPLINGS
5. MANHOLE	1	18" w/DAVIT
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM.		
PACKING		
INSUL. RINGS		
LADDERS & PLATFORMS		

NO.	DATE	BY	REVISIONS



EST WEIGHT 10800#

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.

VESSEL BLOWOFF DRUM
FOR HUMBLE OIL AND REFINING COMPANY
PLANT CRUDE OIL PROCESSING AND STORAGE FACILITY
LOCATION SANTA BARBARA CHANNEL
ORDER NO. C-10140 ITEM NO. V-1
MFGR. —
DATE 10-15-70 BY JEW

Stearns-Roger

NO. VESSELS REQ'D. ([redacted].-VERT.) ONE

SHELL DIA. [redacted].-O.D. 24"

SHELL THICKNESS ≈ 5/16"

HEADS THICKNESS [redacted].-O.D. ≈ 5/16"

SHELL & HEAD THICKNESS INCLUDE C.A. YES

SHELL LENGTH (SEAM TO SEAM) 7'-0"

SUPPORT SKIRT x 1'-6" HIGH

DESIGN CONDITIONS

PER ASME VIII STAMP YES

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)		150	
TEMP. (°F)		200	

CORR. ALLOW. SHELL 1/16" HEADS 1/16"

X-RAY SPOT STRESS RELIEF NO

WINDLOAD PER ASA 58.1

SEISMIC ZONE 3

MATERIALS

HEADS A285-C

SHELL A285-C

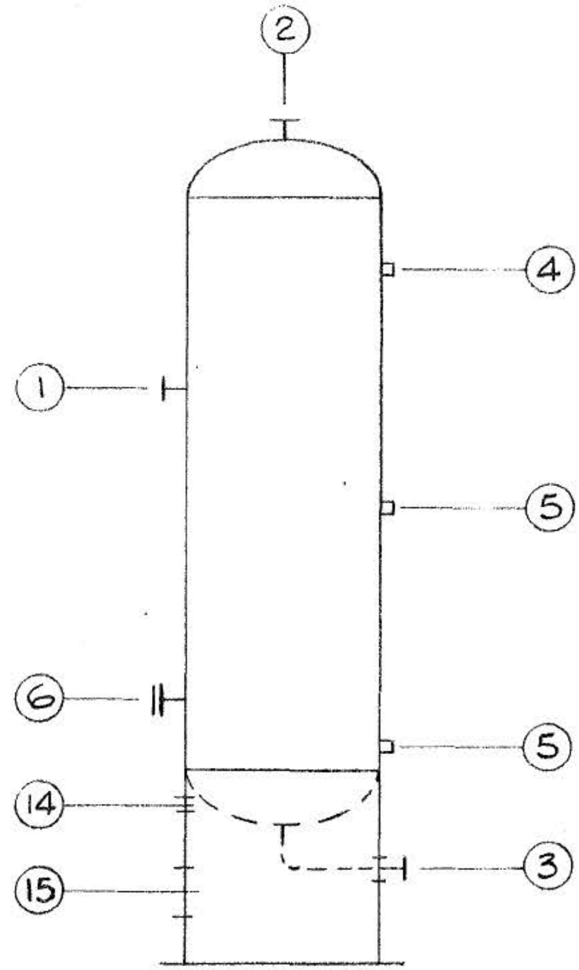
NOZZLES & FLANGES A53 B, A181 GR. 1

GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. AIR IN	1	2"-150# RF
2. AIR OUT	1	2"-150# RF
3. LIQUID OUT	1	2"-150# RF
4. PRESS. IND.	1	3/4" CPLG.
5. LEVEL GAUGE	2	3/4" CPLG.
6. INSP. OPEN W/BLIND	1	3"-150# RF
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14. SKIRT VENTS	2	2" SCH. 80 PIPE
15. SKIRT INSP.	2	6" REINF.

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM.	—	—
PACKING	—	—
INSUL. RINGS	—	—
LADDERS & PLATFORMS	—	—

NO.	DATE	BY	REVISIONS



WEIGHT EMPTY ≈ 1000 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.

(1) WHITE SANDBLAST & ZINC-RICH PRIMER.

(2) BOLTS SA 193-B7, NUTS SA 194-2H.

VESSEL INSTRUMENT AIR RECEIVER

FOR HUMBLE OIL AND REFINING COMPANY

PLANT CRUDE OIL TREATING AND STORAGE FACILITY

LOCATION SBC, CALIFORNIA

ORDER NO. C-10140 ITEM NO. V-2

MFGR.

DATE 8-71 BY [signature]

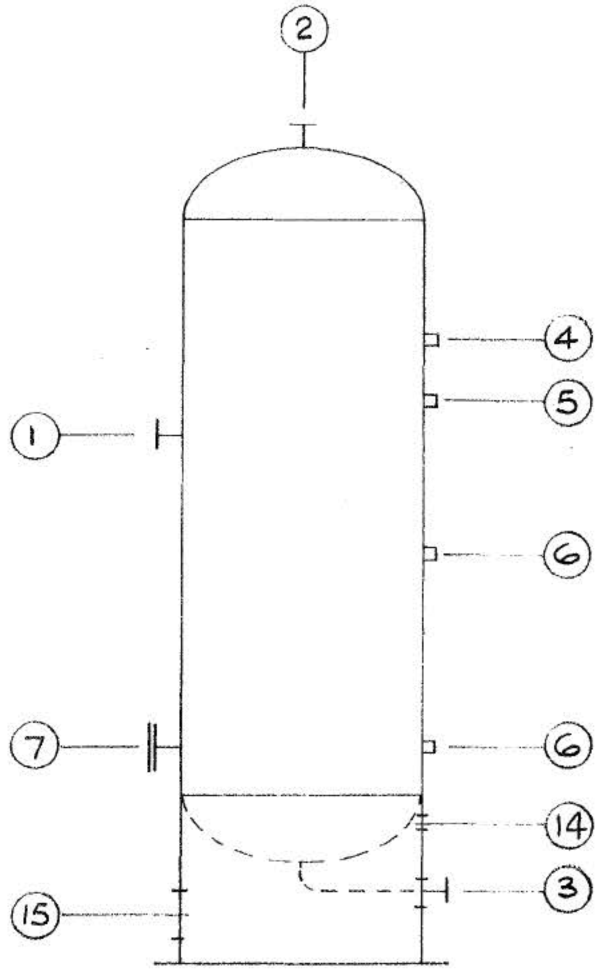
Stearns-Roger

NO. VESSELS REQ'D. ([redacted].-VERT.) ONE			
SHELL DIA. I.D.-[redacted]. 48"			
SHELL THICKNESS ≅ 1/2"			
HEADS THICKNESS S.F.-[redacted]. ≅ 7/16"			
SHELL & HEAD THICKNESS INCLUDE C.A. YES			
SHELL LENGTH (SEAM TO SEAM) 15'-0"			
SUPPORT SKIRT x 2'-6" HIGH			
DESIGN CONDITIONS			
PER ASME VIII STAMP YES			
	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)		200	
TEMP. (°F)		100	
CORR. ALLOW. SHELL 1/16" HEADS 1/16"			
X-RAY SPOT STRESS RELIEF NO			
WINDLOAD PER ASA 58.1			
SEISMIC ZONE 3			
MATERIALS			
HEADS A285-C			
SHELL A285-C			
NOZZLES & FLANGES A53 B, A181 GR.I			
GASKETS			

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. AIR INLET	1	2"-150# RF
2. AIR OUTLET	1	2"-150# RF
3. LIQUID OUT	1	2"-150# RF
4. TEMP. IND.	1	1" CPLG.
5. PRESS. IND.	1	3/4" CPLG.
6. LEVEL GAUGE	2	3/4" CPLG.
7. MANWAY W/DAVIT	1	18"-150# RF
8.		
9.		
10.		
11.		
12.		
13.		
14. SKIRT VENTS	4	2" SCH. 80 PIPE
15. SKIRT ACCESS	1	18" REINF.

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM.	-	-
PACKING	-	-
INSUL. RINGS	-	-
LADDERS & PLATFORMS	-	-

NO.	DATE	BY	REVISIONS



WEIGHT EMPTY ≅ 6100 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
(1) WHITE SANDBLAST & ZINC-RICH PRIMER.
(2) BOLTS SA 193-B7, NUTS SA 194-2H.

VESSEL UTILITY AIR RECEIVER
FOR HUMBLE OIL AND REFINING COMPANY
PLANT CRUDE OIL TREATING AND STORAGE FACILITY
LOCATION SBC, CALIFORNIA
ORDER NO. C-10140 ITEM NO. V-3
MFGR.
DATE 8-71 BY [signature]

Stearns-Roger

NO. VESSELS REQ'D. ([redacted].-VERT.) ONE
SHELL DIA. [redacted].-O.D. 24"
SHELL THICKNESS ≅ 1/4"
HEADS THICKNESS [redacted].-C.D. ≅ 1/4"
SHELL & HEAD THICKNESS INCLUDE C.A. NO
SHELL LENGTH (SEAM TO FLG.) 8'-0"
SUPPORT LEGS 4-REQ'D. × 2'-0"

DESIGN CONDITIONS

CODE ASME VIII STAMP YES

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)		75	
TEMP. (°F)		75	

CORR. ALLOW. SHELL NO HEADS NO
X-RAY SPOT STRESS RELIEF NO
WINDLOAD PER ASA 58.1
SEISMIC ZONE 3

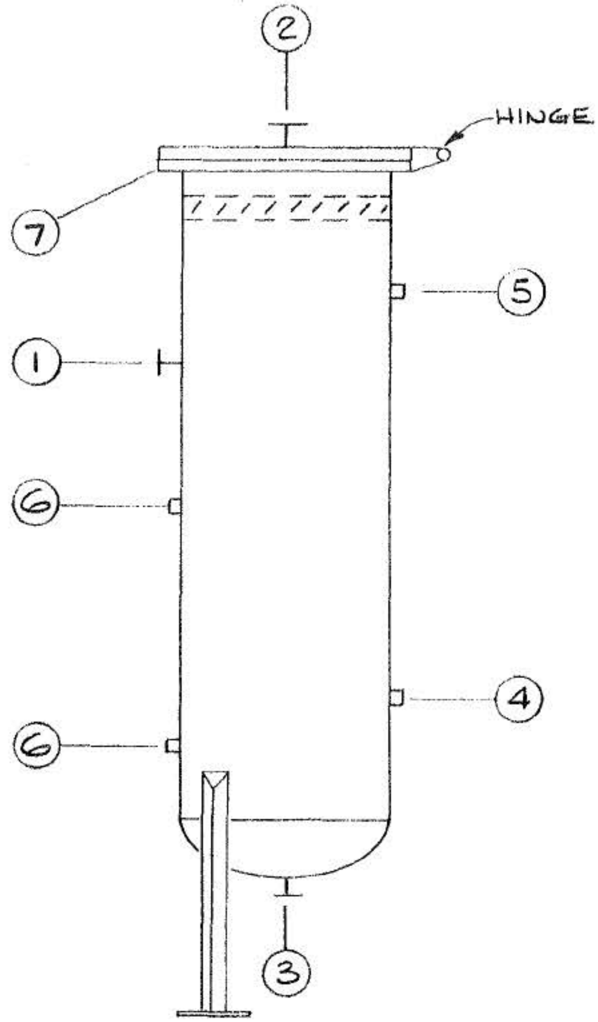
MATERIALS

HEADS A 285-C
SHELL A 285-C
NOZZLES & FLANGES A53B, A181 GR.1
GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. VAPOR IN	1	-150# RF
2. VAPOR OUT	1	-150# RF
3. LIQ. OUT	1	2"-150# RF
4. LEVEL SW.	1	1 CPLG
5. PRESS. IND.	1	3/4" CPLG.
6. LEVEL GAUGE	2	3/4" CPLG.
7. MANWAY W/BLIND	1	24"-150# RFSO
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM. 12 LB/FT³ × 6" S.S.	YES	-
PACKING	-	-
INSUL. RINGS	-	-
LADDERS & PLATFORMS	-	-
HINGED DAVIT	YES	-

NO.	DATE	BY	REVISIONS



WEIGHT EMPTY ≅ 2000 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
(1) WHITE SANDBLAST & ZINC-RICH PRIMER.
(2) BOLTS SA 193-B7, NUTS SA 194-2H.

VESSEL FUEL GAS SCRUBBER

FOR HUMBLE OIL AND REFINING COMPANY

PLANT CRUDE OIL TREATING AND STORAGE FACILITY

LOCATION SBC, CALIFORNIA.

ORDER NO. C-10140 ITEM NO. V-4

MFGR.

DATE 8-71 BY [signature]

Stearns-Roger

MISCELLANEOUS
STUDY DATA SHEET

Stearns-Roger

ITEM No. X-1
ACC'T. ______ PAGE 1
S.R JOB C-10140

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT CRUDE OIL TREATING AND STORAGE FACILITY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA
DATE August 1971 BY RWC

SERVICE Air Vent Flame Arrestor NO. REQ'D. One
REVISIONS: a ______ BY ______ : b ______ BY ______ : c ______ BY ______ : d ______ BY ______
MANUFACTURER Shand and Jurs or Equal SOURCE: QUOTE OF

Shand and Jurs Model 94302 or equal flame arrestor with aluminum body, shell and tube tank. Unit disigned for peak vapor flow up to 780 ACFM instantaneous at 1 oz. absolute pressure with a maximum pressure frop of less than 2" H_2O.

Stearns-Roger

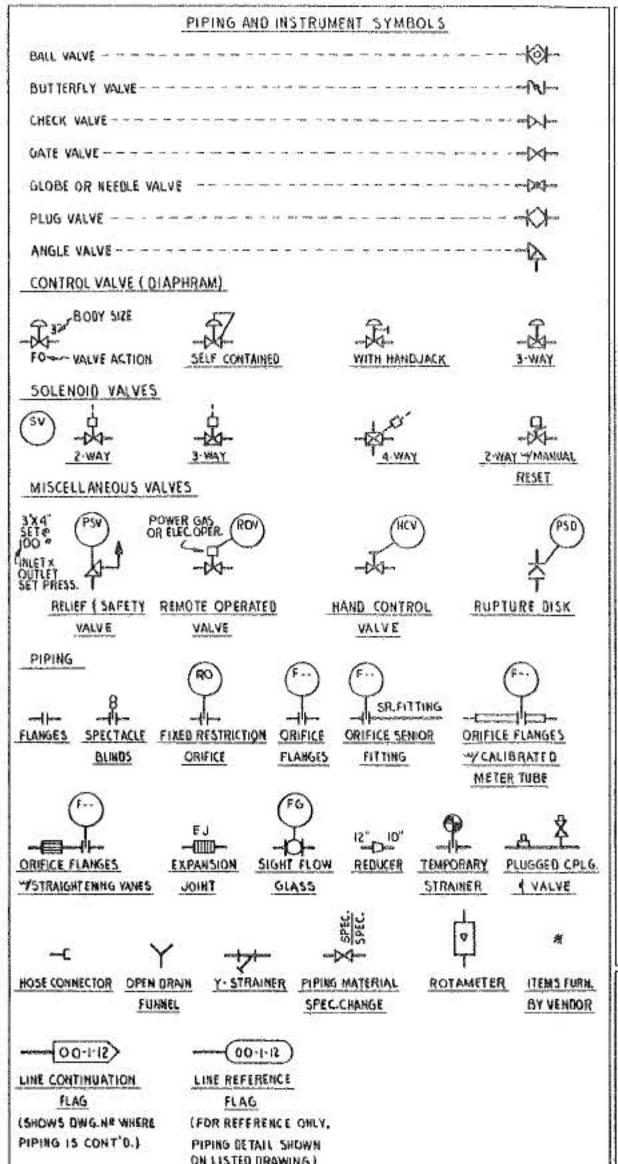
MISCELLANEOUS
STUDY DATA SHEET

ITEM No. X-2
ACC'T. PAGE 1
CUSTOMER HUMBLE OIL AND REFINING COMPANY
S.R JOB C-10140
PROJECT CRUDE OIL TREATING AND STORAGE FACILITY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA
DATE August 1971 BY RWC

SERVICE Gas Vent Flame NO.REQ'D. One
REVISIONS: a BY :b BY :c BY :d BY
MANUFACTURER Shand and Jurs or Equal SOURCE: QUOTE OF

Shand and Jurs Model 94303 or equal flame arrestor with aluminum body, shell, and tube tank. Unit designed for peak vapor instantaneous flow of up to 475 ACFM at 1 ox. absolute pressure with a miaximum pressure drop of less than 2" H_2O.

DRAWINGS



ABBREVIATIONS

BOE = BOTTOM OF EQUIPMENT
CSC = CAR SEAL CLOSE
CSO = CAR SEAL OPEN
CV = CONTROL VALVE
ESD = EMERGENCY SHUTDOWN
FC = FAIL CLOSED
FO = FAIL OPEN
I.A. = INSTRUMENT AIR
L.O. = LOCK OPEN
(1) NILL = NORMAL INTERFACE LIQUID LEVEL
HILA = HIGH INTERFACE LEVEL ALARM
LILA = LOW INTERFACE LEVEL ALARM
HILSD = HIGH INTERFACE LEVEL SHUTDOWN
LILSD = LOW INTERFACE LEVEL SHUTDOWN
NLL = NORMAL LIQUID LEVEL
LAH = LEVEL ALARM HIGH
LAL = LEVEL ALARM LOW
HLSD = HIGH LEVEL SHUTDOWN
(1) LLSD = LOW LEVEL SHUTDOWN
PSIA = POUNDS PER SQUARE INCH ABSOLUTE
PSIG OR # = POUNDS PER SQUARE INCH GAUGE

S.C. = SAMPLE CONNECTION
S-S = SEAM TO SEAM
T-T = TANGENT TO TANGENT
S-F = SEAM TO FACE OF FLANGE

(1) HEIGHT GIVEN IN INCHES ABOVE INSIDE BOTTOM OF HORIZONTAL VESSELS AND ABOVE TRAY OR BOTTOM HEAD SEAM IN TOWERS AND VERTICAL VESSELS.

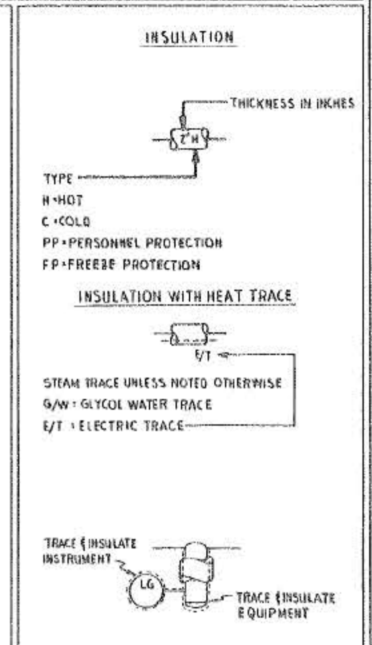
MATERIAL SPECIFICATIONS

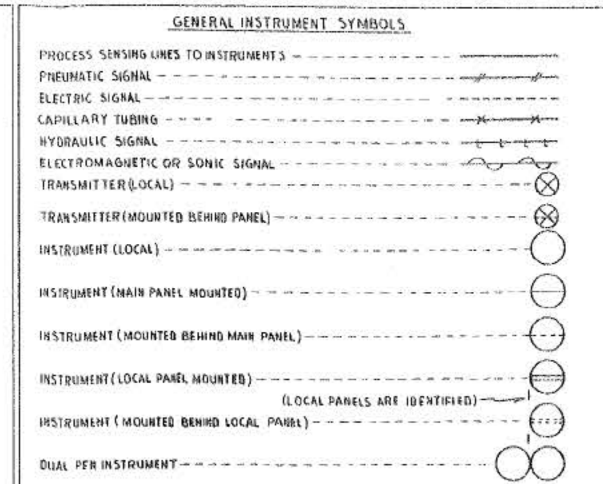
125# FF
- AA - INSTRUMENT AIR 125# FF, C.S., W/C.I. VALVES
- ZW - DRINKING WATER - GALV. PIPE

150# RF C.S.
- BA - PLANT AIR
- BP - SWEET H/C LIQUID & VAPOR
- BT - SOUR H/C LIQUID & VAPOR
- BE - SOUR BRINE
- BW - WATER
- BX - FIREWATER
- BY - DRAINS
- BF - FLARE

600# RF C.S.
- FP - SWEET H/C LIQUID & VAPOR

1500# RF C.S.
- HT - SOUR H/C LIQUID & VAPOR
- HE - SOUR BRINE





FUNCTION DESIGNATIONS FOR RELAYS

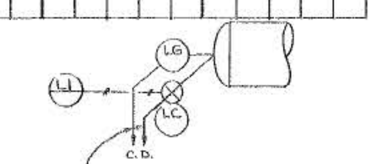
SYMBOL	FUNCTION
1. I-O OR ON-OFF	AUTOMATICALLY CONNECT, DISCONNECT, OR TRANSFER ONE OR MORE CIRCUITS.
2. Σ OR ADD	ADD OR TOTALIZE
3. Δ OR DIFF.	SUBTRACT
4. ±, +, ⊟	BIAS
5. AVG.	AVERAGE
6. % OR 1:3 OR 2:1 (TYP)	GAIN OR ATTENUATE
7. ⊠	MULTIPLY
8. ÷	DIVIDE
9. √ OR SQ. RT.	EXTRACT SQUARE ROOT
10. x^n OR $x^{1/n}$	RAISE TO POWER
11. f(x)	CHARACTERIZE
12. 1:1	BOOST
13. ⊡ OR HIGHEST (MEASURED VARIABLE)	HIGH-SELECT
14. ⊡ OR LOWEST (MEASURED VARIABLE)	LOW-SELECT
15. REV.	REVERSE
16. a. E/P OR P/I (TYP)	CONVERT FOR INPUT/OUTPUT SEQUENCES OF THE FOLLOWING:
b. A/D OR D/A	FOR INPUT/OUTPUT SEQUENCES OF THE FOLLOWING:
17. ∫	INTEGRATE
18. D OR d/dt	DERIVATIVE OR RATE
19. 1/D	INVERSE DERIVATIVE
20. AS REQUIRED	UNCLASSIFIED

DESIGNATION	SIGNAL
E	VOLTAGE
H	HYDRAULIC
I	CURRENT (ELECTRICAL)
O	ELECTROMAGNETIC OR SONIC
P	PNEUMATIC
R	RESISTANCE (ELECTRICAL)
A	ANALOG
D	DIGITAL

INSTRUMENT IDENTIFICATION

VARIABLE	SYMBOL	MEASURING DEVICES: PRIMARY ELEMENT (E)	WELL (W)	RECORDING (R)	INDICATING (I)	TRANSMITTER (BLIND) (T)	OBSERVATION (LOCAL)	CONTROLLING DEVICES: RECORDING (R)	INDICATING (I)	BLIND (C)	SELF CONTAINED CONTROL VALVE (V)	ALARMS (2): BLIND (A)	SWITCHES: INDICATING	BLIND (S)	RELAY (X)	MISCELLANEOUS: VALVES
ANALYZER (6)	A			AR	AI	AT		ARC	AIC			AA				
BURNER FLAME	B											BA		BS		
CONDUCTIVITY	C			CR	CI	CT		CRC	CIC			CA				
DENSITY	D			DR	DI	DT		DRC	DIC			DA				
VOLTAGE (EMF)	E															
FLOW	F	FE		FR	FI	FT	FG	FRC	FIC	FC	FCV	FA	FIS	FS	FX	
GAGING	G															
HAND	H								HIC		HCV			HS		
CURRENT (ELECT)	I															
POWER	J															
TIME	K														KX	
LEVEL	L			LR	LI	LT	(8) LG	LRC	LIC	LC		LA	LIS	LS	LX	
MOISTURE	M			MR	MI	MT		MRC	MIC	MC		MA				
MISCELLANEOUS	N															
MISCELLANEOUS	O															
PRESS OR VAC. (7)	P	PE		PR	PI	PT	PI	PRC	PIC	PC	PCV	PA	PIS	PS	PX	
QUANTITY	Q			QR	QI											
RADIOACTIVITY	R															
SPEED	S			SR	SI	ST		SRC	SIC			SA				
TEMPERATURE	T	TE	TW	TR	TI	TT	TI	TRC	TIC	TC	TCV	TA	TIS	TS	TX	
MULTIVARIABLE	U															
VISCOSITY	V															
WEIGHT	W			WR	WI	WT		WRC	WIC	WC		WA	WIS	WS		
UNCLASSIFIED	X														XR	XCV
MISCELLANEOUS	Y															
POSITION	Z				ZI									ZS		

(1) LOWER CASE LETTER FOLLOWING FIRST LETTER INDICATES USE OF PROCESS VARIABLE, d = DIFFERENTIAL AND r = RATIO i.e. PdR, PrRC.
(2) ALARMS ARE IDENTIFIED HIGH OR LOW THUS: (LAH) (LAL) (LAL) LO/LO
(3) LEVEL GAUGE NOMENCLATURE. QUANITY (2) (LG 2S1) ILLUMINATOR 46" CENTER TO CENTER MOUNTING LENGTH.
(4) CONTROL VALVES HAVE SAME IDENTIFICATION AS CONTROLLER WITH SUFFIX "V" ADDED i.e. FRC-110V.
(5) RELAYS ARE ELECTRIC OR PNEUMATIC. IDENTIFY WITH FUNCTION SUBSCRIPT.
(6) IDENTIFY ANALYZERS AND EQUIPMENT WITH SUBSCRIPT OUTSIDE OF CIRCLE i.e. = CO_2, PH, H_2S, ETC.
(7) FOR VACUUM OR DRAFT INSTRUMENTS - ADD SUBSCRIPT (PI) VAC. (PI) DRAFT
(8) EXCEPTIONS TO ABOVE SCHEDULE:
LD = LIQUID DRAINER
PB = PUSH BUTTON
ROV = REMOTE OPERATED VALVE
SS = SELECTOR SWITCH
ST = STEAM TRAP
SV = SOLENOID VALVE
VS = VIBRATION SWITCH



TYPICAL LEVEL INSTRUMENT DRAINS
C.D. = CLOSED DRAIN

NO.	REVISIONS	DATE	BY	CHK'D	APP'D

NO.	REFERENCE DRAWINGS

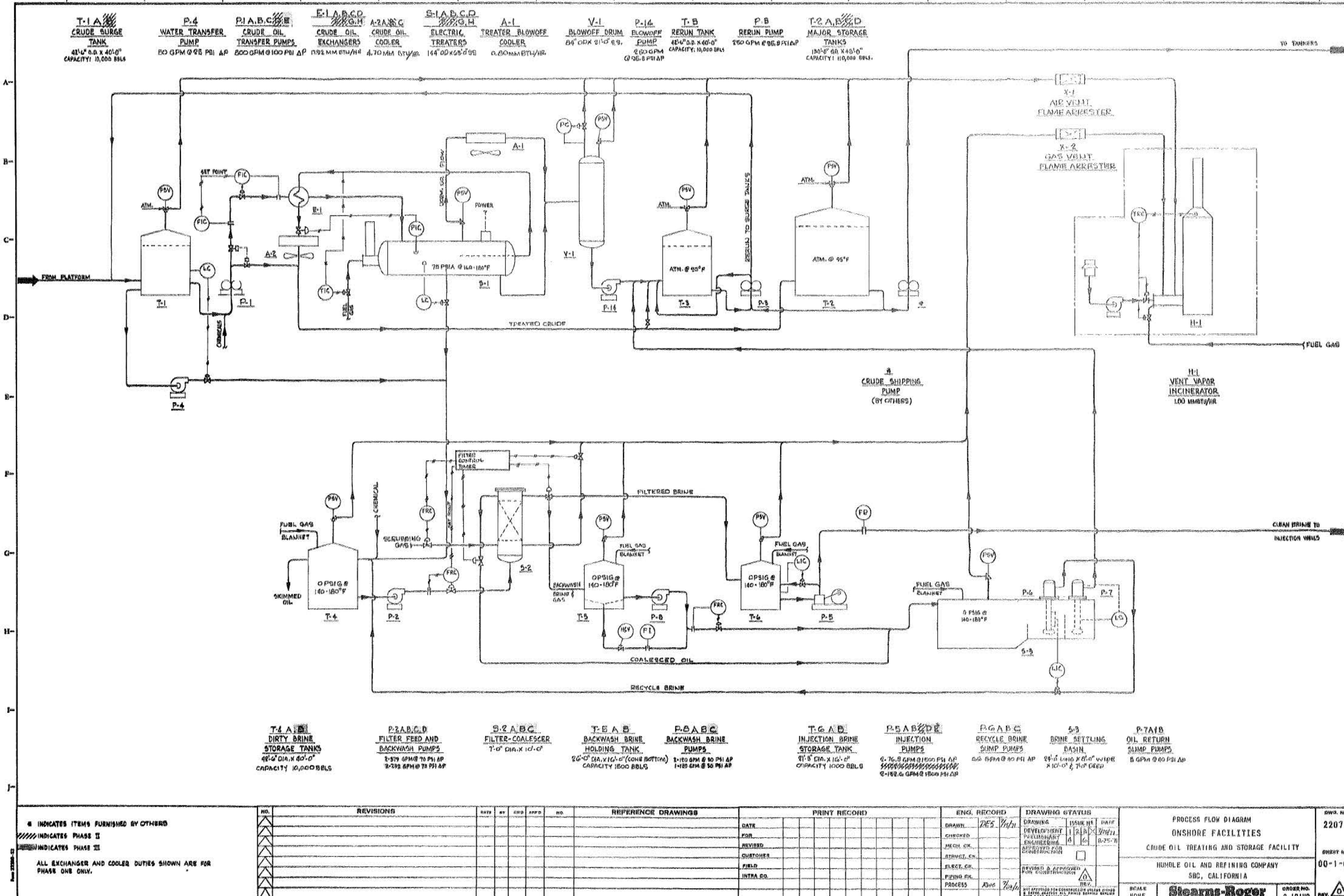
PRINT RECORD: DATE / FOR / REVISED / CUSTOMER / FIELD / INTRA CO.

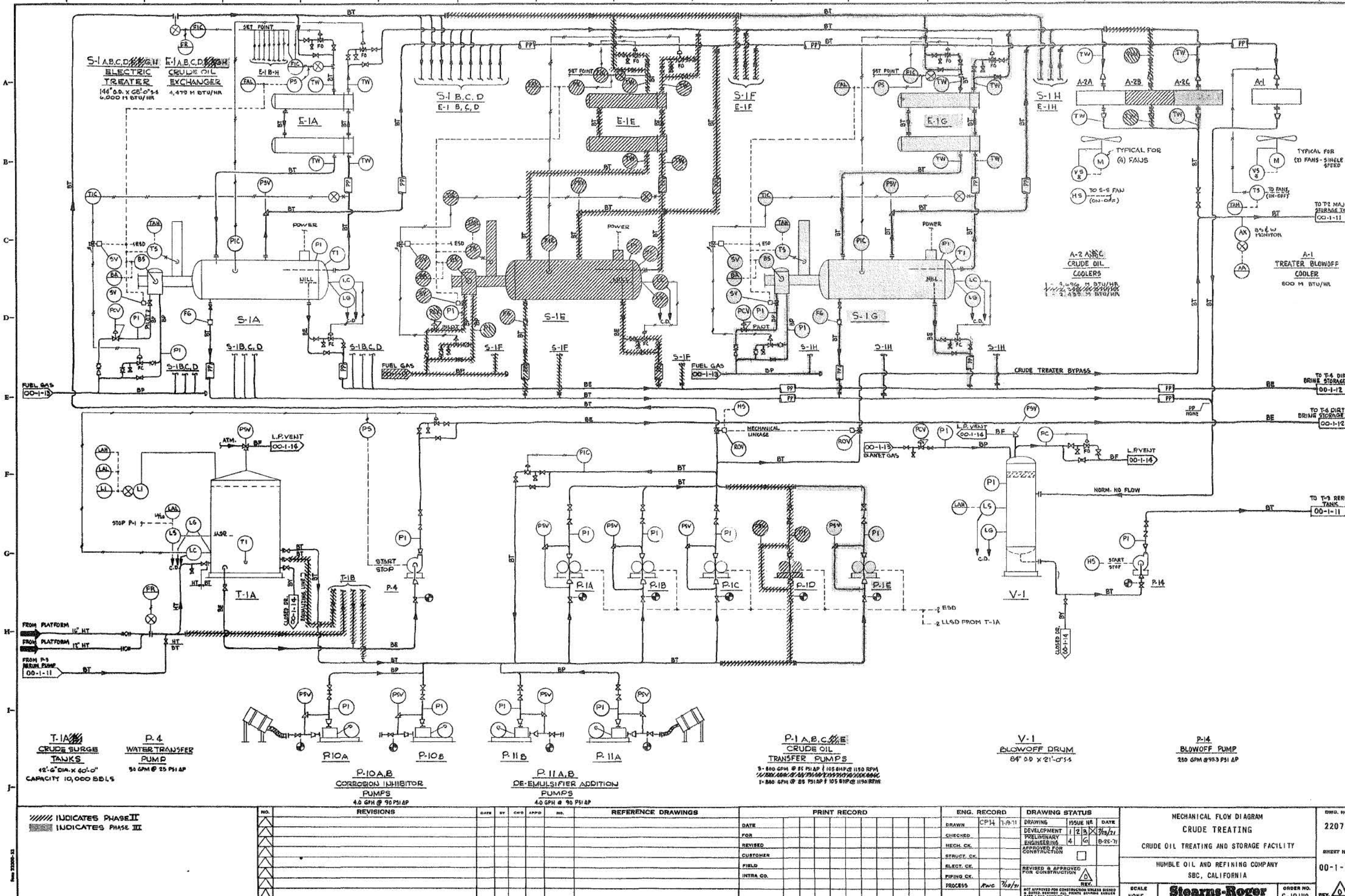
ENG. RECORD		
DRAWN	SPIELMAN	
CHECKED		
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		
PROCESS	RWG	7/20/71

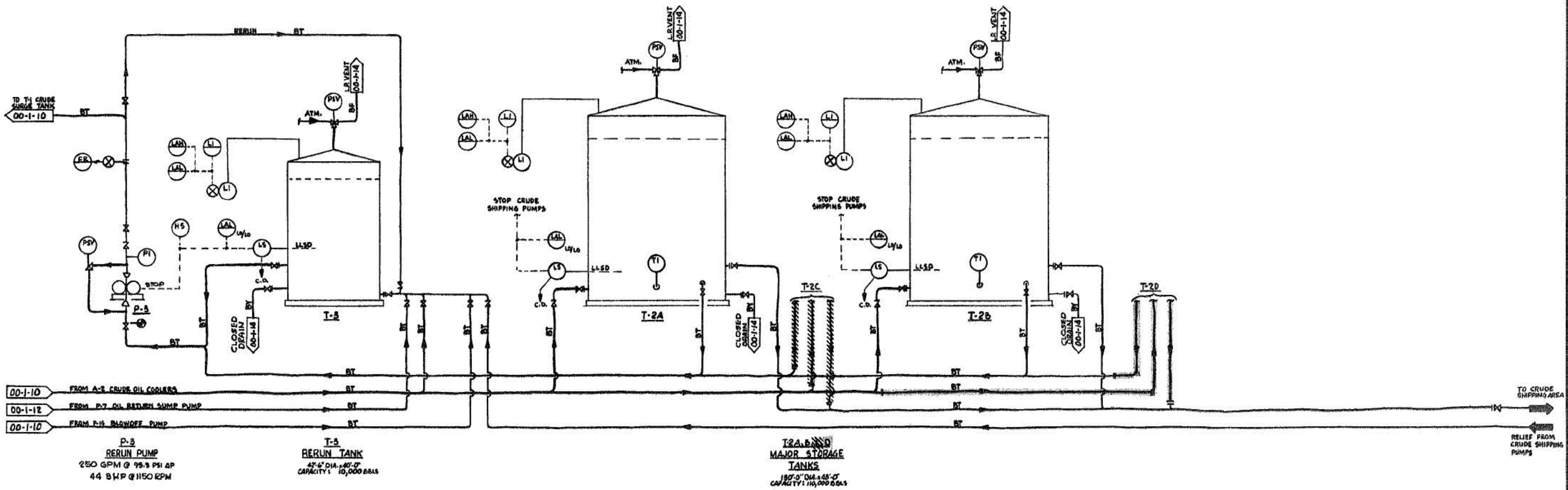
DRAWING STATUS: DRAWING	ISSUE NO	DATE
DEVELOPMENT	1	7/16/71
PRELIMINARY ENGINEERING	6	8-26-71
APPROVED FOR CONSTRUCTION		
REVISED & APPROVED FOR CONSTRUCTION	REV. 0	

MECHANICAL FLOW DIAGRAM
SYMBOLS AND INSTRUMENT LEGEND
CRUDE OIL TREATING AND STORAGE FACILITY
HUMBLE OIL AND REFINING COMPANY
SBC, CALIFORNIA

DWG. NO. 22071
SHEET NO. 00-1-00
SCALE NONE
Stearns-Roger CORPORATION
ORDER NO. C-10140
REV. 0


T-1 A,B
CRUDE SURGE TANK
41'-6" O.D. x 40'-0"
CAPACITY: 10,000 BBLS
P-4
WATER TRANSFER PUMP
50 GPM @ 25 PSI ΔP
P-1 A,B,C,D,E
CRUDE OIL TRANSFER PUMPS
500 GPM @ 100 PSI ΔP
E-1 A,B,C,D,E,F,G,H
CRUDE OIL EXCHANGERS
11.92 MM BTU/HR
A-2 A,B,C
CRUDE OIL COOLER
4.70 MM BTU/HR
S-1 A,B,C,D,E,F,G,H
ELECTRIC TREATERS
144" OD x 65'-0" SS
A-1
TREATER BLOWOFF COOLER
0.80 MM BTU/HR
V-1
BLOWOFF DRUM
84" ODX 21'-0" S.S.
P-14
BLOWOFF PUMP
260 GPM @ 95.5 PSI ΔP
T-3
RERUN TANK
42'-6" O.D. x 40'-0"
CAPACITY: 10,000 BBLS
P-3
RERUN PUMP
260 GPM @ 95.5 PSI ΔP
T-2 A,B,C,D
MAJOR STORAGE TANKS
130'-0" OD x 48'-0"
CAPACITY: 110,000 BBLS
TO TANKERS
X-1
AIR VENT FLAME ARRESTER
X-2
GAS VENT FLAME ARRESTER
FROM PLATFORM
ATM.
SET POINT
CHEMICALS
75 PSIA @ 140-180°F
POWER
TREATED CRUDE
RERUN TO SURGE TANKS
ATM. @ 95°F
FUEL GAS
CRUDE SHIPPING PUMP
(BY OTHERS)
H-1
VENT VAPOR INCINERATOR
1.00 MMBTU/HR
FILTER CONTROL TIMER
FILTERED BRINE
CHEMICAL
FUEL GAS BLANKET
SCRUBBING GAS
SKIMMED OIL
0 PSIG @ 140-180°F
BACKWASH BRINE GAS
CLEAN BRINE TO INJECTION WELLS
COALESCED OIL
RECYCLE BRINE
T-4 A,B
DIRTY BRINE STORAGE TANKS
48'-6" DIA. x 40'-0"
CAPACITY 10,000 BBLS
P-2 A,B,C,D
FILTER FEED AND BACKWASH PUMPS
2-379 GPM @ 70 PSI ΔP
2-393 GPM @ 73 PSI ΔP
S-2 A,B,C
FILTER-COALESCER
7'-0" DIA. x 10'-0"
T-5 A,B
BACKWASH BRINE HOLDING TANK
26'-0" DIA. x 16'-0" (CONE BOTTOM)
CAPACITY 1500 BBLS
P-8 A,B,C
BACKWASH BRINE PUMPS
2-180 GPM @ 50 PSI ΔP
1-120 GPM @ 50 PSI ΔP
T-6 A,B
INJECTION BRINE STORAGE TANK
21'-6" DIA. x 16'-0"
CAPACITY 1000 BBLS
P-5 A,B,C,D,E
INJECTION PUMPS
2-76.9 GPM @ 1500 PSI ΔP
2-182.6 GPM @ 1500 PSI ΔP
P-6 A,B,C
RECYCLE BRINE SUMP PUMPS
50 GPM @ 40 PSI ΔP
S-3
BRINE SETTLING BASIN
24'-5" LONG x 8'-0" WIDE x 10'-0" & 7'-0" DEEP
P-7 A,B
OIL RETURN SUMP PUMPS
5 GPM @ 60 PSI ΔP
* INDICATES ITEMS FURNISHED BY OTHERS
INDICATES PHASE II
INDICATES PHASE III
ALL EXCHANGER AND COOLER DUTIES SHOWN ARE FOR PHASE ONE ONLY.
REVISIONS
REFERENCE DRAWINGS
PRINT RECORD
ENG. RECORD
DRAWING STATUS
PROCESS FLOW DIAGRAM
ONSHORE FACILITIES
CRUDE OIL TREATING AND STORAGE FACILITY
HUMBLE OIL AND REFINING COMPANY
SBC, CALIFORNIA
Stearns-Roger
DWG. NO. 22071
SHEET NO. 00-1-01
ORDER NO. C-10140
SCALE NONE


S-1 A,B,C,D ELECTRIC TREATER
144" O.D. x 65'-0" S-S
6,000 M BTU/HR
E-1 A,B,C,D CRUDE OIL EXCHANGER
4,479 M BTU/HR
E-1A
E-1B-H
S-1 B,C,D
E-1 B,C,D
E-1E
S-1F
E-1F
E-1G
S-1H
E-1H
A-2A
A-2B
A-2C
A-1
TYPICAL FOR (4) FANS
TYPICAL FOR (2) FANS-SINGLE SPEED
TO S-5 FAN (ON-OFF)
TO FANS (ON-OFF)
TO T-2 MAJOR STORAGE TK'S 00-1-11
BS&W MONITOR
A-2 A,B,C CRUDE OIL COOLERS
A-1 TREATER BLOWOFF COOLER
800 M BTU/HR
S-1A
S-1E
S-1G
S-1B,C,D
S-1F
S-1H
POWER
PILOT
FUEL GAS 00-1-13
CRUDE TREATER BYPASS
TO T-4 DIRTY BRINE STORAGE TK. 00-1-12
MECHANICAL LINKAGE
L.P. VENT 00-1-14
BLANKET GAS
NORM. NO FLOW
TO T-3 RERUN TANKS 00-1-11
STOP P-1
START STOP
T-1A
T-1B
P-4
CLOSED DR. 00-1-14
EQUALIZING LINE
P-1A
P-1B
P-1C
P-1D
P-1E
ESD
LLSD FROM T-1A
V-1
P-14
FROM PLATFORM 16" HT
FROM PLATFORM 12" HT
FROM P-3 RERUN PUMP 00-1-11
P-10A
P-10B
P-11B
P-11A
T-1A CRUDE SURGE TANKS
42'-6" DIA. x 40'-0"
CAPACITY 10,000 BBLS
P-4 WATER TRANSFER PUMP
50 GPM @ 25 PSI ΔP
P-10A,B CORROSION INHIBITOR PUMPS
4.0 GPH @ 90 PSI ΔP
P-11A,B DE-EMULSIFIER ADDITION PUMPS
4.0 GPH @ 90 PSI ΔP
P-1 A,B,C CRUDE OIL TRANSFER PUMPS
V-1 BLOWOFF DRUM
84" O.D. x 21'-0" S-S
P-14 BLOWOFF PUMP
INDICATES PHASE II
INDICATES PHASE III
REVISIONS
REFERENCE DRAWINGS
PRINT RECORD
ENG. RECORD
DRAWING STATUS
DRAWN CPH 7-9-71
PROCESS RWC 7/28/71
MECHANICAL FLOW DIAGRAM
CRUDE TREATING
CRUDE OIL TREATING AND STORAGE FACILITY
HUMBLE OIL AND REFINING COMPANY
SBC, CALIFORNIA
Stearns-Roger CORPORATION
DWG. NO. 22071
SHEET NO. 00-1-10
SCALE NONE
ORDER NO. C-10140
REV. 0



INDICATES PHASE II
INDICATES PHASE III

DRAWING	ISSUE NO			DATE
DEVELOPMENT	1	2	3	7-20-71
PRELIMINARY ENGINEERING	4	-	6	8-25-71

ENG. RECORD: DRAWN RdeV. 7-17-71; PROCESS RWC

MECHANICAL FLOW DIAGRAM

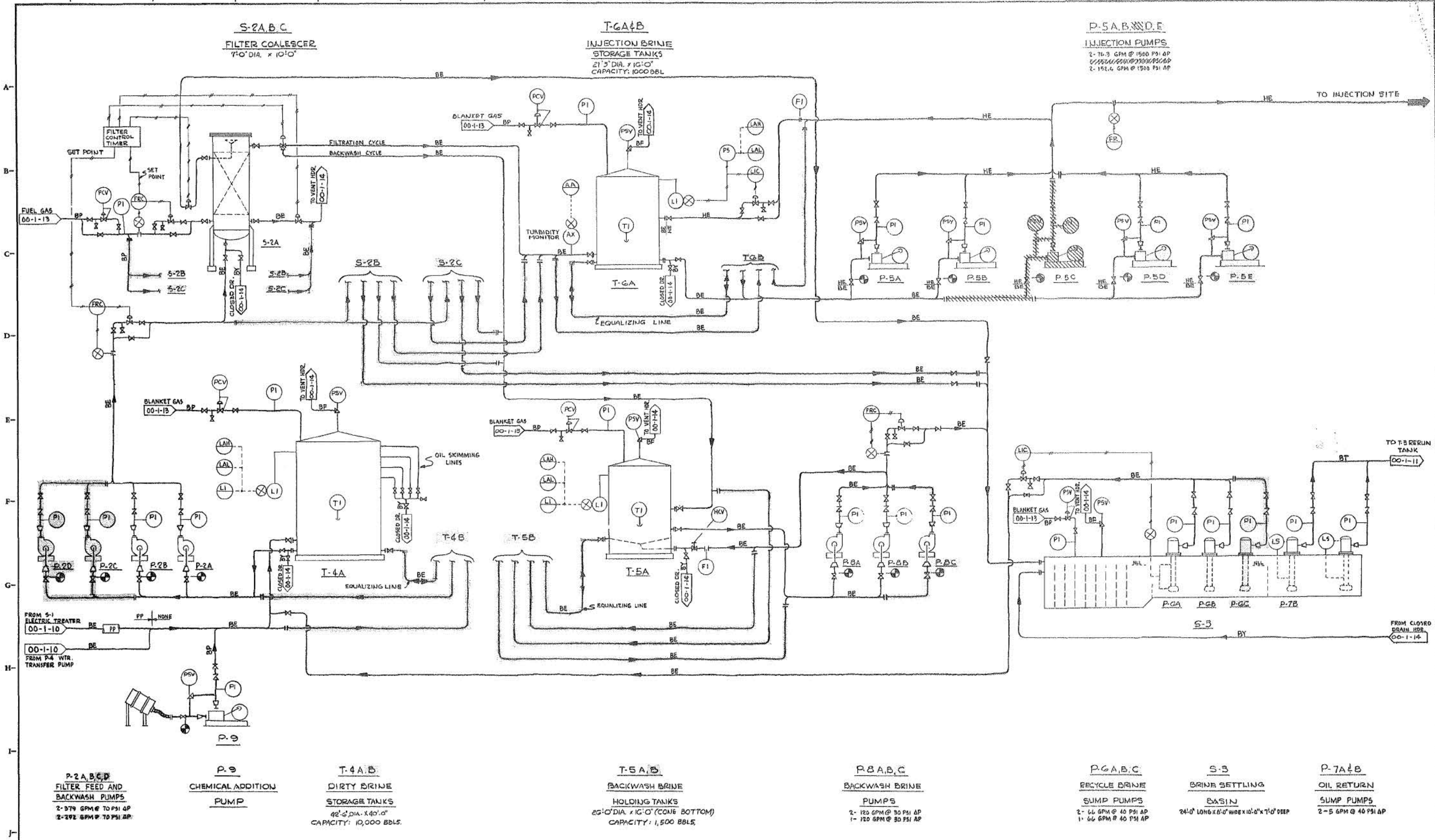
STORAGE AND RERUN

CRUDE OIL TREATING AND STORAGE FACILITY

HUMBLE OIL AND REFINING COMPANY
SBC, CALIFORNIA

SCALE NONE — Stearns-Roger Corporation — ORDER NO. C-10140

DWG. NO. 22071 — SHEET NO. 00-1-11 — REV. 0



//////// INDICATES PHASE II
▓▓▓▓ INDICATES PHASE III

NO.	REVISIONS	DATE	BY	CH'D	APP'D	NO.	REFERENCE DRAWINGS

PRINT RECORD: DATE / FOR / REVISED / CUSTOMER / FIELD / INTRA CO.

ENG. RECORD		
DRAWN	CPH	7-11-71
CHECKED		
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		
PROCESS	RNC	7/28/71

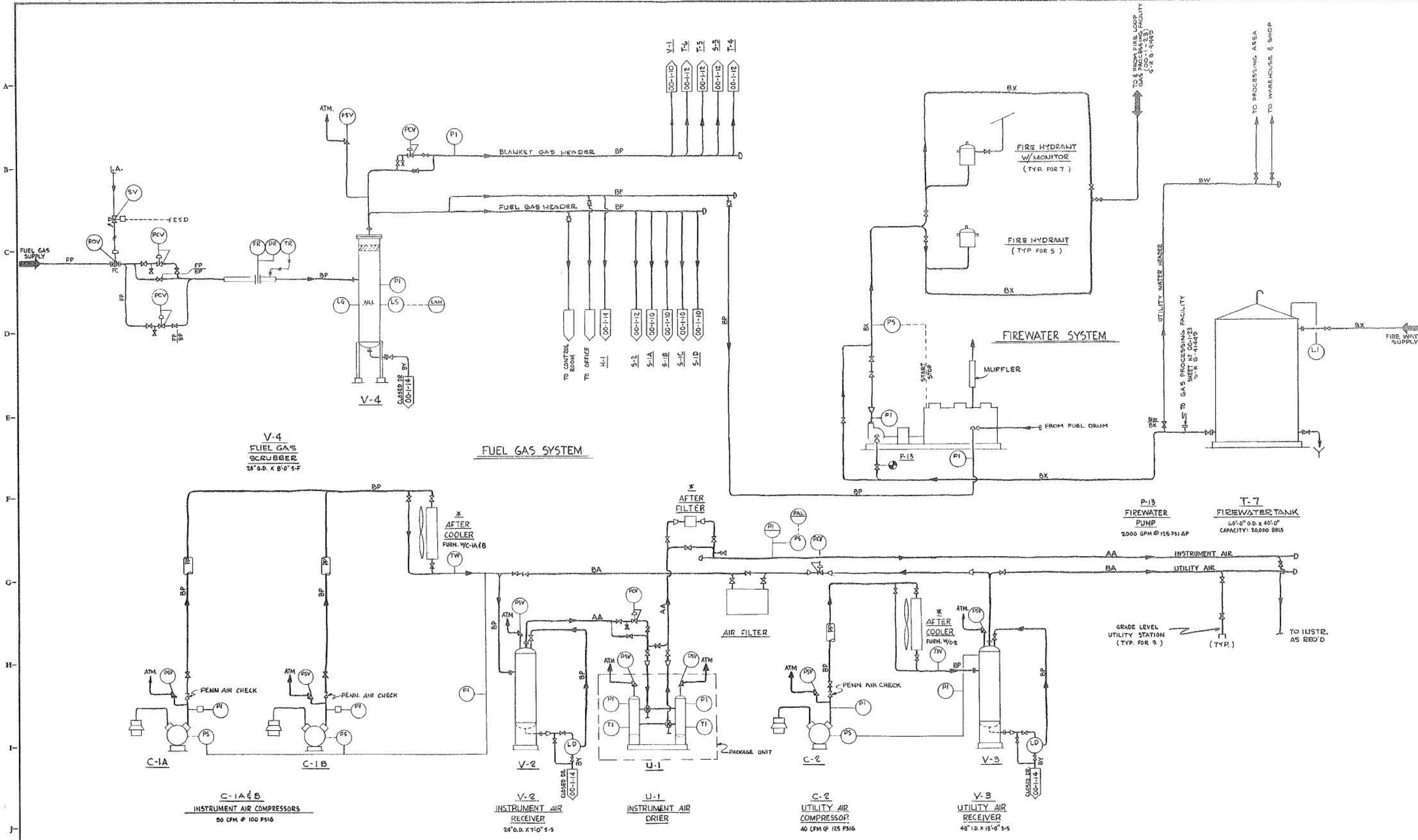
DRAWING STATUS	ISSUE Nº	DATE
DEVELOPMENT	1 2 3 ☒	7-20-71
PRELIMINARY ENGINEERING	4 6	8-25-71
APPROVED FOR CONSTRUCTION	☐	
REVISED & APPROVED FOR CONSTRUCTION	REV. 0	

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

MECHANICAL FLOW DIAGRAM
BRINE TREATING
CRUDE OIL TREATING AND STORAGE FACILITY

HUMBLE OIL AND REFINING COMPANY
SBC, CALIFORNIA

SCALE: NONE
Stearns-Roger CORPORATION
ORDER NO. C-10140
DWG. NO. 22071
SHEET NO. 00-1-12
REV. 0



NOTE:
UTILITY DELIVERIES ARE SHOWN FOR PHASE I.

NO.	REVISIONS	DATE	BY	CH'D	APP'D

NO.	REFERENCE DRAWINGS

PRINT RECORD	
DATE	
FOR	
REVISED	
CUSTOMER	
FIELD	
INTRA CO.	

ENG. RECORD		
DRAWN	RdeV	
CHECKED		
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		
PROCESS	RWC	7/23/71

DRAWING STATUS					
DRAWING	ISSUE NO.				DATE
DEVELOPMENT	1	2	3	X	7/23/71
PRELIMINARY ENGINEERING	4		6		8-25-71
APPROVED FOR CONSTRUCTION					
REVISED & APPROVED FOR CONSTRUCTION	REV. 0				

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

MECHANICAL FLOW DIAGRAM
UTILITIES
CRUDE OIL TREATING AND STORAGE FACILITY

HUMBLE OIL AND REFINING COMPANY
SBC, CALIFORNIA

SCALE NONE

Stearns-Roger CORPORATION

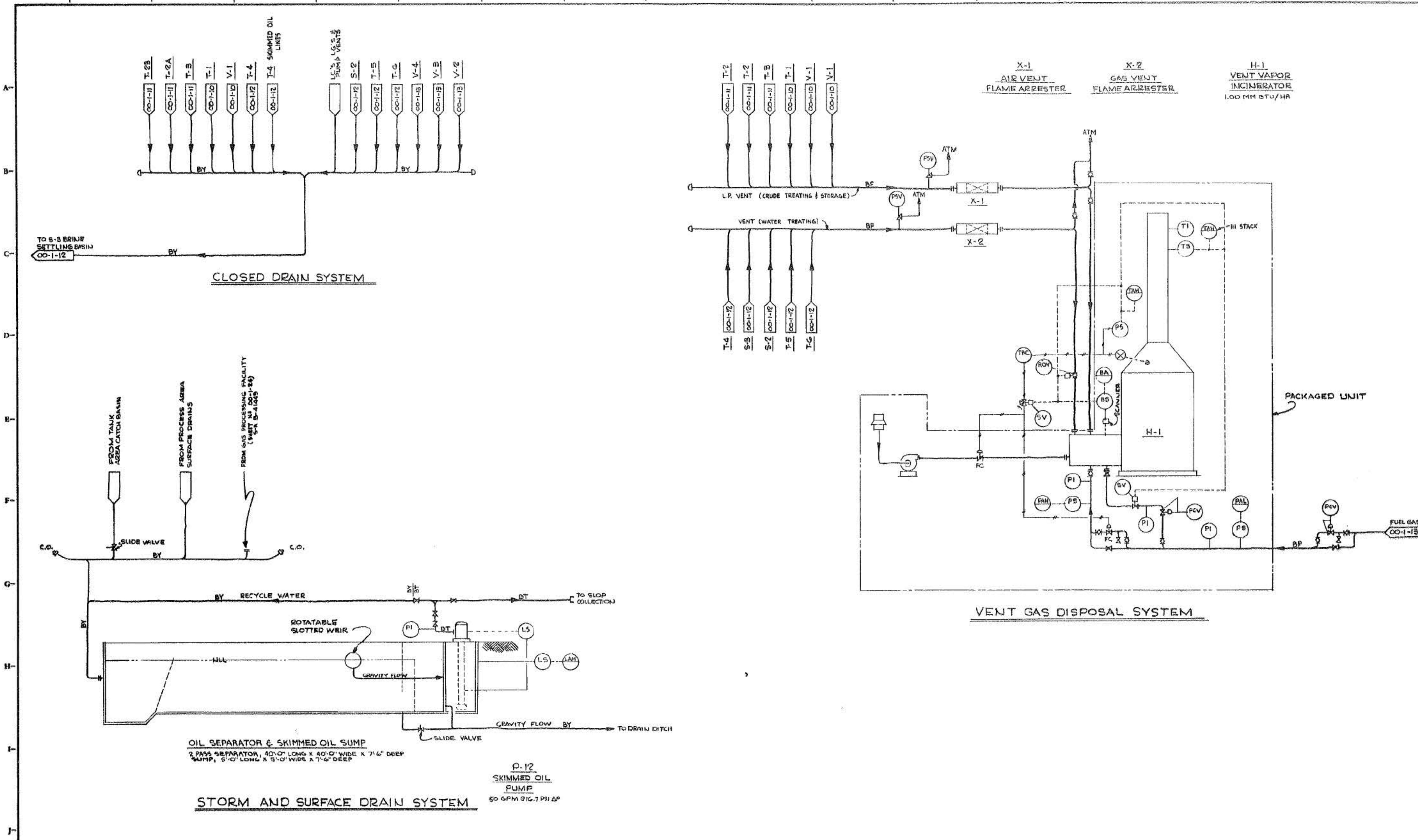
ORDER NO. C-10140

DWG. NO. 22071

SHEET NO. 00-1-13

REV. 0

Form 22300-52



NOTE:

ALL DELIVERIES TO DRAIN AND VENT HEADERS ARE SHOWN FOR PHASE I.

NO.	REVISIONS	DATE	BY	CHK'D	APP'D	NO.	REFERENCE DRAWINGS

PRINT RECORD: DATE / FOR / REVISED / CUSTOMER / FIELD / INTRA CO.

ENG. RECORD		
DRAWN	CPH	7-20-71
CHECKED		
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		
PROCESS	Rowe	7/23/71

DRAWING STATUS	ISSUE NO.	DATE
DEVELOPMENT	1 2 3	7-23-71
PRELIMINARY ENGINEERING	4 6	6-25-71
APPROVED FOR CONSTRUCTION		
REVISED & APPROVED FOR CONSTRUCTION	0	

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED.

MECHANICAL FLOW DIAGRAM
VENT GAS DISPOSAL
AND DRAINS
CRUDE OIL TREATING AND STORAGE FACILITY
HUMBLE OIL AND REFINING COMPANY
SBC, CALIFORNIA

SCALE: NONE
Stearns-Roger CORPORATION
ORDER NO. C-10140
DWG. NO. 22071
SHEET NO. 00-1-14
REV. 0

SHUTDOWNS

EVENTS CAUSING SHUTDOWN	INITIATING DEVICE	ALARM	STOP CRUDE OIL TRANSFER PUMPS R1	CLOSE FUEL GAS TO TREATERS S-1	CLOSE PILOT GAS TO TREATERS	STOP RERUN PUMP P-3	STOP CRUDE SHIPPING PUMPS	CLOSE FUEL GAS TO PLANT	CLOSE FUEL GAS TO VENT VAPOR INCIN. H-1	CLOSE PILOT GAS TO VENT VAPOR INCIN. H-1	CLOSE WTR. TREATING VENT TO H-1	CLOSE COMBUSTION AIR TO H-1	STOP CRUDE OIL TRANSFER PUMPS P-1
POWER FAILURE	BREAKER		X	X	X			X	X	X	X	X	
FIRE (MANUALLY TRIGGER ESD)	VISUAL		X	X	X			X					X
ESD MANUAL SWITCH	HS		X	X	X			X					X
LO/LO LEVEL-CRUDE SURGE TKS T-1	LS	YES	X	X									
FLAME FAILURE - TREATER S-1	BS	YES		X	X								
LO FLOW TO TREATER S-1	PS	YES		X									
HI STACK TEMP. - TREATER S-1	TS	YES		X	X								
LO/LO LEVEL RERUN TANK T-3	LS	YES				X							
LO/LO LEVEL STORAGE TANKS T-2	LS	YES					X						
HI STACK TEMP. - VENT VAPOR INCIN. H-1	TS	YES							X	X	X	X	
HI FURNACE TEMP. - VENT VAPOR INCIN. H-1	PS	YES							X	X	X	X	
FLAME FAILURE - VENT VAPOR INCIN. H-1	BS	YES							X	X	X	X	

ALARMS ONLY

FAULTS CAUSING ALARM	INITIATING DEVICE	ALARM
LOW LEVEL - CRUDE SURGE TKS T-1	LI	LAL
HI LEVEL - CRUDE SURGE TKS T-1	LI	LAH
HI LEVEL - BLOWOFF DRUM V-1	LS	LAH
TREATER BLOWOFF COOLER A-1	TS	TAH
HI LEVEL - RERUN TANK T-3	LI	LAH
LO LEVEL - RERUN TANK T-3	LI	LAL
HI LEVEL - STORAGE TANKS T-2	LI	LAH
LO LEVEL - STORAGE TANKS T-2	LI	LAL
HI LEVEL - DIRTY BRINE STG. T-4	LI	LAH
LO LEVEL - DIRTY BRINE STG. T-4	LI	LAL
HI LEVEL - BACKWASH BRINE TKS. T-5	LI	LAH
LO LEVEL - BACKWASH BRINE TKS. T-5	LI	LAL
HI LEVEL - INJECTION BRINE STG. T-6	PS	LAH
LO LEVEL - INJECTION BRINE STG. T-6	PS	LAL
HI LEVEL - FUEL GAS SCRUBBER V-4	LS	LAH
LO PRESSURE - INSTR. AIR SYSTEM	PS	PAL
HI LEVEL - SKIMMED OIL SUMP S-4	LS	LAH
LO PRESSURE - FUEL GAS TO H-1	PS	PAL
HI PRESSURE - INCIN. BURNER H-1	PS	PAH
HI BS&W - TREATED CRUDE	AX	AA
HI TURBIDITY - TREATED BRINE	AX	AA

NO. | REVISIONS | DATE | BY | CH'D | APP'D | NO. | REFERENCE DRAWINGS | PRINT RECORD: DATE, FOR, REVISED, CUSTOMER, FIELD, INTRA CO.

ENG. RECORD		
DRAWN	H	
CHECKED		
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		
PROCESS	RWC	7/23/71

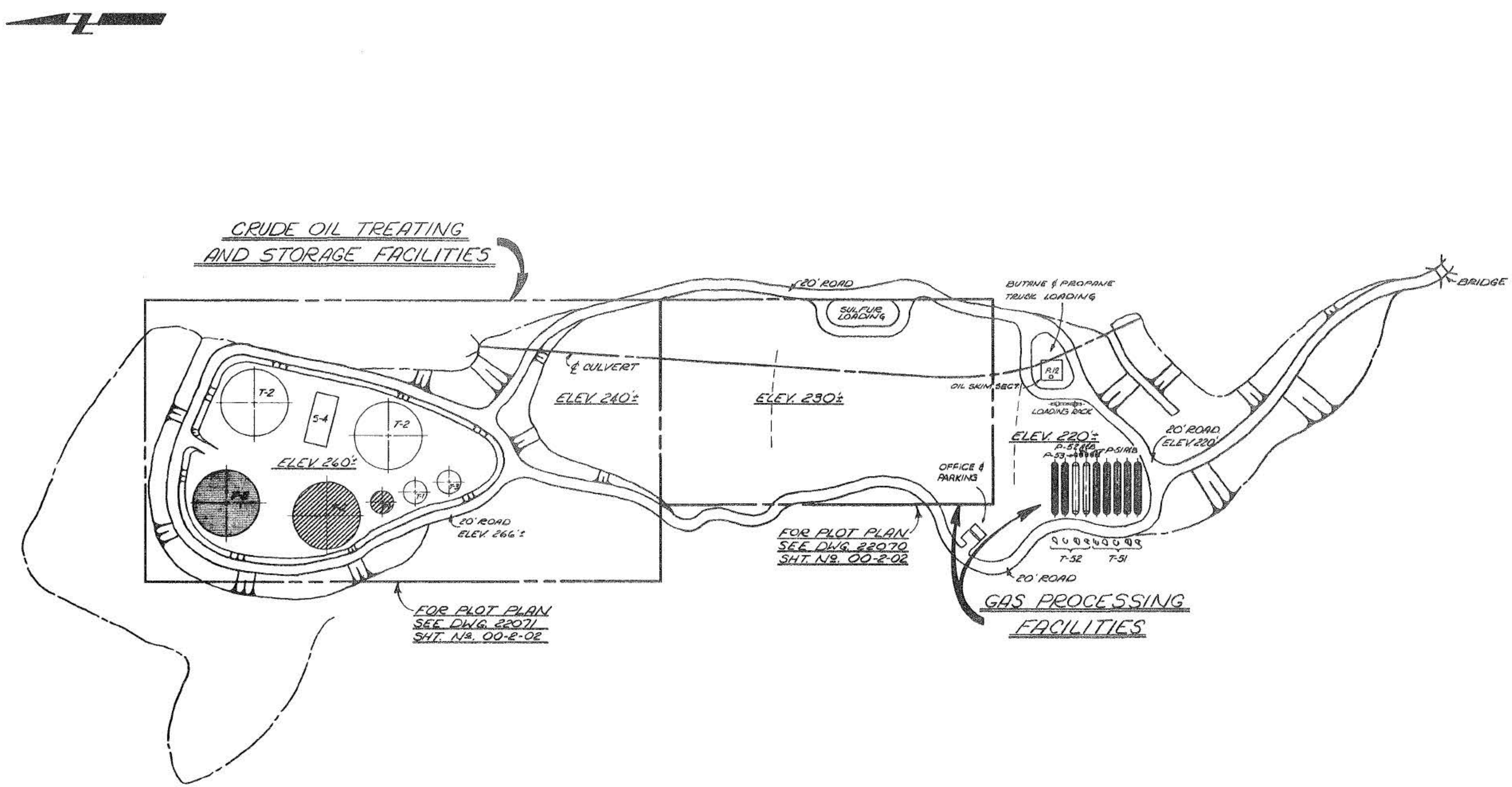
DRAWING STATUS				
DRAWING	ISSUE NO.			DATE
DEVELOPMENT	1	-	-	7/26/71
PRELIMINARY ENGINEERING	4		6	8-25-71
APPROVED FOR CONSTRUCTION				
REVISED & APPROVED FOR CONSTRUCTION	0 REV.			

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

MECHANICAL FLOW DIAGRAM
EMERGENCY SHUTDOWN SYSTEM
CRUDE OIL TREATING AND STORAGE FACILITY
HUMBLE OIL AND REFINING COMPANY
SBC, CALIFORNIA

SCALE: NONE | Stearns-Roger CORPORATION | ORDER NO. C-10140

DWG. NO. 22071
SHEET NO. 00-1-15
REV. 0



DENOTES PHASE II = ▨
DENOTES PHASE III OR ULTIMATE CONDITION = ▩

ENG. RECORD		
DRAWN	DWN	8-27-71
CHECKED		
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		

DRAWING STATUS: PRELIMINARY; FOR COMMENTS AND/OR APPROVAL; APPROVED FOR CONSTRUCTION; REVISED & APPROVED FOR CONSTRUCTION

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

KEY PLOT PLAN

CRUDE OIL PROCESSING & STORAGE STUDY

HUMBLE OIL AND REFINING COMPANY
SBC, CALIFORNIA

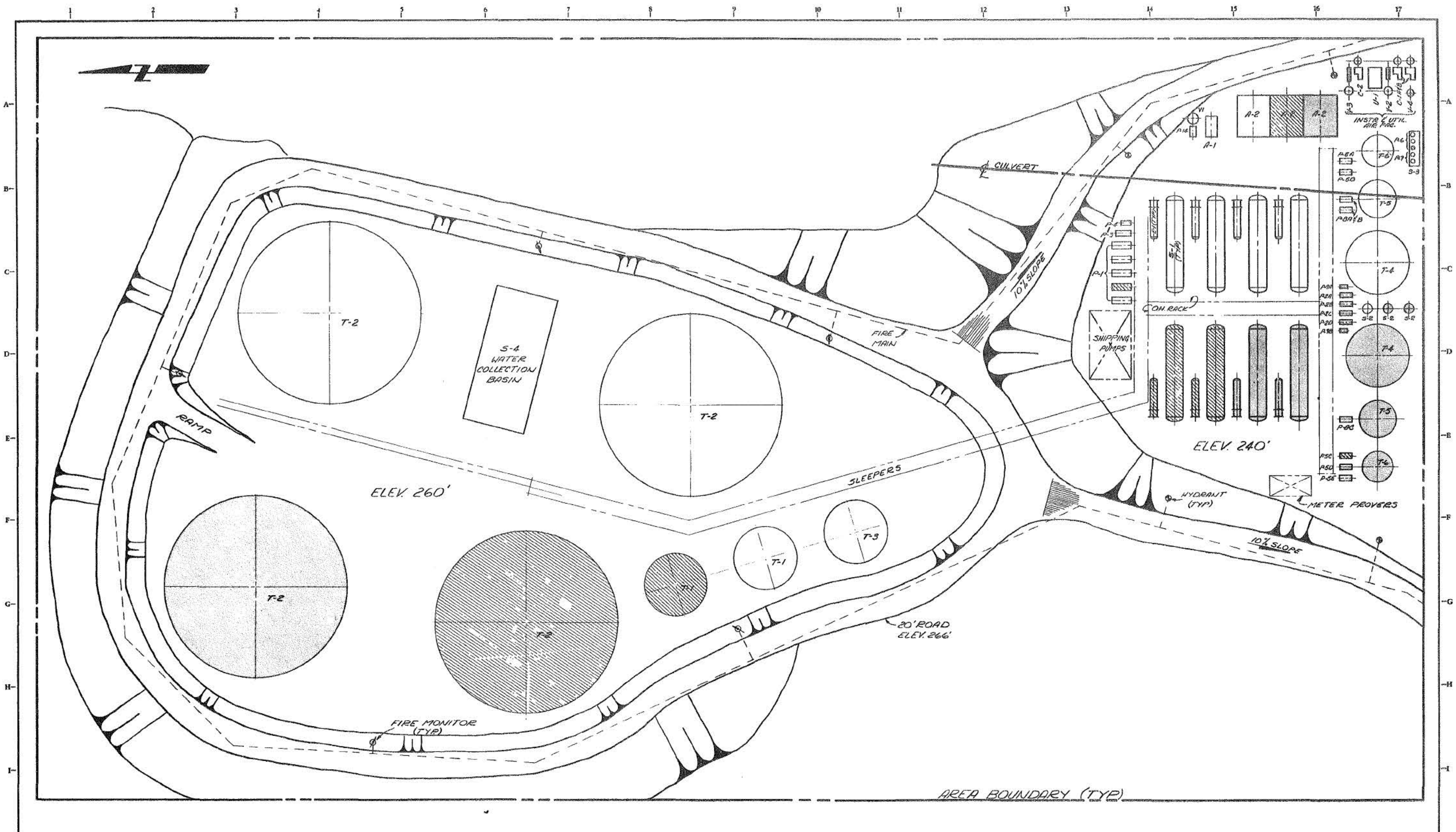
SCALE 1" = 100'

Stearns-Roger Corporation

ORDER NO. C-10140

DWG. NO. 22071

SHEET NO. 00-2-01



PHASE II = ▧
PHASE III = ▢

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NO.	REFERENCE DRAWINGS

PRINT RECORD

DATE	
FOR	
REVISED	
CUSTOMER	
FIELD	
INTRA CO.	

ENG. RECORD

DRAWN	Dhala	8-27-71
CHECKED		
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		
	[illegible]	9-1-71

DRAWING STATUS

ISSUED	DATE
PRELIMINARY	
FOR COMMENTS AND/OR APPROVAL	
APPROVED FOR CONSTRUCTION	
REVISED & APPROVED FOR CONSTRUCTION △ REV.	

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

PLOT PLAN
CRUDE OIL FACILITIES
CRUDE OIL TREATING & STORAGE FACILITY

HUMBLE OIL AND REFINING COMPANY
SBC, CALIFORNIA

SCALE 1" = 30'

Stearns-Roger CORPORATION

ORDER NO. C-10140

DWG. NO. 22071

SHEET NO. 00-2-02

REV. △

FACILITY CONSTRUCTION

C-10140
August 1971

HUMBLE OIL AND REFINING COMPANY
CRUDE OIL TREATING AND STORAGE FACILITY
SANTA BARBARA CHANNEL

FACILITY CONSTRUCTION

GENERAL

As mentioned previously in this report, the crude oil treating and storage facility will be located in Las Flores Canyon approximately 1-1/4 miles north of U.S. Highway 101 and 15 miles west of the city of Santa Barbara in Santa Barbara County, California.

Preliminary schedules indicate the period of construction as being approximately 30 weeks (or 7 months). The attached "bar-chart" schedule gives a preliminary picture of various phases of engineering and construction.

Based on a preliminary field manhour estimate to perform the work, a peak construction crew of approximately 125 men is indicated plus a field supervisory staff of 7-10 people. The attached craft manpower curve gives the prediction of craft requirements during the course of construction. This curve indicates the peak will occur earlier in the project than normal due to a rather large crew of storage tank erectors expected on the job at an early date.

PROCEDURES AND TECHNIQUES

The construction crew will include a supervisory staff of 7-10 people, including a superintendent, an assistant, field engineer, material man/field purchasing agent, accountant, timekeepers, cost engineer, and technical supervisors as required. Craft personnel, averaging 85 in number with a peak of approximately 125, will be employed.

A temporary field office for use during the construction phase will be provided along with a materials warehouse, craft change rooms and sanitary facilities. The requirements of the "Safety and Health Regulations for Construction" as published by the Department of Labor, in regard to drinking water and sanitary facilities, will be met as well as the requirements of any local codes. The criteria for the type of sewage disposal system selected as discussed in the "Facility Design" section of this report will also apply for construction requirements.

PROCEDURES AND TECHNIQUES - continued

Electrical power feeders will be brought into the site area prior to the start of construction. This power will be used on a temporary basis during construction; and then installed in a permanent manner to supply facility requirements. Electrically powered small tools and small construction equipment (such as motor driven air compressors) will be utilized wherever possible. Temporary building heating, if required, will be either electrical or from commercial propane or butane. Other fuel requirements for construction purposes are minimum; therefore, the danger of fire or explosion is minimized.

Since there will be no equipment of any consequential height to be handled, heavy construction equipment required will be a minimum including medium sized cranes, hydraulic cranes, bulldozers, front end loaders, flatbed and pickup trucks, etc.

Ready-mix concrete will be used for all major foundation work in this unit. Ready-mix will be obtained from a nearby existing source (possibly 15 miles away) requiring concrete trucks to utilize the highways in the area. A period of approximately three months will be required to complete the majority of concrete work.

The majority of piping work, 2-1/2" size and larger, will be fabricated in a fabricating shop in a city remote to the facility and hauled to the site for installation. Smaller piping, 2" size and under, will be fabricated in a temporary shop set up at the site. Electrical welding machines will be used (rather than gas engines) in most cases for fabrication and installation.

Most equipment will be fabricated in shops remote to the area and hauled to the site for installation, with the exception of large storage tanks which will be erected in place in the field. This will require a certain amount of construction equipment and welding machines. This erection will take place over a three to four month period.

During the course of construction, daily cleanup of trash and debris will be carried on; and disposal of this trash will be made as required at areas designated by the county authorities.

In general, all construction work will be carried on as rapidly as practical in accordance with the recommended practices and codes established for the industry and in accordance with the requirements of local authorities.

EQUIPMENT/MATERIAL DELIVERY

As mentioned above, most of the operating equipment in this facility (with the exception of storage tanks) will be fabricated or manufactured at locations remote to the area; and then shipped to the site for installation. Some of the larger and heavier items may be shipped by rail to the nearest siding; and then hauled by contract truck to the site. However, the majority of items will be hauled direct from the manufacturer's shops by truck (contract hauler or commercial carrier). Other general materials including piping, electrical, structural steel, concrete reinforcing steel, etc. will be delivered by truck, generally a commercial carrier. Miscellaneous materials purchased locally will be delivered by the supplier's truck or picked up by one of the contractor's vehicles.

ENVIRONMENTAL IMPACT

Every precaution necessary to minimize the impact of construction on the existing environment will be taken.

Most construction projects are susceptible to a dust problem from loose disturbed soil, excavating equipment, and frequent vehicular traffic throughout the site area. To minimize the dust problem a number of steps will be taken including periodically laying down a coat of road oil on the access road from Highway 101 to the site. At completion of the project, a permanent treatment to this road will be made. Another step will be daily sprinkling of the site with water.

The "Safety and Health Regulations for Construction" prescribe limits of noise exposure for construction personnel. Feasible administrative or engineering controls will be utilized to reduce sound levels to the limits noted. If all such controls fail, then personal protective equipment will be provided. The relatively secluded location of the site with the buffering effect of the surrounding hills should be ideal for minimizing the noise level at the surrounding property lines.

It is anticipated that fresh water wells will be drilled at the site and that this water will be available for use during construction. As mentioned earlier, contamination of the flowing stream through the site area will be avoided. Construction waste materials will not be allowed to be dumped or discharged into this stream without proper treatment.

The sewage disposal system installed for construction purposes, as well as the permanent installation, will be a totally enclosed system.

ENVIRONMENTAL IMPACT - continued

Most of the major construction equipment to be used have either gasoline or diesel engine drives which will emit the usual exhaust vapors associated with this type of equipment. However, studies on air currents through this canyon area indicate that an excellent dispersal of this type of vapor will occur.

Traffic congestion on the local highways will be increased to a small degree during the course of construction from a number of causes. Construction personnel, driving to and from the site in early mornings and mid afternoons, will contribute perhaps the heaviest congestion. However, with a peak crew of only 125 men, this will not be appreciable. During the working day, periodic deliveries to the site of equipment, concrete, general materials, etc., will be made with large trucks.

Electrical power will be the main utility for operation of construction tools and small equipment. Gasoline and diesel fuels for heavy construction equipment and vehicles will be stored in minimum quantities; and steps will be taken to prevent spills, fire, etc., from occurring during loading or unloading. Other types of fuel for heating purposes, if required, will be commercial bottled propane or butane; and proper equipment and supervision of installation will be utilized to prevent any accidents occurring.

INSPECTION - CODE COMPLIANCE

During the course of construction, inspectors will regularly be on the job to confirm that the facility is being built strictly in accordance with specifications and construction drawings; and that all applicable codes, regulations, restrictions, etc., are being met. They will also regularly be alert to assure that environmental controls are being adhered to.

Field engineers will keep a close check on concrete quality control through numerous normally prescribed test procedures; and will maintain proper methods of curing to assure minimum design strengths are attained.

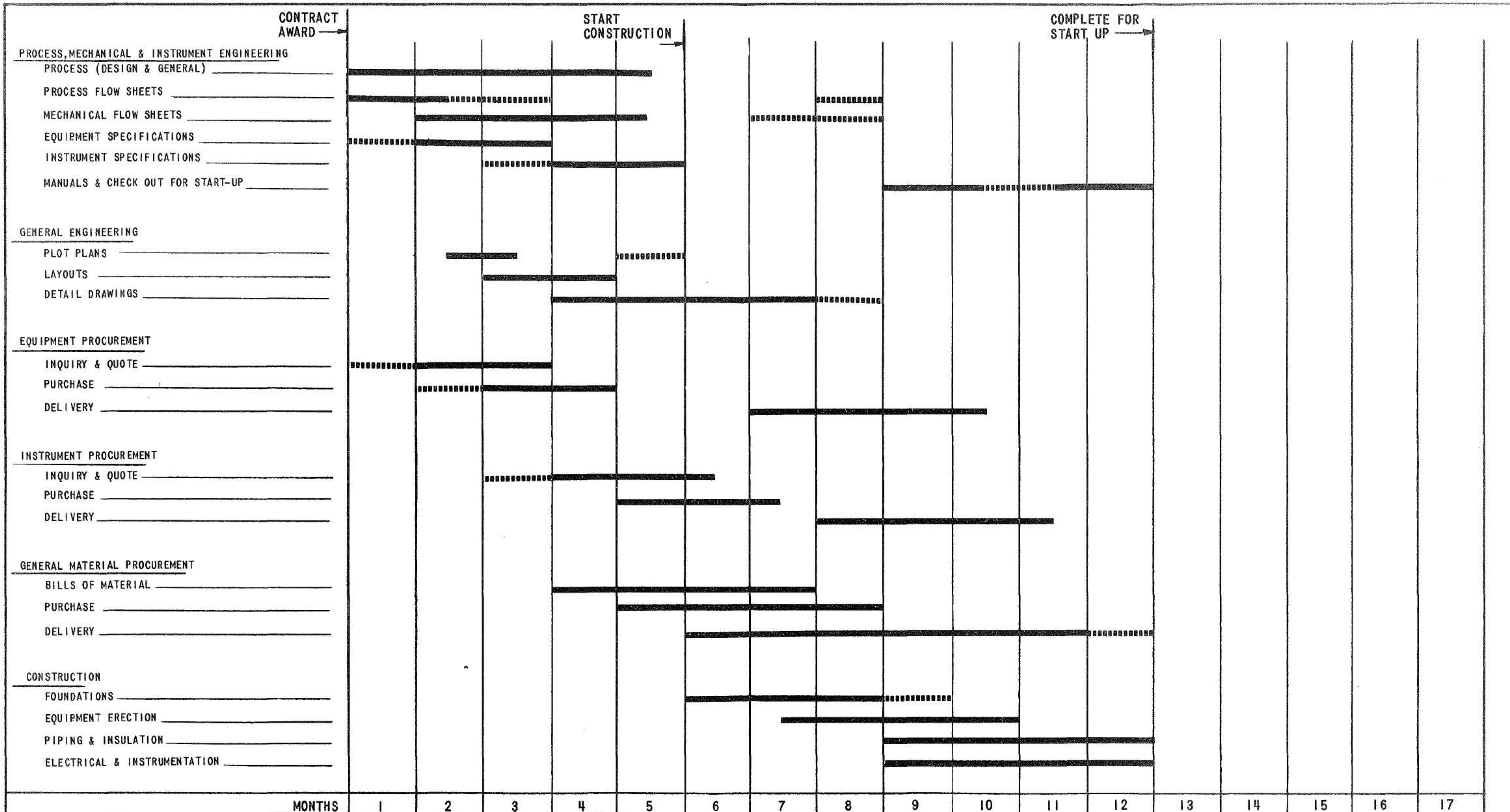
Welding inspectors will check all piping welds made in the field; and x-ray technicians will be used as required by codes to assure welding quality control.

Miscellaneous engineering technicians will be utilized to assure that the proper piping and electrical materials, fittings, etc., are installed in the proper locations. An instrument supervisor will

INSPECTION - CODE COMPLIANCE - continued

check out the installation of all instruments, and will check the setting and calibration of all applicable instruments.

The various inspectors and technicians mentioned above will also assist in establishing certain test procedures of many systems prior to startup. Testing and startup is discussed in the following section of this report on "Facility Operation."



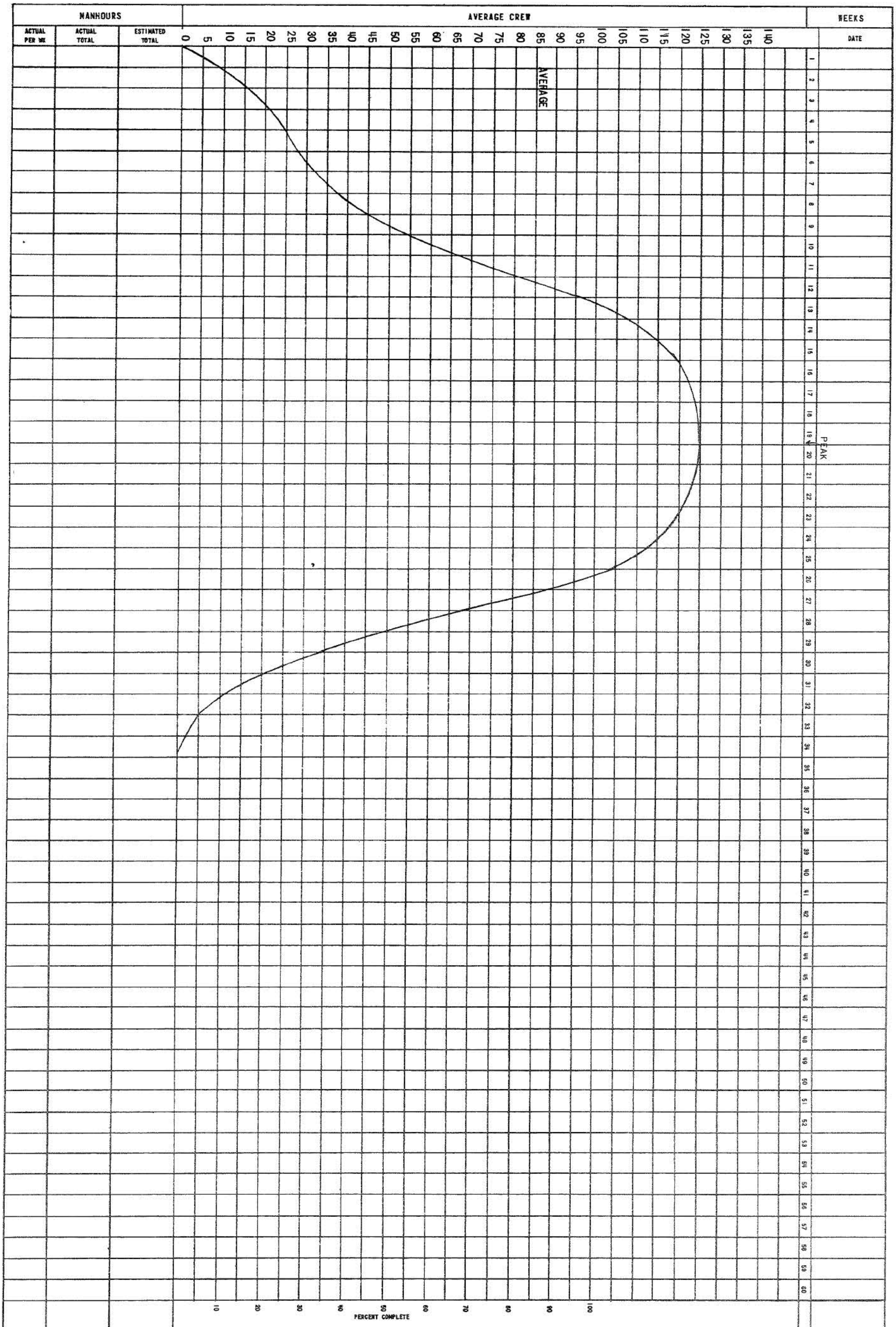
ACTIVE PERIOD

PRELIMINARY OR FOLLOW UP WORK

PRELIMINARY ENGINEERING & CONSTR. SCHEDULE
CRUDE OIL TREATING & STORAGE FACILITY-INITIAL PHASE
HUMBLE OIL & REFINING COMPANY
SANTA BARBARA CHANNEL

Stearns-Roger

C-10140



Stearns-Roger

NOTES:

PRELIMINARY FIELD CONSTRUCTION CRAFT MANPOWER CURVE
CRUDE OIL TREATING & STORAGE FACILITY - INITIAL PHASE
HUMBLE OIL & REFINING COMPANY
SANTA BARBARA CHANNEL

JOB NO.	DATE
C-10140	August 1971

FACILITY OPERATION

C-10140
August 1971

HUMBLE OIL AND REFINING COMPANY
CRUDE OIL TREATING AND STORAGE FACILITY
SANTA BARBARA CHANNEL

FACILITY OPERATIONS

TESTING, STARTUP, AND DEBUGGING

After construction of the crude facility has been completed, the equipment will be subjected to comprehensive testing procedures. All lines and equipment will be hydrostatically tested with fresh water in accordance with applicable codes. Test water will be cleaned prior to discharge into the adjacent stream. Instrument functions and operation will be checked, and all rotating equipment will be checked for proper installation.

The facilities are further checked by process and operating personnel before startup. This phase of checkout normally includes familiarization of operating personnel to the facility safeguards and instruction in shutdown procedures.

After it is determined that the facility is free of any leaks, and is apparently free of obvious flaws, startup of units will proceed. The actual startup of the crude unit would be expected to be relatively uncomplicated. Individual treaters will be placed on line, and any wet crude produced during startup could be recycled through the Crude Rerun Facilities.

It is not anticipated that facility startup would cause any abnormal emission of sulfur dioxide or hydrocarbons. It is possible to field test the operation of the Vent Gas Incinerator without feeding waste vapors, as the unit selected for this service is externally supplied with fuel gas.

The Brine Filter Coalescer may require some initial trial operation to determine proper feed rates, cycle times, and flushing procedures. However, as the operation of this unit is straightforward, and controls can be actuated manually, it is not expected that this unit will prove unduly troublesome. Numerous fine adjustments, however, during this phase of operation would be expected.

NORMAL OPERATIONS

In normal operation, the facility should be capable of almost minimal operator attention except for monitoring the inlet flows of

NORMAL OPERATIONS - continued

crude oil and water. Cycling of storage tanks would be expected, but would not be of a frequent nature. Off-specification crude oil will require rerun to the crude surge tanks in the event of poor treater performance. This would require operators to manually set the proper valves, and to start and stop the crude rerun pump.

Because the exact quantity of produced brine carried by the crude oil cannot be determined precisely until operation commences, it may prove necessary to treat produced brine only a portion of each operating day until the quantity of brine increases sufficiently to load up the Filter-Coalescer. This may prove in time to be the most efficient brine handling procedure.

Measured variables of temperature, flow, pressure, and levels are monitored by operating personnel either at the individual unit or in the central control room. Adjustments to controller set points can be made as necessary to maintain proper control. The operating personnel in the control room will have complete control of the major operating variables. In case of upsets in unit operations, the operator can shut down and by-pass various units, and, if necessary, shut down the entire operation without damage to equipment or release of any undesirable material to the environment.

ENVIRONMENTAL IMPACT

In operation, the facility should release no odors. During periods of potential operating excursions, it is highly unlikely that any vapors would be emitted to the atmosphere without incineration. Emissions to the air will be limited to the products of combustion from burning the 1.45 MMSCF/day (Phase III) of sweet natural gas in the crude treater heaters and the effluent from the incinerator. The incinerator selected for the vent gas service is designed for the complete oxidation of hydrocarbons to a mixutre comprised primarily of carbon dioxide, nitrogen, and water. The primary source of hydrogen sulfide in the vent gas collection system would be expected to be from evaporation of crude oil from the walls of the crude surge and storage tanks during lowering of tank levels and subsequent refilling. In addition, as the brine carried in the brine treating system is expected to be sour, some hydrogen sulfide would be produced in the brine tanks due to partial vaporization. The combined hydrogen sulfide rate from these two sections of the facility is expected to be less than 2.0 lbs./hr. equivalent sulfur dioxide. All brine from the facility will be injected into sub-surface formations. Rain runoff from the curbed and dyked areas will be trapped and skimmed for removal of free oil prior to discharge to the surroundings.

ENVIRONMENTAL IMPACT - continued

Noise levels should be minimal as there are no large reciprocating units required for operation. The equipment is all driven by electric motors except for the engine driven firewater pump. Vibration should be insignificant.

EMERGENCY CONTROLS AND OPERATIONS

Pressure equipment by codes, requires pressure relieving devices. All these items are tied into the closed vent and drain systems. In all operations, emergencies can occur due to mechanical failures or human errors. In case of emergencies in the facility, all vapors will be relieved to the vent gas incinerator for complete thermal oxidation. Liquid materials will be either trapped and recycled or disposed by ground injection.

All combustion equipment is protected with flame failure devices to shut down individual units in case of flame failure. These devices protect against fire box explosions and prevent venting of unburned fuel.

APPENDIX 4.6

SUPPLEMENTAL PLAN OF OPERATIONS

SANTA YNEZ UNIT

APPENDIX 4.6

Engineering Study for Gas Processing Facility,

Santa Barbara Channel

Stearns-Roger Corporation

August, 1971

HUMBLE OIL AND REFINING COMPANY
LOS ANGELES, CALIFORNIA

ENGINEERING STUDY

for

GAS PROCESSING FACILITY
SANTA BARBARA CHANNEL

PREPARED BY

STEARNS-ROGER CORPORATION

DESIGN BASIS

B-41449
August, 1971

HUMBLE OIL AND REFINING COMPANY
GAS PROCESSING FACILITY
SANTA BARBARA CHANNEL

DESIGN BASIS

In requesting this study, covering the design of onshore Gas Processing Facilities for the Santa Barbara Channel area, certain basic data, requirements, and design criteria were set forth by Humble to be used as a basis for design. This information is summarized below:

SITE LOCATION

The Gas Processing Facilities are to be located on the eastern half of a site located about 6-7000 feet north of the highway (US-101) in Las Flores Canyon, just north of its junction with Cañada del Corral. Contour maps of the area were furnished to aid in plant layouts.

BASIC DATA

Inlet Gas Conditions

Pressure	915 psia
Temperature	60°F

Composition, Mol Percent	Initial Gas	Ultimate Gas
Nitrogen	0.09	0.52
Hydrogen Sulfide	0.80	0.35
Carbon Dioxide	7.30	3.23
Methane	68.95	78.41
Ethane	9.19	8.27
Propane	8.17	5.64
i-Butane	0.94	0.74
n-Butane	3.66	2.11
i-Pentane	0.22	0.21
n-Pentane	0.28	0.21
Hexane	0.25	0.17
Heptanes-Plus	0.15	0.14
Total	100.00	100.00

BASIC DATA - continued

Inlet Gas Conditions

Mercaptan Content	500 ppm	200 ppm
Heptanes-Plus Characteristics:		

Molecular Weight	100
Specific Gravity	0.732

Inlet Gas Volumes

Initial Plant	28 MMSCF/D
Ultimate Plant	90 MMSCF/D

Residue Gas Specifications

Delivery Pressure, Minimum	850 psia
Carbon Dioxide, Maximum	3% by volume
Hydrogen Sulfide, Maximum	1 Grain/100 SCF
Total Sulfur, Maximum	20 grains/100 SCF
Heating Value, Minimum	1000 BTU/CF (Gross Saturated)

PROCESS AND FACILITY REQUIREMENTS

The Gas Processing Facilities shall remove acid gases from the inlet gas and process treated gas for plant liquids recovery.

The facilities will be installed in two phases. The initial phase will process the initial gas described above. Processing facilities will be of single-train design, with the hydrocarbon recovery facilities being a simple refrigeration unit designed to recover a single butanes-plus product.

The second phase will be a plant expansion designed to process the total gas represented by the ultimate gas described above. Acid gas removal and sulfur recovery facilities shall include two trains with a total capacity of at least 100% of the ultimate requirements. Ultimate hydrocarbon recovery facilities shall be of the refrigerated absorption type for recovering 75% of the propane and substantially all of the butanes-plus in the feed gas. The hydrocarbon products will consist of Commercial Propane and an iso-Butane-plus mixture.

A minimum of three days product storage is to be included in each phase of the design. Truck loading facilities will be included for the single product in the initial phase.

PROCESS AND FACILITY REQUIREMENTS - continued

Standby gas dehydration is required for the treated gas in the ultimate facility.

The facility will recover 99% of the inlet hydrogen sulfide as sulfur or other non-polluting product. Any unrecovered sulfur compounds will be incinerated to sulfur dioxide before venting.

AIR QUALITY CRITERIA

The facility is to be odor free. No hydrogen sulfide is to be vented without incineration to sulfur dioxide. The facility shall be designed to meet the anticipated rules and regulations (4-8-71 Draft) of the Air Pollution Control District of Santa Barbara County.

WATER QUALITY CRITERIA

Any open discharge of water from the facility will meet Regional Water Quality Control Board standards, Environmental Protection Agency regulations, California Fish and Game regulations, and the 1965 Federal Water Pollution Control Act for discharge of water to the Pacific Ocean.

Any sub-surface discharge of water from the facility will be clarified, cleaned, and treated before sub-surface injection.

PLANT DESIGN

B-41449
August 1971

HUMBLE OIL AND REFINING COMPANY
GAS PROCESSING FACILITY
SANTA BARBARA CHANNEL

PLANT DESIGN

This study covers the design of a Gas Processing Facility to process gas for the initial conditions of flow rates and composition given in the "Design Basis" section of this report. The facility is more fully described in the other sections of this report where a plant description, equipment lists and specifications, flow diagrams, and layouts will be found.

The initial facility is designed to be expandable into a facility capable of handling the flow rates and composition for the "Ultimate" gas as given in the "Design Basis." Changes necessary to accomplish this expansion are described in the section on "Ultimate Plant Description."

Certain process and facility requirements and other criteria as outlined in the "Design Basis" dictated some of the plant design philosophy. The effects of these requirements on the design are discussed below.

DESIGN FOR AIR QUALITY CRITERIA

In designing the facility to be odor free and to meet the anticipated rules and regulations of the Air Pollution Control District of Santa Barbara County (APCD), several areas of the facility must be examined. These include not only major areas such as the sulfur recovery unit and the incinerator, but also smaller features such as product loading and miscellaneous minor vents and drains. The design of these systems from an air quality standpoint is discussed below.

Drain Systems - Since the major source of odors in a sour gas processing plant (assuming the sulfur recovery unit is operating properly) is miscellaneous venting and accidental liquid spills, every effort must be made in the plant design to control these seemingly minor items. For this reason, all items such as gauge glasses and liquid level controls, which are routinely blown-down in the normal course of operations, have been connected into closed drain systems.

DESIGN FOR AIR QUALITY CRITERIA

Drain Systems - continued

All process vessels and other equipment which would normally be drained for maintenance purposes are also connected into these closed drain systems. Vapors from these drain systems, released in closed vent tanks at essentially atmospheric pressure, are collected and incinerated.

Flares and Vents - All hydrocarbon vapors discharged from the facility either by safety relief valves or by manual or automatic control valves will be collected in a flare system and discharged to smokeless flares. This equipment is sized to handle maximum venting rates from any of the plant sources.

Any acid gases (mixtures of H_2S and CO_2, containing too little hydrocarbons to burn) released by safety relief valves or other controls at time of plant upsets or emergencies, will be collected in a low pressure vent gas system and discharged to the sulfur unit tail gas incinerator. This same low pressure vent system will gather any oil separator and drain system vent tank vapors for incineration.

Fuel and Combustion Equipment

All fuel consumed in the facility will be sweet natural gas obtained from within the processing units or from the sales gas pipeline. Total sulfur content of the fuel gas will be not more than 20 gr/100 SCF, well below the maximum of 50 gr./100 SCF allowed in the APCD regulations. Fuel gas will be used in direct fired process heaters, a small steam boiler, an industrial type gas turbine, and as fuel gas for the waste gas incinerator. A total initial fuel gas consumption of 973 MSCF/D is anticipated.

Product Loading - The initial facility will produce a single liquid hydrocarbon product, a mixture of iso-butane and heavier hydrocarbons having a calculated vapor pressure of 51 psia at 100°F. This mixture will be stored in pressure storage tanks and shipped by trucks. The truck loading and vapor return lines will be fitted with suitable connectors to comply with APCD regulations.

DESIGN FOR AIR QUALITY CRITERIA

Fuel and Combustion Equipment - continued

Product sulfur will be shipped as a liquid at about 300°F in insulated tank trucks. Because of the low vapor pressure of sulfur at this temperature, no vapor collection system is provided.

Sulfur Plant Design - The sulfur recovery unit, while ultimately recovering about 12 long ton/day of sulfur, is primarily an air pollution control unit. As such, it has been designed for reliability and flexibility of operation and for low sulfur (sulfur dioxide) emissions. To accomplish this, the facility has been broken down into a primary Claus unit recovering about 95% of the available sulfur, and a secondary tail gas unit to bring the overall recovery up to 99%. The residual 1% of sulfur compounds will be incinerated to sulfur dioxide before being vented from a stack. No unburned hydrogen sulfide will be vented.

This proposed combination of units will meet the anticipated APCD regulations allowing not more than 0.2 volume percent of sulfur dioxide to be emitted. In the initial facility, normal emissions of sulfur dioxide should be less than 12 lb/hr. at a concentration of about 370 ppm (by volume) in the incinerator stack. The ultimate facility would increase this figure to about 16 lb/hr. at the same concentration.

The proposed sulfur recovery facility represents a workable combination of proven units, all pieces of which are in industrial operation at the present time. With the combination, a sulfur recovery of 99% is obtainable.

The field of sulfur recovery, and particularly tail gas clean-up, is a constantly changing one in which new developments and new processes are continually emerging. One of these promising new processes is the Stretford process which removes hydrogen sulfide from a mixture of gases and converts it directly to sulfur. The removal efficiency of this process is good and it would probably cut the sulfur emissions. However, the process has some operating problems at present, and until these are worked out, we feel that we have picked the most practical design at the present time. If these operating problems are resolved in the near future, it may be that a Stretford unit, operating on the acid gas from the treating unit, would be considered as a substitute for the present design.

DESIGN FOR WATER QUALITY CRITERIA

In designing the unit to meet water quality regulations, several factors are involved. The problem has been simplified by the decision to make the facility as "dry" as practical. Very little makeup water is required; therefore, very little waste water is produced.

All plant cooling is accomplished by using aerial coolers so that no water cooling tower is required. This eliminates a major source of blow-down water. In the few cases where an aqueous liquid cooling medium is required, such as for engine jackets and bearing cooling, small closed loop jacket water systems with aerial coolers or radiators have been provided.

In general, plant heating requirements are handled by a circulating hot oil system, or by direct fired process heaters. In the sulfur recovery unit, where direct heating and aerial cooling are not practical, a small steam system will be required. This steam system will require a small treated water makeup, and will produce a small blowdown water stream.

All waste water streams from the facility will be collected in closed or open drain systems and routed to a collecting or vent tank at essentially atmospheric pressure. These waste streams will include any produced water from the inlet facilities, water removed from the gas by the glycol dehydration unit, backwash and regeneration water and brine from the water treating unit, backwash water from the amine filters, and steam system blowdown. These total waste water streams should average under 1000 Lb./Hr. After collection, these waste streams will be pumped to the water injection unit in the adjacent Crude Oil Facilities (report C-10140) where they will be diluted with produced water and injected into a subsurface formation.

The operating areas of the facility, which might be subject to accidental spills of hydrocarbons or lubricating oil from equipment, will be provided with curbs. All surface drainage from these areas will be routed to skimming facilities where any oil and hydrocarbons will be separated from the water before discharge to the creek. Any skimmed oil will be pumped to the Crude Oil Facilities.

Sewage Disposal - The gas processing facilities will utilize a permanent crew of operators and staff personnel. Proper sanitary facilities, as required by codes and ordinances, will be provided for these personnel in the office/shop/warehouse area and in the control building.

DESIGN FOR WATER QUALITY CRITERIA - continued

The type of soil at the plantsite, as determined by a soil investigation, will have a great deal to do with the selection of the method of sewage disposal. If the resulting soil is a granular type (sand, gravel, etc.) with a relatively high degree of porosity, ideal for natural percolation, a conventional septic tank system with a disposal or leaching field will be recommended. If the soil is a highly compacted clay type impervious to liquid percolation, an alternate system, such as "Extended Aeration," will be proposed. Both systems mentioned above will be "odor free" with proper periodic maintenance.

OTHER DESIGN CRITERIA

Certain general factors such as codes, safety requirements, control and protection systems, and special materials have entered into the design of the facilities. These factors are discussed below:

Equipment Codes - All equipment in the facility will be of types usually used in oil and gas processing facilities. The following are the codes which will be used in the design and fabrication of the major items of equipment:

ASME Boiler and Pressure Vessel Code

Standards of Tubular Exchanger Manufacturers Association (TEMA Standards)

Standards of the Hydraulic Institute (Pumps)

American Petroleum Institute (API) various standards for tanks.

Building Codes - Numerous other codes, standards, regulations, etc., will be used in the design and installation of this plant, including but not limited to those listed below:

1. Uniform Building Code, as published by the International Conference of Building Officials.

2. California Administrative Code, Title 24, State Building Standards, Parts 1A and 2, Basic Building Regulations.

3. Concrete and Foundations

   a. ACI Building Code - American Concrete Institute.

OTHER DESIGN CRITERIA

Building Codes - continued

b. CRSI Design Handbooks - Concrete Reinforcing Steel Institute.
c. ASTM Standards - American Society for Testing Materials.

4. Structural Steel

a. AISC Manual of Steel Construction - American Institute of Steel Construction.
b. AWS Standards - American Welding Society.
c. ASTM Standards - American Society for Testing Materials.

5. Piping

a. Standard Codes for Pressure Piping as published by ASME (American Society of Mechanical Engineers)

    1. ANSI B31.3 Petroleum Refinery Piping - American National Standards Institute.
    2. ANSI B31.4 Liquid Petroleum Transportation Piping Systems.
    3. ANSI B31.8 Gas Transmission and Distribution Piping Systems.

b. Miscellaneous API (American Piping Institute) designations on material and other requirements.
c. Miscellaneous ASTM Specifications or Standards.

6. Electrical

a. NEC - National Electrical Code
b. California Administrative Code, Title 24, State Building Standards, Part 3, Basic Electrical Regulations.
c. API, RP-500A - Area Classifications

7. Instrumentation

a. ISA Standards and Practices for Instrumentation - Instrument Society of America.
b. API Standards and Recommended Practices.
c. AGA Orifice Metering of Natural Gas.
d. "Flow Meter Engineering" by Spink.
e. ASME Boiler and Pressure Vessel Code for Relief Valves.

OTHER DESIGN CRITERIA

Building Codes - Continued

8. General

   a. "General Industry Safety Orders," issued by the Division of Industrial Safety, State of California.
   b. "Petroleum Safety Orders - Refining, Transportation, and Handling," issued by the Division of Industrial Safety, State of California.
   c. Occupational Safety and Health Standards for General Industry, as published by the Department of Labor, Occupational Safety and Health Administration.
   d. Safety and Health Regulations for Construction, as published by the Department of Labor, Bureau of Labor Standards.
   e. All applicable local codes - Santa Barbara County and State of California.

9. All design calculations and drawings on foundations, structures, buildings, etc., will be stamped by an engineer registered in the State of California.

Foundation Design - A complete soil investigation of the entire plantsite by a qualified soils engineering and materials testing firm will be required.

The results and recommendations from the soil investigation, along with earthquake design criteria, will then establish the criteria for the design of all foundations for buildings, structures, tanks, and all other equipment and material. It is felt at this time that either spread footings or some form of concrete piling (drilled and cast-in-place) will be suitable for most requirements.

Special Materials of Construction - In general, for a facility such as this, standard materials are suitable in most areas. In certain portions of the inlet and gas treating sections, where the sour gas is handled, controlled composition carbon steels may be required. Heat treating (stress relief) after fabrication will be required for corrosion protection of certain of the sour gas equipment and piping. Extensive use of special materials such as the stainless steels is not required in this type of facility.

OTHER DESIGN CRITERIA

Equipment Spares and Redundancy - Normal plant practice with respect to spare equipment will be followed. In general, rotating equipment such as pumps will be spared, if failure of the item would cause a plant shutdown. Equipment such as heat exchangers and pressure vessels will not be spared.

In the ultimate facility, certain units will be installed as multiple trains of equipment. Thus, a major upset or breakdown of a single train would result in the loss of only partial plant capacity.

Fire Protection System - A firewater system with tank, pump, hydrants, and monitor nozzles is provided. The system is interconnected with the firewater loop in the Crude Oil Facilities, so that the fire pump in either facility can provide protection to both facilities.

Central Control and Emergency Systems - A central control room will be provided to control the process. Operating variables such as pressures, temperatures, flow rates, and levels from the various units will be transmitted to the control room where they will be displayed and used as input to process controllers. The plant operator thus has a complete picture before him of the current status of the operation and can make whatever adjustments are necessary. Alarm points and automatic shutdown are also displayed in the control room.

Emergency plant shutdown, if required, can be initiated by the operator from the control room. In addition to total plant shutdown, certain units and individual pieces of equipment have their own safety shutdown systems. These would include flame failure shutdown systems on fired equipment, vibration shutdowns on fans for aerial coolers, and pump shutdowns on low level in suction vessels. The various shutdown systems are described more fully on drawing 00-1-27.

Noise and Vibration Factors - Proper silencing of equipment, air intakes, and vents will be provided to keep operating noise from the facility at an acceptable level.in accordance with the Occupational safety and Health Standards for General Industry. Because very little reciprocating equipment, of relatively small sizes, has been used in the plant design, there will be no measurable vibration of the earth at the plant boundary.

MATERIAL AND UTILITY BALANCES

B-41449
August 1971

HUMBLE OIL AND REFINING COMPANY
GAS PROCESSING FACILITY
SANTA BARBARA CHANNEL

PLANT MATERIAL BALANCE

		Initial Case	Ultimate Case
Plant Inlet Stream	MMSCF/D	28	90
Plant Outlet Streams			
Sales Gas	MMSCF/D	23.39	76.95
Sulfur	LT/D	8.36	11.80
Commercial Propane	BPD	-	2640
Iso-Butane Plus Mixture	BPD	960	2537
In-Plant Fuel Gas	MMSCF/D	0.97	2.42
Plant Conditions			
Basic Refrigeration Level	°F	0	0
Total Lean Oil Rate	GPM	-	150
Sales Gas Gross Heating Value	BTU/SCF	1251	1094

Stearns-Roger

B-41449
August 1971

HUMBLE OIL AND REFINING COMPANY
GAS PROCESSING FACILITY
SANTA BARBARA CHANNEL

UTILITY REQUIREMENTS
FUEL GAS BALANCE

	MSCF/D	
Normal Fuel Demand	Initial Case	Ultimate Case
Refrigeration Compressor	201	779
Lean Oil Fractionator Reboiler	-	534
Amine Still Reboiler	615	868
Regeneration Gas Heater	-	20
Air and Acid Gas Preheater	28	45
Converter Gas Reheater	22	27
SO_2 Generator	19	33
Incinerator	88	112
Total Normal Fuel	973	2418
Intermittent Fuel Demands		
Glycol Regenerator	-	64
Standby Steam Boiler	94	120
Emergency Generator	16	20
Fuel Gas Net Heating Value BTU/SCF	1550	1218

B-41449
August 1971

HUMBLE OIL AND REFINING COMPANY
GAS PROCESSING FACILITY
SANTA BARBARA CHANNEL

UTILITY REQUIREMENTS - STEAM

55# STEAM SUMMARY - INITIAL CASE

	#/hr.
Glycol Regenerator	482
Sulfur Plant Tracing	1,000
I.F.P. Unit	1,000
Sour Gas Heater E-2	1,436
Tank Heaters T-11, T-12	600
TOTAL	4,518
Sulfur Plant Steam Make	4,150
Standby Boiler	368
TOTAL	4,518

55# STEAM SUMMARY - ULTIMATE CASE

	#/hr.
Glycol Regenerator	1,630
Sulfur Plant Tracing	1,000
I.F.P. Unit	1,000
Sour Gas Heater E-2	--
Tank Heaters T-11, T-12	600
Excess Steam Condenser A-8	1,621
TOTAL	5,851
Sulfur Plant Steam Make	5,851

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B-41449
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HUMBLE OIL AND REFINING COMPANY
GAS PROCESSING FACILITY
SANTA BARBARA CHANNEL

UTILITY REQUIREMENTS

MAKE-UP WATER

Normal Requirements	1.5 GPM Initial
	1.7 GPM Ultimate

ELECTRIC POWER

	Initial	Ultimate
Normal Operating Load	1,022 KW	1,640 KW

(See following detailed sheets)

FORM No. 4.901

PLANT ELECTRICAL OPERATING LOAD

ESTIMATE OR JOB NO. B-41449

CUSTOMER HUMBLE OIL & REFINING CO.

PROJECT GAS PROCESSING STUDY SBC

INITIAL CASE

PAGE 1 OF 2

DATE AUG. 1971

BY JGN

ITEM NO.	SERVICE	NO. INSTALLED	NO. OPERATING	MOTOR HP	MOTOR RPM	MOTOR VOLTS	ONE MOTOR LOAD B.HP	ONE MOTOR % LOAD B.HP/HP	FROM TABLES KW	FROM TABLES KVAR	TOTAL KW	TOTAL KVAR	REMARKS
A-11	AMINE SOLUTION COOLER	6	6	25			21		18.0		108		
A-12	AMINE STILL CONDENSER	2	2	25			18.5		15.9		32		
A-44	BUTANES + PRODUCT COOLER	3	3	5			4		3.6		11		
A-61	PROPANE CONDENSER	2	2	30			28		23.9		48		
C-21	COMBUSTION AIR BLOWER	2	1	40			30		25.1		25		
C-22	INCINERATOR F.D. FAN	2	1	7½			5		4.8		5		
C-28	UTILITY AIR COMPRESSOR	1	0	25			21.5		18.0		18		
C-29	INSTRUMENT AIR COMPRESSOR	2	1	40			35		30.0		30		
C-32	RECOMPRESSOR	2	1	200			174		140.5		140		
P-1	DUMP LIQUID PUMP	1	0	25			16.3		14.9		1		
P-6	HC VENT TANK PUMP	1	0	2			1.3		1.4		—		
P-7	DRAIN TANK PUMP	1	0	1½			0.5		0.6		—		
P-8	FIRE WATER PUMP	1	0	200			185		149.2		1		
P-11	AMINE BOOSTER PUMP	2	1	300			240		188.4		188		
P-12	HP AMINE PUMP	2	1	500			407		316.3		316		
P-13	AMINE STILL REFLUX PUMP	2	1	3			0.75		0.8		1		
P-14	AMINE REBOILER PUMP	2	1	30			22		19.0		19		
P-15	AMINE TRANSFER PUMP	1	0	3			1.5		1.5		—		
P-16	AMINE SUMP PUMP	1	0	15			10		9.3		—		
P-21	SULFUR LOADING PUMP	2		25			14.3		13.4		—		$\frac{1 \times 13.4}{175} < 1$
	TOTALS												

PLANT KVA $=\sqrt{\text{TOTAL KW}^2 + \text{TOTAL KVAR}^2} =$

PLANT P.F. = TOTAL KW/TOTAL KVA =

FORM NO 4.301

PLANT ELECTRICAL OPERATING LOAD

ESTIMATE OR JOB NO. B-41449

CUSTOMER HUMBLE OIL & REFINING CO.

INITIAL CASE

DATE AUG. 1971

PROJECT GAS PROCESSING STUDY SBC

BY JGN

ITEM NO.	SERVICE	NO. INSTALLED	NO. OPERATING	MOTOR HP	MOTOR RPM	MOTOR VOLTS	ONE MOTOR LOAD B.HP	ONE MOTOR % LOAD B.HP/HP	FROM TABLES KW	FROM TABLES KVAR	TOTAL KW	TOTAL KVAR	REMARKS
P-22	SULFUR TRANSFER PUMP	1		7½			4		3.5		—		
P-23	IFP SOLVENT PUMP	1	1	1			1		1.0		1		
P-24	IFP CATALYST PUMP	1	1	1			1		1.0		1		
P-25	BOILER FEED PUMP	2	1	15			8		7.2		7		
P-26	RAW WATER MAKE-UP PUMP	2	1	2			0.5		0.6		1		
P-44	DEPROP. BTMS. CIRC. PUMP	2	1	25			23.2		20.1		20		
P-45	DEPROPANIZER REFLUX PUMP	2	1	2			1.7		1.7		2		
P-52	BUTANE + LOADING PUMP	2		50			44		37.1		2		$\frac{28 \times 37.1}{500}$
P-53	RERUN PUMP	1	0	20			16		14.2		1		
P-57	GLYCOL INHIBITOR PUMP	1	1	¼			.25		0.3		—		
P-58	GLYCOL INJECTION PUMP	2	1	10			9.4		8.4		8		
P-59	GLYCOL SUMP PUMP	1	0	1½			1.1		1.1		—		
P-60	TREATED WATER PUMP	2	1	2			0.5		0.6		1		
S-11	AMINE FILTER PUMP	1	0	5			4		3.0		—		
U-6	INSTRUMENT AIR DRYER								2.4		2		
	LIGHTING & MISC.										50		
	TOTALS										1022		

PLANT KVA = $\sqrt{\text{TOTAL KW}^2 + \text{TOTAL KVAR}^2}$ =

PLANT P.F. = TOTAL KW/TOTAL KVA =

MARCH '67

Form 4.

PLANT ELECTRICAL OPERATING LOAD

ESTIMATE OR JOB NO. B-41449 — PAGE 1 OF 2

CUSTOMER HUMBLE OIL & REFINING CO. — ULTIMATE CASE — DATE AUG. 1971

PROJECT GAS PROCESSING STUDY SBC — BY JGN

ITEM NO.	SERVICE	NO. IN-STALLED	NO. OPERA-TING	MOTOR HP	MOTOR RPM	MOTOR VOLTS	ONE MOTOR LOAD B.HP	ONE MOTOR % LOAD B.HP/HP	FROM TABLES KW	FROM TABLES KVAR	TOTAL KW	TOTAL KVAR	REMARKS
ADD FOR ULTIMATE													
A-8	EXCESS STEAM CONDENSER	3	3	5			4.0		3.6		11		
A-12	AMINE STILL CONDENSER	2	2	25			18.5		15.9		32		
A-31	LEAN OIL COOLER	1	1	15			14.0		12.4		12		
A-41	DEPROPANIZER CONDENSER	4	4	25			21.0		18.0		72		
A-42	L.O. FRACT. CONDENSER	2	2	15			14.0		12.4		25		
A-43	REGEN. GAS COOLER	3	3	5			4.0		3.6		11		
A-61	PROPANE CONDENSER	6	6	30			28		23.9		143		
C-21	COMBUSTION AIR BLOWER	1	1	40			30		25.1		25		
C-32	RECOMPRESSOR	1	1	200			96		78.0		78		
P-13	AMINE STILL REFLUX PUMP	1	1	3			0.75		0.8		1		
P-14	AMINE REBOILER PUMP	1	1	30			22		19.0		19		
P-31	H P LEAN OIL PUMP	2	1	75			65		54.8		55		
P-32	L P LEAN OIL PUMP	2	1	75			66		55.6		56		
P-33	ABSORBER PRESAT. PUMP	2	1	10			9.2		8.4		8		
P-34	DEETH. PRESAT. PUMP	2	1	5			3.5		3.3		3		
P-40	DEPROPANIZER REFLUX PUMP	2	1	20			16.3		14.2		14		
P-41	L.O. FRACT. REFLUX PUMP	2	1	20			16.0		14.2		14		
P-42	L.O. FRACT. BOTTOMS PUMP	2	1	75			66		55.6		56		
P-51	PROPANE LOADING PUMP	2		100			71		58.0		9		$\frac{77 \times 58}{500} = 9$
	TOTALS												

PLANT KVA = $\sqrt{\text{TOTAL KW}^2 + \text{TOTAL KVAR}^2}$ =

PLANT P.F. = TOTAL KW/TOTAL KVA =

Form No 4.501

PLANT ELECTRICAL OPERATING LOAD

ESTIMATE OR JOB NO. B-41449

CUSTOMER HUMBLE OIL & REFINING CO.

PROJECT GAS PROCESSING STUDY SBC

ULTIMATE CASE

PAGE 2 OF 2

DATE Aug., 1971

BY JGN

ITEM NO.	SERVICE	NO. IN-STALLED	NO. OPERA-TING	MOTOR HP	MOTOR RPM	MOTOR VOLTS	ONE MOTOR LOAD B.HP	ONE MOTOR % LOAD B.HP/HP	FROM TABLES KW	FROM TABLES KVAR	TOTAL KW	TOTAL KVAR	REMARKS
ADD FOR ULTIMATE													
P-54	L.O. INJECTION PUMP	1	0	3			2.3		2.2		2		
	LIGHTING & MISC										5		
	TOTAL ADD										651		
DELETE FOR ULTIMATE													
A-44	BUTANES + PRODUCT COOLER	3	3	5			4		3.6		11		
P-44	DEPROP. BTMS. CIRC. PUMP	2	1	25			23.2		20.1		20		
P-45	DEPROPANIZER REFLUX PUMP	2	1	2			1.7		1.7		2		
	TOTAL DEDUCT										33		
NET ADD FOR ULTIMATE											618		
	TOTALS												

PLANT KVA = $\sqrt{\text{TOTAL KW}^2 + \text{TOTAL KVAR}^2}$ =

PLANT P.F. = TOTAL KW/TOTAL KVA =

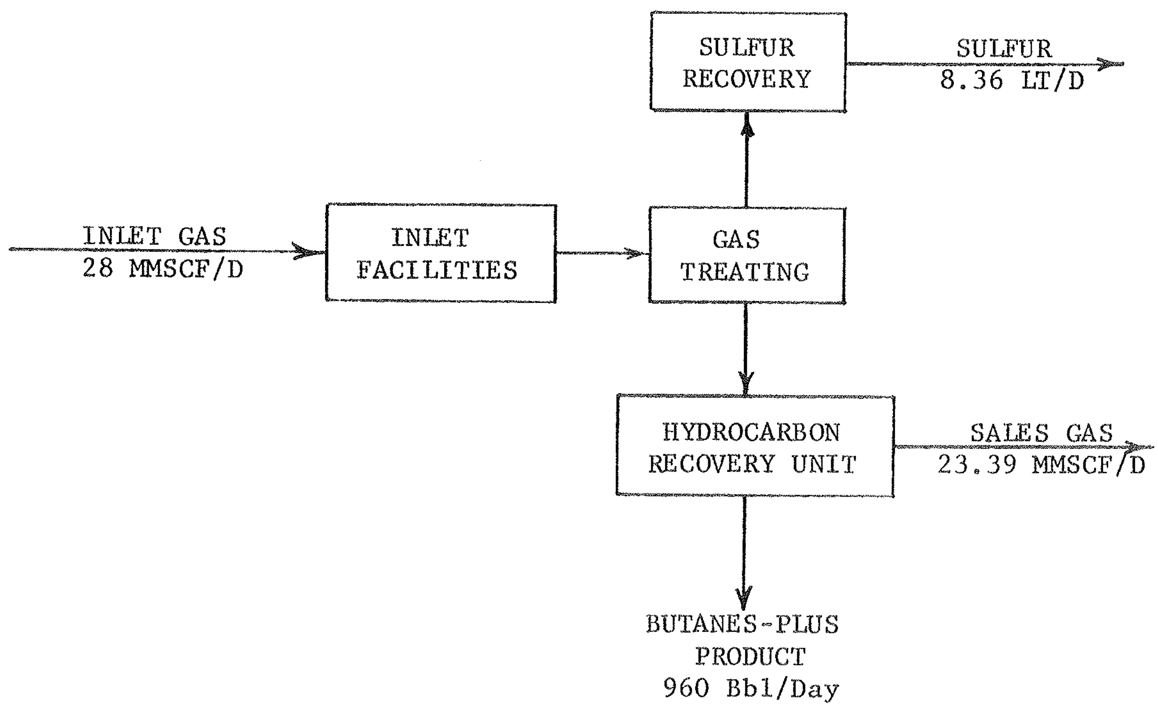
INITIAL PLANT DESCRIPTION

B-41449
August 1971

HUMBLE OIL AND REFINING COMPANY
GAS PROCESSING FACILITY
SANTA BARBARA CHANNEL

PLANT DESCRIPTION - INITIAL

The following sections describe the main items of equipment and their method of operation for the initial case. The block flow diagram below shows the interconnection of the principal process units and their product rates.



INLET FACILITIES

Plant inlet facilities are described below and shown on Drawings 00-1-01 & 00-1-10.

The initial gas flow of 28 MMSCF/D enters the unit at 60°F and 915 psia as a mixed phase stream. The liquid portion amounts to about 16 GPM and could enter the unit in slugs because of the large vertical rise in the offshore piping. Because of this, facilities have been included to admit these slugs into the unit at a controlled rate.

The sour gas and liquid are separated in the Inlet Separator (V-2). Liquids are removed from the drum on flow control (reset by level control) and flows to the inlet of the Sour Gas Heater (E-2) where it is vaporized and heated to 100°F with the sour gas from E-1.

The sour gas from V-2 flows through the Sour Gas Exchanger (E-1) where it is heated by exchange with treated gas from the amine unit.

From the Sour Gas Heater (E-2) the stream flows through the Sour Gas Final Separator where any unvaporized liquid is removed before the sour gas passes on to the amine unit.

The 100°F gas temperature was chosen since it is about 20°F above the dew point of the total stream. This represents a reasonable safety factor to prevent hydrocarbon condensation in the amine contactors.

V-2 has a capacity of approximately 8,750 gallons. This size was chosen in order to be able to contain either a 15 minute slug of inlet fluid or a slug equal to 700 feet of inlet pipe without filling the drum over 65% full.

In the event that a very large slug reaches the unit, an emergency liquid disposal system has been provided. This is actuated by a level switch which dumps the liquid through E-3 where it is heated to approximately 100°F. The dumped liquid then flows to the Low Pressure Condensate Separator (V-4). Vapor from V-4 combines with the Amine Vent Tank gas and together they are treated in the Low Pressure Amine Contactor. Liquid from V-4 is normally returned to the Inlet Separator(V-2) at a controlled rate by P-1 for disposal through the normal liquid flow control system. An emergency dump system is also provided on V-4 which dumps excess liquid to the closed drain.

GAS TREATING

For the initial case one 100% capacity treating train is provided using aqueous diethanolamine (DEA) as the treating solution. Normally this train will be operating at design with the initial inlet gas.

The gas treating processing scheme is described below and on Drawings 00-1-02, 00-1-11, 12, 13.

The sour gas from the inlet facilities enters the bottom of the HP Amine Contactor (V-11), which contains 22 valve trays where it is contacted by a 25 wt. % DEA stream. The H_2S and CO_2 in the sour gas are absorbed in the DEA and a sweet gas stream leaves the top of the contactor.

The sweetened gas stream flows through a Treated Gas Scrubber (V-12) where entrained DEA and water are removed. The sweet gas stream then flows to E-1 (Sour Gas Exchanger) where it is cooled by heat exchange with the inlet sour gas before flowing to the hydrocarbon recovery section.

Rich amine is removed from the bottom of the Contactor (V-11) on level control and flows to the Amine Vent Tank (V-13) which operates at 90 psia. Dissolved gases separate from the rich amine in the vent tank. Vent gas is fed to the low pressure Amine Contactor (V-15).

V-15 is a packed column in which the vent gases are counter-currently contacted with DEA to remove the acid gases. The sweetened vent gas leaves the top of the tower, on pressure control, and flows to the low pressure fuel system. Rich amine from the Low Pressure Contactor (V-14) flows back to the vent tank via a gravity return system with a liquid seal inside the vent tank. This contactor has not been spared since the gas volume is very low and could be flared for short periods without significantly raising the sulfur emissions from the plant.

The total rich amine stream from the vent tank flows (on level control) to the Amine Solution Exchanger (E-11) where it is heated to 213^{o}F by heat exchange with the hot lean amine from the still. The rich stream then flows to the Amine Still (V-16).

The Amine Still (V-16) contains 20 valve trays. Valve-type trays are recommended due to the large capacity variation that may

GAS TREATING - continued

occur on this unit in the future. The feed stream enters the still at the 18th tray where it is contacted with reflux from the 19th tray and by stripping steam generated by heat in-put at the bottom of the tower. The steam strips the acid gases from the solution, producing an amine stream essentially free of acid gases at the bottom of the tower.

The overhead vapor stream from the still will be at approximately 216°F and contains the stripped acid gases, steam and a small amount of hydrocarbons. These vapors flow to the Amine Still Condenser (A-12) where the stream is cooled to 110°F, condensing most of the steam. The effluent from A-12 flows to the Amine Still Reflux Accumulator (V-17) where the water and uncondensed acid gases are separated. The water is returned to the still as top reflux by the Reflux Pump (P-13). The acid gas stream from V-17 then flows to the sulfur plant.

Heat input to the Amine Still is by means of a forced circulation fired heater; the Amine Still Reboiler (H-11). This unit is specified with low heat flux and low temperature rise to minimize corrosion. The amine to the reboiler is pumped by the Reboiler Pump (P-14) to the reboiler on flow control.

The net lean amine flows, on level control, from V-16 to the Amine Solution Exchanger (E-11) where it is cooled from 250°F to 186°F. The lean amine stream then flows into a single Amine Surge Tank (T-11), a gas blanketed, cone-roof tank with a capacity of 370 bbl. A by-pass is provided so that this tank can be taken out of service.

From T-11, the total lean amine is pumped by the Amine Booster Pump (P-11) through the Amine Solution Cooler (A-11) where it is cooled to 110°F. A-11 is an air cooler sized for the ultimate of the design flow and specified so that it will be constructed in two separate sections.

From A-11, some of the cooled amine flows on flow control to the low pressure contactor, while the remainder goes to the H.P. Amine Pump (P-12). From P-12, the high pressure amine is fed on flow control to the H.P. Amine Contactor (V-11).

A single Amine Solution Filter (S-11) is provided on the discharge of P-11 upstream of the Amine Cooler (A-11). This filter is an automated precoat type sized to handle 10% of the total ultimate

GAS TREATING - continued

circulation rate. The filtering rate is relatively high in order to ensure low concentrations of contaminants in the circulating amine stream to minimize corrosion in the system.

SULFUR RECOVERY

The sulfur recovery system consists of a split flow, three converter, Claus unit and an IFP Tail Gas Cleanup Unit. The system is designed to convert 99% of the inlet H_2S to liquid sulfur.

One train of 100% initial capacity is provided for the Claus unit with a single tail gas unit sized for the ultimate plant. This is a highly efficient Claus unit, which will keep the sulfur recovery above 95.1% even if the tail gas unit is off-line.

The main reactions taking place in any Sulfur Recovery Unit are:

$$2H_2S + 3O_2 \longrightarrow 2H_2O + 2SO_2 \qquad (1)$$

$$2H_2S + SO_2 \longrightarrow 2H_2O + 3S \qquad (2)$$

$$2H_2S + O_2 \longrightarrow 2H_2O + 2S \qquad (3)$$

In the split flow process proposed here, reaction (1) takes place in the SO_2 Generator and reaction (2) in the convertors. The IFP Tail Gas Cleanup Unit continues reaction (2) in its approach to equilibrium. Reaction (3) above shows the overall results of the reactions in a sulfur recovery unit.

These systems are described in the following writeup and are shown in detail on Drawing 00-1-03, 00-1-14, 15, 16.

A. Claus Unit

Acid gas from the amine unit passes through an Inlet Scrubber (V-21) where any entrained water and DEA are removed. The acid gas from V-21 is then split by a ratio control system into two streams:

1. A "one-third stream" which goes to the SO_2 generator (H-21) and,
2. A "two-thirds stream" which by-passes the SO_2 generator.

The acid gas stream to H-21 is preheated to 450°F in the Feed Gas Heater (H-23), a small, dual service heater which is used to

SULFUR RECOVERY

A. Claus Unit - continued

preheat the acid gas and to preheat the combustion air to 750°F.

Combustion air is delivered to the system by the Combustion Air Blower (C-21). Air flow is controlled by a ratio control system which measures both the acid gas and the auxiliary fuel to the SO_2 generator and adjusts the flow to keep a stoichiometric volume of air going to the generator.

The preheated air and gas streams from H-23 flow to the SO_2 Generator (H-21) where they burn and form SO_2. H-21 is similar in design to a normal Claus unit reaction chamber. The main difference is the very large residence time (3.0 seconds) in the chamber. The large residence time is necessary to ensure complete conversion of the H_2S to SO_2 when processing feeds with low H_2S concentrations. In addition to this, the combustion chamber temperature has been set at 2000°F to ensure stable combustion. A small amount of auxiliary fuel gas is required to achieve the 2000°F level.

The exhaust gases from the generator are cooled from 2000°F to 790°F by generating 55 psig steam in the Waste Heat Boiler (B-21), a fire-tube type boiler. The cooled SO_2 stream then mixes with the acid gas stream which by-passes the SO_2 generator and flows to the Claus converter system. The mixture at this point will have the correct H_2S and SO_2 ratio (2:1) and temperature (460°F) to ensure high Claus unit conversion.

One added feature has been incorporated in the design to ensure conversion of the H_2S and SO_2 with minimum excess air. This is a provision which allows 45% (instead of 1/3) of the inlet acid gas to be diverted to the SO_2 Generator to let the excess H_2S act as an oxygen scavenger.

The combined gas stream then flows through a 3-converter Claus sulfur train. The three converters V-22, 23, and 24 are combined in one vessel with internal partitions. This reduces the plot area required and allows the use of a larger diameter vessel which improves access to the catalyst bed for dumping, loading, and leveling. The combined gases flow first to the No. 1 Converter (V-22). In V-22, approximately 85% of the inlet H_2S and SO_2 are converted to sulfur raising the effluent temperature to approximately 535°F.

SULFUR RECOVERY

A. Claus Unit - continued

The gases then flow to the No. 1 Condenser (E-21) where the sulfur and gases are condensed and cooled to 335°F by generating 55 psig steam. The liquid sulfur and uncondensed vapors are separated in the outlet channel of the exchanger. The liquid sulfur drains through a seal pot into the sulfur pit and the vapor passes through a demister to reduce sulfur entrainment.

The condensed gases from E-21 next flow through an externally fired reheater (H-22). This type of a reheater, rather than a reheat exchanger, was chosen to insure proper temperature control with the large variations in throughput that will be experienced on this unit. This heater is a dual service heater which combines both the first and second reheater in one shell. The gases leave the reheater at 410°F and flow to the No. 2 Converter (V-23). Approximately 69% of the H_2S and SO_2 in the feed to V-23 are converted to sulfur in this converter raising the effluent temperature to 420°F. The gases from V-23 then flow to the No. 2 Condenser (E-22) where the sulfur and gases are condensed, cooled to 335°F and separated from the uncondensed vapors (as noted for E-21).

The uncondensed gases from E-22 then flow back to the reheat furnace where they are reheated to 400°F. From the heater, they flow to the third Converter (V-24), where approximately 22% of the remaining H_2S and SO_2 are converted to sulfur. The gases leave the converter at 401°F and are condensed and cooled to 265°F in E-23. E-23 is similar in design to E-21 and E-22; but, because of the lower temperature, boiler feed water is used as the coolant rather than steam generation.

The uncondensed gases from E-23 flow through a high efficiency tail gas coalescer where entrained liquid sulfur is removed from the stream before entering the tail gas clean-up unit.

B. Tail Gas Cleanup Unit

The tail gas unit proposed is an IFP (Institute Francais Du Petrole) Claus sulfur plant tail gas cleanup unit. This is a proprietary unit of IFP's which uses a liquid organic solvent and a catalyst to dissolve the H_2S and SO_2 from the tail gas and to continue the

SULFUR RECOVERY

B. Tail Gas Cleanup Unit - continued

Reaction of H_2S and SO_2 to form sulfur. This reaction takes place in a packed tower. Liquid sulfur is drawn off the bottom and flows to the sulfur storage area. The solvent and catalyst are continuously recirculated from the interface zone (above the sulfur boot) to the top of the tower to increase the efficiency. Both a heater and cooler are provided on the recirculated solvent stream. The heating unit is basically for startup while the cooler is required during operation to remove a small amount of the heat of reaction and for temperature control to keep catalyst/solvent losses low.

Solvent and catalyst storage tanks for approximately 3-6 months inventory have been provided, together with the necessary makeup pumps.

From the top of the IFP contactor the gases flow to the Tail Gas Incinerator (H-24) where any remaining sulfur compounds are incinerated at 1000°F with 25 to 30% excess air, prior to venting through a 100 foot high stack. This incinerator and stack has been designed to keep the SO_2 concentration in the stack gases below 0.2 volume percent. In a separate study by Metronics Associates, Inc. (Technical Report No. 177), it is pointed out that even with the Sulfur Recovery Unit shut down, a stack such as this should give off property ground level SO_2 concentrations generally below the State standards.

C. Sulfur Recovery Steam System

This is shown on Drawing 00-1-17.

Boiler feed water (from the treating system on Drawing 00-1-07) is preheated in E-23 and flows into the 55 psig Steam Drum (V-26) and the Waste Heat Boiler (B-21) on level control. Boiler feed water from V-26 is fed to the two Sulfur Condensers (E-21 and E-22) via thermosyphon circuits. About 1380 #/hr. of 55 psig steam is generated in this circuit in the initial case. Steam generation in B-21 (the waste heat boiler) is approximately 2770

D. Special Design Considerations

1. Controls

Both the Claus unit and IFP unit are sensitive to the ratio of H_2S to SO_2. Ideally, this ratio should be 2.0, however,

SULFUR RECOVERY

D. Special Design Considerations

1. Controls - continued

ratios of 1.9 to 2.1 do not reduce overall recoveries noticeably. The ratio control system included in the design will minimize these variations.

2. Third Converter

The third converter in the design is basically a pollution control feature, added to ensure high overall recovery in the event of either poor operation of the first or second converters, or the need to shut down the tail gas cleanup unit.

HYDROCARBON RECOVERY FACILITIES

This system consists primarily of sweet gas chilling, depropanization of the resultant liquid, recompression, butanes-plus product cooling, and chiller separator vapor heating. The system is shown on drawings 00-1-04 and 00-1-18.

The inlet gas is the DEA-treated gas stream at 885 psia and 75°F. This sweet gas is cooled to 41°F by exchange with chiller separator vapor in the Main Gas Exchanger (E-31). In order to prevent the formation of hydrates in the exchanger, ethylene glycol is sprayed into the inlet channel. After the exchange, the mixture is chilled to 0°F by propane refrigeration in the Main Gas Chiller (E-32). Ethylene glycol is also sprayed into the inlet channel of the chiller. Following the chiller, the mixture flows into the Chiller Separator (V-31) where the glycol is collected in a bootleg and returned to the glycol system. The vapor from the separator at 0°F and 875 psia is heated to 65°F in the Gas Exchanger (E-31) and then flows into the sales gas line. The liquid from the separator is heated to 17°F in the Depropanizer Feed-Ovhd. Exchanger (E-43) and is then fed to the Depropanizer (V-47) at 234 psia.

Depropanizer overhead vapors are partially condensed in E-43 and collected in the Depropanizer Reflux Accumulator (V-48). The vapor from the accumulator at 36°F and 225 psia flows to the Recompressor Suction Scrubber (V-37). Part of the vapor from the suction scrubber is taken for fuel gas uses. The remaining vapor is compressed by the

HYDROCARBON RECOVERY FACILITIES - continued

Recompressor (C-32) and joins the chiller separator vapor going to sales. The liquid from the reflux accumulator is pumped back to the top of the column as reflux by the Depropanizer Reflux Pump (P-45).

The bottoms from the Depropanizer at 219^{o}F and 237 psia are split with part being pumped directly through the waste heat Depropanizer Reboiler (E-42), part being circulated to heating oil uses before returning to the reboiler, and part going to storage as butanes-plus product. Heat from the exhaust gas of the refrigeration compressor turbine-driver is utilized to heat the reboiler feed to 231^{o}F before returning it to the bottom of the column. The butanes-plus product is cooled to 105^{o}F at 227 psia in the butanes-plus Product Cooler (A-44) before being sent to storage.

GLYCOL INJECTION UNIT

The glycol injection unit is shown on drawing 00-1-19. The unit is designed for the ultimate plant; initially, 5.0 GPM of lean glycol is circulated to remove 90.7 lb/Hr of water from the process streams.

Lean glycol is pumped by the Glycol Injection Pump (P-58) to injection points on the Main Gas Exchanger (E-31) and the Main Gas Chiller (E-32). Rich glycol solution is separated from the gas and hydrocarbon liquids in the Chiller Separator (V-31) and flows through the Glycol Exchanger (E-6) and Glycol Trim Heater (E-7) and into the Glycol Flash Tank (V-51) where any disolved hydrocarbons are removed. From V-51, the rich solution flows to the Glycol Still (V-52) where the glycol is regenerated in a packed tower by boiling off the water. Heat is supplied to the tower by a steam heated Glycol Reboiler (E-8). The resulting regenerated, or lean, glycol flows from E-8, and is cooled in E-6 on its way to the Glycol Surge Tank (V-50).

REFRIGERATION

Cooling for the Main Gas Chiller (E-32) is provided by a propane refrigeration system shown on drawings 00-1-07 and 00-1-20. The gas is chilled in E-32 to 0^{o}F, using propane refrigerant at -10^{o}F. The propane is condensed in an aerial cooler at 105^{o}F. A single interstage economizer is used. The system requires an input of 590 BHP which is furnished by a gas turbine driven centrifugal compressor (C-61). Exhaust heat from this gas turbine is recovered in the Depropanizer Reboiler (E-42).

REFRIGERATION - continued

A total propane flow of 28,000 #/Hr. is discharged from the compressor and condensed in the Propane Condenser (A-61). The liquid propane then flows to the propane Receiver (V-62) at 202 psia and 105°F and is flashed into the Propane Economizer (V-63) at 79 psia and 41°F. 6,900 #/Hr. of flash vapor flows from the economizer, through the Propane Interstage Scrubber (V-64), and into the suction side of an intermediate compressor stage. The remainder of the propane is flashed from the economizer to 31 psia and -10°F prior to exchange in the chiller. The propane vapor from the chiller flows through the Propane Suction Scrubber (V-61) and back to the first stage suction of the compressor.

STORAGE AND SHIPPING

The storage, shipping, and rerun facilities are described below and are detailed on Drawings 00-1-06 and 00-1-22.

The butane-plus storage facilities consist of two 90,000 gallon 100 psig, horizontal storage tanks (T-52) which provide three days-plus product storage. Butane-plus product from T-52 is pumped by the loading pumps (P-52) at a rate of 500 GPM to truck loading facilities. Vapors from the truck loading are returned to the storage tanks in a vapor return line. A rerun pump (P-53) is available to pump liquids from T-52 back to the unit for reprocessing.

A one spot truck loading facility has been provided for loading liquid sulfur.

STEAM AND WATER

The steam generation equipment and feedwater treatment is shown on drawings 00-1-07 and 00-1-17.

Make-up water to the plant is pumped by the Raw Water Pump (P-26) through the make-up Water Treater (W-21) into the Treated Water Storage Tank (T-23). From here it is fed to the D.A. Heater (W-22) with a side stream available for displacement in the Amine Filter (S-11).

The base of the D.A. Heater is a surge space from where the Boiler Feed Pump (P-25) takes suction and delivers feed-water to the stand-by Steam Boiler (B-22) and the sulfur plant with a small stream available as make-up to the amine stills.

STEAM AND WATER - continued

During normal operation, the bulk of the steam demand will be supplied by the Sulfur Plant export steam with a small amount made-up by the stand-by boiler.

FLARES, VENTS, AND DRAINS

These facilities are shown on drawing 00-1-24.

The high pressure plant facilities relieve to a high pressure flare header and the remaining plant facilities, with the exception of those operating at or near atmospheric pressure, relieve to a low pressure flare header. The two flare headers terminate at the Flare Separator (V-8). Liquid removed in V-8 is discharged to the Hydrocarbon Vent Tank (V-7). The vapor from the separator flows to an integrated flare system.

The integrated flare system consists of a fan-assisted flare and an elevated flare. The elevated flare is sized to handle the ultimate plant inlet of 90 MMSCF/D. The fan-assisted flare is sized to handle 22 MMSCF/D, the largest quantity of gas which may reasonably be expected to be flared for any appreciable duration. In event a quantity of gas in excess of 22 MMSCF/D is flared, the excess gas will be diverted to the elevated flare. The gas may also be diverted to the elevated flare during times of maintenance of the fan-assisted flare. The flare system will burn smokelessly. A flame front generator is provided for remote ignition of the pilots on both flares.

Vapors at or near atmospheric pressure are collected in the vent vapor header and are discharged to the sulfur plant Tail Gas Incinerator (H-24). The Amine Still Reflux Accumulator excess pressure controller and safety valve also relieve to this system. This acid gas stream was taken to the incinerator rather than to the low pressure flare in order to obtain more complete combustion of hydrogen sulfide and to obtain better dispersion of the resulting combustion gas.

Equipment and instruments containing hydrocarbon are drained to the closed hydrocarbon drain which terminates at the Hydrocarbon Vent Tank (V-7), which is equipped with a pump to deliver waste liquids to the Crude Oil Facility (C-10140). Water from the L.P. Condensate Separator (V-14) is drained to the closed water drain which also terminates in V-7. Water is discharged separately to the vent tank to prevent freezing which would result from the auto-refrigeration effect

FLARES, VENTS, AND DRAINS - continued

of flashing hydrocarbon streams. Open drains are collected in the open drain system which is provided with seals at appropriate locations. The overhead from the glycol reconcentrator also discharges to the open drain system which also terminates at V-7. Boiler blowdown is drained from the boiler drum to V-7.

Equipment and instruments containing amine are drained to the amine drain which terminates at the Amine Sump (T-13). The Amine Sump is equipped with a pump which returns amine from the sump back to the gas treating system.

Equipment and instruments containing glycol are drained to the glycol drain which terminates at the Glycol Sump (V-53). This sump is equipped with a pump which returns glycol from the sump back to the glycol system.

Back Wash from the precoat amine filter is drained to the Amine Filter Drain Tank (V-79). The drain tank is equipped with a pump which transfers water to the Hydrocarbon Vent Tank. Solids which collect in the drain tank will have to be removed periodically.

All low pressure vent tanks and sumps discussed above are vented to the Tail Gas Incinerator.

FUEL GAS SYSTEM

The plant fuel gas system is shown on Drawing 00-1-23. A dual pressure system is used in order to make the best use of inplant fuel sources. For start-up and emergency makeup, fuel gas can be taken from the sales gas pipeline outside the plant valve.

High pressure fuel gas is taken at about 200 psig from the Recompressor Suction Scrubber (V-37), heated in the Fuel Gas Heater (E-44) to prevent condensation after pressure reduction and fed to the H.P. Fuel Gas Scrubber (V-77). Some high pressure fuel is used for the Gas Turbine Driver (C-61) and the rest is reduced in pressure to about 75 psig and sent to the L.P. Fuel Gas Scrubber (V-78).

Treated gases from the L.P. Amine Contactor (V-15) also feed the Scrubber (V-78). Fuel gas requirements for all remaining plant services are distributed from this point.

ELECTRIC POWER

Plant electric power requirements will be furnished by purchased power from local utilities. In order to protect the plant and provide means for an orderly shutdown in case of a power failure, a 220 KW gas turbine driven Emergency Generator (G-1) is provided. This generator will supply emergency power to one instrument air compressor, motorized plant block valves, and some emergency lights.

In order to provide continuous power to certain electronic instruments (analyzers and combustion controls) and to the emergency shutdown system, a battery-inverter system will be provided to override momentary power outages.

GENERAL PLANT UTILITIES

An instrument air system complete with air-cooled, nonlubricated compressor and spare, an air receiver, and an automatic air dryer will be furnished as shown on drawing 00-1-23.

A utility air system complete with air-cooled compressor and air receiver will be furnished as shown on drawing 00-1-23. Utility air will also serve as a backup to the instrument air system.

FIRE PROTECTION SYSTEM

A motor driven Fire Water Pump (P-8) will be furnished to supply water to a fire loop in the Gas Processing Facilities. A valved connection will connect this loop with the fire system in the Crude Oil Facilities (C-10140) where the fire pump is engine driven. Thus either system can spare the other. Suction to both pumps is from a common 20,000 Bbl water tank. The system is shown on Drawing 00-1-23.

In addition to a water system, numerous hand and wheeled dry chemical fire extinguishers should be located around the facility.

EMERGENCY SHUTDOWN SYSTEM

The functions of the emergency shutdown system are shown on drawing 00-1-25. Individual alarms and unit shutdowns are covered on this sheet as well as the effects of power failures and general plant emergency shutdowns.

From this drawing, we see for example that a high H_2S concentration in the treated gas will close the amine contactor outlet valve; closing

EMERGENCY SHUTDOWN SYSTEM

this valve for any reason will automatically close the plant inlet valve. High inlet gas pressure also closes the plant inlet valve.

As another example, a high rising level in the Propane Suction Scrubber (V-61) will first sound an alarm, and then, if the level still rises, will shutdown and stop the fuel gas to C-61 gas turbine, close the compressor (C-61) suction and interstage block valves, stop the flow of Depropanizer bottoms to E-41 Depropanizer Reboiler, and vent the gas turbine (C-61) exhaust to atmosphere.

Most all of the shutdown functions, which are activated by individual unit emergency events, will also be activated by a general plant manual shutdown switch. Such general shutdown stations will be located in the central control room and at one or more remote locations outside the operating area.

ULTIMATE PLANT DESCRIPTION

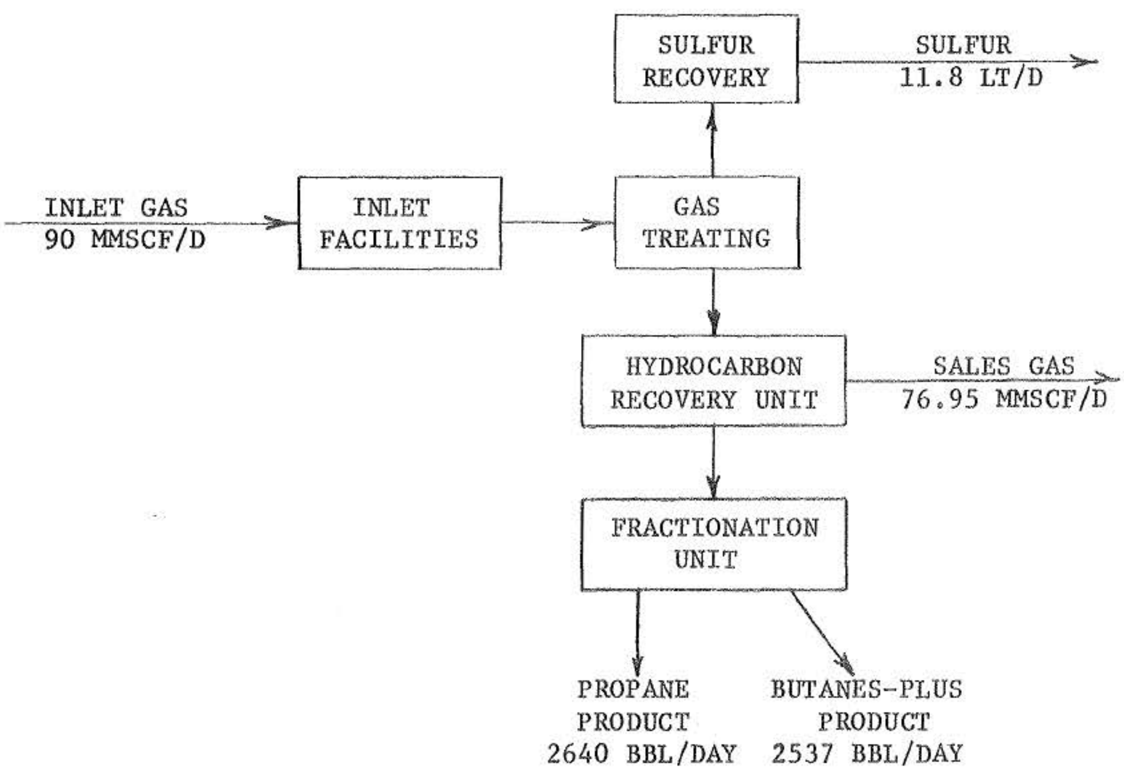
B-41449
August 1971

HUMBLE OIL AND REFINING COMPANY
GAS PROCESSING FACILITY
SANTA BARBARA CHANNEL

PLANT DESCRIPTION - ULTIMATE

INTRODUCTION

Changes to the initial plant to accommodate the increase in feed from 28 to 90 MMSCF/D are described below under the various main sections. As will be seen, the vast majority of the initially installed equipment is used in the ultimate processing scheme with the addition of parallel equipment or trains. The Hydrocarbon Recovery and Fractionation Facilities are considerably expanded along with their support systems such as Refrigeration. The block flow diagram below shows the interconnection of the various processing units.



PLANT DESCRIPTION - ULTIMATE

B-41449
August 1971

INLET FACILITIES

Additions to the inlet facilities are shown shaded on Drawing 00-1-01. The main equipment additions in the inlet area are two more parallel shells to the Sour Gas Exchanger (E-1) and a Standby Glycol Dehydrator (U-31).

All the inlet area vessels installed in the initial case are adequate for the ultimate 90 MMSCF/D case.

The ultimate gas is much drier than the initial and, therefore, the Sour Gas Heater (E-2) would not ordinarily be needed under ultimate design conditions. However, it is possible that some liquids may separate out in the Inlet Separator (V-2), and E-2 is retained in the ultimate scheme to dispose of these. To avoid excessive pressure drop in E-2 at the ultimate rate of 90 MMSCF/D, a by-pass would be installed such that approximately 2/3 of the dry gas did not pass through the exchanger.

In the ultimate case, sour gas would be fed to the amine unit at 90°F; this is 40° above the dew point.

GAS TREATING FACILTIES

Additions to the treating facilities are shown shaded on Drawing 00-1-02. With the increase in inlet gas rate from 28 to 90 MMSCF/D, a duplicate DEA treating train would be added. The size of equipment in the amine treating unit is primarily dictated by circulation rate. With the increase in DEA circulation rate from 422 GPM to the ultimate 593 GPM, each of the two ultimate amine trains would be operating at 70% of their design capacity.

The main equipment additions in the Gas Treating Facilities would, therefore, consist of a second H.P. Contactor (V-11), Vent Tank (V-13), along with a second Amine Still (V-16) with its Reboiler (H-11), Reboiler Pump (P-14), Reflux Condenser (A-12), and Reflux Pump (P-13), thus giving a common spare pump for these services.

The ultimate Hydrocarbon Processing scheme will include Propane Product Treating. To treat the mercaptan-containing regeneration gas, the Regeneration Gas Contactor (V-14) would be added. The sweet gas off the Regeneration Gas Contactor will be used in the fuel gas system and the rich amine will flow on level control to either or both Vent Tanks (V-13).

Other major equipment such as the H.P. Amine Pumps (P-12), Amine Booster Pumps (P-11), Amine Solution Cooler (A-11), along with the Amine Filter (S-11) and the Storage Tanks (T-11 and T-12) were originally sized for the ultimate conditions.

SULFUR RECOVERY

Ultimate sulfur recovery is shown on Drawing 00-1-03 Ultimate. The philosophy of the sulfur recovery expansion to handle the ultimate sour gas rate of 90 MMSCF/D is similar to that used on the amine gas treating unit.

A second three converter Claus sulfur train would be added with the result that at ultimate gas rates both would be operating at 70% of of design.

The I.F.P. Tail Gas Clean-up Unit as initially installed is sized for the ultimate case and would not need to be modified for the expansion to 90 MMSCF/D of inlet gas. Even with the I.F.P. unit off-line, the highly efficient three convertor Claus unit will keep the sulfur recovery above 95.1%.

HYDROCARBON RECOVERY FACILITIES

In order to handle the additional volume of gas in the ultimate case and to obtain both liquid propane and butane-plus products, the hydrocarbon recovery facility will be enlarged and a refrigerated absorption design will be incorporated into the initial scheme.

The process flow suggested is shown on Drawing 00-1-04 Ultimate.

The sweet inlet gas is chilled to 0°F and sent to the Chiller Separator (V-31) as in the initial case. From this point on, the flow and equipment differ from the initial scheme.

The vapor from the separator at 0°F and 875 psia flows into the bottom of the Absorber (V-32), a tower with 24 valve trays, where it is contacted countercurrently with presaturated absorption oil. As the gas flows up through the absorber, approximately 74% of the propane, essentially all of the butane and heavier, and approximately 6% of the lighter hydrocarbon in the feed gas to the absorber are absorbed in the lean oil. The gas from the top of the absorber, which is at 5°F is combined with 121 GPM of lean oil at 89°F, and the mixture is chilled to 0°F in the Absorber Presaturator Chiller (E-33). From the chiller, the mixture flows into the Absorber Presaturator Separator (V-33). The gas off the separator, after being heated to 65°F in the Gas Exchanger (E-31) flows into the sales gas line. The liquid from the separator is pumped back to the top of the absorber as lean oil.

Rich oil from the absorber is combined with liquid from the chiller separator to make a total feed of 385 GPM to the Rich Oil Flash Tank (V-34). The vapor from the flash tank is heated from 3°F to

HYDROCARBON RECOVERY FACILITIES - continued

70°F by exchange with absorber denuded lean oil in the R.O. Flash Tank Vapor Heater (E-39). The heated gas is combined with any deethanizer residue gas not used for fuel and the mixture is compressed and joins absorber residue gas going to sales. The liquid hydrocarbon at 500 psia and 3°F in the flash tank is reduced in pressure to approximately 435 psia and then heated to 17°F by exchange with the feed to the Deethanizer Presaturator Separator (V-36) in the Deethanizer Presaturator Exchanger (E-34). The liquid then flows through the Deethanizer Feed Heater (E-37) where it is heated to 20°F by exchange with the total lean oil stream and is then fed to the Deethanizer (V-35).

The Deethanizer is a combination of a reabsorber and reboiled stripper using presaturated lean oil and producing a deethanized bottom product with a minimum propane loss in the overhead vapors. Vapor off the top of the Deethanizer is combined with 29 GPM of lean oil and the mixture is cooled in E-34, the presaturator exchanger, from 73°F to 20°F as mentioned above. The cooled mixture flows to V-36, the presaturator separator. The liquid from the separator is pumped to the top of the Deethanizer as lean oil while the vapor is heated from 20°F to 45°F in the Deethanizer Residue Gas Heater (E-38) by exchange with the deethanizer lean oil stream. Part of the residue gas is taken for fuel gas uses. The remaining gas is combined with the gas from the Rich Oil Flash Tank and recompressed as mentioned above. Liquid from the bottom of the Deethanizer is cooled from 278°F to 190°F in the Deethanizer Side Heater (E-35) and then flows as feed to the Depropanizer in the Fractionation Unit.

Liquid to the Deethanizer Reboiler (E-36) is drawn off a chimney tray just below tray No. 1 at 222°F and heated to 278°F by exchange with circulating hot lean oil. The lean oil is cooled from 493°F to 242°F in the reboiler. From the circulating lean oil stream, 150 GPM is further cooled to 105°F in the L.O. Cooler (A-31) and proceeds through exchange mentioned above to the Deethanizer Presaturator Separator and the Absorber Presaturator Separator.

FRACTIONATION FACILITIES

Since in the ultimate case, it is desired to recover propane as a separate product, as well as the butane-plus product of the initial case, a fractionation system will be required. This fractionation system is shown on drawing 00-1-05 Ultimate.

The Deethanizer bottoms product from the Hydrocarbon Recovery Unit is fed to the Depropanizer (V-41) at 230 psia and 190°F. Overhead vapors are totally condensed in the Depropanizer Condenser (A-41)

FRACTIONATION FACILITIES - continued

The Deethanizer bottoms product from the Hydrocarbon Recovery Unit is fed to the Depropanizer (V-41 at 230 psia and 190°F. Overhead vapors are totally condensed in the Depropanizer Condenser (A-41) and collected in the Depropanizer Reflux Accumulator (V-42). The liquid from the Accumulator is split into 160 GPM of reflux and 77 GPM of propane product which is sent to the product treater. Bottom liquid is drawn off a chimney tray just below Tray No. 1 at 255°F and flows through the Depropanizer Reboiler (E-41) where it is heated to 350°F, partially vaporized, and returned to the Depropanizer. Circulating hot lean oil is used as the heating oil in the reboiler.

As mentioned above, propane product is directed to the product treaters. The Product Treaters (V-45 A&B) are two vessels operated consecutively (i.e., one is treating while the other is being regenerated) for the purpose of removing trace components containing sulfur (mercaptans, etc.). The liquid propane product flows through the molecular sieves contained in the treater and thence to storage. As the liquid passes through the sieve bed, the mercaptans, other sulfur compounds, and any water which might be present, are absorbed into the sieves resulting in a product essentially free of contaminants. Regeneration is accomplished by flowing fuel gas, heated to 600°F, in the Regeneration Gas Heater (H-42) through the sieve bed of the treater on regeneration cycle. The hot fuel gas drives the contaminants off the sieves. The regeneration gas then flows through the Regeneration Gas Cooler (A-43) and the Regeneration Gas Scrubber (V-46) and to the Regeneration Gas Contactor before rejoining the fuel gas system.

The bottoms from the Drpropanizer are fed to the Lean Oil Fractionator (V-43) where a split between the C-4+ hydrocarbons and circulating lean oil is made. The overhead vapor is totally condensed in the Lean Oil Fractionator Condenser (A-42) and collected in the Lean Oil Fractionator Reflux Accumulator (V-44). The liquid from the Accumulator is split into 148 GPM reflux and 74 GPM of C-4+ product which is sent to storage. The C-4+ product contains all the C-6 and lighter hydrocarbons, 98.8% of the C-7's (F-1 fraction) and 11.5% of the F-2 fraction present in the column feed. The bottoms from the L.O. Fractionator are split with some being pumped directly through the fired Lean Oil Fractionator Reboiler (H-41) and some being circulated to the Dump Liquid Headers, the Depropanizer Reboiler, and the Deethanizer Reboiler as heating oil before returning to the Lean Oil Fractionator Reboiler. 150 GPM of the circulating oil stream is removed as lean oil for the presaturators as already described. Heat from the exhaust gas of the refirgeration compressors turbine drivers is utilized along with supplementary fuel gas firing to heat the Lean Oil Fractionator Reboiler feed to 501°F before returnining it to the bottom of the column.

GLYCOL UNIT AND STAND-BY DEHYDRATION

The initially installed glycol injection unit was sized for the ultimate design conditions and thus will not require any changes to its equipment.

In the ultimate scheme, the lean glycol flow will be 10 GPM which is 100% higher than the initial case. Rich glycol will be returned to the reconcentrator from the Chiller Separator (V-31) with provision to collect any accumulation in Rich Oil Flash Tank (V-34).

In the event of a shutdown of the gas processing operation, standby gas dehydration is provided by Unit U-31. The treated gas from the DEA unit would be dehydrated by glycol in a Glycol Contactor. Rich glycol would be reconcentrated in the Glycol Regnerator and pumped back to the Contactor.

REFRIGERATION

The refrigeration load will be substantially increased in the ultimate case. The additional requirements for this system are shown on Drawing 00-1-07.

In the ultimate case, additional duty is required for the Main Gas Chiller (E-32), and an additional chiller, the Absorber Presaturator Chiller (E-33) must be supplied with refrigeration. The additional HP requirements necessitated by this increased load results in the need for two more gas turbine-driven centrifugal compressors. Additional bays must be added to the Propane Condenser aerial cooler to meet the increased condensing load.

PRODUCT STORAGE AND SHIPPING

In the ultimate case, propane product and additional butane-plus product must be accommodated. The added equipment for the ultimate case is shown on Drawing 00-1-06.

Two additional 90,000 gallon Butane-Plus Storage Tanks (T-52) will be required. Five 90,000 gallon Propane Storage Tanks (T-51) and two 500 GPM Propane Loading Pumps will be installed. These additions will provide three days product storage at the increased product rates.

STEAM AND WATER

The main deifference in the ultimate configuration is that the sulfur plant produces more export steam than the rest of the plant uses which will necessitate the addition of a small Excess Steam Condenser (A-8).

Water usage in the ultimate case will not change significantly from the intial.

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HUMBLE OIL AND REFINING COMPANY
GAS PROCESSING FACILITY
SANTA BARBARA CHANNEL

EQUIPMENT LIST

A-8 Excess Steam Condenser (Ultimate Case Only)
1 - 15' x 5' x 8200 sq. ft. cooler w/3-5 HP motors. 8,000#

A-11 Amine Solution Cooler (Initial & Ultimate)
1 - 30' x 30' x 149,000 sq. ft. cooler w/6-25 HP motors. 121,000#

A-12 Amine Still Condenser (Initial: 1, Ultimate: 2)
1 - 30' x 11' x 49,800 sq. ft. cooler w/2-25 HP motors. 40,000#

A-31 Lean Oil Cooler (Ultimate Case Only)
1 - 15' x 18' x 18,800 sq. ft. cooler w/1-15 HP motor. 15,000#

A-41 Depropanizer Condenser (Ultimate Case Only)
1 - 30' x 24' x 113,700 sq. ft. cooler w/4-25 HP motors. 167,000#

A-42 L.O. Fractionator Condenser (Ultimate Case Only)
1 -30' x 19' x 87,700 sq. ft. cooler w/2-40 HP motors. 72,000#

A-43 Regenerator Gas Cooler (Ultimate Case Only)
1 - 15' x 5' x 8200 sq. ft. cooler w/3-5 HP motors. 8,000#

A-44 Butanes - Plus Product Cooler (Initial Case Only)
1 - 15' x 5' x 8200 sq. ft. cooler w/3-5 HP motors. 8,000#

A-61 Propane Condenser (Initial: 1, Ultimate: 4)
30' x 16' x 75,800 sq. ft. cooler w/2-30 HP motors. 62,000#

B-21 Waste Heat Boiler (Initial: 1, Ultimate: 2)
2,770#/Hr. x 105 psig (design) waste heat boiler
Approx. size 12' (L) x 6' (W) x 6' (H). 8,000# each

B-22 Steam Boiler (Initial & Ultimate)
1 - 8,000#/Hr. x 105 psig (design) packaged boiler
Approx. Size 12' (L) x 6' (W) x 6' (H). 9,000# each

C-21 Combustion Air Blower (Initial: 2, Ultimate: 3)
Rotary air compressors w/40 HP motors. 2000# each

C-22 Incinerator Forced Draft Fan (Initial & Ultimate)
2 - 1400 scfm blowers w/7.5 HP motors

C-28 Utility Air Compressor (Initial & Ultimate)
1 - 6 x 5 air cooled air compressor w/25 HP motor. 2000#

C-29 Instrument Air Compressor (Initial & Ultimate)
2 - 8 x 8 non-lubricated air cooled air compressors w/40 HP motors.

C-32 Recompressor (Initial: 2, Ultimate: 3)
1 cylinder reciprocating compressors w/200 HP motors.

C-61 Propane Refrigant Compressor (Initial: 1, Ultimate: 3)
Centrifugal compressor driven by 1,100 HP solar gas turbine.

E-1 Sour Gas Exchanger (Initial: 1 shell, Ultimate: 3 shells)
26 x 240 type BEM w/1985 sq. ft. 21,000#

E-2 Sour Gas Heater (Initial & Ultimate)
1 - 10 x 120 type BEM w/106 sq. ft. 3,500#

E-3 Dump Liquid Heater (Initial & Ultimate)
1 - 25' double pipe exchanger w/288 sq. ft. 5,400#

E-6 Glycol Exchanger (Initial & Ultimate)
1 - 16' double pipe exchanger w/322 sq. ft.

E-7 Glycol Trim Heater (Initial & Ultimate)
1 - 8' double pipe exchanger w/35 sq. ft.

E-8 Glycol Reboiler (Initial & Ultimate)
1 - 17 x 27 - 192 AKU exchanger w/345 sq. ft.

E-11 Amine Solution Exchanger (Initial: 1 shell, Ultimate: 2 shells)
44 x 240 type AET w/5,080 sq. ft. 19,000#

E-21 Sulfur Condenser No. 1 (Initial: 1 shell, Ultimate: 2 shells)
32 x 144 type CEN. w/877 sq. ft. 10,000#

E-22 Sulfur Condenser No. 2 (Initial: 1 shell, Ultimate: 2 shells)
22 x 192 type CEN. w/407 sq. ft. 9,000#

E-23 Sulfur Condenser No. 3 (Initial: 1 shell, Ultimate: 2 shells)
30 x 144 type CEN. w/711 sq. ft. 10,000#

E-31 Main Gas Exchanger (Initial: 1 shell, Ultimate: 2 shells)
27 x 288 type BEM w/2960 sq. ft. 27,000#

E-32 Main Gas Chiller (Initial: 1 shell, Ultimate: 2 shells)
34 x 62 - 192 type LKN w/3170 sq. ft. 30,000#

E-33 Absorber Presaturator Chiller (Ultimate Case Only)
1 - 32 x 56 x 240 type BKM w/3220 sq. ft.

E-34 Deethanizer Presaturator Exchanger (Ultimate Case Only)
1 - 20 x 192 type BEM w/655 sq. ft.

E-35 Deethanizer Side Heater (Ultimate Case Only)
1 - 27 x 192 type BEM w/2040 sq. ft.

E-36 Deethanizer Reboiler (Ultimate Case Only)
1 - 29 x 192 type BEM w/exp. jt. w/2130 sq. ft.

E-37 Deethanizer Feed Heater (Ultimate Case Only)
1 - 10' nom. double pipe section w/200 sq. ft. finned surface.

E-38 Deethanizer Residue Gas Heater (Ultimate Case Only)
1 - 10' nom double pipe section w/718 sq. ft. finned surface.

E-39 R.O. Flash Tank Vapor Heater (Ultimate Case Only)
1 - 10' nom double pipe section w/623 sq. ft. finned surface.

E-41 Depropanizer Reboiler (Ultimate Case Only)
1 - 35 x 192 type BEM w/3600 sq. ft.

E-42 Depropanizer Reboiler (Initial Case Only)
1 - 13' L x 10' W x 10' H waste heat exchanger w/6500 sq. ft. total surface. 45,000#

E-43 Depropanizer Feed OVHD Exchanger (Initial Case Only)
1 - 18 x 168 type BEM w/400 sq. ft. 6,000#

E-44 Fuel Gas Heater (Initial & Ultimate)
1 - 10' nom. double pipe section w/104 sq. ft. finned surface.

G-1 Emergency Generator (Initial & Ultimate)
1 - 220 KW emergency generator driven by 325 HP gas turbine, 7500#

H-6 Integrated Flare System (Initial & Ultimate)
1 - integrated flare system consisting of an elevated flare, a fan assisted flare, and a flame front generator

H-11 Amine Still Reboiler (Initial: 1, Ultimate: 2)
24.5MM BTU/Hr. fired heater. Approx. size 14' diam. x 30' box & stack. 200,000#

H-21 SO_2 Generator (Initial: 1, Ultimate: 2)
Reaction furnace type SO_2 generator. Approx. size 8' I.D. x 20'. 9,000#

H-22 Converter Gas Reheater (Initial: 1, Ultimate: 2)
Vertical cylinder heater, 7' I.D. x 12' box & stack. 7,500#
(2 services in each heater)

H-23 Air & Gas Preheater (Initial: 1, Ultimate: 2)
Vertical cylinder heater, 7' I.D. x 12' box & stack. 7,500#
(2 services in each heater)

H-24 Tail Gas Incinerator & Stack (Initial & Ultimate)
1 - 100' high x 14" I.D. 22,000#

H-41 L.O. Fractionator Reboiler (Ultimate Case Only)
1 - Horiz. convection w/turbine exhaust make-up
18' x 24' x 30' high. 300,000#

H-42 Regeneration Gas Heater (Ultimate Case Only)
1 - Vertical cylindrical heater 8' I.D. x 18' & stack. 17,000#

P-1 Dump Liquid Pump (Initial & Ultimate)
1 - 15 GPM triplex P.D. pump w/25 HP motor. 2,500#

P-6 H. C. Vent Tank Pump (Initial & Ultimate)
1 - 20 GPM vertical turbine pump w/2 HP motor.

P-7 Drain Tank Pump (Initial & Ultimate)
1 - 20 GPM vertical turbine pump w/1½ HP motor.

P-8 Fire Water Pump (Initial & Ultimate)
1 - 6 x 10 centrifugal pump w/200 HP motor.

P-11 Amine Booster Pump (Initial & Ultimate)
2 - 4 x 6 x 14 cent. pumps w/300 HP motors. 3,800# each

P-12 H.P. Amine Pump (Initial & Ultimate)
2 - 3 x 4 x 5 stage cent. Pumps w/500 HP motors. 7,100# each

P-13 Amine Still Reflux Pump (Initial: 2, Ultimate: 3)
1 x 2 cent. pumps w/3 HP motors. 350# each

P-14 Amine Reboiler Pump (Initial: 2, Ultimate: 3)
4 x 6 double suction cent. pumps w/30 HP motors. 1,500# each

P-15 Amine Transfer Pump (Initial & Ultimate)
1 - 1 x 2 cent. pump w/3 HP motor. 350#

P-16 Amine Sump Pump (Initial & Ultimate)
1 - vertical centrifugal pump w/15 HP motor. 1,000#

P-21 Sulfur Loading Pump (Initial & Ultimate)
2 - 175 GPM steam jacketed pumps w/25 HP motors. 2,200# each

P-22 Sulfur Transfer Pump (Initial & Ultimate)
1 - 30 GPM steam jacketed pump w/7.5 HP motor. 900#

P-23 IFP Solvent Pump (Initial & Ultimate)
1 - metering pump w/1 HP motor. 225#

P-24 IFP Catalyst Pump (Initial & Ultimate)
1 - metering pump w/1 HP motor. 225#

P-25 Boiler Feedwater Pump (Initial & Ultimate)
2 - 1½ x 2 cent. pumps w/15 HP motors. 1,000# each

P-26 Raw Water Make-up Pump (Initial & Ultimate)
2 - 1 x 1 cent. pumps w/2 HP motors. 250# each

P-31 H.P. Lean Oil Pump (Ultimate Case Only)
2 - 2 x 3 horizontal 3-stage centrifugal w/75 HP motors.

P-32 L.P. Lean Oil Pump (Ultimate Case Only)
2 - 3 x 4 horizontal 3-stage centrifugal w/75 HP motors.

P-33 Absorber Presaturator Pump (Ultimate Case Only)
2 - 3 x 4 vertical in-line w/10 HP motors.

P-34 Deethanizer Presaturator Pump (Ultimate Case Only)
2 - 1½ x 3 vertical in-line w/5 HP motors.

P-41 Depropanizer Reflux Pump (Ultimate Case Only)
2 - 1½ x 3 vertical in-line centrifugals w/20 HP motors.

P-42 L.O. Fractionator Reflux Pump (Ultimate Case Only)
2 - 2½ x 3 horizontal centrifugals w/5 HP motors.

P-43 L.O. Fractionator Bottoms Pump (Ultimate Case Only)
2 - 5 x 9 horizontal centrifugals w/75 HP motors.

P-44 Depropanizer Bottoms Circulating Pump (Initial Case Only)
2 - 3 x 5 horizontal centrifugals w/25 HP motors.

P-45 Depropanizer Reflux Pump (Initial Case Only)
2 - 1½ x 2 vertical in-line centrifugals w/2 HP motors.

P-51 Propane Loading Pump (Ultimate Only)
2 - 500 GPM vertical turbine pumps w/100 HP motors. 4500# each

P-52 Butane - Plus Loading Pump (Initial & Ultimate)
2 - 500 GPM vertical turbine pumps w/50 HP motors. 3200# each

P-53 Rerun Pump (Initial & Ultimate)
1 - 50 GPM vertical turbine pump w/20 HP motor.

P-54 L.O. Injection Pump (Ultimate Only)
1 - 1½ x 2 horizontal centrifugal pump w/3 HP motor.

P-57 Glycol Inhibitor Pump (Initial & Ultimate)
1 - metering pump w/¼ HP motor.

P-58 Glycol Injection Pump (Initial & Ultimate)
2 - 10 GPM reciprocating pumps w/10 HP motors.

P-59 Glycol Sump Pump (Initial & Ultimate)
1 - 15 GPM vertical turbine pump w/1½ HP motor.

P-60 Treated Water Pump (Initial & Ultimate)
2 - 1 x 1 centrifugal pumps w/2 HP motors. 250# each

S-1 Glycol Filter (Initial & Ultimate)
1 - replaceable, 4 micron, cartridge filter, 75# MWP.

S-11 Amine Filter (Initial & Ultimate)
1 - precoat filter sized for 50 GPM. Approx. area req'd. 10' x 15'. 2,500#

T-11 Amine Solution Surge Tank (Initial & Ultimate)
1 - 138" x 20' high atmospheric storage tank. 11,000#

T-12 Amine Storage Tank (Initial & Ultimate)
1 - 120" x 12' high atmospheric storage tank. 10,000#

T-13 Amine Sump (Initial & Ultimate)
1 - 48" x 10' - 0" horizontal drum (buried). 2,500#

T-21 Catalyst Storage Tank (Initial & Ultimate)
1 - 120" x 12' - 0" atmospheric storage tank. 9,800#

T-22 Solvent Storage Tank (Initial & Ultimate)
1 - 120" x 12' - 0" atmospheric storage tank. 9,800#

T-23 Treated Water Storage Tank (Initial & Ultimate)
1 - 84" Dia. x 8' - 0" SS atmospheric storage tank. 2,600#

T-51 Propane Storage Tanks (Ultimate Only)
5 - 90,000 gallon (150" I.D. x 89' - 7") x 250 psig MWP horizontal vessel. 191,000# each

T-52 Butane - Plus Storage Tanks (Initial: 2, Ultimate: 4)
90,000 gallon (150" I.D. x 89' - 7") x 100 psig MWP horizontal vessel. 104,600# each

T-53 L.O. Storage Tank (Ultimate Only)
1 - 120" Dia. x 20' high atmospheric storage tank. 10,500#

U-6 Instrument Air Dryer (Initial & Ultimate)
1 - Kemp dual tower adsorptive dryer complete for fully automatic operation. 1500#

U-21 Tail Gas Cleanup Unit (Initial & Ultimate)
IFP tail gas cleanup unit. Approx. size - absorber 60" I.D. x 80'; plot area - 10' x 30'

U-31 Standby Glycol Dehydration Unit (Ultimate Case Only)
1 - packaged unit 8' x 18' plus 54" I.D. x 16' - 0" SS x 1000# MWP vertical vessel including internal cooling coil. 28,000#

V-2 Inlet Separator (Initial & Ultimate)
1 - 84" I.D. x 28' - 0" N.S. x 1,000# MWP horizontal vessel. 88,300#

V-3 Sour Gas Final Separator (Initial & Ultimate)
1 - 48" I.D. x 9' - 0" SS x 1005# MWP vertical vessel. 14,000#

V-4 Low Pressure Condensate Separator (Initial & Ultimate)
1 - 96" I.D. x 32' - 0" N.S. x 125# MWP horizontal vessel. 23,600#

V-7 H.C. Vent Tank (Initial & Ultimate)
1 - 96" O.D. x 16' - 0" x 10# MWP horizontal vessel. 9,800#

V-8 Flare Separator (Initial & Ultimate)
1 - 78" O.D. x 14' - 0" x 50# MWP vertical vessel. 7,050#

V-11 H.P. Amine Contactor (Initial: 1, Ultimate: 2)
54" I.D. x 53' - 0" x 1000# MWP towers w/21 trays. 73,400# each

V-12 Treated Gas Scrubber (Initial & Ultimate)
1 - 42" I.D. x 9' - 0" x 1000# MWP vertical vessel. 14,500# each

V-13 Amine Vent Tank (Initial: 1, Ultimate: 2)
54" I.D. x 14' - 0" x 125# MWP horizontal vessel. 5,600#

V-14 Regeneration Gas Contactor (Ultimate Only)
1 - 18" O.D. x 37' - 0" x 275# MWP tower w/30 ft. of packing.

V-15 L.P. Amine Contactor (Initial & Ultimate)
1 - 24" O.D. x 37' - 0" x 125# MWP tower w/30 ft. of packing. 8,900#

V-16 Amine Still (Initial: 1, Ultimate: 2)
66" I.D. x 46' - 0" x 50# MWP tower w/20 trays. 28,170#

V-17 Amine Still Reflux Accumulator (Initial: 1, Ultimate: 2)
42" I.D. x 8' - 0" x 50# MWP vertical vessel. 3,340#

V-21 Sulfur Unit Inlet Scrubber (Initial & Ultimate)
1 - 24" I.D. x 6' - 0" x 40# MWP vertical vessel. 3,000#

V-22, V-23, V-24
Sulfur Converters No. 1, 2, & 3 (Initial: 1, Ultimate: 2)
108" x 28' - 0" x 15# MWP horizontal vessels partitioned into 3 sections. 35,000# each.

V-25 Tail Gas Coalescer (Initial & Ultimate)
1 - 84" x 10' - 0" x 15# MWP horizontal vessel. 6,000#

V-26 55 PSIG Steam Drum (Initial: 1, Ultimate: 2)
24" x 8' - 0" x 105# MWP vertical drum. 2,000#

V-31 Chiller Separator (Initial & Ultimate)
1 - 102" I.D. x 25' - 6" x 950# MWP horizontal vessel. 74,600#

V-32 Absorber (Ultimate Case Only)
1 - 54" I.D. x 57' - 0" x 950# MWP vertical vessel w/24 trays.

V-33 Absorber Presaturator Separator (Ultimate Case Only)
1 - 60" I.D. x 15' - 0" x 935# MWP vertical vessel.

V-34 Rich Oil Flash Tank (Ultimate Case Only)
1 - 60" I.D. x 17' - 0" x 600# MWP horizontal vessel.

V-35 Deethanizer (Ultimate Case Only)
1 - 30" & 66" I.D. x 125' - 0" x 440# MWP vertical vessel w/40 trays.

V-36 Deethanizer Presaturator Separator (Ultimate Case Only)
1 - 48" I.D. x 12' - 0" x 450# MWP vertical Vessel.

V-37 Recompressor Suction Scrubber (Initial & Ultimate)
1 - 18" O.D. x 6' - 0" x 420# MWP vertical vessel. 1,700#

V-41 Depropanizer (Ultimate Case Only)
1 - 54" I.D. x 88' - 0" x 270# MWP vertical vessel w/40 trays.

V-42 Depropanizer Reflux Accumulator (Ultimate Case Only)
1 - 60" I.D. x 17' - 0" x 260# MWP horizontal vessel.

V-43 Lean Oil Fractionator (Ultimate Case Only)
1 - 54" & 78" I.D. x 98' - 0" x 100# MWP vertical vessel w/32 trays.

V-44 L.O. Fractionator Reflux Accumulator (Ultimate Case Only)
1 - 60" I.D. x 15' - 0" x 70# MWP horizontal vessel.

V-45 Product Treaters (Ultimate Case Only)
2 - 54" I.D. x 24' - 0" x 275# MWP vertical vessels w/18' - 0" bed of mol sieves.

V-46 Regeneration Gas Scrubber (Ultimate Case Only)
1 - 36" I.D. x 9' - 0" x 275# MWP vertical vessel.

V-47 Depropanizer (Initial Case Only)
1 - 30" I.D. x 113' - 0" x 270# MWP vertical vessel w/30 trays. 32,500#

V-48 Depropanizer Reflux Accumulator (Initial Case Only)
1 - 30" I.D. x 7' - 6" x 260# MWP horizontal vessel. 2,200#

V-50 Glycol Surge Tank (Initial & Ultimate)
1 - 60" O.D. x 16' - 0" x 10# MWP horizontal vessel.

V-51 Glycol Flash Tank (Initial & Ultimate)
1 - 36" O.D. x 14' - 0" x 65# MWP vertical vessel. 3,450#

V-52 Glycol Still (Initial & Ultimate)
1 - 18" O.D. x 21' - 0" x 35# MWP vertical vessel.

V-53 Glycol Sump (Initial & Ultimate)
1 - 36" O.D. x 6' - 0" x 15# MWP horizontal vessel.

V-61 Propane Suction Scrubber (Initial & Ultimate)
1 - 66" I.D. x 7' - 6" x 210# MWP vertical vessel. 7,000#

V-62 Propane Receiver (Initial & Ultimate)
1 - 48" I.D. x 12' - 0" x 255# MWP horizontal vessel. 6,000#

V-63 Propane Economizer (Initial & Ultimate)
1 - 36" I.D. x 8' - 0" x 210# MWP horizontal vessel. 2,600#

V-64 Propane Interstage Scrubber (Initial & Ultimate)
1 - 30" I.D. x 6' - 6" x 255# MWP vertical vessel. 2,500#

V-77 H.P Fuel Gas Scrubber (Initial & Ultimate)
1 - 18" O.D. x 6' - 0" x 250# MWP vertical vessel. 1,700#

V-78 L.P. Fuel Gas Scrubber (Initial & Ultimate)
1 - 18" O.D. x 6' - 0" x 125# MWP vertical vessel. 1,700#

V-79 Amine Filter Drain Tank (Initial & Ultimate)
1 - 96" O.D. x 16' - 0" x 10# MWP horizontal vessel. 9,800#

V-88 Instrument Air Receiver (Initial & Ultimate)
1 - 72" I.D. x 19' - 0" x 130# MWP vertical vessel. 10,900#

V-89 Utility Air Receiver (Initial & Ultimate)
1 - 60" I.D. x 19' - 0" x 155# MWP vertical vessel. 9800#

V-90 Boiler Blowdown Tank(Initial & Ultimate)
1 - 42" O.D. x 5' 0" x 75# MWP vertical vessel. 2400#

W-21 Makeup Water Treater (Initial & Ultimate)
1 - Dual tower zeolite treater. Overall size 10' x 10'. 300#

W-22 D.A. Heater (Initial & Ultimate)
1 - 3' - 0" x 12' - 0" horizontal vessel. 4000#

EQUIPMENT SPECIFICATIONS

Stearns-Roger

STUDY DATA SHEET

ITEM NO. A-11
ACC'T. PAGE
CUSTOMER HUMBLE OIL AND REFINING COMPANY
S-R JOB B-41449
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA
DATE August 1971
BY DJM

REV. | REV.

SERVICE AMINE SOLUTION COOLER
REVISION DATE: a 8/71 BY RTG ; b BY ; c BY
NO REQ'D 1(1) MANUFACTURER SOURCE: QUOTE OF
MODEL & TYPE

CONDITIONS OF SERVICE

CONDITIONS SHOWN FOR TOTAL REQUIRED SERVICE: TOTAL OPERATING UNITS REQUIRED AND SPARE UNITS

FLUID, INSIDE TUBES 25 WT % DEA & H_2O	TEMPERATURE, °F IN 186 OUT 110
LIQUID, #/HR IN 223,240 OUT 223,240	STEAM, #/HR IN OUT
SP. GR. @60° IN OUT	WATER, #/HR IN OUT
MWT IN OUT	VISCOSITY @ °F
VAPOR, #/HR IN OUT	OPERATING PRESURE, PSIG 280 IN (a)
MWT IN OUT	ALLOW. PRESS. DROP, PSI 10 REQ'D. MWP, PSIG 310 (a)

FLUID OUTSIDE TUBES ATMOSPHERIC AIR TEMPERATURE, °F 80 ELEVATION FT. SEA LEVEL
TOTAL DUTY, BTU/HR 15.5×10^6 (21.92×10^6) REQ'D. DESIGN WIND LOAD

PERFORMANCE (OF SINGLE UNIT UNLESS NOTED)	CONSTRUCTION DETAILS
DESIGN DUTY, BTU/HR 21,920,000	CELLS/UNIT SECTIONS/CELL
AIR TEMP. RISE, °F 45 PRESS DROP, PSI	FANS/UNIT FANS/CELL
AIR QUANT./UNIT, #/HR SCFM/FAN	UNIT SIZE, FT., IN. L 30' : W 30' : H
MTD, °F CORR. MTD, °F 37	DESIGN WIND LOAD
FOULING FACTOR 0.001	UNIT SHIPPING WT. ~ 121,000#
CLEAN TRANS RATE, BTU/HR/SQ FT/°F BARE FIN'D	FABRICATED STEEL STRUCTURE ASSEMBLED BY
SER. TRANS. RATE, BTU/HR/SQ. FT/°F BARE 92 FIN'D 4.0	SHOP FINISH

TUBE SECTIONS

SIZE	TUBES: TYPE FINNED
CONNECTED IN	SIZE 1" O.D. x 10 BWG x 30' LONG
BARE SURFACE/SECTION, SQ. FT. 6480	NO/SECT. ROWS/SECT.
FINNED SURFACE/SECTION, SQ. FT. 149,000	SPACING
F.S./UNIT, SQ FT TOTAL F.S., SQ. FT.	MATERIAL A-214
NO. OF PASSES/SECTION ONE	FINS: MATERIAL ALUMINUM
DESIGN PRESSURE 1000 PSIG @ 250 °F	HEIGHT 2 1/4" THICKNESS 0.016
CODE ASME	SPACING 11 PER INCH
INLET NOZZLES 6"	HEADERS: TYPE PLUG
OUTLET NOZZLES 6"	MATERIAL STEEL
	PLUGS STEEL

MECHANICAL EQUIPMENT

FANS: NO./UNIT 6	DRIVE: TYPE V-BELT
TYPE	MFG'R
DIAMETER 10 BLADES/FAN	MODEL
PITCH: SET AT MAX. MIN.	RATIO
BLADE MAT'L. MAX OP. °F	AGMA RATING
HUB MAT'L	NO. & TYPE BELTS
FAN RING	DIAM. SHEAVE: FAN DRIVER
RPM TIP FPM	SUPPORT
BHP FAN (AT SHAFT) 21	
TOTAL BHP UNIT 126	FAN GUARD ✓

AUXILIARIES: LADDER (W CAGE): WALKWAY: HAIL SCREENS: LOUVERS: ~~LOUVER OPERATOR (3-15# AIR): SIDE/END PANELS~~

REMARKS:
1. UNIT TO BE CONSTRUCTED IN TWO 15' SECTIONS WITH SEPARATE INLET HEADERS. (a)
2. DESIGN TO BE CONFIRMED BY VENDORS

DRIVER SUPPLIED BY MOUNTED BY
ELECTRIC MOTOR NO REQ'D 6 MFG'R GE OR EQ. HP 25 RPM 1800 FRAME NO
TYPE TEFC BEARINGS LUBRICATION VOLTS 460 PH. 3 CY. 60
TORQUE THRUST OTHER DRIVER TYPE REF PAGE

Stearns-Roger

STUDY DATA SHEET

ITEM NO. A-12
ACC'T. PAGE
S-R JOB B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA
DATE August 1971
BY DJM

REV. | REV.

SERVICE AMINE STILL CONDENSER

REVISION DATE: a 8/71 BY RTG ; b BY ; c BY

NO REQ'D 1 (2) MANUFACTURER — SOURCE: QUOTE OF

MODEL & TYPE 1 FOR INITIAL AND 1 FOR ULTIMATE

CONDITIONS OF SERVICE

CONDITIONS SHOWN FOR TOTAL REQUIRED SERVICE: TOTAL OPERATING UNITS REQUIRED AND SPARE UNITS

FLUID, INSIDE TUBES STEAM & SOUR GAS		TEMPERATURE, °F IN 216	OUT 110
LIQUID, #/HR IN	OUT 6,000	STEAM, #/HR IN	OUT
SP. GR. @60° IN	OUT	WATER, #/HR IN	OUT
MWT IN	OUT	VISCOSITY @ °F	
VAPOR, #/HR IN 16,978	OUT 10,972	OPERATING PRESURE, PSIG 12.3 IN	
MWT IN	OUT	ALLOW. PRESS. DROP, PSI 2	REQ'D. MWP, PSIG

FLUID OUTSIDE TUBES ATMOSPHERIC AIR TEMPERATURE, °F 80 — ELEVATION FT. SEA LEVEL

TOTAL DUTY, BTU/HR 9,550,000 (6,745,000) — REQ'D. DESIGN WIND LOAD

PERFORMANCE (OF SINGLE UNIT UNLESS NOTED)	CONSTRUCTION DETAILS
DESIGN DUTY, BTU/HR 9,550,000	CELLS/UNIT — SECTIONS/CELL
AIR TEMP. RISE, °F 27 — PRESS DROP, PSI	FANS/UNIT — FANS/CELL
AIR QUANT./UNIT, #/HR — SCFM/FAN	UNIT SIZE, FT, IN. L 30' : W 11' : H
MTD, °F — CORR. MTD, °F 46	DESIGN WIND LOAD
FOULING FACTOR 0.001	UNIT SHIPPING WT. ~ 40,000#
CLEAN TRANS RATE, BTU/HR/SQ FT/°F BARE — FIN'D	FABRICATED STEEL STRUCTURE ASSEMBLED BY
SER. TRANS. RATE, BTU/HR/SQ. FT/°BARE 92 — FIN'D 4.0	SHOP FINISH

TUBE SECTIONS

SIZE	TUBES: TYPE FINNED
CONNECTED IN	SIZE 1" O.D. x 12 BWG x 30' LONG
BARE SURFACE/SECTION, SQ. FT. 2165	NO/SECT. — ROWS/SECT.
FINNED SURFACE/SECTION, SQ. FT. 49800	SPACING
F.S./UNIT, SQ FT — TOTAL F.S. SQ. FT.	MATERIAL A-214
NO. OF PASSES/SECTION ONE	FINS: MATERIAL ALUMINUM
DESIGN PRESSURE 50 PSIG @ 300 °F	HEIGHT 2 1/4" — THICKNESS 0.016"
CODE ASME	SPACING 11 PER INCH
a INLET NOZZLES 6"	HEADERS: TYPE PLUG
a OUTLET NOZZLES 6"	MATERIAL STEEL + 1/8" C.A.
	PLUGS STEEL

MECHANICAL EQUIPMENT

FANS: NO./UNIT 2	DRIVE: TYPE V-BELT
TYPE	MFG'R
DIAMETER 8' — BLADES/FAN	MODEL
PITCH: SET AT — MAX. — MIN.	RATIO
BLADE MAT'L. — MAX OP. °F	AGMA RATING
HUB MAT'L	NO. & TYPE BELTS
FAN RING	DIAM. SHEAVE: FAN — DRIVER
RPM — TIP FPM	SUPPORT
BHP FAN (AT SHAFT) 18.5	
TOTAL BHP UNIT 37.0	FAN GUARD ✓

AUXILIARIES: LADDER (W CAGE): WALKWAY: HAIL SCREENS: LOUVERS: ~~LOUVER OPERATOR (3-15# AIR): SIDE/END PANELS~~

REMARKS: 1. DESIGN TO BE CONFIRMED BY VENDORS.
2. BOTH EXCHANGERS CAN BE MOUNTED IN COMMON STRUCTURE.
3. ULTIMATE TOTAL SERVICE FOR TWO, LB/HR :

	IN	OUT
L		8,499
V	24,084	15,585

DRIVER — SUPPLIED BY — MOUNTED BY

ELECTRIC MOTOR NO REQ'D 2 — MFG'R GE OR EQ. — HP 25 — RPM 1800 — FRAME NO

TYPE TEFC — BEARINGS — LUBRICATION — VOLTS 460 — PH. 3 — CY. 60

TORQUE THRUST — OTHER DRIVER TYPE — REF PAGE

Stearns-Roger

STUDY DATA SHEET

ITEM NO. A-44
ACC'T. PAGE 1
S-R JOB B-41449
DATE August 1971
BY RTG

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

REV.

SERVICE *BUTANES - PLUS PRODUCT COOLER*
REVISION DATE: a 8/71 BY RTG ; b BY ; c BY
NO REQ'D 1 MANUFACTURER SOURCE: QUOTE OF
MODEL & TYPE

CONDITIONS OF SERVICE

CONDITIONS SHOWN FOR TOTAL REQUIRED SERVICE: ONE TOTAL OPERATING UNITS REQUIRED AND 0 SPARE UNITS

FLUID, INSIDE TUBES
LIQUID, #/HR IN 8,421 OUT 8,421
SP. GR. @60° IN 0.596 OUT 0.596
MWT IN 62.03 OUT 62.03
VAPOR, #/HR IN OUT
MWT IN OUT

TEMPERATURE, °F IN 219 OUT 105
STEAM, #/HR IN OUT
WATER, #/HR IN OUT
VISCOSITY @ °F
OPERATING PRESURE, PSIG IN 222 a
ALLOW. PRESS. DROP, PSI REQ'D. MWP, PSIG

FLUID OUTSIDE TUBES ATMOSPHERIC AIR TEMPERATURE, °F 80 ELEVATION FT. SEA LEVEL a
TOTAL DUTY, BTU/HR 600,000 REQ'D. DESIGN WIND LOAD

PERFORMANCE (OF SINGLE UNIT UNLESS NOTED)

DESIGN DUTY, BTU/HR 600,000
AIR TEMP. RISE, °F 9 PRESS DROP, PSI
AIR QUANT./UNIT, #/HR SCFM/FAN
MTD, °F CORR. MTD, °F 64
FOULING FACTOR .001
CLEAN TRANS RATE, BTU/HR/SQ FT/°F BARE FIN'D
a SER. TRANS. RATE, BTU/HR/SQ.FT/°F BARE 26.5 FIN'D 1.15

CONSTRUCTION DETAILS

CELLS/UNIT one SECTIONS/CELL One
FANS/UNIT three FANS/CELL three
UNIT SIZE, FT, IN. L 15' : W 5' : H
DESIGN WIND LOAD a
UNIT SHIPPING WT. 8000# a
FABRICATED STEEL STRUCTURE ASSEMBLED BY
SHOP FINISH

TUBE SECTIONS

SIZE
CONNECTED IN
a BARE SURFACE/SECTION, SQ. FT. 356
a FINNED SURFACE/SECTION, SQ. FT. 8200
a F.S./UNIT, SQ FT TOTAL F.S., SQ. FT.
NO. OF PASSES/SECTION
DESIGN PRESSURE PSIG @ °F
CODE ASME Sec VIII
a INLET NOZZLES 2"
a OUTLET NOZZLES 2"

TUBES: TYPE
SIZE 1" O.D. x 12 BWG x 15' LONG
NO/SECT. ROWS/SECT.
SPACING
MATERIAL C. Steel
FINS: MATERIAL Aluminum
HEIGHT 5/8" THICKNESS
SPACING 11/inch
HEADERS: TYPE Steel-Box
MATERIAL
PLUGS

MECHANICAL EQUIPMENT

FANS: NO./UNIT three
TYPE induced
a DIAMETER 4' BLADES/FAN
PITCH: SET AT MAX. MIN.
BLADE MAT'L. MAX OP. °F
HUB MAT'L
FAN RING
RPM TIP FPM
BHP FAN (AT SHAFT) 4
TOTAL BHP UNIT 12

DRIVE: TYPE V-Belt
MFG'R
MODEL
RATIO
AGMA RATING
NO. & TYPE BELTS
DIAM. SHEAVE: FAN DRIVER
SUPPORT
FAN GUARD ✓

AUXILIARIES: LADDER (W CAGE): WALKWAY: HAIL SCREENS: LOUVERS: LOUVER OPERATOR (3-15# AIR): SIDE/END PANELS

REMARKS:
* Design is approximate

DRIVER SUPPLIED BY Vendor MOUNTED BY Contractor
ELECTRIC MOTOR NO REQ'D three MFG'R G.E. or Equiv. HP 5 RPM 1800 FRAME NO
TYPE TEFC BEARINGS LUBRICATION VOLTS 460 PH. 3 CY. 60
TORQUE THRUST OTHER DRIVER TYPE REF PAGE

Stearns-Roger

STUDY DATA SHEET

ITEM NO. A-61
ACC'T.
PAGE 1
S-R JOB B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

DATE August 1971
BY RTG

REV. | REV.

SERVICE *PROPANE CONDENSER*

REVISION DATE: a *8/71* BY *RTG* ; b BY ; c BY

NO REQ'D *One* MANUFACTURER SOURCE: QUOTE OF

MODEL & TYPE

CONDITIONS OF SERVICE

CONDITIONS SHOWN FOR TOTAL REQUIRED SERVICE: *ONE* TOTAL OPERATING UNITS REQUIRED AND *0* SPARE UNITS

FLUID, INSIDE TUBES *COMMERCIAL PROPANE*		TEMPERATURE, °F IN *161*	OUT *105*
LIQUID, #/HR IN	OUT *28,000*	STEAM, #/HR IN	OUT
SP. GR. @60° IN	OUT *0.51*	WATER, #/HR IN	OUT
MWT IN	OUT *44.1*	VISCOSITY @ °F	
VAPOR, #/HR IN *28,000*	OUT	OPERATING PRESURE, PSIG	IN *192*
MWT IN *44.1*	OUT	ALLOW. PRESS. DROP, PSI *3*	REQ'D. MWP, PSIG *300*
FLUID OUTSIDE TUBES ATMOSPHERIC AIR TEMPERATURE, °F *80*		ELEVATION FT. *sea level*	
TOTAL DUTY, BTU/HR *4,520,000*		REQ'D. DESIGN WIND LOAD	

PERFORMANCE (OF SINGLE UNIT UNLESS NOTED)	CONSTRUCTION DETAILS
DESIGN DUTY, BTU/HR *4,520,000*	CELLS/UNIT *one* SECTIONS/CELL *one*
AIR TEMP. RISE, °F *14* PRESS DROP, PSI	FANS/UNIT *two* FANS/CELL
AIR QUANT./UNIT, #/HR SCFM/FAN	UNIT SIZE, FT, IN. L *30'* : W *16'* : H
(a) MTD, °F CORR. MTD, °F *42.6 O.A.*	DESIGN WIND LOAD
FOULING FACTOR *.001*	UNIT SHIPPING WT. *62,000 #* (a)
CLEAN TRANS RATE, BTU/HR/SQ FT/°F BARE FIN'D	FABRICATED STEEL STRUCTURE ASSEMBLED BY
(a) SER. TRANS. RATE, BTU/HR/SQ. FT/°F BARE *32.2* FIN'D *1.4*	SHOP FINISH

TUBE SECTIONS

SIZE	TUBES: TYPE
CONNECTED IN	SIZE *1"* O.D. x *12* BWG x *30'* LONG
(a) BARE SURFACE/SECTION, SQ. FT. *3,300*	NO/SECT. ROWS/SECT.
(a) FINNED SURFACE/SECTION, SQ. FT. *75,800*	SPACING
(a) F.S./UNIT, SQ FT TOTAL F.S. SQ. FT.	MATERIAL *C. steel*
NO. OF PASSES/SECTION	FINS: MATERIAL *Aluminum*
(a) DESIGN PRESSURE *300* PSIG @ *150* °F	HEIGHT *5/8"* THICKNESS
CODE *ASME SEC. VIII*	SPACING *11/inch*
INLET NOZZLES	HEADERS: TYPE *steel-box*
OUTLET NOZZLES	MATERIAL
	PLUGS

MECHANICAL EQUIPMENT

FANS: NO./UNIT *two*	DRIVE: TYPE *V-belt*
TYPE *induced*	MFG'R
(a) DIAMETER *12'* BLADES/FAN	MODEL
PITCH: SET AT MAX. MIN.	RATIO
BLADE MAT'L. *Al.* MAX OP. °F	AGMA RATING
HUB MAT'L	NO. & TYPE BELTS
FAN RING	DIAM. SHEAVE: FAN DRIVER
RPM TIP FPM	SUPPORT
BHP/FAN (AT SHAFT) *28*	
TOTAL BHP UNIT *56*	FAN GUARD ✓

AUXILIARIES: LADDER (W. CAGE): WALKWAY: HAIL SCREENS: LOUVERS: LOUVER OPERATOR (3-15# AIR): SIDE/END PANELS

REMARKS:

** Design is approximate*

DRIVER

SUPPLIED BY *vendor* MOUNTED BY *Field*

ELECTRIC MOTOR NO REQ'D *2* MFG'R *G.E. or Equiv.* HP *30* RPM *1800* FRAME NO

TYPE *TEFC* BEARINGS LUBRICATION VOLTS *460* PH. *3* CY. *60*

TORQUE THRUST OTHER DRIVER TYPE REF PAGE

Stearns-Roger

BOILERS
STUDY DATA SHEET

ITEM No. B-21
ACC'T. ____ PAGE ____
S.R JOB B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

DATE August, 1971 BY DJM

SERVICE Waste Heat Boiler NO. REQ'D. 1 (2)

REVISIONS: a 8/71 BY RTG : b ____ BY ____ : c ____ BY ____ : d ____ BY ____

MANUFACTURER ____ SOURCE: QUOTE OF ____

1 (2) - Waste heat boiler (fire tube type) to cool the exhaust gases noted below from 2000°F to 790°F by generating 55 psig steam. The boiler is to be complete with all necessary controls and equipment for unattended operation.

General design conditions are:

			Initial	Ultimate	
A.	Gas Rate	SO_2	197	139	mols/day
		CO_2	1881	1329	mols/day
		N_2	1733	1167	mols/day
		H_2O	540	364	mols/day
		O_2	1	1	mols/day

B. Gas Temperature - 2000°F inlet
790°F outlet

C. Steam Rate 2,770 (1950)#/hr. @ 55 psig each.

D. Design Blowdown - 2% each.

E. Design Pressure - 105 psig each.

F. Water Inlet Temperature - 302°F each.

Stearns-Roger

BOILERS
STUDY DATA SHEET

ITEM No. B-22
ACC'T. ____ PAGE ____
S.R JOB B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

DATE August, 1971 BY JW/DJ

SERVICE Standby Steam Boiler NO. REQ'D. 1 (1)

REVISIONS: a 8/71 BY RTG :b ____ BY ____ :c ____ BY ____ :d ____ BY ____

MANUFACTURER ____ SOURCE: QUOTE OF ____

One (1) - packaged steam boiler - (fire tube type) to produce 8000#/hr. of 55 psig steam. The boiler is to be complete with all equipment and controls required for unattended operation.

General design conditions are:

A. Steam Rate - 8000#/hr. @ 55 psig.

B. Design Pressure - 105 psig

C. Water Inlet Temperature - 215°F

D. Blowdown Rate - 2%

a E. Fuel - 1,550 BTU/SCF (LHV) gas

FORM 1.44
12-69
REV.

REV

Stearns-Roger

FAN OR BLOWER
STUDY DATA SHEET

ITEM NO. C-21
ACC'T. PAGE
S.R JOB B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA
DATE August 1971 BY JEW/DJ

SERVICE COMBUSTION AIR BLOWER NO. REQ'D. 2 (3)
REVISIONS: a 8/71 BY RTG : b BY : c BY : d BY
MANUFACTURER SOURCE: QUOTE OF
MODEL & TYPE

OPERATING CONDITIONS

FLUID HANDLED	AIR				
COMPOSITION			GRAVITY		
TEMPERATURE, SUCTION	40 - 80	°F	DISCHARGE		°F
PRESSURE, SUCTION	14.7 PSIA	"H_2O	DISCHARGE	24.5 PSIA	"H_2O a
STATIC PRESSURE		"H_2O			
CAPACITY, NORMAL, @ 60°F & 14.7 PSIA		597			SCFM
CAPACITY, DESIGN, @ 60°F & 14.7 PSIA		660			SCFM
CAPACITY, DESIGN, @ SUCTION CONDITIONS					ACFM
HORSEPOWER, BHP @ DESIGN CONDITIONS	ESTIMATED @ 30		MOTOR HP	40	
MOTOR TEFC ENCLOSURE	460 VOLTS	3 PHASE	60 CYCLE		

SPECIFICATIONS

MFR. SIZE & TYPE FAN
SINGLE WIDTH, SINGLE INLET — DOUBLE WIDTH, DOUBLE INLET
ARRANGEMENT — CLASS — FAN RPM — DRIVER RPM
DRIVE, DIRECT — GEAR — V-BELT — GUARD
COUPLING — COUPLING GUARD
SUCTION SIZE — DISCH. SIZE
OUTLET VELOCITY, MAX. FT/MIN. — DESIGN FT/MIN.
DRIVER FURNISHED BY — MOUNTED BY
PACKING — MECH. SEAL
BEARING COOLING WATER REQUIRED — GPM, TEMP. °F
DAMPERS, INLET — OUTLET

MATERIALS

CASING	STEEL OR CI	LINER	MFG. STD.
IMPELLER	MFG. STD.	SHAFT	STEEL
PACKING OR SEALS			

GENERAL INFORMATION

NET WT. FAN & BASE — INSPECTION
NET WT. FAN ONLY — MOTOR — TURBINE — TESTS
PERFORMANCE CURVE NO.
DIMENSIONAL PRINT NO.
ADDITIONAL SPECS. NAFM BULL. #110
REMARKS:
SINGLE STAGE CENTRIFUGAL, OR ROTARY OR LOBE TYPE ARE ACCEPTABLE

FORM 1.44
12-69
REV.

Stearns-Roger

FAN OR BLOWER STUDY DATA SHEET

ITEM NO. C-22
ACC'T. PAGE
S.R JOB B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

DATE August 1971 BY JEW/DI

SERVICE INCINERATOR FORCED DRAFT FAN NO. REQ'D. 2(2)
REVISIONS: a BY :b BY :c BY :d BY
MANUFACTURER SOURCE: QUOTE OF
MODEL & TYPE

OPERATING CONDITIONS

FLUID HANDLED AIR
COMPOSITION GRAVITY
TEMPERATURE, SUCTION 40 - 80 °F DISCHARGE °F
PRESSURE, SUCTION 14.5 PSIA "H_2O DISCHARGE "H2O
STATIC PRESSURE ~ 9 PSIA "H_2O
CAPACITY, NORMAL @ 60°F & 14.7 PSIA SCFM
CAPACITY, DESIGN @ 60°F & 14.7 PSIA 1400 SCFM
CAPACITY, DESIGN @ SUCTION CONDITIONS ACFM
HORSEPOWER, BHP @ DESIGN CONDITIONS 2-3 MOTOR HP 7.5
MOTOR TEFC ENCLOSURE 460 VOLTS 3 PHASE 60 CYCLE

SPECIFICATIONS

MFR. SIZE & TYPE FAN
SINGLE WIDTH, SINGLE INLET DOUBLE WIDTH, DOUBLE INLET
ARRANGEMENT CLASS FAN RPM DRIVER RPM
DRIVE, DIRECT GEAR V-BELT GUARD
COUPLING COUPLING GUARD
SUCTION SIZE DISCH. SIZE
OUTLET VELOCITY, MAX. FT/MIN. DESIGN FT/MIN.
DRIVER FURNISHED BY MOUNTED BY
PACKING MECH. SEAL
BEARING COOLING WATER REQUIRED GPM, TEMP. °F
DAMPERS, INLET OUTLET

MATERIALS

CASING MFG. STD. LINER MFG. STD
IMPELLER MFG. STD. SHAFT STEEL
PACKING OR SEALS PACKING

GENERAL INFORMATION

NET WT. FAN & BASE INSPECTION
NET WT. FAN ONLY MOTOR TURBINE TESTS
PERFORMANCE CURVE No.
DIMENSIONAL PRINT No.
ADDITIONAL SPECS. NAFM BULL. #110
REMARKS:
SIZED ON ULTIMATE CASE

REV. | | REV.

Stearns-Roger

AIR COMPRESSOR
STUDY DATA SHEET

ITEM NO. C-28
ACC'T. ______ PAGE ______
S.R JOB B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

DATE August, 1971 BY DJM

SERVICE Utility Air Compressor NO. REQ'D. 1 (1)

REVISIONS: a ______ BY ______ : b ______ BY ______ : c ______ BY ______ : d ______ BY ______

MANUFACTURER ______ SOURCE: QUOTE OF ______

1 (1) - 6x5 synthetic lubricated double acting air compressor driven by multiple V-Belts by 25 hp. 1800 rpm, 440V 3 phase, 60 cycle open drip proof induction motor.

Unit complete with air cooled aftercooler and all flywheel and shaft guards.

Approximate Weight:	2,000 lbs.
Suction Pressure:	0 PSIG
Discharge Pressure:	125 PSIG
Suction Temperature:	35°F to 95°F
Compressor RPM:	450

REV.

Stearns-Roger

AIR COMPRESSOR
STUDY DATA SHEET

ITEM No. C-29
ACC'T. ______ PAGE ______
S.R JOB B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

DATE August, 1971 BY DJM

SERVICE Instrument Air Compressor NO. REQ'D. 2 (2)
REVISIONS: a ______ BY ______ : b ______ BY ______ : c ______ BY ______ : d ______ BY ______
MANUFACTURER ______ SOURCE: QUOTE OF ______

Two (2) - 8x8 non-lubricated double acting air compressors driven by multiple V-belts by 40 hp., 1800 rpm, 440 V, 3 phase, 60 Cycle open drip proof induction motor.

Unit complete with air cooled aftercooler and all flywheel and shaft guards.

Approximate Weight:	3,000 lbs.
Suction Pressure:	0 PSIG
Discharge Pressure:	100 PSIG
Suction Temperature:	35°F to 95°F
Compressor rpm.:	450

REV.

Stearns-Roger

COMPRESSORS
STUDY DATA SHEET

ITEM NO. C-32
ACC'T. ______ PAGE ______
S.R JOB B-40300

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA
DATE August 1971 BY RTG

SERVICE Recompressor NO. REQ'D. 2
REVISIONS: a ______ BY ______ : b ______ BY ______ : c ______ BY ______ : d ______ BY ______
MANUFACTURER ______ SOURCE: QUOTE OF ______

Capacity: Normal: 2,768 MMSCFD (14.7 psia, 60°F)
Rated: 3,183 MMSCFD (115% normal)

Compressor Horse Power (Includes Parasite): 174 h.p. normal
200 h.p. rated

Gas: M.W. = 28.48 CP/CV = 1.191 S.G. = .983
Z_S = 0.855 Z_D = 0.682 Hydrocarbon Gas (Sweet)

Operating Conditions:

	Temp.	Pressure
Suction	36°F	218 psia
Discharge	162°F	890 psia
Compression Ratio		4.08

Compressor Type: 1 cylinder reciprocating,
Capacity Control by engine speed control and purchaser's by-pass
Each cylinder equipped with suction valve lifters

Driver: Electric Motor 200 Hp Explosion proof 4160 Volts, 3 phase, 60 Hz.

Location: Sea Level Ambient: 80°F
Equipment suitable for outdoors/under-roof

FORM 1.42

CENTRIFUGAL COMPRESSORS

STUDY DATA SHEET

Stearns-Roger

ITEM NO. C-61
ACC'T. ______ PAGE 1 OF 2
CUSTOMER HUMBLE OIL AND REFINING COMPANY
S.R JOB B-41449
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA
DATE August 1971 BY RTG

a SERVICE PROPANE REFRIGERANT COMPRESSOR — NO. REQ'D. ONE

REVISIONS: a 8/71 BY RTG : b ______ BY ______ : c ______ BY ______ : d ______ BY ______

MANUFACTURER ______ SOURCE: QUOTE OF ______

MODEL & TYPE ______

	PROCESS REQUIREMENTS	
GAS HANDLED	COMMERCIAL PROPANE	
BAROMETER, PSIA	14.7	
STREAM	L.P. FEED	SIDE STREAM
WEIGHT FLOW, LB. PER MIN.	350	115
INLET CONDITIONS		
PRESSURE, PSIA	30	78
TEMPERATURE, DEG. F.	-8	70
MOLECULAR WEIGHT (M)	44.1	44.1
CP/CV (K_1)	1.14	1.12
COMPRESSIBILITY (Z) AVG.	0.94	0.88
INLET VOLUME, CFM (INLET COND.)		
DISCHARGE CONDITIONS		
PRESSURE, PSIA	79	207
TEMPERATURE, DEG. F.	79	161
CP/CV (K_2)	1.12	1.10
COMPRESSIBILITY (Z)	0.88	0.77
HORSEPOWER REQD. BY DRIVER	590	
SPEED, RPM		
ESTIMATED SURGE, ICFM (AT SPEED ABOVE)		
POLYTROPIC HEAD (HG)		
PERFORMANCE CURVE NO.		
TYPE OF DRIVER & REF. PAGE		
TYPE OF GEAR & REF. PAGE	Gas Turbine (PG. 2 of 2)	

Rev. a (line 34)

REMARKS: Unit includes CI case, base for compressor only, control panel, oil coolers, paint, safety shutdowns & alarms.

FORM 1.115

REV. | REV.

Stearns-Roger

GAS FIRED TURBINES

STUDY DATA SHEET

ITEM NO. C-61

ACC'T. ______ PAGE 2 OF 2

S.R JOB B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY

PROJECT GAS PROCESSING STUDY

LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

DATE August 1971 BY RTG

SERVICE *PROPANE REFRIGERANT COMPRESSOR* NO. REQ'D. *ONE*

REVISIONS: a ______ BY ______ : b ______ BY ______ : c ______ BY ______ : d ______ BY ______

MANUFACTURER ______ SOURCE: QUOTE OF ______

OPERATING CONDITIONS

BHP: RATED *1100* MAX. *1130* MIN. ______

CYCLE: SIMPLE ☐ REGENERATIVE ☐ % EFFECTIVE ______

SPEED (RPM) FULL LOAD *7580* RANGE ______

ALTITUDE *sea level* FT. ATM. PRESS. *14.7* PSIA

AMBIENT AIR TEMP. (°F) DESIGN *80* MAX. *85* MIN. *0*

FUEL: NAT. GAS ☒ DISTILLATE ☐ DUAL ☐ PROPANE ☐

NET HEAT VALVE *1550* BTU/CU.FT. ______ BTU/LB.

EST. HEAT RATE ______ BTU/HP/HR.

EXHAUST TEMP. AT DESIGN CONDITIONS ______ °F

ALLOW. PRESS. DROP: (PSIG) INLET DUCT ______ OUTLET ______

AIR FLOW (LBS/SEC.) INLET ______ OUTLET ______

ROTATION (VIEWED FROM END OPPOSITE COUPLING) ______

STARTING TIME: (SECS.) TO IDLE ______ TO FULL SPEED ______

INSTALLATION: INDOOR ☐ OUTDOOR ☐ SHED ☒

DRIVEN EQUIPMENT: *Centrifugal Compressor*

EXHAUST GAS USE: *Waste Heat*

CONSTRUCTION

SINGLE SHAFT ☐ TWO SHAFT ☐

CASING: HORIZ. SPLIT ☐ VERT. SPLIT ☐

BLADING	COMPRESSOR	TURBINE
STATOR, MATERIAL		
FABRICATION		
ROTOR, MATERIAL		
FABRICATION		
STAGES		

CASE MATERIALS: COMPRESSOR *C.I.*

TURBINE ______ COMB. CHAMBER ______

SEALS: MFG. ______ TYPE ______

BEARINGS: JOURNAL ______ THRUST ______

CONTROL PANEL: OPEN ☐ ENCLOSED ☒

PRESSURIZED ☐ INTERNAL PRESS. ______ H_2O

LOCATION: ON SKID ☒ SEPARATE ☐

FLOOR SPACE: L ______ W ______ H ______

ELECTRICAL DESIGN	NEMA CLASS	VOLTS	PH.	CY.
MOTORS: STARTER				
LUBE OIL PUMP				
AERIAL COOLER				
AIR FILTER				
CONTROLS:				

WEIGHTS & DIMENSIONS

NET WT. (LBS.) ______ MAX. MAINT. WT. ______

APPROX. FLOOR SPACE (FT.) L ______ W ______ H ______

ACCESSORIES

AIR FILTER ☒ MFG. ______

MODEL & TYPE ______ DUCTING INCLUDED ☐

ACCESSORIES ______

INTAKE SILENCER ☒ MFG. ______

MODEL & TYPE ______ DUCTING INCLUDED ☐

ACCESSORIES: ______

LUBRICATING OIL SYSTEMS

PUMP INCLUDED ☒ GPM ______ TYPE ______

DRIVER INCLUDED ☐ GEARBOX ☒ ELEC. MOTOR ☐ ___ HP ___ RPM

RESERVOIR: ☒ CAPACITY ______

COOLER ☒ SHELL & TUBE ☐ AERIAL ☐

DUTY ______ BTU/HR. OIL TEMP. (°F) ______ IN ______ OUT

DRIVE: GEAR ☐ V-BELT ☐ HP ___ FAN RPM ______

LOCATION: ON SKID ☐ SEPARATE ☐

DRIVER INCLUDED ☐ ELEC. MOTOR ☐ HYD. ☐ ___ HP ___ RPM

FILTER ☒ MFG. ______ TYPE ______

STARTER ☐ HP ______ RPM ______

TYPE: AC ELEC. ☐ D.C. ELEC. ☐ VOLTS ___ AMP. RATING ___

PNEUMATIC: NATR. GAS ☒ COMP. AIR ☐

OPR. PRESS. (PSIA) ______ SCFM ______

OTHER ______

GOVERNOR: CONSTANT SPEED ☐ VARIABLE SPEED ☒

MFG. ______ TYPE ______

RESET: AIR SIGNAL ☒ ELECT. SIGNAL ☐ MANUAL ☐

SPEED RANGE (RPM) MAX. ______ MIN. ______

SIGNAL RANGE (RPM) MAX. ______ MIN. ______

GEARBOX ☒ MFG. ______

SIZE OR TYPE ______

MAX. CONT. HP RATING ______ RATIO ______

AGMA SERVICE RATING ______ MECH. EFF. ______

LUBRICATION: PRESSURE ☐ SPLASH ☐

TURBINE TACHOMETER [redacted] ☒

EVAPORATIVE COOLER ON INLET ☐

STARTING BATTERY ☐ CONTROLS BATTERY ☐

BATTERY CHARGER: TRICKLE ☐ GENERATOR ☐

SHEET METAL ENCLOSURE ☐ SOUNDPROOF ENCLOSURE ☒

Unit includes base, cplg, inlet filter/silencer, exhaust muffler, control panel, annunciators.

Form 1.21

Stearns-Roger

HEAT EXCHANGERS
STUDY DATA SHEET

ITEM NO. E-1A (B,C)
ACCT. PAGE
JOB NO. B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

DATE August, 1971 BY DJM
REV. a BY
b
c
d

SERVICE SOUR GAS EXCHANGER
MANUFACTURER
PROPOSAL OF

NO. OF UNITS 1(3) SHELLS PER UNIT 1(3) ARRANGEMENT (3 HORIZONTAL)
SIZE 26 X 240 TYPE BEM POSITION HORIZONTAL
SURFACE PER UNIT 1985 FT.² SURFACE PER SHELL 1985 FT.²

PERFORMANCE OF ONE UNIT

	SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED	SWEET GAS		SOUR GAS	
VAPOR #/HR.	IN 63,861(196,725)	OUT 62,477(196,725)	IN 70,509(212,300)	OUT 70,509(212,300)
MOLECULAR WEIGHT	22.72(20.69)	22.46(20.69)	23.69(21.484)	23.69(21.484)
LIQUID #/HR.		1384.(0)		
GRAVITY SG. @ T.		.536 (0)		
VISCOSITY				
STEAM #/HR.				
WATER #/HR.				
NON-CONDENSABLES #/HR.				
TEMPERATURE IN °F.	110		60	
TEMPERATURE OUT °F.	75(75)		91(89)	
OPERATING PRESSURE P.S.I.A.	885 (OUTLET)		910 (OUTLET)	
NUMBER OF PASSES PER SHELL	ONE		ONE	
VELOCITY FT./SEC.				
PRESSURE DROP P.S.I.	5 ALLOWED	CALC.	5 ALLOWED	CALC.
FOULING RESISTANCE	0.001		0.002	

HEAT EXCHANGED—B.T.U./HR. 2,023,000 (6,074,000) M.T.D. (CORRECTED) 17 (17)
TRANSFER RATE—SERVICE

CONSTRUCTION — EACH SHELL

	SHELL SIDE	TUBE SIDE
DESIGN PRESSURE P.S.I.G.	1000	1000
TEST PRESSURE P.S.I.	CODE	CODE
DESIGN TEMPERATURE °F.	150	150
CORROSION ALLOWANCE	1/8"	1/8"

CODE REQUIREMENTS CODE- ASME TEMA CLASS R
TUBES A-334 GR1 (SR) NO. O.D. 3/4" BWG. 14 LENGTH 20' PITCH 15/16" TRI.
SHELL A-515-70 I.D. 26" O.D. THICKNESS
SHELL COVER FLOATING HEAD COVER
CHANNEL A-516-70 (SR) CHANNEL COVER A-516-70 (SR)
TUBE SHEETS—STATIONARY FLOATING
BAFFLES—CROSS TYPE THICKNESS
BAFFLE —LONG TYPE THICKNESS
BAFFLE —IMP'T. GASKETS
TUBE SUPPORTS THICKNESS
CONNECTIONS—SHELL—IN 8" OUT 8" SERIES 600# RF
CHANNEL—IN 8" OUT 8" SERIES 600# RF
WEIGHTS—EACH SHELL AND BUNDLE ~21000# BUNDLE ONLY FULL OF WATER
OVERALL LENGTH APPROX. 25FT.
(S.R.) INDICATES STRESS RELIEVING & (X.R.) INDICATES RADIOGRAPHING
REMARKS:—

Form 1.21

Stearns-Roger

HEAT EXCHANGERS
STUDY DATA SHEET

ITEM NO. E-2
ACCT. PAGE
JOB NO. B-41449
DATE August, 1971 BY DJM
REV. a BY
b
c
d

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

SERVICE SOUR GAS HEATER
MANUFACTURER
PROPOSAL OF

NO. OF UNITS 1 (1) SHELLS PER UNIT 1 (1) ARRANGEMENT
SIZE 10 X 120 TYPE BEM POSITION HORIZONTAL
SURFACE PER UNIT 106 FT.² SURFACE PER SHELL 106 FT.²

PERFORMANCE OF ONE UNIT

	Shell Side IN	Shell Side OUT	Tube Side IN	Tube Side OUT
FLUID CIRCULATED	STEAM		SOUR GAS	
VAPOR #/HR.			70,509	74,818
MOLECULAR WEIGHT			23.69	24.34
LIQUID #/HR.			4,308	
~~GRAVITY~~ SP. GRAVITY			.5277	
VISCOSITY				
STEAM #/HR.	1,440			
WATER #/HR.		1,440		
NON-CONDENSABLES #/HR.				

	SHELL SIDE	TUBE SIDE
TEMPERATURE IN °F.	300	88
TEMPERATURE OUT °F.	300	100
OPERATING PRESSURE P.S.I.A.	69	905 OUTLET
NUMBER OF PASSES PER SHELL	ONE	ONE
VELOCITY FT./SEC.		
PRESSURE DROP P.S.I.	5 ALLOWED CALC.	5 ALLOWED CALC.
FOULING RESISTANCE	0.001	0.002

HEAT EXCHANGED-B.T.U./HR. 1,307,000 M.T.D. (CORRECTED) 205
TRANSFER RATE-SERVICE 60.0

CONSTRUCTION - EACH SHELL

	SHELL SIDE	TUBE SIDE
DESIGN PRESSURE P.S.I.G.	105	1000
TEST PRESSURE P.S.I.	CODE	CODE
DESIGN TEMPERATURE °F.	350	150
CORROSION ALLOWANCE		

CODE REQUIREMENTS ASME TEMA CLASS R
TUBES A-334 GR. 1 (SR) NO. O.D. 3/4 BWG. 14 LENGTH 10' PITCH 15/16" TRIANG.
SHELL A-285 OR A-106 I.D. ~ 10" O.D. THICKNESS
SHELL COVER FLOATING HEAD COVER
CHANNEL A-516-70 (SR) CHANNEL COVER A-516-70 (SR)
TUBE SHEETS-STATIONARY FLOATING
BAFFLES-CROSS TYPE THICKNESS
BAFFLE-LONG TYPE THICKNESS
BAFFLE-IMP'T. GASKETS
TUBE SUPPORTS THICKNESS
CONNECTIONS-SHELL-IN 4" OUT 4" SERIES
CHANNEL-IN 6" OUT 6' SERIES
WEIGHTS-EACH SHELL AND BUNDLE ~ 3500# BUNDLE ONLY FULL OF WATER
OVERALL LENGTH 13 FT.
(S.R.) INDICATES STRESS RELIEVING & (X.R.) INDICATES RADIOGRAPHING

REMARKS:-
UNIT INCLUDES APPROX. 50% EXCESS SURFACE

FORM 1.22

DOUBLE PIPE HEAT EXCHANGERS

STUDY DATA SHEET

Stearns-Roger CORPORATION

ITEM NO. E-3
ACC'T. ______ PAGE ______
S-R JOB B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA
DATE August 1971 BY DJM

a SERVICE DUMP LIQUID HEATER NO. REQ'D. ONE

REVISIONS :a 8/71 BY RTG :b ______ BY ______ :c ______ BY ______ :d ______ BY ______

MANUFACTURER ______ SOURCE: QUOTE OF ______

NO. OF UNITS ONE (1) SECTIONS PER UNIT ONE NO. PARALLEL ______ SHELLS ______ TUBES ______

SIZE ~ 25 FT. LONG TYPE ______ POSITION HORIZONTAL

SURFACE PER UNIT (TOTAL) 288 FT.² SURFACE PER SECTION 288 FT.²

PERFORMANCE OF ONE UNIT

	SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED	HOT OIL		H C CONDENSATE	
	IN	OUT	IN	OUT
VAPOR #/HR.				17000
MOLECULAR WEIGHT				
LIQUID #/HR.	71,000	71,000	28000	11000
GRAVITY SG @ T	.757			
VISCOSITY				
STEAM #/HR.				
WATER #/HR.				
NON-CONDENSABLES #/HR.				
TEMPERATURE IN °F.	219		60	
TEMPERATURE OUT °F.	140		100	
OPERATING PRESSURE P.S.I.A.	150		920	
NUMBER OF PASSES PER SHELL				
VELOCITY FT./SEC.				
PRESSURE DROP P.S.I.	5 ALLOWED	CALC.	25 ALLOWED	CALC.
FOULING RESISTANCE	0.001		0.002	

HEAT EXCHANGER-B.T.U./HR. 3,200,000 M.T.D. (CORRECTED) ______

TRANSFER RATE-SERVICE 30 100

CONSTRUCTION-EACH SHELL

	SHELL SIDE	TUBE SIDE
DESIGN PRESSURE P.S.I.G.	250	1015
TEST PRESSURE P.S.I.	CODE	CODE
DESIGN TEMPERATURE °F.	650	200
CORROSION ALLOWANCE		

CODE REQUIREMENTS ______ TEMA CLASS ______

TUBES A-106 NO. ______ O.D. ______ BWG. ______ LENGTH ______ FINS: NO. PER TUBE ______ SIZE ______

SHELL A-106 ~ 4" I.D. ______ O.D. ______ THICKNESS ______

GASKETS ______ TUBE CONNECTIONS ______

CONNECTIONS-SHELL-IN 3 OUT 3 SERIES 600# R.F.

TUBE-IN 1½ OUT 1½ SERIES 600# R.F.

WEIGHTS-EACH SECTION ______ TOTAL ~ 5,400 #

(S.R.) INDICATES STRESS RELIEVING & (X.R.) INDICATES RADIOGRAPHING

REMARKS: ______

FORM 1.22

DOUBLE PIPE HEAT EXCHANGERS

STUDY DATA SHEET

Stearns-Roger Corporation

ITEM No. E-6
ACC'T. PAGE
S-R JOB B-41449
DATE August 1971 BY JGN

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

SERVICE GLYCOL EXCHANGER NO. REQ'D.
REVISIONS :a BY :b BY :c BY :d BY
MANUFACTURER SOURCE: QUOTE OF
NO. OF UNITS ONE SECTIONS PER UNIT TWO NO. PARALLEL 2 SHELLS TUBES
SIZE ~16 FT LONG TYPE POSITION HORIZONTAL
SURFACE PER UNIT (TOTAL) 322 SURFACE PER SECTION 161

PERFORMANCE OF ONE UNIT

	SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED	LEAN ETHYLENE GLYCOL		RICH ETHYLENE GLYCOL	
	IN	OUT	IN	OUT
VAPOR #/HR.				
MOLECULAR WEIGHT				
LIQUID #/HR.				
GRAVITY				
VISCOSITY				
STEAM #/HR.				
WATER #/HR.	1083	1083	1430	1430
NON-CONDENSABLES #/HR.				
ETHYLENE GLYCOL	4333	4333	4333	4333
TEMPERATURE IN °F.	275		0	
TEMPERATURE OUT °F.	150		100	
OPERATING PRESSURE P.S.I.	5		55	
NUMBER OF PASSES PER SHELL				
VELOCITY FT./SEC.				
PRESSURE DROP P.S.I.	1.5 ALLOWED	CALC.	20 ALLOWED	CALC.
FOULING RESISTANCE	0.002		0.002	

HEAT EXCHANGER-B.T.U./HR. 510,000 M.T.D. (CORRECTED) 147.5
TRANSFER RATE-SERVICE 10.2

CONSTRUCTION-EACH SHELL

	SHELL SIDE	TUBE SIDE
DESIGN PRESSURE P.S.I.	400	500
TEST PRESSURE P.S.I.	600	750
DESIGN TEMPERATURE °F.	650	650
CORROSION ALLOWANCE		

CODE REQUIREMENTS TEMA CLASS
TUBES STEEL A-53 Gr B NO. O.D. BWG. Sch 40 LENGTH FINS: NO. PER TUBE SIZE
SHELL STEEL A-53 Gr B I.D. O.D. 3.5" THICKNESS Sch 40
GASKETS TUBE CONNECTIONS
CONNECTIONS-SHELL-IN 2½" OUT 2½" SERIES 600 # RF
TUBE-IN 1½" OUT 1½" SERIES BFW
WEIGHTS-EACH SECTION TOTAL
(S.R.) INDICATES STRESS RELIEVING & (X.R.) INDICATES RADIOGRAPHING
REMARKS:

FORM 1.22

DOUBLE PIPE HEAT EXCHANGERS

STUDY DATA SHEET

Stearns-Roger CORPORATION

ITEM NO. F-7
ACC'T. PAGE
S-R JOB B-41449
DATE August 1971 BY JGN

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

SERVICE GLYCOL TRIM HEATER NO. REQ'D.
REVISIONS :a BY :b BY :c BY :d BY
MANUFACTURER SOURCE: QUOTE OF
NO. OF UNITS ONE SECTIONS PER UNIT ONE NO. PARALLEL ONE SHELLS TUBES
SIZE ~ 8 FT LONG TYPE POSITION HORIZONTAL
SURFACE PER UNIT (TOTAL) 35 SURFACE PER SECTION 35

PERFORMANCE OF ONE UNIT

	SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED	STEAM		RICH ETHYLENE GLYCOL	
VAPOR #/HR.	IN	OUT	IN	OUT
MOLECULAR WEIGHT				
LIQUID #/HR.				
GRAVITY			1.08	1.07
VISCOSITY			4.7 CP	3.0 CP
STEAM #/HR.	137			
WATER #/HR.		137	1430	1430
NON-CONDENSABLES #/HR.				
ETHYLENE GLYCOL			4333	4333
TEMPERATURE IN °F.	301		100	
TEMPERATURE OUT °F.			130	
OPERATING PRESSURE P.S.I.G	55		35	
NUMBER OF PASSES PER SHELL	1		1	
VELOCITY FT./SEC.				
PRESSURE DROP P.S.I.	NIL ALLOWED	CALC.	5 ALLOWED	CALC.
FOULING RESISTANCE	0.0005		0.002	

HEAT EXCHANGER-B.T.U./HR. 124,160 M.T.D. (CORRECTED) 185.5
TRANSFER RATE-SERVICE 22.1

CONSTRUCTION-EACH SHELL

	SHELL SIDE	TUBE SIDE
DESIGN PRESSURE P.S.I.	500	500
TEST PRESSURE P.S.I.	750	750
DESIGN TEMPERATURE °F.	650	650
CORROSION ALLOWANCE		

CODE REQUIREMENTS TEMA CLASS
TUBES STEEL A-53 Gr B NO. O.D. BWG. Sch 40 LENGTH FINS: NO. PER TUBE SIZE
SHELL STEEL A-53 Gr B. I.D. O.D. THICKNESS Sch. 40
GASKETS TUBE CONNECTIONS
CONNECTIONS-SHELL-IN 2" OUT 2" SERIES 600 # RF
TUBE-IN 1½" OUT 1½" SERIES BFW
WEIGHTS-EACH SECTION TOTAL
(S.R.) INDICATES STRESS RELIEVING & (X.R.) INDICATES RADIOGRAPHING
REMARKS:

Form 1.21

Stearns-Roger

HEAT EXCHANGERS
STUDY DATA SHEET

ITEM NO. E-8
ACCT. PAGE
JOB NO. B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

DATE August, 1971 BY JGM
REV. a 8/71 BY RTG
b
c
d

SERVICE GLYCOL REBOILER
MANUFACTURER
PROPOSAL OF

NO. OF UNITS ONE SHELLS PER UNIT ONE ARRANGEMENT
a SIZE 17X27-192 TYPE AKU POSITION
SURFACE PER UNIT 345 SURFACE PER SHELL 345

PERFORMANCE OF ONE UNIT

	SHELL SIDE IN	SHELL SIDE OUT	TUBE SIDE IN	TUBE SIDE OUT
FLUID CIRCULATED	ETHYLENE GLYCOL & WATER		STEAM	
VAPOR #/HR.				
MOLECULAR WEIGHT				
LIQUID #/HR.				
GRAVITY				
VISCOSITY				
STEAM #/HR.		1440	1467	
WATER #/HR.	2523	1083		1467
NON-CONDENSABLES #/HR.				
ETHYLENE GLYCOL	4333	4333		

	SHELL SIDE	TUBE SIDE
TEMPERATURE IN °F.	275	300
TEMPERATURE OUT °F.	275	300
OPERATING PRESSURE P.S.I.G	5	55
NUMBER OF PASSES PER SHELL	KETTLE	TWO
VELOCITY FT./SEC.		
PRESSURE DROP P.S.I.	NIL ALLOWED CALC.	NIL ALLOWED CALC.
FOULING RESISTANCE	0.0025	0.0005

HEAT EXCHANGED-B.T.U./HR. 1,333,000 M.T.D. (CORRECTED) 25
TRANSFER RATE-SERVICE 142

CONSTRUCTION - EACH SHELL

	SHELL SIDE	TUBE SIDE
DESIGN PRESSURE P.S.I.	75	100
TEST PRESSURE P.S.I.	115	150
DESIGN TEMPERATURE °F.	300	340
CORROSION ALLOWANCE		

CODE REQUIREMENTS TEMA CLASS
TUBES STEEL A-179 NO. O.D. BWG. LENGTH PITCH 1" □
SHELL STEEL I.D. O.D. THICKNESS
SHELL COVER FLOATING HEAD COVER
CHANNEL CHANNEL COVER
TUBE SHEETS-STATIONARY FLOATING
BAFFLES-CROSS TYPE THICKNESS
BAFFLE -LONG TYPE THICKNESS
BAFFLE -IMP'T. GASKETS
TUBE SUPPORTS THICKNESS
CONNECTIONS-SHELL-IN 4" OUT 6" & 3" SERIES 150# RF
CHANNEL-IN 3" OUT 3" SERIES 150# RF
WEIGHTS-EACH SHELL AND BUNDLE BUNDLE ONLY FULL OF WATER
OVERALL LENGTH
(S.R.) INDICATES STRESS RELIEVING & (X.R.) INDICATES RADIOGRAPHING

REMARKS:-

Form 1.21

HEAT EXCHANGERS
STUDY DATA SHEET

Stearns-Roger

ITEM NO. E-11 A & B
ACCT. PAGE
JOB NO. B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

DATE August, 1971 BY DJM
REV. a 8/71 BY RTG
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SERVICE AMINE SOLUTION EXCHANGER
MANUFACTURER
PROPOSAL OF

NO. OF UNITS 1 (2) SHELLS PER UNIT ONE ARRANGEMENT
a SIZE 44 X 240 TYPE AEP POSITION HORIZONTAL
SURFACE PER UNIT 5080 FT² SURFACE PER SHELL 5080

PERFORMANCE OF ONE UNIT

	SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED	LEAN AMINE		SOUR AMINE	
VAPOR #/HR.	IN	OUT	IN	OUT
MOLECULAR WEIGHT				
LIQUID #/HR.	215,556(161,000)	215,556(161,000)	239,310(170,289)	239,310(170,289)
GRAVITY	1.03		1.002	
VISCOSITY				
STEAM #/HR.				
WATER #/HR.				
NON-CONDENSABLES #/HR.				
TEMPERATURE IN °F.	250		160	
TEMPERATURE OUT °F.	186		213	
OPERATING PRESSURE P.S.I.	45		90	
NUMBER OF PASSES PER SHELL	ONE		TWO	
VELOCITY FT./SEC.				
PRESSURE DROP P.S.I.	10 ALLOWED	CALC.	20 ALLOWED	CALC.
FOULING RESISTANCE	0.001		0.002	

a HEAT EXCHANGED-B.T.U./HR. (PER UNIT) 13,796,000 (10,305,000) x 1.1 M.T.D. (CORRECTED) 31.3
a TRANSFER RATE-SERVICE 95.5

CONSTRUCTION - EACH SHELL

	SHELL SIDE	TUBE SIDE
DESIGN PRESSURE P.S.I.	100	250
TEST PRESSURE P.S.I.	CODE	CODE
DESIGN TEMPERATURE °F.	325	250
CORROSION ALLOWANCE	1/8"	1/8"

CODE REQUIREMENTS ASME TEMA CLASS
TUBES A-334-1 (SR) NO. O.D. 3/4" BWG. 10 LENGTH 20' PITCH 1.25" SQ.
SHELL A-516-70 (SR) I.D. ~36" O.D. THICKNESS
SHELL COVER FLOATING HEAD COVER
CHANNEL A-516-70 (SR) CHANNEL COVER A-516-70 (SR)
TUBE SHEETS-STATIONARY FLOATING
BAFFLES-CROSS TYPE THICKNESS
BAFFLE -LONG TYPE THICKNESS
BAFFLE -IMP'T. GASKETS
TUBE SUPPORTS THICKNESS
CONNECTIONS-SHELL-IN 8" OUT 8" SERIES 300# R.F.
CHANNEL-IN 6" OUT 6" SERIES 150# R.F.
WEIGHTS-EACH SHELL AND BUNDLE 19,000# BUNDLE ONLY FULL OF WATER
OVERALL LENGTH ~ 26'
(S.R.) INDICATES STRESS RELIEVING & (X.R.) INDICATES RADIOGRAPHING

REMARKS:-

Form 1.21

HEAT EXCHANGERS
STUDY DATA SHEET

Stearns-Roger

ITEM NO. E-21
ACCT. PAGE
JOB NO. B-41449
DATE August, 1971 BY JEW
REV. a 8/71 BY RTG
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CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

SERVICE SULFUR CONDENSER NO. 1
MANUFACTURER
PROPOSAL OF
NO. OF UNITS 1 (2) SHELLS PER UNIT ONE ARRANGEMENT
SIZE 32 X 144 TYPE CEN POSITION HORIZONTAL
SURFACE PER UNIT 877 FT^2 SURFACE PER SHELL 877 FT^2

PERFORMANCE OF ONE UNIT

Rev.		SHELL SIDE IN	SHELL SIDE OUT	TUBE SIDE IN	TUBE SIDE OUT
	FLUID CIRCULATED	WATER		SULFUR VAPOR + ACID GAS	
a	VAPOR #/HR.			13,720 (9,642)	13,091 (9,204)
	MOLECULAR WEIGHT				
a	LIQUID #/HR.				629 (438) SULFUR
	GRAVITY				
	VISCOSITY				
	STEAM #/HR.		775 (417)		
	WATER #/HR.	8,600 (6,217)	7840 (5637)		
	NON-CONDENSABLES #/HR.				
	TEMPERATURE IN °F.	302		535	
	TEMPERATURE OUT °F.	307		335	
	OPERATING PRESSURE P.S.I. A	74.7		21.1	
	NUMBER OF PASSES PER SHELL	ONE		ONE	
	VELOCITY FT./SEC.				
	PRESSURE DROP P.S.I.	0.8 ALLOWED	CALC.	0.5 ALLOWED	CALC.
	FOULING RESISTANCE	0.001		0.002	

a HEAT EXCHANGED-B.T.U./HR. 745,000 (548,000) M.T.D. (CORRECTED) 71.5
TRANSFER RATE-SERVICE 12.0

CONSTRUCTION – EACH SHELL

	SHELL SIDE	TUBE SIDE
DESIGN PRESSURE P.S.I. G	105	50
TEST PRESSURE P.S.I.	CODE	CODE
DESIGN TEMPERATURE °F.	550	600
CORROSION ALLOWANCE	1/8"	1/8"

CODE REQUIREMENTS ASME TEMA CLASS R
TUBES A-214 NO. 187 O.D. 1½" BWG. 12 AVG. LENGTH 12' PITCH 1 7/8" TRI.
SHELL C.S. I.D. 32" O.D. THICKNESS
SHELL COVER FLOATING HEAD COVER
CHANNEL C.S. CHANNEL COVER C.S.
TUBE SHEETS-STATIONARY C.S. FLOATING
BAFFLES-CROSS C.S. TYPE THICKNESS
BAFFLE -LONG TYPE THICKNESS
BAFFLE -IMP'T. GASKETS
TUBE SUPPORTS THICKNESS
CONNECTIONS-SHELL-IN 4" OUT 4" SERIES 150# RF
a CHANNEL-IN 10" OUT 10" SERIES 150# RF
WEIGHTS-EACH SHELL AND BUNDLE 10,000 BUNDLE ONLY FULL OF WATER
OVERALL LENGTH ~ 16 FT
(S.R.) INDICATES STRESS RELIEVING & (X.R.) INDICATES RADIOGRAPHING

REMARKS:-
1. SLOPE BUNDLE 1/8" PER FOOT.
2. SEAL WELD TUBES TO TUBE SHEETS.
3. 4" 304 S.S. DEMISTER REQ'D ON ℄ IN OUTLET CHANNEL
4. SIZING BASED ON INITIAL CONDITIONS.

Form 1.21

HEAT EXCHANGERS
STUDY DATA SHEET

Stearns-Roger

ITEM NO. E-22
ACCT. PAGE
CUSTOMER HUMBLE OIL AND REFINING COMPANY — JOB NO. B-41449
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA — DATE August, 1971 BY EW/DJT
REV. a 8/71 BY RTG
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SERVICE SULFUR CONDENSER NO. 2
MANUFACTURER
PROPOSAL OF

NO. OF UNITS 1 (2)	SHELLS PER UNIT ONE	ARRANGEMENT		
SIZE 22 X 192	TYPE CEN		POSITION HORIZONTAL	
SURFACE PER UNIT 407 FT2			SURFACE PER SHELL 407 FT2	
PERFORMANCE OF ONE UNIT				
	SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED	WATER		SULFUR VAPOR + ACID GAS	
a VAPOR #/HR.	IN	OUT	IN 13,091 (9,204)	OUT 13,011 (9,146)
MOLECULAR WEIGHT				
a LIQUID #/HR.				80 (58)
GRAVITY				
VISCOSITY				
STEAM #/HR.		296 (159)		
WATER #/HR.	3290 (2362)	3000 (2149)		
NON-CONDENSABLES #/HR.				
TEMPERATURE IN °F.	302		420	
TEMPERATURE OUT °F.	307		335	
OPERATING PRESSURE P.S.I. A	74.7		18.9	
NUMBER OF PASSES PER SHELL	ONE		ONE	
VELOCITY FT./SEC.				
PRESSURE DROP P.S.I.	0.8 ALLOWED	CALC.	0.5 ALLOWED	CALC.
FOULING RESISTANCE	0.001		0.002	
a HEAT EXCHANGED-B.T.U./HR.	286,000 (202,000)		M.T.D. (CORRECTED)	64
TRANSFER RATE-SERVICE	11.0			
CONSTRUCTION - EACH SHELL				
DESIGN PRESSURE P.S.I. G	105		50	
TEST PRESSURE P.S.I.	CODE		CODE	
DESIGN TEMPERATURE °F.	550		600	
CORROSION ALLOWANCE	1/8"		1/8"	
CODE REQUIREMENTS	ASME		TEMA CLASS R	

TUBES A 214 NO. 65 O.D. 1 1/2" BWG. 12 AVG. LENGTH 16' PITCH 1 7/8" TRI.
SHELL C.S. I.D. 22 1/2" O.D. THICKNESS
SHELL COVER FLOATING HEAD COVER
CHANNEL C.S. CHANNEL COVER C.S.
TUBE SHEETS-STATIONARY C.S. FLOATING
BAFFLES-CROSS C.S. TYPE THICKNESS
BAFFLE -LONG TYPE THICKNESS
BAFFLE -IMP'T. GASKETS
TUBE SUPPORTS THICKNESS
CONNECTIONS-SHELL-IN 3" OUT 3" SERIES 150# RF
a CHANNEL-IN 10" OUT 10" SERIES 150# RF
WEIGHTS-EACH SHELL AND BUNDLE 9,000# BUNDLE ONLY FULL OF WATER
OVERALL LENGTH ~ 20 FT.
(S.R.) INDICATES STRESS RELIEVING & (X.R.) INDICATES RADIOGRAPHING

REMARKS:-
1. SLOPE BUNDLE 1/8" PER FT.
2. SEAL WELD TUBES TO TUBE SHEET.
3. 4" 304 S.S. DEMISTER REQD ON ℄ IN OUTLET CHANNEL
4. SIZED ON INITIAL CONDITIONS.

Form 1.21

Stearns-Roger

HEAT EXCHANGERS
STUDY DATA SHEET

ITEM NO. E-23
ACCT. PAGE
JOB NO. B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

DATE August, 1971 BY JEW/DJ
REV. a 8/71 BY RTG
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SERVICE SULFUR CONDENSER NO. 3
MANUFACTURER
PROPOSAL OF

NO. OF UNITS 1 (2) SHELLS PER UNIT ONE ARRANGEMENT
SIZE 30 X 144 TYPE CEN POSITION HORIZONTAL
SURFACE PER UNIT 711 FT² SURFACE PER SHELL 711 FT²

PERFORMANCE OF ONE UNIT

		SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED		BOILER FEED WATER		SULFUR + ACID GAS	
(a) VAPOR	#/HR.	IN	OUT	IN 13,011 (9,146)	OUT 12,971 (9111)
MOLECULAR WEIGHT					
(a) LIQUID	#/HR.				40 (35)
GRAVITY					
VISCOSITY					
STEAM	#/HR.				
WATER	#/HR.	3580 (2582)	3580 (2582)		
NON-CONDENSABLES	#/HR.				
TEMPERATURE IN	°F.	215		401	
TEMPERATURE OUT	°F.	338		265	
OPERATING PRESSURE	P.S.I. A	125		16.7	
NUMBER OF PASSES	PER SHELL	ONE		ONE	
VELOCITY	FT./SEC.				
PRESSURE DROP	P.S.I.	5.0 ALLOWED	CALC.	0.5 ALLOWED	CALC.
FOULING RESISTANCE		0.001		0.002	

(a) HEAT EXCHANGED—B.T.U./HR. 438,000 (315,000) M.T.D. (CORRECTED) 56
TRANSFER RATE—SERVICE 11.0

CONSTRUCTION — EACH SHELL

		SHELL SIDE	TUBE SIDE
DESIGN PRESSURE	P.S.I. G	175	50
TEST PRESSURE	P.S.I.	CODE	CODE
DESIGN TEMPERATURE	°F.	550	600
CORROSION ALLOWANCE		1/8"	1/8"

CODE REQUIREMENTS ASME TEMA CLASS R
TUBES A 214 NO. 152 O.D. 1½" BWG. 12 LENGTH 12' PITCH 1 7/8" TRI.
SHELL C.S. I.D. 24" O.D. THICKNESS
SHELL COVER FLOATING HEAD COVER
CHANNEL C.S. CHANNEL COVER C.S.
TUBE SHEETS—STATIONARY C.S. FLOATING
BAFFLES—CROSS C.S. TYPE THICKNESS
BAFFLE —LONG TYPE THICKNESS
BAFFLE —IMP'T. GASKETS
TUBE SUPPORTS THICKNESS
CONNECTIONS—SHELL—IN 3" OUT 3" SERIES 300 # RF
(a) CHANNEL—IN 10" OUT 10" SERIES 300 # RF
WEIGHTS—EACH SHELL AND BUNDLE 10,000# BUNDLE ONLY FULL OF WATER
OVERALL LENGTH ~ 16 FT.
(S.R.) INDICATES STRESS RELIEVING & (X.R.) INDICATES RADIOGRAPHING

REMARKS:—
1. SLOPE BUNDLE 1/8" PER FT.
2. SEAL WELD TUBES TO TUBE SHEET.
3. 4" - 304 S.S. DEMISTER REQ'D ON ℄ IN OUTLET CHANNEL
4. SIZE BASED ON INITIAL CONDITIONS.

Form 1.21

Stearns-Roger

HEAT EXCHANGERS
STUDY DATA SHEET

ITEM NO. E-31
ACCT. PAGE
JOB NO. B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

DATE August, 1971 BY RTG
REV. a 8/71 BY RTG
b
c
d

SERVICE MAIN GAS EXCHANGER
MANUFACTURER
PROPOSAL OF
NO. OF UNITS 1 SHELLS PER UNIT 1 ARRANGEMENT
SIZE 27-288 TYPE BEM POSITION
SURFACE PER UNIT 2960 SURFACE PER SHELL 2960

PERFORMANCE OF ONE UNIT

	SHELL SIDE IN	SHELL SIDE OUT	TUBE SIDE IN	TUBE SIDE OUT
FLUID CIRCULATED	HYDROCARBONS		HYDROCARBONS	
VAPOR #/HR.	43,746	43,746	62,475	53,660
MOLECULAR WEIGHT	19.32	19.32	22.46	20.93
LIQUID #/HR.			1387	10,202
GRAVITY @ 60 °F			0.528	0.496
VISCOSITY				
STEAM #/HR.				
WATER #/HR.				
NON-CONDENSABLES #/HR.				
TEMPERATURE IN °F.	0		75	
TEMPERATURE OUT °F.	65		41	
OPERATING PRESSURE P.S.I.	865		885	
NUMBER OF PASSES PER SHELL	1		1	
VELOCITY FT./SEC.				
PRESSURE DROP P.S.I.	5 ALLOWED	CALC.	5 ALLOWED	CALC.
FOULING RESISTANCE	0.001		0.001	

HEAT EXCHANGED-B.T.U./HR. 2,540,000 X1.15 M.T.D. (CORRECTED) 21.6
TRANSFER RATE-SERVICE 45.7

CONSTRUCTION - EACH SHELL

	SHELL SIDE	TUBE SIDE
DESIGN PRESSURE P.S.I.	960	960
TEST PRESSURE P.S.I.		
DESIGN TEMPERATURE °F.	-20/150	-20/150
CORROSION ALLOWANCE		

CODE REQUIREMENTS ASME TEMA CLASS C
TUBES NO. 628 O.D. 3/4" BWG. 14 LENGTH 24' PITCH 15/16 Δ
SHELL I.D. O.D. THICKNESS
SHELL COVER FLOATING HEAD COVER
CHANNEL CHANNEL COVER
TUBE SHEETS-STATIONARY FLOATING
BAFFLES-CROSS TYPE THICKNESS
BAFFLE - LONG TYPE THICKNESS
BAFFLE - IMP'T. GASKETS
TUBE SUPPORTS THICKNESS
a CONNECTIONS-SHELL-IN 8" OUT 8" SERIES
a CHANNEL-IN 8" OUT 8" SERIES
a WEIGHTS-EACH SHELL AND BUNDLE ~ 27,000# BUNDLE ONLY FULL OF WATER
OVERALL LENGTH
(S.R.) INDICATES STRESS RELIEVING & (X.R.) INDICATES RADIOGRAPHING

REMARKS:- EXCHANGER AS SIZED IS GOOD FOR 120% OF ABOVE STATED DUTY FOR ULTIMATE USE.

Form 1.21

Stearns-Roger

HEAT EXCHANGERS
STUDY DATA SHEET

ITEM NO. E-32
ACCT. PAGE
JOB NO. B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

DATE August, 1971 BY RTG
REV. a 8/71 BY RTG
b
c
d

SERVICE MAIN GAS CHILLER
MANUFACTURER
PROPOSAL OF
NO. OF UNITS 1 SHELLS PER UNIT 1 ARRANGEMENT
SIZE 34x62-192 TYPE LKN POSITION HORIZONTAL
SURFACE PER UNIT 3170 SURFACE PER SHELL 3170

PERFORMANCE OF ONE UNIT

	SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED	PROPANE		HYDROCARBON	
a VAPOR #/HR.	IN 3500	OUT 21,100	IN 53,660	OUT 43,746
MOLECULAR WEIGHT	44.09	44.09	20.93	19.32
LIQUID #/HR.	17,600		10,202	20,116
GRAVITY @ 60°F	0.507		0.496	0.468
VISCOSITY				
STEAM #/HR.				
WATER #/HR.				
NON-CONDENSABLES #/HR.				
TEMPERATURE IN °F.	-10		41	
TEMPERATURE OUT °F.	-10		0	
OPERATING PRESSURE P.S.I.	31		880	
NUMBER OF PASSES PER SHELL				
VELOCITY FT./SEC.				
PRESSURE DROP P.S.I.	NIL ALLOWED	CALC.	5 ALLOWED	CALC.
FOULING RESISTANCE	0.001		0.001	

HEAT EXCHANGED—B.T.U./HR. 3,080,000 x 1.15 M.T.D. (CORRECTED) 25
TRANSFER RATE—SERVICE 44.8

CONSTRUCTION — EACH SHELL

	SHELL SIDE	TUBE SIDE
DESIGN PRESSURE P.S.I.	210	960
TEST PRESSURE P.S.I.		
DESIGN TEMPERATURE °F.	-20/150	-20/150
CORROSION ALLOWANCE		

CODE REQUIREMENTS ASME TEMA CLASS C
TUBES NO. 1000 O.D. 3/4 BWG. 14 LENGTH 16' PITCH 15/16 Δ
SHELL I.D. O.D. THICKNESS
SHELL COVER FLOATING HEAD COVER
CHANNEL CHANNEL COVER
TUBE SHEETS—STATIONARY FLOATING
BAFFLES—CROSS TYPE THICKNESS
BAFFLE —LONG TYPE THICKNESS
BAFFLE —IMP'T. GASKETS
TUBE SUPPORTS THICKNESS
CONNECTIONS—SHELL—IN OUT SERIES
a CHANNEL—IN 8" OUT 8" SERIES
a WEIGHTS—EACH SHELL AND BUNDLE ~ 30,000# BUNDLE ONLY FULL OF WATER
OVERALL LENGTH
(S.R.) INDICATES STRESS RELIEVING & (X.R.) INDICATES RADIOGRAPHING

REMARKS:- EXCHANGER AS SIZED IS GOOD FOR 134% OF ABOVE STATED DUTY FOR ULTIMATE USE.

REV.

Stearns-Roger

STUDY DATA SHEET

ITEM NO. E-42
ACC'T. PAGE 1
S.R JOB B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA
DATE August, 1971 BY RTG

SERVICE Depropanizer Reboiler NO. REQ'D. One

REVISIONS: a BY :b BY :c BY :d BY

MANUFACTURER SOURCE: QUOTE OF

1 - Waste heat exchanger to heat the Depropanizer bottoms using the heat in the exhaust gas from the gas turbine driver on C-61.

Conditions of Service

Heat Duty	6,639,000 BTU/Hr.
Inlet Temperature	157°F
Outlet Temperature	231°F
Flow Rate	82,000#/Hr.

Exhaust Gas Conditions

Flow Rate:	40,700#/Hr. (Approximately)
Inlet Temperature:	745°F (Approximately)

Construction

1. Bypass facilities will be provided by the Contractor.

2. A low pressure drop design on the flue gas side is required to minimize back pressure on the gas turbines.

Estimated Size and Weight

Based on approximately 6,500 ft^2 of surface (4" finned tubes).

Length	13 Ft.
Width	10 Ft.
Height	10 Ft.
Weight	45,000#

REV.

Form 1.21

Stearns-Roger

HEAT EXCHANGERS
STUDY DATA SHEET

ITEM NO. E-43
ACCT. PAGE 1
JOB NO. B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

DATE August, 1971 BY RTG
REV. a 8/71 BY RTG
b
c
d

SERVICE DEPROPANIZER FEED - OVHD EXCHANGER
MANUFACTURER
PROPOSAL OF

NO. OF UNITS 1 SHELLS PER UNIT 1 ARRANGEMENT
SIZE 18 X 168 TYPE BEM POSITION HORIZONTAL
SURFACE PER UNIT 400 SURFACE PER SHELL

PERFORMANCE OF ONE UNIT

Rev.		SHELL SIDE IN	SHELL SIDE OUT	TUBE SIDE IN	TUBE SIDE OUT
a	FLUID CIRCULATED	HYDROCARBON		HYDROCARBON	
	VAPOR #/HR.	17,634	11,695		5403
	MOLECULAR WEIGHT	31.76	28.48		22.91
	LIQUID #/HR.		5,939	20,116	14,713
	GRAVITY @ 60°F		0.486	36.81	0.524
	VISCOSITY				
	STEAM #/HR.				
	WATER #/HR.				
	NON-CONDENSABLES #/HR.				

	SHELL SIDE	TUBE SIDE
TEMPERATURE IN °F.	58	-41
TEMPERATURE OUT °F.	36	17
OPERATING PRESSURE P.S.I.A.	231	245
NUMBER OF PASSES PER SHELL	1	1
VELOCITY FT./SEC.		
PRESSURE DROP P.S.I.	4 ALLOWED CALC.	5 ALLOWED CALC.
FOULING RESISTANCE	.001	.001

HEAT EXCHANGED-B.T.U./HR. 1,090,000 X 1.15 M.T.D. (CORRECTED) 57
TRANSFER RATE-SERVICE 55

CONSTRUCTION - EACH SHELL

Rev.		SHELL SIDE	TUBE SIDE
a	DESIGN PRESSURE P.S.I.A.	275	275
	TEST PRESSURE P.S.I.		
	DESIGN TEMPERATURE °F.	-55/100	-55/100
	CORROSION ALLOWANCE		

CODE REQUIREMENTS ASME TEMA CLASS C
TUBES NO. 285 O.D. 3/4 BWG. 14 LENGTH 14' PITCH 15/16" △
SHELL I.D. O.D. THICKNESS
SHELL COVER FLOATING HEAD COVER
CHANNEL CHANNEL COVER
TUBE SHEETS-STATIONARY FLOATING
BAFFLES-CROSS TYPE THICKNESS
BAFFLE -LONG TYPE THICKNESS
BAFFLE -IMP'T. GASKETS
TUBE SUPPORTS THICKNESS
a CONNECTIONS-SHELL-IN 6" OUT 6" SERIES
a CHANNEL-IN 6" OUT 6" SERIES
a WEIGHTS-EACH SHELL AND BUNDLE ~6,000 # BUNDLE ONLY FULL OF WATER
OVERALL LENGTH
(S.R.) INDICATES STRESS RELIEVING & (X.R.) INDICATES RADIOGRAPHING
REMARKS:-

FORM 1.22

DOUBLE PIPE HEAT EXCHANGERS

STUDY DATA SHEET

Stearns-Roger CORPORATION

ITEM No. E-44
ACC'T. PAGE 1
S-R JOB B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA
DATE August 1971 BY RG

SERVICE FUEL GAS HEATER NO. REQ'D. ONE
REVISIONS :a BY :b BY :c BY :d BY
MANUFACTURER SOURCE: QUOTE OF
NO. OF UNITS ONE SECTIONS PER UNIT NO. PARALLEL ONE SHELLS TUBES
SIZE TYPE FIN-TUBE POSITION HORIZONTAL
SURFACE PER UNIT (TOTAL) 104 Ft² SURFACE PER SECTION 104 Ft²

PERFORMANCE OF ONE UNIT

	SHELL SIDE		TUBE SIDE	
FLUID CIRCULATED	STEAM			
VAPOR #/HR.	IN	OUT	IN 3042	OUT 3042
MOLECULAR WEIGHT			28.48	28.48
LIQUID #/HR.				
GRAVITY				
VISCOSITY				
STEAM #/HR.	184			
WATER #/HR.		184		
NON-CONDENSABLES #/HR.				
TEMPERATURE IN °F.	301		36	
TEMPERATURE OUT °F.	301		100	
OPERATING PRESSURE P.S.I.G	55		200	
NUMBER OF PASSES PER SHELL	1		1	
VELOCITY FT./SEC.				
PRESSURE DROP P.S.I.	NIL ALLOWED	CALC.	20 ALLOWED	CALC.
FOULING RESISTANCE	0.0005		0.001	

HEAT EXCHANGER-B.T.U./HR. 101,200 M.T.D. (CORRECTED) 233.
TRANSFER RATE-SERVICE 4.18

CONSTRUCTION-EACH SHELL

	SHELL SIDE	TUBE SIDE
DESIGN PRESSURE P.S.I.	250	250
TEST PRESSURE P.S.I.		
DESIGN TEMPERATURE °F.	330	130
CORROSION ALLOWANCE		

CODE REQUIREMENTS TEMA CLASS
TUBES Steel NO. O.D. BWG. LENGTH FINS: NO. PER TUBE SIZE
SHELL Steel I.D. O.D. THICKNESS
GASKETS TUBE CONNECTIONS
CONNECTIONS-SHELL-IN OUT SERIES
TUBE-IN OUT SERIES
WEIGHTS-EACH SECTION TOTAL
(S.R.) INDICATES STRESS RELIEVING & (X.R.) INDICATES RADIOGRAPHING
REMARKS:
ABOVE EXCHANGER GOOD FOR ULTIMATE CASE DUTY OF 167,000 BTU/Hr.

Stearns-Roger

EMERGENCY GENERATOR STUDY DATA SHEET

ITEM NO. G-1
ACC'T. PAGE
S.R JOB B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA
DATE August, 1971 BY

SERVICE Emergency Generator (Initial & Ultimate) NO. REQ'D. 1 (1)

REVISIONS: a BY :b BY :c BY :d BY

MANUFACTURER SOURCE: QUOTE OF

1 - 220KW 325 Hp, gas turbine driven alternator 440V, 3 Phase, 60 Cycle. Package complete with battery or gas expansion starter and air lube oil coolers. Exhaust ducted to atmosphere through 18' vertical duct.

All necessary electrical controls, automatic static voltage regulator and generator-mounted control panel containing AC ammeter, AC voltmeter, ammeter/voltmeter phase selector switch, voltage adjust rheostat and frequency meter.

Weight: 7,500 Lbs.

REV. | | REV.

Stearns-Roger

STUDY DATA SHEET

ITEM NO. H-6
ACC'T. ____ PAGE ____
S.R JOB B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

DATE August, 1971 BY JGN

SERVICE Integrated Flare System — NO. REQ'D. One

REVISIONS: a ____ BY ____ : b ____ BY ____ : c ____ BY ____ : d ____ BY ____

MANUFACTURER John Zink — SOURCE: QUOTE OF ____

One (1) Integrated flare system consisting of the following:

One (1) 24" OD x 100' high elevated flare complete with stainless steel tip and pilots and with a molecular seal. Unit designed for 90 MMSCFd of plant inlet gas.

One (1) 48" OD x 35' high fan-assisted, smokeless flare complete with stainless steel tip, pilots, and axial fan. Unit designed for 22 MMSCFd of plant inlet gas.

One (1) Flame Front Generator for remote ignition of flare pilots.

FORM 1.11

FIRED HEATERS
STUDY DATA SHEET

Stearns-Roger

ITEM NO. H-11
ACC'T. ______ PAGE ______
S.R JOB B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

DATE August, 1971 BY DJM

SERVICE AMINE STILL REBOILER — NO. REQ'D. ONE(TWO)
REVISIONS : a 8/71 BY RTG : b ______ BY ______ : c ______ BY ______ : d ______ BY ______
MANUFACTURER ______ SOURCE: QUOTE OF ______
MODEL & TYPE ______

CONDITIONS OF SERVICE

CONDITIONS SHOWN FOR TOTAL REQUIRED SERVICE: TOTAL OPERATING UNITS REQUIRED AND 1 (2) SPARE UNITS —

FLUID 25 WT.% DEA & WATER
LIQUID, LB/HR IN 197,760 OUT 176,760
SP.GR. @ 60° IN ______ OUT ______
MWT IN ______ OUT ______
VIS. @ 60° IN ______ OUT ______
VAPOR, LB/HR IN ______ OUT 21,000
MWT IN ______ OUT ______
LIQ.GR. @ 60° IN ______ OUT ______
ABOVE ARE NORMAL QUANTITIES: INCREASE BY 0 % FOR DESIGN
TEMPERATURE, °F IN 250 OUT 275
PRESSURE, PSIA IN 69 OUT 32
MAX. ALLOWABLE PRESSURE DROP (@ DESIGN RATE), PSI 40

DUTY, BTU/HR NORMAL 24,500,000 DESIGN SAME
DAILY SERVICE DURATION CONTINUOUS
MAX. ALLOW. RADIANT RATE (@ DESIGN RATE), BTU/HR/SQ.FT. 8000
REQUIRED MWP, PSIG 100
CODE API
REQ'D. DESIGN WIND LOAD PER ASA 58.1
ELEVATION, FT. ______
FUEL, TYPE GAS
SP.GR. @ 60° ______
LHV 1550 BTU/SCF
SEISMIC ZONE — 3

PERFORMANCE (OF SINGLE UNIT UNLESS NOTED)

RADIANT TRANSFER RATE (@ DESIGN RATE), BTU/HR/SQ.FT. AVERAGE ______ MAXIMUM ______
CONVECTION TRANS. RATE (@ DESIGN RATE), BTU/HR/SQ.FT. AVERAGE ______ MAXIMUM ______
PRESSURE DROP (@ DESIGN RATE) PSI CALCULATED ______ GUARANTEED ______ @ NORM. DUTY ______
EFFICIENCY BASED ON LHV @ 20 % EXCESS AIR GUARANTEED % ______ MINIMUM % 80

MATERIALS AND DESIGN

TUBES	NO.	O.D.	WALL (AVG/MIN)	LENGTH	EFF. SQ. FT.	MATERIAL & ASTM SPEC.
RADIANT						A-106 SEAMLESS
CONVECTION						
FINNED						

FINS NO./INCH ______ HEIGHT ______ THICKNESS ______ MATERIAL ______

RET'N. BENDS	NO.	SIZE	WALL (AVG/MIN)	TYPE, MATERIAL & ASTM SPEC.
RADIANT				WELDED A-234 OR EQUAL
CONVECTION				

HEADERS, NO. & TYPE ______
TUBE SUPPORTS, MAT'L. & TYPE ______
BURNERS, NO. & TYPE JOHN ZINK OR EQUAL — BURNER PRESSURE, PSIG ______
PILOTS, NO. & TYPE YES — BURNER PRESSURE, PSIG ______
REFRACTORIES ______
NO. OF PASSES: RADIANT (1) CONVECTION (1)
CORROSION ALLOWANCE 1/8" MIN.
MAX. ALLOW. WORKING PRESS., PSIG ______
DESIGN PRESS., PSIG ______ HOURS/1% CREEP ______
THERMOCOUPLE CONN: IN TUBES RAD. OUT EACH PASS
IN RETURN BENDS ______ IN STACK ______

INSULATION ______
INLET NOZZLES ______
OUTLET NOZZLES ______
SAMPLE CONN. ______
DRAFT CONN. ______
SMOTHERING CONN. ______

CONSTRUCTION

HEATER DIM'N. ~14' Ø x 35' + STACK
STACK: DIAM. ______ HT. ABOVE GRADE 50 FT. MAX.
SUPPORT ON HEATER
DESIGN WIND LOAD ______
APPROX. WT: SHIPPING ______ ASSEMBLED ______

DAMPER C.S. - MANUAL OP. FROM GRADE
LADDER & PLATFORM YES
WIND DIVERTER NO
TUBE PULLING FACILITIES BY USER

REMARKS: 1. NO. OF PASSES TO BE MINIMIZED CONSISTANT WITH MAX. ΔP.
2. TURNDOWN RATIO APPROX. 3/1 - NORMAL OPERATION WILL BE 50 - 60% LOAD.

FURNACES

STUDY DATA SHEET

Stearns-Roger

ITEM NO. H-21

ACC'T. ______ PAGE ______

CUSTOMER HUMBLE OIL AND REFINING COMPANY — S.R JOB B-41449

PROJECT GAS PROCESSING STUDY

LOCATION SANTA BARBARA CHANNEL, CALIFORNIA — DATE August, 1971 — BY JW/DJM

SERVICE SO_2 Generator — NO. REQ'D. 1 (2)

REVISIONS: a 8/71 BY RTG : b ______ BY ______ : c ______ BY ______ : d ______ BY ______

MANUFACTURER ______ SOURCE: QUOTE OF ______

One (2) - thermal reaction furnace to convert all of the H_2S in the feed stream (below) to SO_2, under conditions of minimum excess air.

General Design Conditions are:

A. Feed Rate -

H_2S	197 (139)	mols/day
CO_2	1795 (1276)	mols/day
CH_4	5 (4)	mols/day
C_2H_6	1 (0)	mols/day
H_2O	109 (78)	mols/day

B. Feed Temperature - 450°F

C. Air Temperature - 750°F

D. Auxiliary Fuel- 1550 BTU/SCF (LHV)

E. Residence Time - 3.0 seconds (Minimum)

F. Design Gas Outlet Temperature - 2000°F (auxiliary fuel is to be used to obtain this level)

G. Design Excess Air at Outlet of Furnace - 0.2%

Note: 1) Sized on initial conditions

FORM 1.11

FIRED HEATERS
STUDY DATA SHEET

Stearns-Roger

ITEM NO. H-22A
ACC'T. ______ PAGE ______
S.R JOB B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA
DATE August, 1971 BY JEW/DJ

SERVICE CONVERTER GAS REHEATER NO. REQ'D. 1(2)
REVISIONS : a 8/71 BY RTG : b ______ BY ______ : c ______ BY ______ : d ______ BY ______
MANUFACTURER ______ SOURCE: QUOTE OF ______
MODEL & TYPE VERTICAL - CYLINDRICAL (ALL RADIANT)

CONDITIONS OF SERVICE

CONDITIONS SHOWN FOR TOTAL REQUIRED SERVICE: 1(2) TOTAL OPERATING UNITS REQUIRED AND – SPARE UNITS

FLUID	ACID GAS ($H_2S + SO_2 + S$)		DUTY, BTU/HR NORMAL 243,000 (175,000) DESIGN	SAME
LIQUID, LB/HR	IN	OUT	DAILY SERVICE DURATION	CONTINUOUS
SP. GR. @ 60°	IN	OUT	MAX. ALLOW. RADIANT RATE (@ DESIGN RATE), BTU/HR/SQ.FT.	8000
MWT	IN	OUT	REQUIRED MWP, PSIG	
VIS. @ 60°	IN	OUT	CODE	API & MFG. STD.
a VAPOR, LB/HR	IN 13,091 (9204)	OUT 13,091 (9204)	REQ'D. DESIGN WIND LOAD	PER ASA 58.1
a MWT	IN 37.39	OUT 37.39	ELEVATION, FT.	SEA LEVEL
LIQ. GR. @ 60°	IN	OUT	FUEL, TYPE	FUEL GAS
ABOVE ARE NORMAL QUANTITIES: INCREASE BY – % FOR DESIGN			SP. GR. @ 60°	
TEMPERATURE, °F	IN 335	OUT 410	LHV	1550 BTU/SCF a
a PRESSURE, PSIG	IN 5.9	OUT 5.1		
MAX. ALLOWABLE PRESSURE DROP (@ DESIGN RATE), PSI	0.8		SEISMIC ZONE 3	

PERFORMANCE (OF SINGLE UNIT UNLESS NOTED)

RADIANT TRANSFER RATE (@ DESIGN RATE), BTU/HR/SQ.FT. AVERAGE ______ MAXIMUM ______
CONVECTION TRANS. RATE (@ DESIGN RATE), BTU/HR/SQ.FT. AVERAGE ______ MAXIMUM ______
PRESSURE DROP (@ DESIGN RATE) PSI CALCULATED ______ GUARANTEED ______ @ NORM. DUTY ______
EFFICIENCY BASED ON LHV @ ______ % EXCESS AIR GUARANTEED % ______ MINIMUM % ______

MATERIALS AND DESIGN

TUBES	NO.	O.D.	WALL (AVG/MIN)	LENGTH	EFF. SQ. FT.	MATERIAL & ASTM SPEC.
RADIANT						A-106 B SEAMLESS
CONVECTION						NOT REQ'D
FINNED						" "

FINS NO./INCH ______ HEIGHT ______ THICKNESS ______ MATERIAL ______

RET'N. BENDS	NO.	SIZE	WALL (AVG/MIN)	TYPE, MATERIAL & ASTM SPEC.
RADIANT				WELDED A-234 OR EQUAL
CONVECTION				

HEADERS, NO. & TYPE ______
TUBE SUPPORTS, MAT'L. & TYPE ______
BURNERS, NO. & TYPE J. ZINC OR EQUAL BURNER PRESSURE, PSIG ______
PILOTS, NO. & TYPE YES BURNER PRESSURE, PSIG ______

REFRACTORIES	INSULATION
NO. OF PASSES: RADIANT 1 CONVECTION	INLET NOZZLES
CORROSION ALLOWANCE 1/8"	OUTLET NOZZLES
MAX. ALLOW. WORKING PRESS., PSIG 50	SAMPLE CONN.
DESIGN PRESS., PSIG ______ HOURS/1% CREEP	DRAFT CONN.
THERMOCOUPLE CONN: IN TUBES	SMOTHERING CONN.
IN RETURN BENDS ______ IN STACK	

CONSTRUCTION

HEATER DIM'N. APPROX. 7'Ø X 12' + STACK	DAMPER MANUAL - SS - OP. FROM GRADE
STACK: DIAM. ______ HT. ABOVE GRADE 50 FT.	LADDER ~~& PLATFORM~~ TO PEEPHOLES ONLY
SUPPORT ON HEATER	WIND DIVERTER NO
DESIGN WIND LOAD PER ASA 58.1	TUBE PULLING FACILITIES NO
APPROX. WT: SHIPPING ______ ASSEMBLED ______	

REMARKS: 1) H-22A & H-22B TO BE COMBINED IN ONE HEATER. HEATER TO BE ALL RADIANT DESIGN WITH TWO SEPARATE RADIANT SECTIONS.
2) SINGLE PASS DESIGN IS REQ'D.
3) SIZE BASED ON INITIAL CONDITIONS.

FORM 1.11

FIRED HEATERS
STUDY DATA SHEET

Stearns-Roger

ITEM NO. H-22B
ACC'T. ______ PAGE ______
S.R JOB B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA
DATE August, 1971 BY JEW/DJM

SERVICE CONVERTER GAS REHEATER NO. REQ'D. 1 (2)
REVISIONS : a 8/71 BY RTG : b ______ BY ______ : c ______ BY ______ : d ______ BY ______
MANUFACTURER ______ SOURCE: QUOTE OF ______
MODEL & TYPE VERTICAL - CYLINDRICAL - ALL RADIANT

CONDITIONS OF SERVICE

CONDITIONS SHOWN FOR TOTAL REQUIRED SERVICE: TOTAL OPERATING UNITS REQUIRED AND ______ SPARE UNITS

FLUID ACID GAS ($H_2S + SO_2 + S$)			DUTY, BTU/HR NORMAL 208,000 (150,000) DESIGN SAME
LIQUID, LB/HR	IN	OUT	DAILY SERVICE DURATION CONTINUOUS
SP. GR. @ 60°	IN	OUT	MAX. ALLOW. RADIANT RATE (@ DESIGN RATE), BTU/HR/SQ. FT. 8000
MWT	IN	OUT	REQUIRED MWP, PSIG
VIS. @ 60°	IN	OUT	CODE API & MFG. STD.
(a) VAPOR, LB/HR	IN 13,011 (9146)	OUT 13,011 (9146)	REQ'D. DESIGN WIND LOAD PER ASA 58-1
(a) MWT	IN 37.25	OUT 37.25	ELEVATION, FT. SEA LEVEL
LIQ. GR. @ 60°	IN	OUT	FUEL, TYPE FUEL GAS
ABOVE ARE NORMAL QUANTITIES: INCREASE BY ___ % FOR DESIGN			SP. GR. @ 60°
TEMPERATURE, °F	IN 335	OUT 400	LHV 1550 BTU/SCF (a)
(a) PRESSURE, PSIG	IN 3.7	OUT 2.9	
MAX. ALLOWABLE PRESSURE DROP (@ DESIGN RATE), PSI 0.8			SEISMIC ZONE 4

PERFORMANCE (OF SINGLE UNIT UNLESS NOTED)

RADIANT TRANSFER RATE (@ DESIGN RATE), BTU/HR/SQ. FT. AVERAGE ______ MAXIMUM ______
CONVECTION TRANS. RATE (@ DESIGN RATE), BTU/HR/SQ. FT. AVERAGE ______ MAXIMUM ______
PRESSURE DROP (@ DESIGN RATE) PSI CALCULATED ______ GUARANTEED ______ @ NORM. DUTY ______
EFFICIENCY BASED ON LHV @ ______ % EXCESS AIR GUARANTEED % ______ MINIMUM % ______

MATERIALS AND DESIGN

TUBES	NO.	O.D.	WALL (AVG/MIN)	LENGTH	EFF. SQ. FT.	MATERIAL & ASTM SPEC.
RADIANT						A-106-B
CONVECTION						NOT REQ'D
FINNED						" "

FINS NO./INCH ______ HEIGHT ______ THICKNESS ______ MATERIAL ______

RET'N. BENDS	NO.	SIZE	WALL (AVG/MIN)	TYPE, MATERIAL & ASTM SPEC.
RADIANT				WELDED A-234 OR EQUAL
CONVECTION				

HEADERS, NO. & TYPE ______
TUBE SUPPORTS, MAT'L & TYPE ______
BURNERS, NO. & TYPE JOHN ZINC OR EQUAL BURNER PRESSURE, PSIG ______
PILOTS, NO. & TYPE YES BURNER PRESSURE, PSIG ______

REFRACTORIES	INSULATION
NO. OF PASSES: RADIANT 1 CONVECTION	INLET NOZZLES
CORROSION ALLOWANCE 1/8"	OUTLET NOZZLES
MAX. ALLOW. WORKING PRESS., PSIG 50	SAMPLE CONN.
DESIGN PRESS., PSIG ______ HOURS/1% CREEP	DRAFT CONN.
THERMOCOUPLE CONN: IN TUBES	SMOTHERING CONN.
IN RETURN BENDS ______ IN STACK	

CONSTRUCTION

HEATER DIM'N. APPROX. 7' Ø X 12' + STACK	DAMPER MANUAL - SS - OP. FROM GRADE
STACK: DIAM. ______ HT. ABOVE GRADE 50 FT.	LADDER ~~& PLATFORM~~ TO PEEPHOLES ONLY
SUPPORT ON HEATER	WIND DIVERTER NO
DESIGN WIND LOAD PER ASA 58.1	TUBE PULLING FACILITIES NO

APPROX. WT: SHIPPING ______ ASSEMBLED ______

REMARKS: 1) H-22A & H-22B TO BE COMBINED IN ONE HEATER. HEATER TO BE ALL RADIANT DESIGN WITH TWO SEPARATE RADIANT SECTIONS.
2) SINGLE PASS DESIGN IS REQ'D
3) SIZE BASED ON INITIAL CONDITIONS.

FORM 1.11

REV. | REV.

Stearns-Roger

FIRED HEATERS
STUDY DATA SHEET

ITEM NO. H-23A
ACC'T. ______ PAGE ______
S.R JOB B-41449

CUSTOMER: HUMBLE OIL AND REFINING COMPANY
PROJECT: GAS PROCESSING STUDY
LOCATION: SANTA BARBARA CHANNEL, CALIFORNIA
DATE: August, 1971 BY: JEW/DJM

SERVICE: ACID GAS PREHEATER — NO. REQ'D.: 1 (2)
REVISIONS: a 8/71 BY RTG; b ______ BY ______; c ______ BY ______; d ______ BY ______
MANUFACTURER: ______ SOURCE: QUOTE OF ______
MODEL & TYPE: ______

CONDITIONS OF SERVICE

CONDITIONS SHOWN FOR TOTAL REQUIRED SERVICE: TOTAL OPERATING UNITS REQUIRED AND ______ SPARE UNITS

Rev.	Item	In	Out
	FLUID	ACID GAS + H_2O	
	LIQUID, LB/HR		
	SP.GR. @ 60°		
	MWT		
	VIS. @ 60°		
	VAPOR, LB/HR	3657 (2598)	3657 (2598)
a	MWT	41.65	41.65
	LIQ.GR. @ 60°		
	ABOVE ARE NORMAL QUANTITIES: INCREASE BY 36 % FOR DESIGN		
a	TEMPERATURE, °F	110	450
a	PRESSURE, PSIA	24.4	23.4
	MAX. ALLOWABLE PRESSURE DROP (@ DESIGN RATE), PSI	1.0	

Item	Value	Rev.
DUTY, BTU/HR	NORMAL 473,000 (335,000) DESIGN SAME	a
DAILY SERVICE DURATION	CONTINUOUS	
MAX. ALLOW. RADIANT RATE (@ DESIGN RATE), BTU/HR/SQ.FT.	10000	
REQUIRED MWP, PSIG		
CODE	API & MFG. STD.	
REQ'D. DESIGN WIND LOAD	PER ASA 58.1	
ELEVATION, FT.	SEA LEVEL	
FUEL, TYPE	GAS	
SP.GR. @ 60°		
LHV	1550 BTU/SCF	a
	SEISMIC ZONE 3	

PERFORMANCE (OF SINGLE UNIT UNLESS NOTED)

RADIANT TRANSFER RATE (@ DESIGN RATE), BTU/HR/SQ.FT. AVERAGE ______ MAXIMUM ______
CONVECTION TRANS. RATE (@ DESIGN RATE), BTU/HR/SQ.FT. AVERAGE ______ MAXIMUM ______
PRESSURE DROP (@ DESIGN RATE) PSI CALCULATED ______ GUARANTEED ______ @ NORM. DUTY ______
EFFICIENCY BASED ON LHV @ ______ % EXCESS AIR GUARANTEED % ______ MINIMUM % ______

MATERIALS AND DESIGN

TUBES	NO.	O.D.	WALL (AVG/MIN)	LENGTH	EFF. SQ.FT.	MATERIAL & ASTM SPEC.
RADIANT						A-106
CONVECTION						NOT REQ'D
FINNED						" "

FINS NO./INCH ______ HEIGHT ______ THICKNESS ______ MATERIAL ______

RET'N. BENDS	NO.	SIZE	WALL (AVG/MIN)	TYPE, MATERIAL & ASTM SPEC.
RADIANT				WELDED A234 OR EQUAL
CONVECTION				

HEADERS, NO. & TYPE ______
TUBE SUPPORTS, MAT'L & TYPE ______
BURNERS, NO. & TYPE ______ BURNER PRESSURE, PSIG ______
PILOTS, NO. & TYPE ______ BURNER PRESSURE, PSIG ______

REFRACTORIES	INSULATION
NO. OF PASSES: (1) RADIANT ONE CONVECTION	INLET NOZZLES
CORROSION ALLOWANCE 1/8" MIN.	OUTLET NOZZLES
MAX. ALLOW. WORKING PRESS., PSIG	SAMPLE CONN.
DESIGN PRESS, PSIG ______ HOURS/1% CREEP	DRAFT CONN.
THERMOCOUPLE CONN: IN TUBES	SMOTHERING CONN.
IN RETURN BENDS ______ IN STACK	

CONSTRUCTION

HEATER DIM'N. ~ 7'Ø X 12' BOX	DAMPER YES - SS - OP. FROM GRADE
STACK: DIAM. ______ HT. ABOVE GRADE 50' MAX.	LADDER ~~& PLATFORM~~ TO PEEPHOLES ONLY
SUPPORT	WIND DIVERTER NO
DESIGN WIND LOAD	TUBE PULLING FACILITIES NO
APPROX. WT: SHIPPING ______ ASSEMBLED	

REMARKS: 1) H-23A & H-23B TO BE COMBINED IN ONE HEATER, HEATER TO BE ALL RADIANT DESIGN WITH TWO SEPARATE RADIANT SECTIONS
2) SINGLE PASS DESIGN IS REQ'D.
3) SIZE IS BASED ON INITIAL CONDITIONS.

FORM 1.11

FIRED HEATERS
STUDY DATA SHEET

Stearns-Roger

ITEM NO. H-23B
ACC'T. ______ PAGE ______
S.R JOB B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA
DATE August, 1971 BY JEW/DTM

SERVICE AIR PREHEATER — NO. REQ'D. 1 (2)

REVISIONS: a 8/71 BY RTG : b ______ BY ______ : c ______ BY ______ : d ______ BY ______

MANUFACTURER ______ SOURCE: QUOTE OF ______

MODEL & TYPE ______

CONDITIONS OF SERVICE

CONDITIONS SHOWN FOR TOTAL REQUIRED SERVICE: TOTAL OPERATING UNITS REQUIRED AND SPARE UNITS

- FLUID AIR + 4% H_2O
- DUTY, BTU/HR NORMAL 282,000 (201,000) DESIGN 390,000 — a
- LIQUID, LB/HR IN ______ OUT ______
- DAILY SERVICE DURATION CONTINUOUS
- SP. GR. @ 60° IN ______ OUT ______
- MAX. ALLOW. RADIANT RATE (@ DESIGN RATE), BTU/HR/SQ.FT 8000
- MWT IN ______ OUT ______
- REQUIRED MWP, PSIG ______
- VIS. @ 60° IN ______ OUT ______
- CODE API & MFG. STD.
- a — VAPOR, LB/HR IN 2696 (1814) OUT 2696 (1814)
- REQ'D. DESIGN WIND LOAD PER ASA 58.1
- a — MWT IN 28.51 OUT 28.51
- ELEVATION, FT. SEA LEVEL
- LIQ. GR. @ 60° IN ______ OUT ______
- FUEL, TYPE FUEL GAS
- ABOVE ARE NORMAL QUANTITIES: INCREASE BY ____ % FOR DESIGN
- SP. GR. @ 60° ______
- TEMPERATURE, °F IN 180 OUT 750
- LHV 1550 BTU/SCF — a
- a — PRESSURE, PSIA IN 24.4 OUT 23.4
- MAX. ALLOWABLE PRESSURE DROP (@ DESIGN RATE), PSI 1.0
- SEISMIC ZONE 3

PERFORMANCE (OF SINGLE UNIT UNLESS NOTED)

- RADIANT TRANSFER RATE (@ DESIGN RATE), BTU/HR/SQ.FT. AVERAGE ______ MAXIMUM ______
- CONVECTION TRANS. RATE (@ DESIGN RATE), BTU/HR/SQ.FT. AVERAGE ______ MAXIMUM ______
- PRESSURE DROP (@ DESIGN RATE) PSI CALCULATED ______ GUARANTEED ______ @ NORM. DUTY ______
- EFFICIENCY BASED ON LHV @ ______ % EXCESS AIR GUARANTEED % ______ MINIMUM % ______

MATERIALS AND DESIGN

TUBES	NO.	O.D.	WALL (AVG/MIN)	LENGTH	EFF. SQ. FT.	MATERIAL & ASTM SPEC.
RADIANT						A-106-B SEAMLESS
CONVECTION						NOT REQ'D
FINNED						" "

FINS NO./INCH ______ HEIGHT ______ THICKNESS ______ MATERIAL ______

RET'N. BENDS	NO.	SIZE	WALL (AVG/MIN)	TYPE, MATERIAL & ASTM SPEC.
RADIANT				WELDED A234 OR EQUAL
CONVECTION				

- HEADERS, NO. & TYPE ______
- TUBE SUPPORTS, MAT'L & TYPE ______
- BURNERS, NO. & TYPE ______ BURNER PRESSURE, PSIG ______
- PILOTS, NO. & TYPE ______ BURNER PRESSURE, PSIG ______
- REFRACTORIES ______
- INSULATION ______
- NO. OF PASSES: RADIANT ONE CONVECTION ______
- INLET NOZZLES ______
- CORROSION ALLOWANCE ______
- OUTLET NOZZLES ______
- MAX. ALLOW. WORKING PRESS., PSIG ______
- SAMPLE CONN. ______
- DESIGN PRESS., PSIG ______ HOURS/1% CREEP
- DRAFT CONN. ______
- THERMOCOUPLE CONN: IN TUBES ______
- SMOTHERING CONN. ______
- IN RETURN BENDS ______ IN STACK ______

CONSTRUCTION

- HEATER DIM'N. 2-7'Ø X 12' BOX
- DAMPER YES - SS - OP. FROM GRADE
- STACK: DIAM. ______ HT. ABOVE GRADE 50' MAX
- LADDER ~~& PLATFORM~~ TO PEEPHOLES ONLY
- SUPPORT ______
- WIND DIVERTER NO
- DESIGN WIND LOAD ______
- TUBE PULLING FACILITIES NO.
- APPROX. WT: SHIPPING ______ ASSEMBLED ______

REMARKS: 1) H-23B & H-23A TO BE COMBINED IN ONE HEATER, HEATER TO BE ALL RADIANT DESIGN WITH TWO SEPARATE RADIANT SECTIONS.
2) SINGLE PASS DESIGN IS REQ'D.
3) SIZE IS BASED ON INITIAL CONDITIONS.

Stearns-Roger

INCINERATORS
STUDY DATA SHEET

ITEM NO. H-24
ACC'T. ______ PAGE ______
S.R JOB B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

DATE August, 1971 BY JW/D

SERVICE Tail Gas Incinerator & Stack — NO. REQ'D. 1 (1)

REVISIONS: a 8/71 BY RTG : b BY : c BY : d BY

MANUFACTURER — SOURCE: QUOTE OF

One (1) - tail gas incinerator to convert the sulfur compounds in the claus sulfur plant tail gas stream (below) completely to SO_2.

General design considerations are:

A. Feed Rate -

H_2S	4	(4)	mols/day
CO_2	5472	(7765)	mols/day
SO_2	2	(2)	mols/day
H_2O	1149	(1589)	mols/day
O_2	1	(1)	mols/day
N_2	1734	(2336)	mols/day
S_8V	Trace	(Trace)	mols/day
C_1	10	(13)	mols/day
C_2	0	(1)	mols/day

B. Stack Height - 100 Feet

C. Stack Outlet Temperature - 1000 degrees F minimum

D. Air blower by others

Note: 1) Size unit on <u>ultimate</u> case in parenthesis

FORM 1.32

REV.

RECIPROCATING PUMPS

STUDY DATA SHEET

Stearns-Roger

ITEM NO. P-1

ACC'T. ____ PAGE ____

S.R JOB B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY

PROJECT GAS PROCESSING STUDY

LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

DATE August 1971 BY DJM

SERVICE DUMP LIQUID PUMP — NO. REQ'D. ONE (1)

REVISIONS :a ____ BY ____ :b ____ BY ____ :c ____ BY ____ :d ____ BY ____

MANUFACTURER ____ SOURCE: QUOTE OF ____

MODEL TYPE & SIZE MOTOR DRIVEN TRIPLEX

CONDITIONS OF SERVICE

CONDITIONS SHOWN FOR TOTAL REQUIRED SERVICE: TOTAL OPERATING PUMPS REQUIRED AND 0 SPARE PUMPS

- FLUID HC CONDENSATE
- PUMPING TEMPERATURE, °F 100°F
- SP. GR. @ 60°F ____ @ P.T. .54
- VISCOSITY @ P.T. 0.1 CPS
- VAPOR PRESSURE, PSIA 90 @ 100 °F
- BAROMETRIC PRESSURE, PSIA 14.7
- NPSH AVAILABLE @ SUCT. FLG., FT. OF FLUID 10 FT.
- REQ'D. ____ GPM @ 60°
- 15 GPM @ P.T., NORM. 15 DESIGN 30
- SUCT. PRESS., PSIA 95
- DISCH. PRESS., PSIA 935
- DIFF. PRESS., PSIA 840
- DRIVING MEDIUM MOTOR
- PRESSURE, PSIG SUPPLY ____ EXHAUST ____
- SUPPLY TEMP. °F ____ QUALITY % ____

PERFORMANCE (OF SINGLE UNIT UNLESS NOTED)

- NPSH REQ'D. @ SUCT. FLG., FT. OF FLUID ____
- DESIGN ____ GPM EACH PUMP ____ TOTAL ____
- DESIGN PISTON SPEED, FPM ____ RPM ____
- MAX. ALLOW. PISTON SPEED, FPM ____ RPM ____
- STALLING PRESSURE, PSIG ____ @ 100% M.E. WITH ____ PSIG SUPPLY, ____ PSIG EXH.
- DESIGN EFFICIENCY, % VOLUMETRIC ____ MECH. ____
- DESIGN HYDRAULIC HORSEPOWER, HHP 14.7
- BHP (POWER PUMPS) DESIGN ____ MAX. ____
- STEAM CONSUMPTION, LB/HHP/HR ____ LB/HR ____
- STEAM CHEST PRESS. @ DESIGN RATE, PSIG ____

MATERIALS AND DESIGN

- LIQUID END: CYLINDER STEEL
  - CYLINDER LINER ____
  - TYPE ____
  - PISTON/PLUNGER ____
  - PISTON PACKING ____
  - PISTON ROD ____
  - ROD PACKING ____
  - STUFFING BOX ____
  - LANTERN RING ____
  - PACKING GLAND ____
  - STEAM JACKET ____
  - MAX. ALLOW. W.P. ____ PSIG @ ____ °F
  - CORR. ALLOW. IN. ____ HYD. TEST PSIG ____
- STEAM END: CYLINDER ____
  - PISTON ROD ____
  - PACKING ____
  - TYPE VALVE ____
  - MAX. ALLOW. W.P. ____ PSIG @ ____ °F TEST PSIG ____
  - SUPPLY NOZZLE ____
  - EXHAUST NOZZLE ____
- LIQUID END: VALVES STEEL
  - VALVE SEATS ____
  - VALVE SPRINGS ____
  - SUCT. VALVES, NO. & SIZE ____ SQ. IN. ____
  - VELOCITY, FPM DESIGN ____ MAX. ____
  - DISCH. VALVES, NO. & SIZE ____ SQ. IN. ____
  - VELOCITY, FPM DESIGN ____ MAX. ____
  - COOLING WATER ____ @ ____ °F & ____ PSIG
  - ____ GPM TO ____
  - ____ GPM TO ____
  - VENTS ____ DRAINS ____
  - SUCT. NOZZLE ____
  - DISCH. NOZZLE ____
- POWER: FRAME TYPE ____
  - MAINSHAFT RPM ____ GEARSHAFT RPM ____
  - GEAR RATIO ____ LUBRICATION ____
  - DRIVE TYPE ____
  - GUARD ____
  - BASEPLATE ____
  - DRIVER MOUNTING ____

LUBRICATOR ____ LAGGING ____ REVOLUTION COUNTER ____

REMARKS: ____

DRIVER

FURNISHED BY ____ MOUNTED BY ____

ELECTRIC MOTOR NO. REQ'D. 1 MFG'R GE OR EQ. OTHER DRIVER TYPE & REF PG. ____

HP 25 RPM ____ FRAME ____ TYPE TEFC BEARINGS ____

VOLTS 460 PH 3 CY 60 LUBRICATION ____ TORQUE/THRUST ____

REV.

Form 1.34
REV. 9-69

Stearns-Roger

CENTRIFUGAL PUMP
STUDY DATA SHEET

TAG No. P-6
ACC'T.
S.R JOB B-41449
PAGE 1 OF 1
DATE August 1971 BY

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

SERVICE H.C. VENT TANK PUMP   NO. OPERATING 1   SPARE 0
REVISIONS: a BY ; b BY ; c BY ; d BY
MANUFACTURER   MODEL   SIZE   TYPE VERT. TURB.
SOURCE: QUOTATION No: DATE:

LIQUID CHARACTERISTICS
LIQUID Hydrocarbon
PT °F 60 SP GR @ 60°F/@PT 0.7 / 0.7
VIS (CP) @ °F/@PT /
VAP. PRESS. PSIA@ °F/@PT /
BAROMETRIC PRESS. PSIA 14.7
OTHER

CONDITIONS OF SERVICE-EACH PUMP

	CALCULATED	RATED	MIN / MAX
USGPM @ 60°F		20	/
USGPM @ PT		20	/
DIS PRESS PSIG		50	/
SUC PRESS PSIG		0	/
DIFF HEAD FT.		165	/
NPSHA FT(SUC FLG)			/

AVAILABLE SUMP DEPTH FT

CONSTRUCTION REQUIREMENTS
CUST. SPECS
TYPE: API 610☐ AVS☐ OTHER
SUPPORT: CENTERLINE☐ BASE☐ IN-LINE☐ VERTICAL☐
CASE SPLT: RADIAL☐ AXIAL☐ CORROSION ALLOW IN
CPLG & GUARD BY DRIVER HALF MTD. BY
COUPLING MFG MODEL
☐ MECH. SEAL: MFG MODEL
SINGLE☐ DOUBLE☐ TANDEM☐ BAL.☐ UNBAL.☐
☐ PACKING: MFG & TYPE
BASEPLATE: CI☐ FAB STL☐ DRIP LIP☐ EXTENDED☐

AUXILIARY CONNECTIONS

SERVICE	SIZE	LIQUID	GPM	°F	PSIG	PIPED BY
FLUSHING INLET						
FLUSHING OUTLET						
COOLING INLET						
COOLING OUTLET						
QUENCHING INLET						
QUENCHING OUTLET						
CLG. JKT - SEAL						
CLG. JKT-BEARING						
CLG. JKT-PEDESTAL						
OTHER						

TOTAL EXTERNAL COOLING WATER GPM@ °F
CASING VENT CASING DRAIN GAGE CONN'S
WTS: PUMP BASE DRIVER

PERFORMANCE & CONSTRUCTION
RATED RPM ROTATION(FACING PUMP CPLG)
NO. OF STAGES MIN CONT FLOW GPM
MIN SUBMER REQ'D FT IMPELLER TYPE
MAX ALLOW CASE WP PSIG @ °F

	RATED	MIN/MAX
NPSHR FT	@SUC FLG	
EFF %		/
BHP	~ 1 1/3	/
IMP DIA		/

CONNECTIONS	SIZE	ASA	FACE	POSITION
SUCTION				
DISCHARGE				

DRIVER: FURNISHED BY VENDOR MTD BY VENDOR
MFG. GE or Equiv. ENC Exp Prf. FRAME
HP 2 RPM 3600 VOLTS/PHASE/HZ
SEE DRIVER SPEC

AUXILIARY PIPING & ACCESSORIES
MECH SEAL FLUSH PLAN (API 610 APP C)

	BY S-R	BY MFG.		BY S-R	BY MFG
PIPE	☐	☐	TUBING	☐	☐
HEAT EXCHANGER	☐	☐	STRAINER	☐	☐
ORIFICE	☐	☐	SEPARATOR	☐	☐

OTHER

MATERIALS:

PUMP		SEAL	
CASING		ROT FACE	
IMPELLER		STAT FACE	
SHAFT		SPRINGS	
SLEEVE		SHAFT SEAL	
IMP WEAR RINGS		STAT SEAL	
CASE WEAR RINGS		AUX. SEAL	
STATIC SEALS		PIPE/TUBING	
BUSHINGS		OTHER	

TESTING & INSPECTION (W INDICATES WITNESSED)
CERTIFIED SHOP TESTS:
PERFORMANCE☐ HYDRO☐@ PSIG
NPSHR (ON WATER)☐ NONE☐ OTHER
INSPECTION:
☐NONE ☐OTHER
CERT PERF CURVE(MIN/MAX HD, FLOW, EFF, BHP, NPSHR) ☐
PERF CURVE NO.
BEARINGS: PLAIN☐ ANTIFRICTION☐
LUBRICATION: GREASE☐ OIL RING☐
FORCE FEED☐ OTHER☐

REMARKS:

Form 1.34
Rev. 9-69

Stearns-Roger

CENTRIFUGAL PUMP
STUDY DATA SHEET

TAG NO. P-7
ACC'T.
S.R JOB B-41449
PAGE ___ OF ___
DATE August 1971 BY KGW

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

REV.

SERVICE DRAIN TANK PUMP — NO. OPERATING ONE — SPARE NO
REVISIONS: a ___ BY ___ :b ___ BY ___ :c ___ BY ___ :d ___ BY ___
MANUFACTURER ___ MODEL ___ SIZE ___ TYPE VERT TURB
SOURCE: ___ QUOTATION NO: ___ DATE:

LIQUID CHARACTERISTICS

LIQUID HC & WATER
PT °F 60 SP GR @ 60°F/PT 0.7/1.0
VIS (CP) @ ___ °F/@PT ___ /
VAP. PRESS. PSIA @ ___ °F/@PT ___ /
BAROMETRIC PRESS. PSIA ___
OTHER ___

CONDITIONS OF SERVICE-EACH PUMP

	CALCULATED	RATED	MIN / MAX
USGPM @ 60°F		20	/
USGPM @ PT		20	/
DIS PRESS PSIG		26/37	
SUC PRESS PSIG		0	
DIFF HEAD FT.		60	
NPSHA FT(SUC FLG)			

AVAILABLE SUMP DEPTH FT ___

CONSTRUCTION REQUIREMENTS

CUST. SPECS ___
TYPE: API 610☐ AVS☐ OTHER ___
SUPPORT: CENTERLINE☐ BASE☐ IN-LINE☐ VERTICAL☐
CASE SPLT: RADIAL☐ AXIAL☐ CORROSION ALLOW ___ IN
CPLG & GUARD BY ___ DRIVER HALF MTD. BY ___
COUPLING MFG ___ MODEL ___
☐ MECH. SEAL: MFG ___ MODEL ___
SINGLE☐ DOUBLE☐ TANDEM☐ BAL.☐ UNBAL.☐
☐ PACKING: MFG & TYPE ___
BASEPLATE: CI☐ FAB STL☐ DRIP LIP☐ EXTENDED☐

AUXILIARY CONNECTIONS

SERVICE	SIZE	LIQUID	GPM	°F	PSIG	PIPED BY
FLUSHING INLET						
FLUSHING OUTLET						
COOLING INLET						
COOLING OUTLET						
QUENCHING INLET						
QUENCHING OUTLET						
CLG. JKT - SEAL						
CLG. JKT-BEARING						
CLG. JKT-PEDESTAL						
OTHER						

TOTAL EXTERNAL COOLING WATER ___ GPM @ ___ °F
CASING VENT ___ CASING DRAIN ___ GAGE CONN'S ___
WTS: PUMP ___ BASE ___ DRIVER ___

PERFORMANCE & CONSTRUCTION

RATED RPM ___ ROTATION (FACING PUMP CPLG) ___
NO. OF STAGES ___ MIN CONT FLOW GPM ___
MIN SUBMER REQ'D ___ FT IMPELLER TYPE ___
MAX ALLOW CASE WP ___ PSIG @ ___ °F

	RATED	MIN/MAX
NPSHR FT	@SUC FLG	
EFF %		/
BHP	~ 0.5	/
IMP DIA		/

CONNECTIONS	SIZE	ASA	FACE	POSITION
SUCTION				
DISCHARGE				

DRIVER: FURNISHED BY VENDOR MTD BY VENDOR
MFG. GE OR EQ ENC. EXP PRF FRAME ___
HP 1½ RPM 3600 VOLTS/PHASE/HZ ___
SEE DRIVER SPEC ___

AUXILIARY PIPING & ACCESSORIES

MECH SEAL FLUSH PLAN (API 610 APP C) ___

	BY S-R	BY MFG.		BY S-R	BY MFG
PIPE	☐	☐	TUBING	☐	☐
HEAT EXCHANGER	☐	☐	STRAINER	☐	☐
ORIFICE	☐	☐	SEPARATOR	☐	☐

OTHER ___

MATERIALS:

PUMP		SEAL	
CASING		ROT FACE	
IMPELLER		STAT FACE	
SHAFT		SPRINGS	
SLEEVE		SHAFT SEAL	
IMP WEAR RINGS		STAT SEAL	
CASE WEAR RINGS		AUX. SEAL	
STATIC SEALS		PIPE/TUBING	
BUSHINGS		OTHER	

TESTING & INSPECTION (W INDICATES WITNESSED)

CERTIFIED SHOP TESTS:
___ PERFORMANCE☐ ___ HYDRO☐ @ ___ PSIG
___ NPSHR (ON WATER)☐ NONE☐ OTHER ___
INSPECTION:
☐NONE ☐OTHER ___
CERT PERF CURVE (MIN/MAX HD, FLOW, EFF, BHP, NPSHR) ☐
PERF CURVE NO. ___
BEARINGS: PLAIN☐ ANTIFRICTION☐
LUBRICATION: GREASE☐ OIL RING☐ FORCE FEED☐ OTHER☐

REMARKS: USE NO COPPER OR COPPER ALLOYS IN CONTACT WITH PUMPED FLUID.

Form 1.34
REV. 9-69

CENTRIFUGAL PUMP
STUDY DATA SHEET

Stearns-Roger

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

TAG NO. P-8
ACC'T.
S.R JOB B-41449
PAGE 1 OF 1
DATE August 1971 BY RTG

SERVICE FIRE WATER PUMP — NO. OPERATING one SPARE 0
REVISIONS: a BY :b BY :c BY :d BY
MANUFACTURER MODEL SIZE 6X10 TYPE HORIZONTAL
SOURCE: QUOTATION NO: DATE:

LIQUID CHARACTERISTICS
LIQUID Water
PT °F 60 SP GR @ 60°F/@PT 1.0 / 1.0
VIS (CP) @ °F/@PT /
VAP. PRESS.PSIA@ °F/@PT /
BAROMETRIC PRESS. PSIA 14.7
OTHER

CONDITIONS OF SERVICE-EACH PUMP

	CALCULATED	RATED	MIN / MAX
USGPM @ 60°F			/
USGPM @ PT		2000	/
DIS PRESS PSIG		125	/
SUC PRESS PSIG		0	/
DIFF HEAD FT.		289'	/
NPSHA FT(SUC FLG)		AMPLE	/

AVAILABLE SUMP DEPTH FT

CONSTRUCTION REQUIREMENTS
CUST. SPECS
TYPE: API 610☐ AVS☐ OTHER
SUPPORT: CENTERLINE☐ BASE☐ IN-LINE☐ VERTICAL☐
CASE SPLT: RADIAL☐ AXIAL☐ CORROSION ALLOW IN
CPLG & GUARD BY DRIVER HALF MTD. BY
COUPLING MFG MODEL
☐ MECH. SEAL: MFG MODEL
SINGLE☐ DOUBLE☐ TANDEM☐ BAL.☐ UNBAL.☐
☒ PACKING: MFG & TYPE
BASEPLATE: CI☐ FAB STL☐ DRIP LIP☐ EXTENDED☐

AUXILIARY CONNECTIONS

SERVICE	SIZE	LIQUID	GPM	°F	PSIG	PIPED BY
FLUSHING INLET						
FLUSHING OUTLET						
COOLING INLET						
COOLING OUTLET						
QUENCHING INLET						
QUENCHING OUTLET						
CLG. JKT - SEAL						
CLG. JKT-BEARING						
CLG. JKT-PEDESTAL						
OTHER						

TOTAL EXTERNAL COOLING WATER GPM@ °F
CASING VENT CASING DRAIN GAGE CONN'S
WTS: PUMP BASE DRIVER

PERFORMANCE & CONSTRUCTION
RATED RPM 1775 ROTATION(FACING PUMP CPLG)
NO. OF STAGES 1 MIN CONT FLOW GPM
MIN SUBMER REQ'D FT IMPELLER TYPE
MAX ALLOW CASE WP PSIG @ °F

	RATED	MIN/MAX
NPSHR FT	@SUC FLG	
EFF %		/
BHP	185	/
IMP DIA		/

CONNECTIONS	SIZE	ASA	FACE	POSITION
SUCTION				
DISCHARGE				

DRIVER: FURNISHED BY VENDOR MTD BY VENDOR
MFG. GE or EQUIV ENC ODP FRAME
HP 200 RPM 1800 VOLTS/PHASE/HZ 4160/3/60
SEE DRIVER SPEC

AUXILIARY PIPING & ACCESSORIES
MECH SEAL FLUSH PLAN (API 610 APP C)

	BY S-R	BY MFG.		BY S-R	BY MFG
PIPE	☐	☐	TUBING	☐	☐
HEAT EXCHANGER	☐	☐	STRAINER	☐	☐
ORIFICE	☐	☐	SEPARATOR	☐	☐

OTHER

MATERIALS:

PUMP		SEAL	
CASING		ROT FACE	
IMPELLER		STAT FACE	
SHAFT		SPRINGS	
SLEEVE		SHAFT SEAL	
IMP WEAR RINGS		STAT SEAL	
CASE WEAR RINGS		AUX. SEAL	
STATIC SEALS		PIPE/TUBING	
BUSHINGS		OTHER	

TESTING & INSPECTION(W INDICATES WITNESSED)
CERTIFIED SHOP TESTS:
PERFORMANCE☐ HYDRO☐@ PSIG
NPSHR(ON WATER)☐ NONE☐ OTHER
INSPECTION:
☐NONE ☐OTHER
CERT PERF CURVE(MIN/MAX HD,FLOW,EFF,BHP,NPSHR) ☐
PERF CURVE NO.
BEARINGS: PLAIN☐ ANTIFRICTION☐
LUBRICATION: GREASE☐ OIL RING☐ FORCE FEED☐ OTHER☐

REMARKS:

Form 1.84
REV. 9-69

Stearns-Roger

CENTRIFUGAL PUMP
STUDY DATA SHEET

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

TAG NO. P-11
ACC'T.
S.R JOB B-41449
PAGE ___ OF ___
DATE August 1971 BY DJM

SERVICE AMINE BOOSTER PUMP NO. OPERATING 1(1) SPARE 1 (1)
REVISIONS: a 8/71 BY RTG :b BY :c BY :d BY
MANUFACTURER MODEL SIZE 4×6×14 TYPE HORIZONTAL
SOURCE: QUOTATION NO: DATE:

LIQUID CHARACTERISTICS

LIQUID 25 WT % DEA & WATER
PT °F 186 SP GR @ 60°F/@PT / 0.970
VIS (CP) @ ___ °F/@PT / 1.0
VAP. PRESS.PSIA@ ___ °F/@PT /
BAROMETRIC PRESS. PSIA
OTHER

CONDITIONS OF SERVICE-EACH PUMP

	CALCULATED	RATED	MIN / MAX
USGPM @ 60°F			/
USGPM @ PT		760	/
DIS PRESS PSIG		280	/
SUC PRESS PSIG		0	/
DIFF HEAD FT.		668	/
NPSHA FT(SUC FLG)		10	/

AVAILABLE SUMP DEPTH FT

CONSTRUCTION REQUIREMENTS

CUST. SPECS
TYPE: API 610☒ AVS☐ OTHER
SUPPORT: CENTERLINE☐ BASE☐ IN-LINE☐ VERTICAL☐
CASE SPLT: RADIAL☐ AXIAL☐ CORROSION ALLOW ___ IN
CPLG & GUARD BY ___ DRIVER HALF MTD. BY ___
COUPLING MFG ___ MODEL ___
☐ MECH. SEAL: MFG ___ MODEL ___
SINGLE☐ DOUBLE☒ TANDEM☐ BAL.☐ UNBAL.☐
☐ PACKING: MFG & TYPE
BASEPLATE: CI☐ FAB STL☐ DRIP LIP☐ EXTENDED☒

AUXILIARY CONNECTIONS

SERVICE	SIZE	LIQUID	GPM	°F	PSIG	PIPED BY
FLUSHING INLET						
FLUSHING OUTLET						
COOLING INLET						
COOLING OUTLET						
QUENCHING INLET						
QUENCHING OUTLET						
CLG. JKT - SEAL						
CLG. JKT-BEARING						
CLG. JKT-PEDESTAL						
OTHER						

TOTAL EXTERNAL COOLING WATER ___ GPM@ ___ °F
CASING VENT ___ CASING DRAIN ___ GAGE CONN'S ___
a WTS: PUMP ___ BASE ___ TOTAL 3800#

PERFORMANCE & CONSTRUCTION

RATED RPM 3550 ROTATION(FACING PUMP CPLG) ___
NO. OF STAGES 1 MIN CONT FLOW GPM ___
MIN SUBMER REQ'D ___ FT IMPELLER TYPE ___
MAX ALLOW CASE WP ___ PSIG @ ___ °F

	RATED	MIN/MAX
NPSHR FT	@SUC FLG	
EFF %	52	/
BHP	240	/
IMP DIA		/

a

CONNECTIONS	SIZE	ASA	FACE	POSITION
SUCTION				
DISCHARGE				

DRIVER: FURNISHED BY ___ MTD BY ___
MFG. GE OR EQ ENC TEFC FRAME ___
HP 300 RPM 3600 VOLTS/PHASE/HZ 4160/3/60
SEE DRIVER SPEC

AUXILIARY PIPING & ACCESSORIES

MECH SEAL FLUSH PLAN (API 610 APP C) ___

	BY S-R	BY MFG.		BY S-R	BY MFG
PIPE	☐	☐	TUBING	☐	☐
HEAT EXCHANGER	☐	☐	STRAINER	☐	☐
ORIFICE	☐	☐	SEPARATOR	☐	☐

OTHER

MATERIALS:

PUMP		SEAL	
CASING	C.I.	ROT FACE	
IMPELLER	C.I.	STAT FACE	
SHAFT	STEEL	SPRINGS	
SLEEVE		SHAFT SEAL	
IMP WEAR RINGS		STAT SEAL	
CASE WEAR RINGS		AUX. SEAL	
STATIC SEALS		PIPE/TUBING	
BUSHINGS		OTHER	

TESTING & INSPECTION (W INDICATES WITNESSED)

CERTIFIED SHOP TESTS:
___ PERFORMANCE☐ ___ HYDRO☐@ ___ PSIG
___ NPSHR(ON WATER)☐ NONE☐ OTHER ___
INSPECTION:
☐NONE ☐OTHER ___
CERT PERF CURVE(MIN/MAX HD,FLOW,EFF,BHP,NPSHR) ☐
PERF CURVE NO.
BEARINGS: PLAIN☐ ANTIFRICTION☐
LUBRICATION: GREASE☐ OIL RING☐ FORCE FEED☐ OTHER☐

REMARKS:

Form 1.84
REV. 9-69

Stearns-Roger

CENTRIFUGAL PUMP
STUDY DATA SHEET

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ACC'T.
S.R JOB B-41449
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CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

REV.

SERVICE H.P. AMINE PUMP — NO. OPERATING 1(1) SPARE 1(1)
REVISIONS: a 8/71 BY RTG : b BY : c BY : d BY
MANUFACTURER MODEL SIZE 3X4 TYPE — a
SOURCE: QUOTATION NO: DATE:

LIQUID CHARACTERISTICS

LIQUID 25% DEA & H_2O
PT °F 110 SP GR @ 60°F/@PT — / 1.01
VIS (CP) @ °F/@PT / 1.6
VAP. PRESS. PSIA @ °F/@PT /
BAROMETRIC PRESS. PSIA
OTHER

CONDITIONS OF SERVICE-EACH PUMP

	CALCULATED	RATED	MIN / MAX
USGPM @ 60°F			/
USGPM @ PT		630	/
DIS PRESS PSIG		970	
SUC PRESS PSIG		260	
a DIFF HEAD FT.		1620	
NPSHA FT(SUC FLG)		25+	

AVAILABLE SUMP DEPTH FT

CONSTRUCTION REQUIREMENTS

CUST. SPECS
TYPE: API 610☐ AVS☐ OTHER
SUPPORT: CENTERLINE☐ BASE☐ IN-LINE☐ VERTICAL☐
CASE SPLT: RADIAL☐ AXIAL☐ CORROSION ALLOW IN
CPLG & GUARD BY DRIVER HALF MTD. BY
COUPLING MFG MODEL
☐ MECH. SEAL: MFG MODEL
SINGLE☐ DOUBLE☒ TANDEM☐ BAL.☐ UNBAL.☐
☐ PACKING: MFG & TYPE
BASEPLATE: CI☐ FAB STL☐ DRIP LIP☐ EXTENDED☒

AUXILIARY CONNECTIONS

SERVICE	SIZE	LIQUID	GPM	°F	PSIG	PIPED BY
FLUSHING INLET						
FLUSHING OUTLET						
COOLING INLET						
COOLING OUTLET						
QUENCHING INLET						
QUENCHING OUTLET						
CLG. JKT - SEAL						
CLG. JKT-BEARING						
CLG. JKT-PEDESTAL						
OTHER						

TOTAL EXTERNAL COOLING WATER GPM@ °F
CASING VENT CASING DRAIN GAGE CONN'S
a WTS: PUMP BASE DRIVER 7,100# TOTAL

PERFORMANCE & CONSTRUCTION

RATED RPM 3550 ROTATION(FACING PUMP CPLG)
NO. OF STAGES 5 MIN CONT FLOW GPM
MIN SUBMER REQ'D FT IMPELLER TYPE
MAX ALLOW CASE WP PSIG @ °F

	RATED	MIN/MAX
NPSHR FT	@SUC FLG	
EFF %	64.5	/
BHP	407	/
IMP DIA		/

CONNECTIONS	SIZE	ASA	FACE	POSITION
SUCTION				
DISCHARGE				

DRIVER: FURNISHED BY MTD BY
MFG. GE OR EQ. ENC TEFC FRAME
HP 500 RPM 3600 VOLTS/PHASE/HZ 4160/3/60
SEE DRIVER SPEC

AUXILIARY PIPING & ACCESSORIES

MECH SEAL FLUSH PLAN (API 610 APP C)

	BY S-R	BY MFG.		BY S-R	BY MFG
PIPE	☐	☐	TUBING	☐	☐
HEAT EXCHANGER	☐	☐	STRAINER	☐	☐
ORIFICE	☐	☐	SEPARATOR	☐	☐

OTHER

MATERIALS: PUMP SEAL

PUMP		SEAL	
CASING	STEEL	ROT FACE	
IMPELLER	C.I.	STAT FACE	
SHAFT	STEEL	SPRINGS	
SLEEVE		SHAFT SEAL	
IMP WEAR RINGS		STAT SEAL	
CASE WEAR RINGS		AUX. SEAL	
STATIC SEALS		PIPE/TUBING	
BUSHINGS		OTHER	

TESTING & INSPECTION (W INDICATES WITNESSED)

CERTIFIED SHOP TESTS:
PERFORMANCE☐ HYDRO☐@ PSIG
NPSHR (ON WATER)☐ NONE☐ OTHER
INSPECTION:
☐NONE ☐OTHER
CERT PERF CURVE(MIN/MAX HD, FLOW, EFF, BHP, NPSHR) ☐
PERF CURVE NO.
BEARINGS: PLAIN☐ ANTIFRICTION☐
LUBRICATION: GREASE☐ OIL RING☐ FORCE FEED☐ OTHER☐

REMARKS:

Form 1.84
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CENTRIFUGAL PUMP
STUDY DATA SHEET

REV.

Stearns-Roger

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

TAG NO. P-13
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S.R JOB B-41449
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SERVICE AMINE STILL REFLUX PUMP NO. OPERATING 1(2) SPARE 1 (1)
REVISIONS: a ____ BY ____ :b ____ BY ____ :c ____ BY ____ :d ____ BY ____
MANUFACTURER ____ MODEL ____ SIZE 1 X 2 TYPE HORIZONTAL
SOURCE: ____ QUOTATION NO: ____ DATE: ____

LIQUID CHARACTERISTICS
LIQUID SOUR WATER
PT °F 110 SP GR @ 60°F/@PT / 1.0
VIS (CP) @ ____ °F/@PT ____ / ____
VAP. PRESS.PSIA@ ____ °F/@PT ____ / ____
BAROMETRIC PRESS. PSIA ____
OTHER ____

CONDITIONS OF SERVICE-EACH PUMP

	CALCULATED	RATED	MIN / MAX
USGPM @ 60°F			/
USGPM @ PT		25	/
DIS PRESS PSIG		59	
SUC PRESS PSIG		8	
DIFF HEAD FT.		118	
NPSHA FT(SUC FLG)		6	

AVAILABLE SUMP DEPTH FT ____

CONSTRUCTION REQUIREMENTS
CUST. SPECS ____
TYPE: API 610☐ AVS☐ OTHER ____
SUPPORT: CENTERLINE☐ BASE☐ IN-LINE☐ VERTICAL☐
CASE SPLT: RADIAL☐ AXIAL☐ CORROSION ALLOW ____ IN
CPLG & GUARD BY ____ DRIVER HALF MTD. BY ____
COUPLING MFG ____ MODEL ____
☐ MECH. SEAL: MFG ____ MODEL ____
SINGLE☐ DOUBLE☒ TANDEM☐ BAL.☐ UNBAL.☐
☐ PACKING: MFG & TYPE ____
BASEPLATE: CI☐ FAB STL☐ DRIP LIP☐ EXTENDED☒

AUXILIARY CONNECTIONS

SERVICE	SIZE	LIQUID	GPM	°F	PSIG	PIPED BY
FLUSHING INLET						
FLUSHING OUTLET						
COOLING INLET						
COOLING OUTLET						
QUENCHING INLET						
QUENCHING OUTLET						
CLG. JKT - SEAL						
CLG. JKT-BEARING						
CLG. JKT-PEDESTAL						
OTHER						

TOTAL EXTERNAL COOLING WATER ____ GPM@ ____ °F
CASING VENT ____ CASING DRAIN ____ GAGE CONN'S ____
WTS: PUMP ____ BASE ____ DRIVER ____

PERFORMANCE & CONSTRUCTION
RATED RPM 3550 ROTATION(FACING PUMP CPLG) ____
NO. OF STAGES 1 MIN CONT FLOW GPM ____
MIN SUBMER REQ'D ____ FT IMPELLER TYPE ____
MAX ALLOW CASE WP ____ PSIG @ ____ °F

	RATED	MIN/MAX
NPSHR FT	@SUC FLG	
EFF %		/
BHP	~ 1 3/4	/
IMP DIA		/

CONNECTIONS	SIZE	ASA	FACE	POSITION
SUCTION				
DISCHARGE				

DRIVER: FURNISHED BY ____ MTD BY ____
MFG. GE OR EQ. ENC TEFC FRAME ____
HP 3 RPM 3600 VOLTS/PHASE/HZ 460/3/60
SEE DRIVER SPEC ____

AUXILIARY PIPING & ACCESSORIES
MECH SEAL FLUSH PLAN (API 610 APP C) ____

	BY S-R	BY MFG.		BY S-R	BY MFG
PIPE	☐	☐	TUBING	☐	☐
HEAT EXCHANGER	☐	☐	STRAINER	☐	☐
ORIFICE	☐	☐	SEPARATOR	☐	☐

OTHER ____

MATERIALS:

PUMP		SEAL	
CASING	STEEL	ROT FACE	
IMPELLER	STEEL	STAT FACE	
SHAFT	STEEL	SPRINGS	
SLEEVE		SHAFT SEAL	
IMP WEAR RINGS		STAT SEAL	
CASE WEAR RINGS		AUX. SEAL	
STATIC SEALS		PIPE/TUBING	
BUSHINGS		OTHER	

TESTING & INSPECTION(W INDICATES WITNESSED)
CERTIFIED SHOP TESTS:
____ PERFORMANCE☐ ____ HYDRO☐@ ____ PSIG
____ NPSHR (ON WATER)☐ NONE☐ OTHER ____
INSPECTION:
☐NONE ☐OTHER ____
CERT PERF CURVE(MIN/MAX HD,FLOW,EFF,BHP,NPSHR) ☐
PERF CURVE NO. ____
BEARINGS: PLAIN☐ ANTIFRICTION☐
LUBRICATION: GREASE☐ OIL RING☐
FORCE FEED☐ OTHER☐

REMARKS:

Form 1.84
Rev. 9-69

Stearns-Roger

CENTRIFUGAL PUMP
STUDY DATA SHEET

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ACC'T.
S.R JOB B-41449
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DATE August 1971 BY DJM

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

SERVICE AMINE REBOILER PUMP — NO. OPERATING 1(2) SPARE 1(1)
REVISIONS: a 8/71 BY RTG ; b ___ BY ___ ; c ___ BY ___ ; d ___ BY ___
MANUFACTURER ___ MODEL ___ SIZE 4 X 6 D.S. TYPE HORIZONTAL
SOURCE: ___ QUOTATION No: ___ DATE: ___

LIQUID CHARACTERISTICS
LIQUID 25 WT % AMINE ± H_2O
PT °F 250 SP GR @ 60°F/@PT ___ / 0.947
VIS (CP) @ ___ °F/@PT ___ / ___
VAP. PRESS. PSIA @ ___ °F/@PT ___ / ___
BAROMETRIC PRESS. PSIA ___
OTHER ___

CONDITIONS OF SERVICE-EACH PUMP

	CALCULATED	RATED	MIN / MAX
USGPM @ 60°F			/
USGPM @ PT		560	/
DIS PRESS PSIG		64	
SUC PRESS PSIG		15	
a DIFF HEAD FT.		119	
NPSHA FT(SUC FLG)		10	

AVAILABLE SUMP DEPTH FT ___

CONSTRUCTION REQUIREMENTS
CUST. SPECS ___
TYPE: API 610☐ AVS☐ OTHER ___
SUPPORT: CENTERLINE☐ BASE☐ IN-LINE☐ VERTICAL☐
CASE SPLT: RADIAL☐ AXIAL☐ CORROSION ALLOW ___ IN
CPLG & GUARD BY ___ DRIVER HALF MTD. BY ___
COUPLING MFG ___ MODEL ___
☐ MECH. SEAL: MFG ___ MODEL ___
SINGLE☐ DOUBLE☒ TANDEM☐ BAL.☐ UNBAL.☐
☐ PACKING: MFG & TYPE ___
BASEPLATE: CI☐ FAB STL☐ DRIP LIP☐ EXTENDED☒

AUXILIARY CONNECTIONS

SERVICE	SIZE	LIQUID	GPM	°F	PSIG	PIPED BY
FLUSHING INLET						
FLUSHING OUTLET						
COOLING INLET						
COOLING OUTLET						
QUENCHING INLET						
QUENCHING OUTLET						
CLG. JKT - SEAL						
CLG. JKT-BEARING						
CLG. JKT-PEDESTAL						
OTHER						

TOTAL EXTERNAL COOLING WATER ___ GPM@ ___ °F
CASING VENT ___ CASING DRAIN ___ GAGE CONN'S ___
WTS: PUMP ___ BASE ___ DRIVER ___

PERFORMANCE & CONSTRUCTION
RATED RPM 1750 ROTATION(FACING PUMP CPLG) ___
NO. OF STAGES 1 MIN CONT FLOW GPM ___
MIN SUBMER REQ'D ___ FT IMPELLER TYPE ___
MAX ALLOW CASE WP ___ PSIG @ ___ °F

	RATED	MIN/MAX
NPSHR FT	@SUC FLG	
EFF %	73	/
BHP	22	/
IMP DIA		/

CONNECTIONS	SIZE	ASA	FACE	POSITION
SUCTION				
DISCHARGE				

DRIVER: FURNISHED BY ___ MTD BY ___
MFG. GE OR EQ. ENC TEFC FRAME ___
HP 30 RPM 3600 VOLTS/PHASE/HZ 460/3/60
SEE DRIVER SPEC ___

AUXILIARY PIPING & ACCESSORIES
MECH SEAL FLUSH PLAN (API 610 APP C) ___

	BY S-R	BY MFG.		BY S-R	BY MFG
PIPE	☐	☐	TUBING	☐	☐
HEAT EXCHANGER	☐	☐	STRAINER	☐	☐
ORIFICE	☐	☐	SEPARATOR	☐	☐

OTHER ___

MATERIALS:

PUMP		SEAL	
CASING	C.I.	ROT FACE	
IMPELLER	C.I.	STAT FACE	
SHAFT	STEEL	SPRINGS	
SLEEVE		SHAFT SEAL	
IMP WEAR RINGS		STAT SEAL	
CASE WEAR RINGS		AUX. SEAL	
STATIC SEALS		PIPE/TUBING	
BUSHINGS		OTHER	

TESTING & INSPECTION(W INDICATES WITNESSED)
CERTIFIED SHOP TESTS:
___ PERFORMANCE☐ ___ HYDRO☐@ ___ PSIG
___ NPSHR(ON WATER)☐ NONE☐ OTHER ___
INSPECTION:
☐NONE ☐OTHER ___
CERT PERF CURVE(MIN/MAX HD, FLOW, EFF, BHP, NPSHR) ☐
PERF CURVE NO. ___
BEARINGS: PLAIN☐ ANTIFRICTION☐
LUBRICATION: GREASE☐ OIL RING☐ FORCE FEED☐ OTHER☐

REMARKS:

Rev: a (line 18)

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Rev. 9-69

Stearns-Roger

CENTRIFUGAL PUMP
STUDY DATA SHEET

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S.R JOB B-41449
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REV.

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

SERVICE AMINE TRANSFER PUMP NO. OPERATING ONE (1) SPARE —
REVISIONS: a 8/71 BY RTG :b ___ BY ___ :c ___ BY ___ :d ___ BY ___
MANUFACTURER ___ MODEL ___ SIZE 1 X 2 TYPE HORIZONTAL
SOURCE: ___ QUOTATION NO: ___ DATE: ___

LIQUID CHARACTERISTICS
LIQUID AMINE (DEA)
PT °F 60 SP GR @ 60°F/@PT 1.03 /
VIS (CP) @ ___ °F/@PT ___ / .97
VAP. PRESS. PSIA @ ___ °F/@PT ___ /
BAROMETRIC PRESS. PSIA ___
OTHER ___

CONDITIONS OF SERVICE-EACH PUMP

	CALCULATED	RATED	MIN / MAX
USGPM @ 60°F			/
USGPM @ PT		50	/
DIS PRESS PSIG		33	
SUC PRESS PSIG		0	
DIFF HEAD FT.		75	
NPSHA FT (SUC FLG)		15+	

AVAILABLE SUMP DEPTH FT ___

CONSTRUCTION REQUIREMENTS
CUST. SPECS ___
TYPE: API 610☐ AVS☐ OTHER MFG. STD.
SUPPORT: CENTERLINE☐ BASE☐ IN-LINE☐ VERTICAL☐
CASE SPLT: RADIAL☐ AXIAL☐ CORROSION ALLOW ___ IN
CPLG & GUARD BY ___ DRIVER HALF MTD. BY ___
COUPLING MFG ___ MODEL ___
☐ MECH. SEAL: MFG ___ MODEL ___
SINGLE☒ DOUBLE☐ TANDEM☐ BAL.☐ UNBAL.☐
☐ PACKING: MFG & TYPE ___
BASEPLATE: CI☐ FAB STL☐ DRIP LIP☐ EXTENDED☐

AUXILIARY CONNECTIONS

SERVICE	SIZE	LIQUID	GPM	°F	PSIG	PIPED BY
FLUSHING INLET						
FLUSHING OUTLET						
COOLING INLET						
COOLING OUTLET						
QUENCHING INLET						
QUENCHING OUTLET						
CLG. JKT - SEAL						
CLG. JKT-BEARING						
CLG. JKT. PEDESTAL						
OTHER						

TOTAL EXTERNAL COOLING WATER ___ GPM@ ___ °F
CASING VENT ___ CASING DRAIN ___ GAGE CONN'S ___
WTS: PUMP ___ BASE ___ DRIVER ___

PERFORMANCE & CONSTRUCTION
RATED RPM 3550 ROTATION (FACING PUMP CPLG) ___
NO. OF STAGES ___ MIN CONT FLOW GPM ___
MIN SUBMER REQ'D ___ FT IMPELLER TYPE ___
MAX ALLOW CASE WP ___ PSIG @ ___ °F

	RATED	MIN/MAX
NPSHR FT	@SUC FLG	
EFF %	64	/
BHP	1½	/
IMP DIA		/

a

CONNECTIONS	SIZE	ASA	FACE	POSITION
SUCTION				
DISCHARGE				

DRIVER: FURNISHED BY ___ MTD BY ___
MFG. GE OR EQ. ENC TEFC FRAME ___
HP 3 RPM 3600 VOLTS/PHASE/HZ 460/3/60
SEE DRIVER SPEC ___

AUXILIARY PIPING & ACCESSORIES
MECH SEAL FLUSH PLAN (API 610 APP C) ___

	BY S-R	BY MFG.		BY S-R	BY MFG
PIPE	☐	☐	TUBING	☐	☐
HEAT EXCHANGER	☐	☐	STRAINER	☐	☐
ORIFICE	☐	☐	SEPARATOR	☐	☐

OTHER ___

MATERIALS: PUMP		SEAL	
CASING	C.I.	ROT FACE	
IMPELLER	C.I.	STAT FACE	
SHAFT	STEEL	SPRINGS	
SLEEVE		SHAFT SEAL	
IMP WEAR RINGS		STAT SEAL	
CASE WEAR RINGS		AUX. SEAL	
STATIC SEALS		PIPE/TUBING	
BUSHINGS		OTHER	

TESTING & INSPECTION (W INDICATES WITNESSED)
CERTIFIED SHOP TESTS:
___ PERFORMANCE☐ ___ HYDRO☐ @ ___ PSIG
___ NPSHR (ON WATER)☐ NONE☐ OTHER ___
INSPECTION:
☐ NONE ☐ OTHER ___
CERT PERF CURVE (MIN/MAX HD, FLOW, EFF, BHP, NPSHR) ☐
PERF CURVE NO. ___

BEARINGS: PLAIN☐ ANTIFRICTION☐
LUBRICATION: GREASE☐ OIL RING☐
FORCE FEED☐ OTHER☐

REMARKS:

Form 1.34
Rev. 9-69

Stearns-Roger

CENTRIFUGAL PUMP
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ACC'T. ______
S.R JOB B-41449
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CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

SERVICE AMINE SUMP PUMP NO. OPERATING ONE (1) SPARE —

REVISIONS: a 8/71 BY RTG : b ______ BY ______ : c ______ BY ______ : d ______ BY ______

MANUFACTURER ______ MODEL ______ SIZE ______ TYPE VERTICAL

SOURCE: ______ QUOTATION NO: ______ DATE: ______

LIQUID CHARACTERISTICS

LIQUID DEA & WATER
PT °F ______ SP GR @ 60°F/@PT ______ / 1.03
VIS (CP) @ ______ °F/@PT ______ /
VAP. PRESS. PSIA@ ______ °F/@PT ______ /
BAROMETRIC PRESS. PSIA ______
OTHER ______

CONDITIONS OF SERVICE-EACH PUMP

	CALCULATED	RATED	MIN / MAX
USGPM @ 60°F			/
USGPM @ PT		10	/
DIS PRESS PSIG		150	
SUC PRESS PSIG		0	
a DIFF HEAD FT.		336	
NPSHA FT (SUC FLG)			

AVAILABLE SUMP DEPTH FT ______

CONSTRUCTION REQUIREMENTS

CUST. SPECS ______
TYPE: API 610☐ AVS☐ OTHER MFG. STD.
SUPPORT: CENTERLINE☐ BASE☐ IN-LINE☐ VERTICAL☐
CASE SPLT: RADIAL☐ AXIAL☐ CORROSION ALLOW ______ IN
CPLG & GUARD BY ______ DRIVER HALF MTD. BY ______
COUPLING MFG ______ MODEL ______
☐ MECH. SEAL: MFG ______ MODEL ______
SINGLE☒ DOUBLE☐ TANDEM☐ BAL.☐ UNBAL.☐
☐ PACKING: MFG & TYPE ______
BASEPLATE: CI☐ FAB STL☐ DRIP LIP☐ EXTENDED☐

AUXILIARY CONNECTIONS

SERVICE	SIZE	LIQUID	GPM	°F	PSIG	PIPED BY
FLUSHING INLET						
FLUSHING OUTLET						
COOLING INLET						
COOLING OUTLET						
QUENCHING INLET						
QUENCHING OUTLET						
CLG. JKT - SEAL						
CLG. JKT-BEARING						
CLG. JKT-PEDESTAL						
OTHER						

TOTAL EXTERNAL COOLING WATER ______ GPM@ ______ °F
CASING VENT ______ CASING DRAIN ______ GAGE CONN'S ______
WTS: PUMP ______ BASE ______ DRIVER ______

PERFORMANCE & CONSTRUCTION

RATED RPM 3550 ROTATION (FACING PUMP CPLG) ______
NO. OF STAGES 4 MIN CONT FLOW GPM ______
MIN SUBMER REQ'D ______ FT IMPELLER TYPE ______
MAX ALLOW CASE WP ______ PSIG @ ______ °F

	RATED	MIN/MAX
NPSHR FT	@SUC FLG	
EFF %		/
BHP	~ 10	/
IMP DIA		/

CONNECTIONS	SIZE	ASA	FACE	POSITION
SUCTION				
DISCHARGE				

DRIVER: FURNISHED BY ______ MTD BY ______
MFG. GE OR EQ. ENC TEFC FRAME ______
HP 15 RPM 3600 VOLTS/PHASE/HZ ______
SEE DRIVER SPEC ______

AUXILIARY PIPING & ACCESSORIES

MECH SEAL FLUSH PLAN (API 610 APP C) ______

	BY S-R	BY MFG.		BY S-R	BY MFG
PIPE	☐	☐	TUBING	☐	☐
HEAT EXCHANGER	☐	☐	STRAINER	☐	☐
ORIFICE	☐	☐	SEPARATOR	☐	☐

OTHER ______

MATERIALS:

PUMP		SEAL	
CASING	STEEL	ROT FACE	
IMPELLER	STEEL	STAT FACE	
SHAFT	STEEL	SPRINGS	
SLEEVE		SHAFT SEAL	
IMP WEAR RINGS		STAT SEAL	
CASE WEAR RINGS		AUX. SEAL	
STATIC SEALS		PIPE/TUBING	
BUSHINGS		OTHER	

TESTING & INSPECTION (W INDICATES WITNESSED)

CERTIFIED SHOP TESTS:
______ PERFORMANCE☐ ______ HYDRO☐ @ ______ PSIG
______ NPSHR (ON WATER)☐ NONE☐ OTHER ______
INSPECTION:
☐ NONE ☐ OTHER ______
CERT PERF CURVE (MIN/MAX HD, FLOW, EFF, BHP, NPSHR) ☐
PERF CURVE NO. ______

BEARINGS: PLAIN☐ ANTIFRICTION☐
LUBRICATION: GREASE☐ OIL RING☐
FORCE FEED☐ OTHER☐

REMARKS:

Form 1.34
Rev. 9-69

Stearns-Roger

CENTRIFUGAL PUMP
STUDY DATA SHEET

TAG No. P-21
ACC'T.
S.R Job B-41449
PAGE ___ OF ___
DATE August 1971 BY JEW/DJM

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

SERVICE SULFUR LOADING PUMP — NO. OPERATING 1 (1) SPARE 1 (1)
REVISIONS: a ___ BY ___ :b ___ BY ___ :c ___ BY ___ :d ___ BY ___
MANUFACTURER LEWIS/LAWRENCE MODEL ___ SIZE ___ TYPE VERT. SUMP
SOURCE: ___ QUOTATION No: ___ DATE: ___

LIQUID CHARACTERISTICS
LIQUID LIQUID SULFUR
PT °F 250-270 SP GR [illegible] /@PT 1.77
VIS (CP) @ ___ °F/@PT ___
VAP. PRESS. PSIA @ ___ °F/@PT ___
BAROMETRIC PRESS. PSIA ___
OTHER ___

CONDITIONS OF SERVICE-EACH PUMP

	CALCULATED	RATED	MIN / MAX
USGPM @ 60°F			
USGPM @ PT		175	
DIS PRESS PSIG		60	
SUC PRESS PSIG		0	
DIFF HEAD FT.		78	
NPSHA FT (SUC FLG)			

AVAILABLE SUMP DEPTH FT ___

CONSTRUCTION REQUIREMENTS
CUST. SPECS ___
TYPE: API 610 ☐ AVS ☐ OTHER MFG. STD.
SUPPORT: CENTERLINE ☐ BASE ☐ IN-LINE ☐ VERTICAL ☐
CASE SPLT: RADIAL ☐ AXIAL ☐ CORROSION ALLOW ___ IN
CPLG & GUARD BY ___ DRIVER HALF MTD. BY ___
COUPLING MFG ___ MODEL ___
☐ MECH. SEAL: MFG ___ MODEL ___
SINGLE ☐ DOUBLE ☐ TANDEM ☐ BAL. ☐ UNBAL. ☐
☐ PACKING: MFG & TYPE ___
BASEPLATE: CI ☐ FAB STL ☐ DRIP LIP ☐ EXTENDED ☐

AUXILIARY CONNECTIONS

SERVICE	SIZE	LIQUID	GPM	°F	PSIG	PIPED BY
FLUSHING INLET						
FLUSHING OUTLET						
COOLING INLET						
COOLING OUTLET						
QUENCHING INLET						
QUENCHING OUTLET						
CLG. JKT - SEAL						
CLG. JKT-BEARING						
CLG. JKT-PEDESTAL						
OTHER						

TOTAL EXTERNAL COOLING WATER ___ GPM @ ___ °F
CASING VENT ___ CASING DRAIN ___ GAGE CONN'S ___
WTS: PUMP ___ BASE ___ DRIVER ___

PERFORMANCE & CONSTRUCTION (STEAM JACKETED)
RATED RPM 1750 ROTATION (FACING PUMP CPLG) ___
NO. OF STAGES ___ MIN CONT FLOW GPM ___
MIN SUBMER REQ'D ___ FT IMPELLER TYPE ___
MAX ALLOW CASE WP ___ PSIG @ ___ °F

	RATED	MIN/MAX
NPSHR FT	@SUC FLG	
EFF %		
BHP	14.3	
IMP DIA		

CONNECTIONS	SIZE	ASA	FACE	POSITION
SUCTION				
DISCHARGE				

DRIVER: FURNISHED BY ___ MTD BY ___
MFG. GE OR EQ. ENC TEFC FRAME ___
HP 25 RPM 1750 VOLTS/PHASE/HZ 460/3/60
SEE DRIVER SPEC ___

AUXILIARY PIPING & ACCESSORIES
MECH SEAL FLUSH PLAN (API 610 APP C) ___

	BY S-R	BY MFG.		BY S-R	BY MFG
PIPE	☐	☐	TUBING	☐	☐
HEAT EXCHANGER	☐	☐	STRAINER	☐	☐
ORIFICE	☐	☐	SEPARATOR	☐	☐

OTHER ___

MATERIALS:

	PUMP		SEAL
CASING	CI	ROT FACE	
IMPELLER	CI	STAT FACE	
SHAFT	STEEL	SPRINGS	
SLEEVE		SHAFT SEAL	
IMP WEAR RINGS		STAT SEAL	
CASE WEAR RINGS		AUX. SEAL	
STATIC SEALS		PIPE/TUBING	
BUSHINGS		OTHER	

TESTING & INSPECTION (W INDICATES WITNESSED)
CERTIFIED SHOP TESTS:
___ PERFORMANCE ☐ ___ HYDRO ☐ @ ___ PSIG
___ NPSHR (ON WATER) ☐ NONE ☐ OTHER ___
INSPECTION:
☐ NONE ☐ OTHER ___
CERT PERF CURVE (MIN/MAX HD, FLOW, EFF, BHP, NPSHR) ☐
PERF CURVE NO. ___
BEARINGS: PLAIN ☐ ANTIFRICTION ☐
LUBRICATION: GREASE ☐ OIL RING ☐ FORCE FEED ☐ OTHER ☐

REMARKS:
1) SIZED FOR ULTIMATE CONDITIONS

Form 1.34
REV. 9-69

Stearns-Roger

CENTRIFUGAL PUMP
STUDY DATA SHEET

REV.

CUSTOMER	HUMBLE OIL AND REFINING COMPANY
PROJECT	GAS PROCESSING STUDY
LOCATION	SANTA BARBARA CHANNEL, CALIFORNIA

TAG NO. P-22
ACC'T.
S.R JOB B-41449
PAGE ____ OF ____
DATE August 1971 BY JEW/DTM

SERVICE SULFUR TRANSFER PUMP NO. OPERATING 1 (1) SPARE –
REVISIONS: a ____ BY ____ : b ____ BY ____ : c ____ BY ____ : d ____ BY ____
MANUFACTURER LEWIS/LAWRENCE MODEL ____ SIZE ____ TYPE VERT. SUMP
SOURCE: ____ QUOTATION NO: ____ DATE: ____

LIQUID CHARACTERISTICS
LIQUID LIQUID SULFUR
PT °F 270 SP GR /@PT 1.77 /
VIS (CP) @ ____ °F/@PT ____ /
VAP. PRESS. PSIA@ ____ °F/@PT ____ /
BAROMETRIC PRESS. PSIA ____
OTHER ____

CONDITIONS OF SERVICE-EACH PUMP

	CALCULATED	RATED	MIN / MAX
USGPM @ 60°F			/
USGPM @ PT		30	/
DIS PRESS PSIG		60	
SUC PRESS PSIG		0	
DIFF HEAD FT.		78	
NPSHA FT(SUC FLG)			

AVAILABLE SUMP DEPTH FT ____

CONSTRUCTION REQUIREMENTS
CUST. SPECS ____
TYPE: API 610☐ AVS☐ OTHER MFG. STD.
SUPPORT: CENTERLINE☐ BASE☐ IN-LINE☐ VERTICAL☐
CASE SPLT: RADIAL☐ AXIAL☐ CORROSION ALLOW ____ IN
CPLG & GUARD BY ____ DRIVER HALF MTD. BY ____
COUPLING MFG ____ MODEL ____
☐ MECH. SEAL: MFG ____ MODEL ____
SINGLE☐ DOUBLE☐ TANDEM☐ BAL.☐ UNBAL.☐
☐ PACKING: MFG & TYPE ____
BASEPLATE: CI☐ FAB STL☐ DRIP LIP☐ EXTENDED☐

AUXILIARY CONNECTIONS

SERVICE	SIZE	LIQUID	GPM	°F	PSIG	PIPED BY
FLUSHING INLET						
FLUSHING OUTLET						
COOLING INLET						
COOLING OUTLET						
QUENCHING INLET						
QUENCHING OUTLET						
CLG. JKT - SEAL						
CLG. JKT-BEARING						
CLG. JKT-PEDESTAL						
OTHER						

TOTAL EXTERNAL COOLING WATER ____ GPM@ ____ °F
CASING VENT ____ CASING DRAIN ____ GAGE CONN'S ____
WTS: PUMP ____ BASE ____ DRIVER ____

PERFORMANCE & CONSTRUCTION (STEAM JACKETED)
RATED RPM 1750 ROTATION(FACING PUMP CPLG) ____
NO. OF STAGES ____ MIN CONT FLOW GPM ____
MIN SUBMER REQ'D ____ FT IMPELLER TYPE ____
MAX ALLOW CASE WP ____ PSIG @ ____ °F

	RATED	MIN/MAX
NPSHR FT	@SUC FLG	
EFF %		/
BHP	~4	/
IMP DIA		/

CONNECTIONS	SIZE	ASA	FACE	POSITION
SUCTION				
DISCHARGE				

DRIVER: FURNISHED BY ____ MTD BY ____
MFG. GE OR EQ ENC TEFC FRAME ____
HP 7 1/2 RPM 1750 VOLTS/PHASE/HZ 460/3/60
SEE DRIVER SPEC ____

AUXILIARY PIPING & ACCESSORIES
MECH SEAL FLUSH PLAN (API 610 APP C) ____

	BY S-R	BY MFG.		BY S-R	BY MFG
PIPE	☐	☐	TUBING	☐	☐
HEAT EXCHANGER	☐	☐	STRAINER	☐	☐
ORIFICE	☐	☐	SEPARATOR	☐	☐

OTHER ____

MATERIALS:

PUMP		SEAL	
CASING	CI	ROT FACE	
IMPELLER	CI	STAT FACE	
SHAFT	STEEL	SPRINGS	
SLEEVE		SHAFT SEAL	
IMP WEAR RINGS		STAT SEAL	
CASE WEAR RINGS		AUX. SEAL	
STATIC SEALS		PIPE/TUBING	
BUSHINGS		OTHER	

TESTING & INSPECTION (W INDICATES WITNESSED)
CERTIFIED SHOP TESTS:
____ PERFORMANCE☐ ____ HYDRO☐@ ____ PSIG
____ NPSHR (ON WATER)☐ NONE☐ OTHER ____
INSPECTION:
☐NONE ☐OTHER ____
CERT PERF CURVE(MIN/MAX HD, FLOW, EFF, BHP, NPSHR) ☐
PERF CURVE NO. ____
BEARINGS: PLAIN☐ ANTIFRICTION☐
LUBRICATION: GREASE☐ OIL RING☐ FORCE FEED☐ OTHER☐

REMARKS:

FORM 1.34

METERING PUMPS

STUDY DATA SHEET

Stearns-Roger CORPORATION

ITEM NO. P-23
ACC'T. ______ PAGE ______
S-R JOB B-41449
DATE August, 1971 BY JEW/DJM

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

SERVICE IFP SOLVENT PUMP NO. REQ'D. 1 (1)

REVISIONS :a ______ BY ____ :b ______ BY ____ :c ______ BY ____ :d ______ BY ____

MANUFACTURER ______ SOURCE: QUOTE OF ______

TYPE PUMP: PLUNGER [X] DIAPHRAGM [ ] DIRECT ACTING [ ] POWER FRAME [ ]
METERING HEADS: SIMPLEX [X] DUPLEX [ ] TRIPLEX [ ] * HEAD GANG [ ]

* USE SEPARATE DATA SHEET FOR EACH LIQUID END

MATERIALS

LIQUID END STEEL (arrow drawn down through FRAME)
PLUNGER
CROSS HEAD
CONN. ROD
CRANK
GEAR (DRIVER)
GEAR (DRIVEN)
GEAR HOUSING
FRAME
VALVES SS
VALVE SEATS SS
VALVE BODY SS
PACKING ______ MAX. TEMP. °F ______
GASKETS
DIAPHRAGM ______ MAX. TEMP. °F ______
GLAND
LANTERN RING
VALVE CAPS

CONNECTIONS

	SIZE	TYPE	RATING
SUCTION			
DISCHARGE			
DRAINS			
FLUSHING			

AIR OR GAS PURGING YES [ ] NO [ ]
VALVES REPLACEABLE YES [ ] NO [ ]

LIQUID END

LIQUID END BODY: TYPE (PLUNGER) (DIAPHRAGM) (REMOTE) (SUBMERGED)
PLUNGER DIAM. ______ STROKE ______
STROKES/MIN/CYLINDER ______
S.W.P. ______ w/QUOTED DRIVER SWP ______ w/MAX. DRIVER

VALVES	SUCTION	DISCHARGE
TYPE		
NUMBER		
AREA IN.^{2}		

PLUNGER SUPPORT ______ (PACKING) ______ (CROSS HEAD) ______
PACKING SIZE ______ TYPE ______
SPECIAL SEALS ______

LUBRICATION

PACKING ______ DRIVER BRGS. ______
CONN. ROD BRGS. ______
CROSS HEAD ______ GEARING ______
POWER CYLINDER ______
HYDRAULIC FLUID (DIAPHRAGM PLUNGER PUMP) ______

STROKE ADJUSTMENT

MANUAL [X] AUTO [ ] WHILE RUNNING [X] OR STOPPED [ ]
REMOTE [ ] LOCAL [ ]
SIGNAL: PNEUMATIC [ ] ELECTRIC [ ] HYDRAULIC [ ]

AUXILIARY FEATURES

JACKETED [ ] STROKE COUNTER [ ]
TIMER & MULTIPORT VALVE [ ] SPARE PACKING [ ]

DRIVE

ELECTRIC [X] GAS [ ] AIR [ ] BHP ______
MAKE GE OR EQ. CONSTANT SPEED [X] VAR. SPEED [ ]
RPM ______ PHASE 1 CYCLES 60 VOLTS 110
ENCLOSURE ______ FRAME NO. ______
FULL LOAD CURRENT ______ LOCKED ROTOR CURRENT ______
POWER CYLINDER: DIAM. ______ STROKE ______
GAS PRESS. SUPPLY ______ EXHASUT ______
GAS CONSUMPTION ______ SCFM @ MAX. SPEED

SPEED CONTROL ELECT. [ ] PNEUMATIC [ ] MANUAL [ ]
AUTOMATIC [ ] NONE [X]
SPEED REDUCER: MFR. ______ INTEG. [ ] SEPARATE [ ]
MODEL ______ RATIO ______ CLASS. ______
COUPLING: MAKE ______ TYPE ______
GUARDS: COUPLING [ ] CRANK [ ]
SPEED INDIC. YES [ ] NO [ ] REMOTE [ ] LOCAL [ ]

SERVICE CONDITIONS

LIQUID END NO. ______ LIQ. ORGANIC LIQ. (ACID) (BASIC)
PUMPING TEMP. AMB °F. VAPOR PRESS. @ P.T. LOW
VISCOSITY 1.0 C.P. SPECIFIC GRAVITY 1.0
CORROSION OR EROSION FACTORS ______
CAPACITY GPH: MAX. 60 MIN. 0 NORM. ______
SUCT. PRESS. PSIG: MAX. 10 MIN. 0 NORM. ______
DISCH. PRESS. PSIG: MAX. 30 MIN. 30 NORM. 30
NPSH AVAILABLE 25 Ft. + REQ'D. ______
BHP @ RATING < 1/2
BASE PLATE ______
TEST: HYD. [X] PERF. [ ] WITNESSED [ ] NOT WITNESSED [ ]

REMARKS: ______

FORM 1.34

METERING PUMPS

STUDY DATA SHEET

Stearns-Roger CORPORATION

ITEM NO. P-24
ACC'T. ______ PAGE ______
S-R JOB B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

DATE August, 1971 BY JEW/DJM

REV. | REV.

SERVICE IFP CATALYST PUMP NO. REQ'D. 1 (1)

REVISIONS :a ______ BY ____ :b ______ BY ____ :c ______ BY ____ :d ______ BY ____

MANUFACTURER ______ SOURCE: QUOTE OF ______

TYPE PUMP: PLUNGER ☐ DIAPHRAGM ☐ DIRECT ACTING ☐ POWER FRAME ☐

METERING HEADS: SIMPLEX ☐ DUPLEX ☐ TRIPLEX ☐ * HEAD GANG ☐

* USE SEPARATE DATA SHEET FOR EACH LIQUID END

MATERIALS

LIQUID END STEEL (arrow down through FRAME)
PLUNGER
CROSS HEAD
CONN. ROD
CRANK
GEAR (DRIVER)
GEAR (DRIVEN)
GEAR HOUSING
FRAME
VALVES SS
VALVE SEATS SS
VALVE BODY SS
PACKING ______ MAX. TEMP. °F ______
GASKETS
DIAPHRAGM ______ MAX. TEMP. °F ______
GLAND
LANTERN RING
VALVE CAPS

CONNECTIONS

	SIZE	TYPE	RATING
SUCTION			
DISCHARGE			
DRAINS			
FLUSHING			

AIR OR GAS PURGING YES ☐ NO ☐
VALVES REPLACEABLE YES ☐ NO ☐

LIQUID END

LIQUID END BODY: TYPE (PLUNGER) (DIAPHRAGM) (REMOTE) (SUBMERGED)
PLUNGER DIAM. ______ STROKE ______
STROKES/MIN/CYLINDER ______
S.W.P. ______ W/QUOTED DRIVER SWP ______ W/MAX. DRIVER

VALVES	SUCTION	DISCHARGE
TYPE		
NUMBER		
AREA IN.^{2}		

PLUNGER SUPPORT ______ (PACKING) ______ (CROSS HEAD) ______
PACKING SIZE ______ TYPE ______
SPECIAL SEALS ______

LUBRICATION

PACKING ______ DRIVER BRGS. ______
CONN. ROD BRGS. ______
CROSS HEAD ______ GEARING ______
POWER CYLINDER ______
HYDRAULIC FLUID (DIAPHRAGM PLUNGER PUMP) ______

STROKE ADJUSTMENT

MANUAL ☒ AUTO ☐ WHILE RUNNING ☒ OR STOPPED ☐
REMOTE ☐ LOCAL ☐
SIGNAL: PNEUMATIC ☐ ELECTRIC ☐ HYDRAULIC ☐

AUXILIARY FEATURES

JACKETED ☐ STROKE COUNTER ☐
TIMER & MULTIPORT VALVE ☐ SPARE PACKING ☐

DRIVE

ELECTRIC ☒ GAS ☐ AIR ☐ BHP 1
MAKE GE OR EQ. CONSTANT SPEED ☒ VAR. SPEED ☐
RPM ______ PHASE 1 CYCLES 60 VOLTS 110
ENCLOSURE ______ FRAME NO. ______
FULL LOAD CURRENT ______ LOCKED ROTOR CURRENT ______
POWER CYLINDER: DIAM. ______ STROKE ______
GAS PRESS. SUPPLY ______ EXHAUST ______
GAS CONSUMPTION ______ SCFM @ MAX. SPEED

SPEED CONTROL ELECT. ☐ PNEUMATIC ☐ MANUAL ☐
AUTOMATIC ☐ NONE ☒
SPEED REDUCER: MFR. ______ INTEG. ☐ SEPARATE ☐
MODEL ______ RATIO ______ CLASS. ______
COUPLING: MAKE ______ TYPE ______
GUARDS: COUPLING ☐ CRANK ☐
SPEED INDIC. YES ☐ NO ☐ REMOTE ☐ LOCAL ☐

SERVICE CONDITIONS

LIQUID END NO. ______ LIQ. ______ (ACID) (BASIC)
PUMPING TEMP. AMB °F. VAPOR PRESS. @ P.T. LOW
VISCOSITY 1.0 C.P. SPECIFIC GRAVITY 1.0
CORROSION OR EROSION FACTORS ______
CAPACITY GPH: MAX. 60 MIN. 0 NORM. ______
SUCT. PRESS. PSIG: MAX. 0 MIN. 0 NORM. ______
DISCH. PRESS. PSIG: MAX. 30 MIN. 30 NORM. 30
NPSH AVAILABLE 25 FT + REQ'D. ______
BHP @ RATING ~ 1/2
BASE PLATE ______
TEST: HYD. ☐ PERF. ☐ WITNESSED ☐ NOT WITNESSED ☐

REMARKS: ______

Form 1.84
Rev. 9-69

Stearns-Roger

CENTRIFUGAL PUMP

STUDY DATA SHEET

TAG No. P-25
ACC'T.
S.R Job B-41449
PAGE ___ OF ___
DATE August 1971 BY JEW/DJM

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

SERVICE BOILER FEED WATER PUMP NO. OPERATING 1 (1) SPARE 1(1)
REVISIONS: a 8/71 BY RTG : b ___ BY ___ : c ___ BY ___ : d ___ BY ___
MANUFACTURER ___ MODEL ___ SIZE 1½ X 3 TYPE HORIZ.
SOURCE: ___ QUOTATION No: ___ DATE: ___

LIQUID CHARACTERISTICS

LIQUID HOT WATER
a PT °F 215 SP GR @ 60°F/@PT 1.0 / 0.959
VIS (CP) @ ___ °F/@PT ___ /
VAP. PRESS.PSIA@ ___ °F/@PT ___ /
BAROMETRIC PRESS. PSIA ___
OTHER ___

CONDITIONS OF SERVICE-EACH PUMP

	CALCULATED	RATED	MIN / MAX
USGPM @ 60°F			/
USGPM @ PT		13(18)	/
DIS PRESS PSIG		140	/
SUC PRESS PSIG		5	/
a DIFF HEAD FT.		325	/
NPSHA FT(SUC FLG)		4	/

AVAILABLE SUMP DEPTH FT ___

CONSTRUCTION REQUIREMENTS

CUST. SPECS ___
TYPE: API 610☐ AVS☐ OTHER ___
SUPPORT: CENTERLINE☐ BASE☐ IN-LINE☐ VERTICAL☐
CASE SPLT: RADIAL☐ AXIAL☐ CORROSION ALLOW ___ IN
CPLG & GUARD BY ___ DRIVER HALF MTD. BY ___
COUPLING MFG ___ MODEL ___
☐ MECH. SEAL: MFG ___ MODEL ___
SINGLE☐ DOUBLE☐ TANDEM☐ BAL.☐ UNBAL.☐
☐ PACKING: MFG & TYPE ___
BASEPLATE: CI☐ FAB STL☐ DRIP LIP☐ EXTENDED☐

AUXILIARY CONNECTIONS

SERVICE	SIZE	LIQUID	GPM	°F	PSIG	PIPED BY
FLUSHING INLET						
FLUSHING OUTLET						
COOLING INLET						
COOLING OUTLET						
QUENCHING INLET						
QUENCHING OUTLET						
CLG. JKT - SEAL						
CLG. JKT-BEARING						
CLG. JKT-PEDESTAL						
OTHER						

TOTAL EXTERNAL COOLING WATER ___ GPM@ ___ °F
CASING VENT ___ CASING DRAIN ___ GAGE CONN'S ___
WTS: PUMP ___ BASE ___ DRIVER ___

PERFORMANCE & CONSTRUCTION

RATED RPM 3550 ROTATION(FACING PUMP CPLG) ___
NO. OF STAGES 1 MIN CONT FLOW GPM ___
MIN SUBMER REQ'D ___ FT IMPELLER TYPE ___
MAX ALLOW CASE WP ___ PSIG @ ___ °F

	RATED	MIN/MAX
NPSHR FT	@SUC FLG	/
EFF %		/
BHP	~8	/
IMP DIA		/

CONNECTIONS	SIZE	ASA	FACE	POSITION
SUCTION				
DISCHARGE				

DRIVER: FURNISHED BY ___ MTD BY ___
MFG. GE OR EQ ENC TEFC FRAME ___
HP 15 RPM 3600 VOLTS/PHASE/HZ 460/3/60
SEE DRIVER SPEC ___

AUXILIARY PIPING & ACCESSORIES

MECH SEAL FLUSH PLAN (API 610 APP C) ___

	BY S-R	BY MFG.		BY S-R	BY MFG
PIPE	☐	☐	TUBING	☐	☐
HEAT EXCHANGER	☐	☐	STRAINER	☐	☐
ORIFICE	☐	☐	SEPARATOR	☐	☐

OTHER ___

MATERIALS: PUMP / SEAL

CASING STEEL ROT FACE ___
IMPELLER CI STAT FACE ___
SHAFT STEEL SPRINGS ___
SLEEVE ___ SHAFT SEAL ___
IMP WEAR RINGS ___ STAT SEAL ___
CASE WEAR RINGS ___ AUX. SEAL ___
STATIC SEALS ___ PIPE/TUBING ___
BUSHINGS ___ OTHER ___

TESTING & INSPECTION(W INDICATES WITNESSED)

CERTIFIED SHOP TESTS:
___ PERFORMANCE☐ ___ HYDRO☐@ ___ PSIG
___ NPSHR(ON WATER)☐ NONE☐ OTHER ___
INSPECTION:
☐NONE ☐OTHER ___
CERT PERF CURVE(MIN/MAX HD,FLOW,EFF,BHP,NPSHR) ☐
PERF CURVE NO. ___
BEARINGS: PLAIN☐ ANTIFRICTION☐
LUBRICATION: GREASE☐ OIL RING☐ FORCE FEED☐ OTHER☐

REMARKS:
1) SIZED FOR ULTIMATE CASE

Form 1.34
REV. 9-69

Stearns-Roger

CENTRIFUGAL PUMP
STUDY DATA SHEET

TAG NO. P-26
ACC'T.
S.R JOB B-41449
PAGE ___ OF ___
DATE August 1971 BY JEW/DJM

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

SERVICE RAW WATER MAKE-UP PUMP — NO. OPERATING 1 (1) SPARE 1 (1)
REVISIONS: a ___ BY ___ : b ___ BY ___ : c ___ BY ___ : d ___ BY ___
MANUFACTURER ___ MODEL ___ SIZE 1X1 TYPE HORIZ.
SOURCE: ___ QUOTATION NO: ___ DATE:

LIQUID CHARACTERISTICS
LIQUID WATER
PT °F 40-80 SP GR @ 60°F/@PT 1.0 /
VIS (CP) @ ___ °F/@PT ___ /
VAP. PRESS. PSIA @ ___ °F/@PT ___ /
BAROMETRIC PRESS. PSIA ___
OTHER ___

CONDITIONS OF SERVICE-EACH PUMP

	CALCULATED	RATED	MIN / MAX
USGPM @ 60°F			/
USGPM @ PT		6	/
DIS PRESS PSIG		40	
SUC PRESS PSIG		0	
DIFF HEAD FT.		92	
NPSHA FT (SUC FLG)		15+	

AVAILABLE SUMP DEPTH FT ___

CONSTRUCTION REQUIREMENTS
CUST. SPECS ___
TYPE: API 610☐ AVS☐ OTHER ___
SUPPORT: CENTERLINE☐ BASE☐ IN-LINE☐ VERTICAL☐
CASE SPLT: RADIAL☐ AXIAL☐ CORROSION ALLOW ___ IN
CPLG & GUARD BY ___ DRIVER HALF MTD. BY ___
COUPLING MFG ___ MODEL ___
☐ MECH. SEAL: MFG ___ MODEL ___
SINGLE☐ DOUBLE☐ TANDEM☐ BAL.☐ UNBAL.☐
☐ PACKING: MFG & TYPE ___
BASEPLATE: CI☐ FAB STL☐ DRIP LIP☐ EXTENDED☐

AUXILIARY CONNECTIONS

SERVICE	SIZE	LIQUID	GPM	°F	PSIG	PIPED BY
FLUSHING INLET						
FLUSHING OUTLET						
COOLING INLET						
COOLING OUTLET						
QUENCHING INLET						
QUENCHING OUTLET						
CLG. JKT - SEAL						
CLG. JKT-BEARING						
CLG. JKT-PEDESTAL						
OTHER						

TOTAL EXTERNAL COOLING WATER ___ GPM@ ___ °F
CASING VENT ___ CASING DRAIN ___ GAGE CONN'S ___
WTS: PUMP ___ BASE ___ DRIVER ___

PERFORMANCE & CONSTRUCTION
RATED RPM ___ ROTATION (FACING PUMP CPLG) ___
NO. OF STAGES ___ MIN CONT FLOW GPM ___
MIN SUBMER REQ'D ___ FT IMPELLER TYPE ___
MAX ALLOW CASE WP ___ PSIG @ ___ °F

	RATED	MIN/MAX
NPSHR FT	@SUC FLG	
EFF %	25-30	/
BHP	~0.5	/
IMP DIA		/

CONNECTIONS	SIZE	ASA	FACE	POSITION
SUCTION				
DISCHARGE				

DRIVER: FURNISHED BY ___ MTD BY ___
MFG. GE OR EQ. ENC TEFC FRAME ___
HP 2 RPM 3600 VOLTS/PHASE/HZ 460/3/60
SEE DRIVER SPEC ___

AUXILIARY PIPING & ACCESSORIES
MECH SEAL FLUSH PLAN (API 610 APP C) ___

	BY S-R	BY MFG.		BY S-R	BY MFG
PIPE	☐	☐	TUBING	☐	☐
HEAT EXCHANGER	☐	☐	STRAINER	☐	☐
ORIFICE	☐	☐	SEPARATOR	☐	☐

OTHER ___

MATERIALS:

PUMP		SEAL	
CASING	STEEL	ROT FACE	
IMPELLER	CI OR STL	STAT FACE	
SHAFT	STEEL	SPRINGS	
SLEEVE		SHAFT SEAL	
IMP WEAR RINGS		STAT SEAL	
CASE WEAR RINGS		AUX. SEAL	
STATIC SEALS		PIPE/TUBING	
BUSHINGS		OTHER	

TESTING & INSPECTION (W INDICATES WITNESSED)
CERTIFIED SHOP TESTS:
___ PERFORMANCE☐ ___ HYDRO☐ @ ___ PSIG
___ NPSHR (ON WATER)☐ NONE☐ OTHER ___
INSPECTION:
☐ NONE ☐ OTHER ___
CERT PERF CURVE (MIN/MAX HD, FLOW, EFF, BHP, NPSHR) ☐
PERF CURVE NO. ___
BEARINGS: PLAIN☐ ANTIFRICTION☐
LUBRICATION: GREASE☐ OIL RING☐ FORCE FEED☐ OTHER☐

REMARKS:
1) BASED ON ULTIMATE CASE.

Form 1.84
REV. 9-69

Stearns-Roger

CENTRIFUGAL PUMP
STUDY DATA SHEET

TAG No. P-44
ACC'T.
S.R JOB B-41449
PAGE 1 OF 1
DATE August 1971 BY RTG

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

SERVICE DEPROPANIZER BOTTOMS CIRC. PUMP   NO. OPERATING 1   SPARE 1
REVISIONS: a ___ BY ___ : b ___ BY ___ : c ___ BY ___ : d ___ BY ___
MANUFACTURER ___ MODEL ___ SIZE 3X5   TYPE Horizontal
SOURCE: ___ QUOTATION NO: ___ DATE: ___

LIQUID CHARACTERISTICS
LIQUID Hydrocarbon
PT °F 219 SP GR @ 60°F/@PT 0.596 / 0.479
VIS (CP) @ ___ °F/@PT ___ /
VAP. PRESS. PSIA @ ___ °F/@PT ___ / 237
BAROMETRIC PRESS. PSIA 14.7
OTHER ___

CONDITIONS OF SERVICE-EACH PUMP

	CALCULATED	RATED	MIN / MAX
USGPM @ 60°F	275	344	/
USGPM @ PT	342	428	/
DIS PRESS PSIG		287	/
SUC PRESS PSIG		222	/
DIFF HEAD FT.		313	/
NPSHA FT (SUC FLG)		10	/

AVAILABLE SUMP DEPTH FT ___

CONSTRUCTION REQUIREMENTS
CUST. SPECS ___
TYPE: API 610☐ AVS☐ OTHER ___
SUPPORT: CENTERLINE☐ BASE☐ IN-LINE☐ VERTICAL☒
CASE SPLT: RADIAL☐ AXIAL☐ CORROSION ALLOW ___ IN
CPLG & GUARD BY ___ DRIVER HALF MTD. BY ___
COUPLING MFG ___ MODEL ___
☒ MECH. SEAL: MFG ___ MODEL ___
SINGLE☐ DOUBLE☐ TANDEM☐ BAL.☐ UNBAL.☐
☐ PACKING: MFG & TYPE ___
BASEPLATE: CI☐ FAB STL☐ DRIP LIP☐ EXTENDED☐

AUXILIARY CONNECTIONS

SERVICE	SIZE	LIQUID	GPM	°F	PSIG	PIPED BY
FLUSHING INLET						
FLUSHING OUTLET						
COOLING INLET						
COOLING OUTLET						
QUENCHING INLET						
QUENCHING OUTLET						
CLG. JKT - SEAL						
CLG. JKT-BEARING						
CLG. JKT-PEDESTAL						
OTHER						

TOTAL EXTERNAL COOLING WATER ___ GPM@ ___ °F
CASING VENT ___ CASING DRAIN ___ GAGE CONN'S ___
WTS: PUMP ___ BASE ___ DRIVER ___

PERFORMANCE & CONSTRUCTION
RATED RPM ___ ROTATION (FACING PUMP CPLG) ___
NO. OF STAGES ___ MIN CONT FLOW GPM ___
MIN SUBMER REQ'D ___ FT   IMPELLER TYPE ___
MAX ALLOW CASE WP ___ PSIG @ ___ °F

	RATED	MIN/MAX
NPSHR FT	@SUC FLG	
EFF %	70	/
BHP	23.2	/
IMP DIA		/

CONNECTIONS	SIZE	ASA	FACE	POSITION
SUCTION				
DISCHARGE				

DRIVER: FURNISHED BY ___ MTD BY ___
MFG. ___ ENC ___ FRAME ___
HP 25 RPM 3600 VOLTS/PHASE/HZ 480/3/60
SEE DRIVER SPEC ___

AUXILIARY PIPING & ACCESSORIES
MECH SEAL FLUSH PLAN (API 610 APP C) ___

	BY S-R	BY MFG.		BY S-R	BY MFG
PIPE	☐	☐	TUBING	☐	☐
HEAT EXCHANGER	☐	☐	STRAINER	☐	☐
ORIFICE	☐	☐	SEPARATOR	☐	☐

OTHER ___

MATERIALS:

PUMP		SEAL	
CASING		ROT FACE	
IMPELLER		STAT FACE	
SHAFT		SPRINGS	
SLEEVE		SHAFT SEAL	
IMP WEAR RINGS		STAT SEAL	
CASE WEAR RINGS		AUX. SEAL	
STATIC SEALS		PIPE/TUBING	
BUSHINGS		OTHER	

TESTING & INSPECTION (W INDICATES WITNESSED)
CERTIFIED SHOP TESTS:
___ PERFORMANCE☐   ___ HYDRO☐ @ ___ PSIG
___ NPSHR (ON WATER)☐   NONE☐   OTHER ___
INSPECTION:
☐NONE ☐OTHER ___
CERT PERF CURVE (MIN/MAX HD, FLOW, EFF, BHP, NPSHR) ☐
PERF CURVE NO. ___
BEARINGS: PLAIN☐ ANTIFRICTION☐
LUBRICATION: GREASE☐ OIL RING☐ FORCE FEED☐ OTHER☐

REMARKS:

Form 1, 34
REV. 9-69

Stearns-Roger

CENTRIFUGAL PUMP

STUDY DATA SHEET

TAG NO. P-45
ACC'T.
S.R JOB B-41449
PAGE 1 OF 1
DATE August 1971 BY RTG

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

SERVICE DEPROPANIZER REFLUX PUMP NO. OPERATING ____ SPARE ____
REVISIONS: a ____ BY ____ :b ____ BY ____ :c ____ BY ____ :d ____ BY ____
MANUFACTURER ____ MODEL ____ SIZE 1½ x 2 TYPE VERT. IN-LINE
SOURCE: ____ QUOTATION NO: ____ DATE: ____

LIQUID CHARACTERISTICS

LIQUID Hydrocarbon
PT °F 36 SP GR @ 60°F/@PT 0.486 / 0.505
VIS (CP) @ ____ °F/@PT ____ /
VAP. PRESS. PSIA@ ____ °F/@PT ____ / 225
BAROMETRIC PRESS. PSIA 14.7
OTHER ____

CONDITIONS OF SERVICE-EACH PUMP

	CALCULATED	RATED	MIN / MAX
USGPM @ 60°F	24	30	/
USGPM @ PT	23	29	/
DIS PRESS PSIG		270	/
SUC PRESS PSIG		210	/
DIFF HEAD FT.		276	/
NPSHA FT(SUC FLG)		6	/

AVAILABLE SUMP DEPTH FT ____

CONSTRUCTION REQUIREMENTS

CUST. SPECS ____
TYPE: API 610☐ AVS☐ OTHER ____
SUPPORT: CENTERLINE☐ BASE☐ IN-LINE☒ VERTICAL☐
CASE SPLT: RADIAL☐ AXIAL☐ CORROSION ALLOW ____ IN
CPLG & GUARD BY ____ DRIVER HALF MTD. BY ____
COUPLING MFG ____ MODEL ____
☒ MECH. SEAL: MFG ____ MODEL ____
SINGLE☐ DOUBLE☐ TANDEM☐ BAL.☐ UNBAL.☐
☐ PACKING: MFG & TYPE ____
BASEPLATE: CI☐ FAB STL☐ DRIP LIP☐ EXTENDED☐

AUXILIARY CONNECTIONS

SERVICE	SIZE	LIQUID	GPM	°F	PSIG	PIPED BY
FLUSHING INLET						
FLUSHING OUTLET						
COOLING INLET						
COOLING OUTLET						
QUENCHING INLET						
QUENCHING OUTLET						
CLG. JKT - SEAL						
CLG. JKT-BEARING						
CLG. JKT-PEDESTAL						
OTHER						

TOTAL EXTERNAL COOLING WATER ____ GPM@ ____ °F
CASING VENT ____ CASING DRAIN ____ GAGE CONN'S ____
WTS: PUMP ____ BASE ____ DRIVER ____

PERFORMANCE & CONSTRUCTION

RATED RPM ____ ROTATION(FACING PUMP CPLG) ____
NO. OF STAGES ____ MIN CONT FLOW GPM ____
MIN SUBMER REQ'D ____ FT IMPELLER TYPE ____
MAX ALLOW CASE WP ____ PSIG @ ____ °F

	RATED	MIN/MAX
NPSHR FT	@SUC FLG	
EFF %	60	/
BHP	1.7	/
IMP DIA		/

CONNECTIONS	SIZE	ASA	FACE	POSITION
SUCTION				
DISCHARGE				

DRIVER: FURNISHED BY ____ MTD BY ____
MFG. ____ ENC ____ FRAME ____
HP 2 RPM 3600 VOLTS/PHASE/HZ 480/3/60
SEE DRIVER SPEC ____

AUXILIARY PIPING & ACCESSORIES

MECH SEAL FLUSH PLAN (API 610 APP C) ____

	BY S-R	BY MFG.		BY S-R	BY MFG
PIPE	☐	☐	TUBING	☐	☐
HEAT EXCHANGER	☐	☐	STRAINER	☐	☐
ORIFICE	☐	☐	SEPARATOR	☐	☐

OTHER ____

MATERIALS:

PUMP		SEAL	
CASING		ROT FACE	
IMPELLER		STAT FACE	
SHAFT		SPRINGS	
SLEEVE		SHAFT SEAL	
IMP WEAR RINGS		STAT SEAL	
CASE WEAR RINGS		AUX. SEAL	
STATIC SEALS		PIPE/TUBING	
BUSHINGS		OTHER	

TESTING & INSPECTION (W INDICATES WITNESSED)

CERTIFIED SHOP TESTS:
____ PERFORMANCE☐ ____ HYDRO☐@ ____ PSIG
____ NPSHR (ON WATER)☐ NONE☐ OTHER ____
INSPECTION:
☐NONE ☐OTHER ____
CERT PERF CURVE(MIN/MAX HD, FLOW, EFF, BHP, NPSHR) ☐
PERF CURVE NO. ____
BEARINGS: PLAIN☐ ANTIFRICTION☐
LUBRICATION: GREASE☐ OIL RING☐ FORCE FEED☐ OTHER☐

REMARKS:

Form 1.34
REV. 9-69

Stearns-Roger

CENTRIFUGAL PUMP
STUDY DATA SHEET

REV.

TAG No. P-52
ACC'T.
S.R JOB B-41449
PAGE ____ OF ____
DATE August 1971 BY RTG

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

SERVICE BUTANE-PLUS LOADING PUMPS   NO. OPERATING ONE   SPARE ONE
REVISIONS: a 8/71 BY RTG : b ____ BY ____ : c ____ BY ____ : d ____ BY ____
MANUFACTURER WORTHINGTON   MODEL 12L54   SIZE ____   TYPE VERTICAL
SOURCE: QUOTATION No: DATE:

LIQUID CHARACTERISTICS
LIQUID N-BUTANE
PT °F 60 SP GR @ 60°F/@PT — / 0.596
VIS (CP) @ ____ °F/@PT — / 0.170
VAP. PRESS. PSIA @ ____ °F/@PT / 27
BAROMETRIC PRESS. PSIA 14.7
OTHER

CONDITIONS OF SERVICE-EACH PUMP

	CALCULATED	RATED	MIN / MAX
USGPM @ 60°F	500	500	/
USGPM @ PT			/
DIS PRESS PSIG	137	137	
SUC PRESS PSIG	12	12	
a DIFF HEAD FT.	484	484	
NPSHA FT (SUC FLG)	0	0	

AVAILABLE SUMP DEPTH FT

CONSTRUCTION REQUIREMENTS
CUST. SPECS
TYPE: API 610☐ AVS☐ OTHER WORTH. STD.
SUPPORT: CENTERLINE☐ BASE☒ IN-LINE☐ VERTICAL☐
CASE SPLT: RADIAL☐ AXIAL☒ CORROSION ALLOW 1/8 IN
CPLG & GUARD BY ____ DRIVER HALF MTD. BY FIELD
COUPLING MFG ____ MODEL SPACER
☒ MECH. SEAL: MFG CRANE MODEL 8B1-XP-171
SINGLE☐ DOUBLE☐ TANDEM☐ BAL.☒ UNBAL.☐
☐ PACKING: MFG & TYPE
BASEPLATE: CI☐ FAB STL☐ DRIP LIP☐ EXTENDED☐

AUXILIARY CONNECTIONS

SERVICE	SIZE	LIQUID	GPM	°F	PSIG	PIPED BY
FLUSHING INLET						
FLUSHING OUTLET						
COOLING INLET						
COOLING OUTLET						
QUENCHING INLET						
QUENCHING OUTLET						
CLG. JKT - SEAL						
CLG. JKT-BEARING						
CLG. JKT-PEDESTAL						
OTHER						

TOTAL EXTERNAL COOLING WATER ____ GPM@ ____ °F
CASING VENT ____ CASING DRAIN ____ GAGE CONN'S ____
WTS: PUMP 2354 BASE — DRIVER 800

PERFORMANCE & CONSTRUCTION
RATED RPM 1750 ROTATION (FACING PUMP CPLG) ____
NO. OF STAGES 6 MIN CONT FLOW GPM ____
MIN SUBMER REQ'D 10 FT IMPELLER TYPE ENCL.
MAX ALLOW CASE WP 220 PSIG @ 200 °F

	BARREL RATED		MIN/MAX
NPSHR FT	0 @SUC FLG		
EFF %	83.0		/
BHP	44.0		/ 47.5
IMP DIA	8 3/4	7 3/4	/ 8 3/4

CONNECTIONS	SIZE	ASA	FACE	POSITION
SUCTION	6"	300#	RF	SIDE
DISCHARGE	4"	300#	RF	SIDE

DRIVER: FURNISHED BY VENDOR MTD BY FIELD
MFG. GE OR EQ ENC EXP. PRF.* FRAME
HP 50 RPM 1800 VOLTS/PHASE/HZ 440/3/60
[redacted] * CL.1, GRP.D, DIV.1

AUXILIARY PIPING & ACCESSORIES
MECH SEAL FLUSH PLAN (API 610 APP C) ____

	BY S-R	BY MFG.		BY S-R	BY MFG
PIPE	☐	☐	TUBING	☐	☐
HEAT EXCHANGER	☐	☐	STRAINER	☐	☐
ORIFICE	☐	☐	SEPARATOR	☐	☐

OTHER

MATERIALS:

	PUMP		SEAL
~~CASING~~ BOWL	CI	ROT FACE	CARBON
IMPELLER	BRZ	STAT FACE	NI-RESIST
SHAFT	416 SS	SPRINGS	—
SLEEVE	303 SS	SHAFT SEAL	—
IMP WEAR RINGS	NONE	STAT SEAL	—
CASE WEAR RINGS	NONE	AUX. SEAL	—
STATIC SEALS	NONE	PIPE/TUBING	—
~~BUSHINGS~~ BEARINGS	GRAPHITAR	OTHER	—

TESTING & INSPECTION (W INDICATES WITNESSED)
CERTIFIED SHOP TESTS:
BOWL PERFORMANCE☒ BOWL HYDRO☒@ ____ PSIG
____ NPSHR (ON WATER)☐ NONE☐ OTHER ____
INSPECTION:
☒NONE ☐OTHER ____
CERT PERF CURVE (MIN/MAX HD, FLOW, EFF, BHP, NPSHR) ☒
PERF CURVE NO.
BEARINGS: PLAIN☒ ANTIFRICTION☐
LUBRICATION: GREASE☐ OIL RING☐ FORCE FEED☐ OTHER☒

REMARKS:

Form 1.84
REV. 9-69

Stearns-Roger

CENTRIFUGAL PUMP

STUDY DATA SHEET

TAG No. P-53
ACC'T.
S.R JOB B-41449
PAGE ___ OF ___
DATE August 1971 BY RTG

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

REV.

SERVICE RE-RUN PUMP — NO. OPERATING ONE — SPARE NO
REVISIONS: a 8/71 BY RTG : b ___ BY ___ : c ___ BY ___ : d ___ BY ___
MANUFACTURER ___ MODEL ___ SIZE ___ TYPE VERTICAL
SOURCE: ___ QUOTATION NO: ___ DATE:

LIQUID CHARACTERISTICS

a LIQUID HYDROCARBON
PT °F 60 SP GR @ 60°F/@PT ___ / 0.508
VIS (CP) @ ___ °F/@PT ___ / 0.105
VAP. PRESS.PSIA@ ___ °F/@PT ___ / 108
BAROMETRIC PRESS. PSIA 14.7
OTHER

CONDITIONS OF SERVICE-EACH PUMP

	CALCULATED	RATED	MIN / MAX
USGPM @ 60°F	50	50	/
USGPM @ PT			/
DIS PRESS PSIG	500	500	
SUC PRESS PSIG	100	100	
DIFF HEAD FT.	1819	1820	
NPSHA FT(SUC FLG)	0	0	

AVAILABLE SUMP DEPTH FT

CONSTRUCTION REQUIREMENTS

CUST. SPECS
TYPE: API 610☐ AVS☐ OTHER
SUPPORT: CENTERLINE☐ BASE☒ IN-LINE☐ VERTICAL☐
CASE SPLT: RADIAL☐ AXIAL☒ CORROSION ALLOW 1/8 IN
CPLG & GUARD BY ___ DRIVER HALF MTD. BY FIELD
COUPLING MFG ___ MODEL
☒ MECH. SEAL: MFG ___ MODEL
SINGLE☐ DOUBLE☐ TANDEM☐ BAL.☒ UNBAL.☐
☐ PACKING: MFG & TYPE
BASEPLATE: CI☐ FAB STL☐ DRIP LIP☐ EXTENDED☐

AUXILIARY CONNECTIONS

SERVICE	SIZE	LIQUID	GPM	°F	PSIG	PIPED BY
FLUSHING INLET						
FLUSHING OUTLET						
COOLING INLET						
COOLING OUTLET						
QUENCHING INLET						
QUENCHING OUTLET						
CLG. JKT - SEAL						
CLG. JKT-BEARING						
CLG. JKT-PEDESTAL						
OTHER						

TOTAL EXTERNAL COOLING WATER ___ GPM@ ___ °F
CASING VENT ___ CASING DRAIN ___ GAGE CONN'S ___
WTS: PUMP ___ BASE ___ DRIVER ___

PERFORMANCE & CONSTRUCTION

RATED RPM 3520 ROTATION(FACING PUMP CPLG)
NO. OF STAGES 26 MIN CONT FLOW GPM
MIN SUBMER REQ'D 11 FT IMPELLER TYPE ENCL.
MAX ALLOW CASE WP 960 PSIG @ 200 °F

	BARREL RATED	MIN/MAX
NPSHR FT	0 @SUC FLG	
EFF %	73.0	/
BHP	16.0	/ 20.0
IMP DIA		/

CONNECTIONS	SIZE	ASA	FACE	POSITION
SUCTION				
DISCHARGE				

DRIVER: FURNISHED BY VENDOR MTD BY FIELD
MFG. GE OR EQ. ENC. EX. PRF.* FRAME
HP 20 RPM 3600 VOLTS/PHASE/HZ 440/3/60
S[redacted] * CL. 1, GRP. D, DIV. 1

AUXILIARY PIPING & ACCESSORIES

MECH SEAL FLUSH PLAN (API 610 APP C)

	BY S-R	BY MFG.		BY S-R	BY MFG
PIPE	☐	☐	TUBING	☐	☐
HEAT EXCHANGER	☐	☐	STRAINER	☐	☐
ORIFICE	☐	☐	SEPARATOR	☐	☐

OTHER

MATERIALS:

PUMP		SEAL	
CASING BOWL	CI	ROT FACE	
IMPELLER		STAT FACE	
SHAFT		SPRINGS	
SLEEVE		SHAFT SEAL	
IMP WEAR RINGS		STAT SEAL	
CASE WEAR RINGS		AUX. SEAL	
STATIC SEALS		PIPE/TUBING	
BUSHINGS		OTHER	

TESTING & INSPECTION(W INDICATES WITNESSED)

CERTIFIED SHOP TESTS:
___ PERFORMANCE☐ ___ HYDRO☐@ ___ PSIG
___ NPSHR(ON WATER)☐ NONE☐ OTHER
INSPECTION:
☐NONE ☐OTHER
CERT PERF CURVE(MIN/MAX HD,FLOW,EFF,BHP,NPSHR) ☐
PERF CURVE NO.
BEARINGS: PLAIN☐ ANTIFRICTION☐
LUBRICATION: GREASE☐ OIL RING☐ FORCE FEED☐ OTHER☐

REMARKS:

Stearns-Roger

METERING PUMPS
STUDY DATA SHEET

ITEM NO. P-57
ACC'T. ______ PAGE ______

CUSTOMER HUMBLE OIL AND REFINING COMPANY
S.R JOB B-41449

PROJECT GAS PROCESSING STUDY

LOCATION SANTA BARBARA CHANNEL, CALIFORNAI
DATE August, 1971 BY JGN

SERVICE Glycol Inhibitor Pump
NO. REQ'D. 1

REVISIONS: a ______ BY ______ : b ______ BY ______ : c ______ BY ______ : d ______ BY ______

MANUFACTURER ______ SOURCE: QUOTE OF ______

One (1) Manually adjustable stroke metering pump for 0.2 GPH maximum chemical feed rate at 25 PSIG discharge pressure. Unit complete with 1/4 Hp, 1800 rpm, explosion proof electric motor and one 5 gallon galvanized chemical tank.

FORM 1.32

REV.

Stearns-Roger

RECIPROCATING PUMPS

STUDY DATA SHEET

ITEM NO. P-58

ACC'T. ______ PAGE ______

S.R JOB B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY

PROJECT GAS PROCESSING STUDY

LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

DATE August 1971 BY JGN

REV.

SERVICE GLYCOL INJECTION PUMP NO. REQ'D. TWO

REVISIONS :a 8/71 BY RTG :b ______ BY ______ :c ______ BY ______ :d ______ BY ______

MANUFACTURER ______ SOURCE: QUOTE OF ______

MODEL TYPE & SIZE ______

CONDITIONS OF SERVICE

CONDITIONS SHOWN FOR TOTAL REQUIRED SERVICE: ONE TOTAL OPERATING PUMPS REQUIRED AND ONE SPARE PUMPS

FLUID 80 wt % ETHYLENE GLYCOL	REQ'D 45 GPM @ 60°
PUMPING TEMPERATURE, °F 150	U.S. GPM @ P.T. NORM. ______ DESIGN 10 (a)
SP. GR. @ 60°F 1.10 @ P.T. 1.06	SUCT. PRESS., PSIG 0
VISCOSITY @ P.T. 2.7 cp	DISCH. PRESS., PSIG 1260
VAPOR PRESSURE, PSIA 1.75 @ 150 °F	DIFF. PRESS., PSIG 1260
BAROMETRIC PRESSURE, PSIA 14.7	DRIVING MEDIUM ELECTRIC MOTOR
NPSH AVAILABLE @ SUCT. FLG., FT. OF FLUID 20	PRESSURE, PSIG SUPPLY ______ EXHAUST ______
	SUPPLY TEMP., °F ______ QUALITY % ______

PERFORMANCE (OF SINGLE UNIT UNLESS NOTED)

NPSH REQ'D. @ SUCT. FLG., FT. OF FLUID ______	DESIGN EFFICIENCY, % VOLUMETRIC ______ MECH. ______
DESIGN ______ GPM EACH PUMP ______ TOTAL ______	DESIGN HYDRAULIC HORSEPOWER, HHP ______
DESIGN PISTON SPEED, FPM ______ RPM ______	BHP (POWER PUMPS) DESIGN 9.4 MAX. ______
MAX. ALLOW. PISTON SPEED, FPM ______ RPM ______	STEAM CONSUMPTION, LB/HHP/HR ______
STALLING PRESSURE, PSIG ______ @ 100% M.E.	LB/HR ______
WITH ______ PSIG SUPPLY, ______ PSIG EXH.	STEAM CHEST PRESS. @ DESIGN RATE, PSIG ______

MATERIALS AND DESIGN

LIQUID END: CYLINDER FORGED STEEL	LIQUID END: VALVES ______
CYLINDER LINER ______	VALVE SEATS ______
TYPE ______	VALVE SPRINGS ______
PISTON/PLUNGER ______	SUCT. VALVES, NO. & SIZE ______ SQ. IN. ______
PISTON PACKING ______	VELOCITY, FPM DESIGN ______ MAX. ______
PISTON ROD ______	DISCH. VALVES, NO. & SIZE ______ SQ. IN. ______
ROD PACKING ______	VELOCITY, FPM DESIGN ______ MAX. ______
STUFFING BOX ______	COOLING WATER ______ @ ______ °F & ______ PSIG
LANTERN RING ______	______ GPM TO ______
PACKING GLAND ______	______ GPM TO ______
STEAM JACKET ______	VENTS ______ DRAINS ______
MAX. ALLOW. W.P. ______ PSIG @ ______ °F	SUCT. NOZZLE ______
CORR. ALLOW. IN. ______ HYD. TEST PSIG ______	DISCH. NOZZLE ______
STEAM END: CYLINDER ______	POWER: FRAME TYPE ______
PISTON ROD ______	MAINSHAFT RPM ______ GEARSHAFT RPM ______
PACKING ______	GEAR RATIO ______ LUBRICATION ______
TYPE VALVE ______	DRIVE TYPE ______
MAX. ALLOW. W.P. ______ PSIG @ ______ °F TEST PSIG ______	GUARD ______
SUPPLY NOZZLE ______	BASEPLATE ______
EXHAUST NOZZLE ______	DRIVER MOUNTING ______

LUBRICATOR YES LAGGING ______ REVOLUTION COUNTER ______

REMARKS ______

DRIVER

FURNISHED BY ______ MOUNTED BY ______

ELECTRIC MOTOR NO. REQ'D. 2 MFG'R GE OR EQUAL OTHER DRIVER TYPE & REF PG ______

HP 10 RPM 1200 FRAME ______ TYPE EXPLOSION PROOF BEARINGS ______

VOLTS 440 PH 3 CY 60 LUBRICATION GREASE TORQUE/THRUST ______

Form 1.34
Rev. 9-69

CENTRIFUGAL PUMP
STUDY DATA SHEET

Stearns-Roger

Rev.

TAG No. P-59
Acc't.
S.R Job B-41449
PAGE ____ OF ____
DATE August 1971 BY KW

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

SERVICE GLYCOL SUMP PUMP — NO. OPERATING ONE — SPARE NO
REVISIONS: a ____ BY ____ :b ____ BY ____ :c ____ BY ____ :d ____ BY ____
MANUFACTURER ____ MODEL ____ SIZE ____ TYPE VERT. TURB
SOURCE: ____ QUOTATION No: ____ DATE: ____

LIQUID CHARACTERISTICS
LIQUID ETHYLENE GLYCOL-WATER SOLUTION
PT °F 60 SP GR @ 60°F 1.10
VIS (CP) @ 60 °F 12 cp
VAP. PRESS. PSIA @ 60°F NIL
BAROMETRIC PRESS. PSIA 14.7
OTHER ____

CONDITIONS OF SERVICE-EACH PUMP

	CALCULATED	RATED	MIN / MAX
USGPM @ 60°F		15	/
USGPM @ PT		15	/
DIS PRESS PSIG		55	
SUC PRESS PSIG		0	
DIFF HEAD FT.		115.5	
NPSHA FT (SUC FLG)			

AVAILABLE SUMP DEPTH FT ____

CONSTRUCTION REQUIREMENTS
CUST. SPECS ____
TYPE: API 610☐ AVS☐ OTHER ____
SUPPORT: CENTERLINE☐ BASE☐ IN-LINE☐ VERTICAL☐
CASE SPLT: RADIAL☐ AXIAL☐ CORROSION ALLOW ____ IN
CPLG & GUARD BY ____ DRIVER HALF MTD. BY ____
COUPLING MFG ____ MODEL ____
☐ MECH. SEAL: MFG ____ MODEL ____
SINGLE☐ DOUBLE☐ TANDEM☐ BAL.☐ UNBAL.☐
☒ PACKING: MFG & TYPE ____
BASEPLATE: CI☐ FAB STL☐ DRIP LIP☐ EXTENDED☐

AUXILIARY CONNECTIONS

SERVICE	SIZE	LIQUID	GPM	°F	PSIG	PIPED BY
FLUSHING INLET						
FLUSHING OUTLET						
COOLING INLET						
COOLING OUTLET						
QUENCHING INLET						
QUENCHING OUTLET						
CLG. JKT - SEAL						
CLG. JKT-BEARING						
CLG. JKT-PEDESTAL						
OTHER						

TOTAL EXTERNAL COOLING WATER ____ GPM@ ____ °F
CASING VENT ____ CASING DRAIN ____ GAGE CONN'S ____
WTS: PUMP ____ BASE ____ DRIVER ____

PERFORMANCE & CONSTRUCTION
RATED RPM ____ ROTATION (FACING PUMP CPLG) ____
NO. OF STAGES ____ MIN CONT FLOW GPM ____
MIN SUBMER REQ'D ____ FT IMPELLER TYPE ____
MAX ALLOW CASE WP ____ PSIG @ ____ °F

	RATED	MIN/MAX
NPSHR FT	@SUC FLG	
EFF %	44	/
BHP	1.1	/
IMP DIA		/

CONNECTIONS	SIZE	ASA	FACE	POSITION
SUCTION				
DISCHARGE				

DRIVER: FURNISHED BY VENDOR MTD BY VENDOR
MFG. GE OR EQ ENC. EXP. PRF FRAME ____
HP 1½ RPM 3600 VOLTS/PHASE/HZ 440/3/60
SEE DRIVER SPEC ____

AUXILIARY PIPING & ACCESSORIES
MECH SEAL FLUSH PLAN (API 610 APP C) ____

	BY S-R	BY MFG.		BY S-R	BY MFG
PIPE	☐	☐	TUBING	☐	☐
HEAT EXCHANGER	☐	☐	STRAINER	☐	☐
ORIFICE	☐	☐	SEPARATOR	☐	☐

OTHER ____

MATERIALS:

PUMP		SEAL	
CASING		ROT FACE	
IMPELLER		STAT FACE	
SHAFT		SPRINGS	
SLEEVE		SHAFT SEAL	
IMP WEAR RINGS		STAT SEAL	
CASE WEAR RINGS		AUX. SEAL	
STATIC SEALS		PIPE/TUBING	
BUSHINGS		OTHER	

TESTING & INSPECTION (W INDICATES WITNESSED)
CERTIFIED SHOP TESTS:
____ PERFORMANCE☐ ____ HYDRO☐ @ ____ PSIG
____ NPSHR (ON WATER)☐ NONE☐ OTHER ____
INSPECTION:
☐NONE ☐OTHER ____
CERT PERF CURVE (MIN/MAX HD, FLOW, EFF, BHP, NPSHR) ☐
PERF CURVE NO. ____
BEARINGS: PLAIN☐ ANTIFRICTION☐
LUBRICATION: GREASE☐ OIL RING☐ FORCE FEED☐ OTHER☐

REMARKS: 1. USE NO COPPER OR COPPER ALLOYS IN CONTACT WITH PUMPED FLUID.

Form 1.3d
Rev. 9-69

Stearns-Roger

CENTRIFUGAL PUMP

STUDY DATA SHEET

Rev.

TAG No. P-60
Acc't. ____
S.R Job B-41449
PAGE ____ OF ____
DATE August 1971 BY AUM

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

SERVICE TREATED WATER PUMP — NO. OPERATING 1 (1) SPARE 1 (1)
REVISIONS: a 8/71 BY RTG : b ____ BY ____ : c ____ BY ____ : d ____ BY ____
MANUFACTURER ____ MODEL ____ SIZE 1 X 1 TYPE HORIZ.
SOURCE: ____ QUOTATION NO: ____ DATE: ____

LIQUID CHARACTERISTICS

LIQUID WATER
PT °F 40-80 SP GR @ 60°F/@PT 1.0 /
VIS (CP) @ ____ °F/@PT ____ /
VAP. PRESS. PSIA @ ____ °F/@PT ____ /
BAROMETRIC PRESS. PSIA ____
OTHER ____

CONDITIONS OF SERVICE-EACH PUMP

	CALCULATED	RATED	MIN / MAX
USGPM @ 60°F			/
USGPM @ PT		8	/
DIS PRESS PSIG		40	/
SUC PRESS PSIG		0	/
DIFF HEAD FT.		92	/
NPSHA FT (SUC FLG)		0	

AVAILABLE SUMP DEPTH FT ____

CONSTRUCTION REQUIREMENTS

CUST. SPECS ____
TYPE: API 610☐ AVS☐ OTHER ____
SUPPORT: CENTERLINE☐ BASE☐ IN-LINE☐ VERTICAL☐
CASE SPLT: RADIAL☐ AXIAL☐ CORROSION ALLOW ____ IN
CPLG & GUARD BY ____ DRIVER HALF MTD. BY ____
COUPLING MFG ____ MODEL ____
☐ MECH. SEAL: MFG ____ MODEL ____
SINGLE☐ DOUBLE☐ TANDEM☐ BAL.☐ UNBAL.☐
☐ PACKING: MFG & TYPE ____
BASEPLATE: CI☐ FAB STL☐ DRIP LIP☐ EXTENDED☐

AUXILIARY CONNECTIONS

SERVICE	SIZE	LIQUID	GPM	°F	PSIG	PIPED BY
FLUSHING INLET						
FLUSHING OUTLET						
COOLING INLET						
COOLING OUTLET						
QUENCHING INLET						
QUENCHING OUTLET						
CLG. JKT - SEAL						
CLG. JKT-BEARING						
CLG. JKT-PEDESTAL						
OTHER						

TOTAL EXTERNAL COOLING WATER ____ GPM @ ____ °F
CASING VENT ____ CASING DRAIN ____ GAGE CONN'S ____
WTS: PUMP ____ BASE ____ DRIVER ____

PERFORMANCE & CONSTRUCTION

RATED RPM ____ ROTATION (FACING PUMP CPLG) ____
NO. OF STAGES ____ MIN CONT FLOW GPM ____
MIN SUBMER REQ'D ____ FT IMPELLER TYPE ____
MAX ALLOW CASE WP ____ PSIG @ ____ °F

	RATED	MIN/MAX
NPSHR FT	@SUC FLG	
EFF %	35 - 40	/
BHP	~ 0.5	/
IMP DIA		/

a

CONNECTIONS	SIZE	ASA	FACE	POSITION
SUCTION				
DISCHARGE				

DRIVER: FURNISHED BY ____ MTD BY ____
MFG. GE OR EQUAL ENC TEFC FRAME ____
HP 2 RPM 3600 VOLTS/PHASE/HZ 460/3/60
SEE DRIVER SPEC ____

AUXILIARY PIPING & ACCESSORIES

MECH SEAL FLUSH PLAN (API 610 APP C) ____

	BY S-R	BY MFG.		BY S-R	BY MFG
PIPE	☐	☐	TUBING	☐	☐
HEAT EXCHANGER	☐	☐	STRAINER	☐	☐
ORIFICE	☐	☐	SEPARATOR	☐	☐

OTHER ____

MATERIALS:

PUMP		SEAL	
CASING	STEEL	ROT FACE	
IMPELLER	CI OR STL	STAT FACE	
SHAFT	STEEL	SPRINGS	
SLEEVE		SHAFT SEAL	
IMP WEAR RINGS		STAT SEAL	
CASE WEAR RINGS		AUX. SEAL	
STATIC SEALS		PIPE/TUBING	
BUSHINGS		OTHER	

TESTING & INSPECTION (W INDICATES WITNESSED)

CERTIFIED SHOP TESTS:
____ PERFORMANCE☐ ____ HYDRO☐ @ ____ PSIG
____ NPSHR (ON WATER)☐ NONE☐ OTHER ____
INSPECTION:
☐ NONE ☐ OTHER ____
CERT PERF CURVE (MIN/MAX HD, FLOW, EFF, BHP, NPSHR) ☐
PERF CURVE NO. ____

BEARINGS: PLAIN☐ ANTIFRICTION☐
LUBRICATION: GREASE☐ OIL RING☐ FORCE FEED☐ OTHER☐

REMARKS: 1) BASED ON ULTIMATE CASE

Stearns-Roger

FILTERS
STUDY DATA SHEET

ITEM NO. S-1
ACC'T. ____ PAGE ____
S.R JOB B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

DATE August, 1971 BY JGN

SERVICE Glycol Filter NO. REQ'D. One

REVISIONS: a ____ BY ____ : b ____ BY ____ : c ____ BY ____ : d ____ BY ____

MANUFACTURER ____ SOURCE: QUOTE OF ____

One (1) Replaceable cartridge filter to remove 98% solid particles 4 microns and larger from 10 GPM of 80 weight percent ethylene glycol water solution at 130°F and 40 psig. Unit to be designed for 75 psig @ 200°F.

Stearns-Roger

FILTERS
STUDY DATA SHEET

ITEM NO. S-11
ACC'T. ______ PAGE ______
S.R JOB B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

DATE August, 1971 BY DJM

SERVICE Amine Solution Filter NO. REQ'D. 1(1)

REVISIONS: a BY :b BY :c BY :d BY

MANUFACTURER SOURCE: QUOTE OF

One (1) - self cleaning pressure leaf filter, complete with precoat tank and pump, mix tank, mixer, and all necessary piping, valves, drivers and controls.

General design conditions are as follows:

Fluid	25 wt. % DEA
Temperature	186°F - design 250°
Pressure	100 psig - design 150 psig
Flow Rate	50 GPM @ 186°F

NO. VESSELS REQ'D. ([redacted].-VERT.) ONE (1)	
SHELL DIA. I.D. -[redacted] 138"	
SHELL THICKNESS ≈ 3/16"	
HEADS THICKNESS CONE ROOF ≈ 3/16"	
SHELL & HEAD THICKNESS INCLUDE C.A.	
SHELL LENGTH 20'-0"	
SUPPORT FLAT BOTTOM ≈ 1/4"	

DESIGN CONDITIONS

CODE API 620 STAMP YES

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	ATMOS.	ATMOS.	
TEMP. (°F)	186		

CORR. ALLOW. SHELL NO	HEADS NO
X-RAY	STRESS RELIEF NO
WINDLOAD PER ASA 58.1	
SEISMIC ZONE 3	

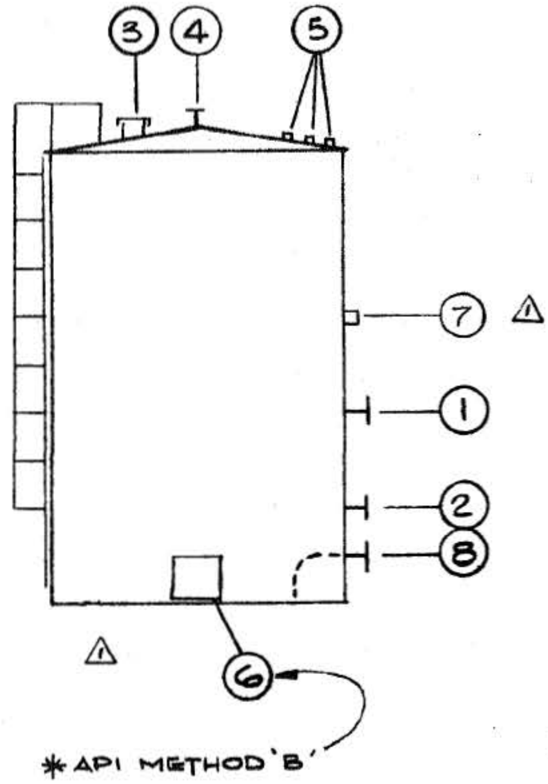
MATERIALS

ROOF & BOTTOM	STEEL
SHELL	STEEL
NOZZLES & FLANGES	
GASKETS	

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. INLET	1	6"-150# RF
2. OUTLET	1	8"-150# RF △1
3. TOP MANWAY	1	20" API STD.
4. GAS BLANKET	1	3"-150# RF
5. TANK GAUGE	3	1½"-3000# CPLG.
6. FLUSH TYPE OPEN.	1	24"×36" *
7. TEMP. IND.	1	1" CPLG. △1
8. DRAIN	1	2"-150# RF
9.		
10.		
11.		
12.		
13.		
14.		
15.		

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM.	—	—
PACKING	—	—
INSUL. RINGS	—	—
LADDERS	YES	—
INTERNALS	YES	—

NO.	DATE	BY	REVISIONS
△1	8/71	RTG	GEN. REV.



WEIGHT EMPTY ≈ 11,000 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.

△1

WHITE SANDBLAST & ZINC-RICH PRIMER.

VESSEL AMINE SOLUTION SURGE TANK

FOR HUMBLE OIL AND REFINING COMPANY

PLANT GAS PROCESSING STUDY

LOCATION SBC, CALIFORNIA.

ORDER NO. B-41449 ITEM NO. T-11

MFGR.

DATE 8-71 BY [signature]

Stearns-Roger

NO. VESSELS REQ'D. ([redacted].-VERT.) ONE (1)	
SHELL DIA. I.D.-[redacted]. 120"	
SHELL THICKNESS [redacted] 3/16"	
HEADS THICKNESS CONE ROOF ≅ 3/16"	
SHELL & HEAD THICKNESS INCLUDE C.A.	
SHELL LENGTH 12'-0"	
SUPPORT FLAT BOTTOM ≅ 1/4"	

DESIGN CONDITIONS

CODE API 620 STAMP YES

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	ATMOS.		
TEMP. (^{o}F)	150		

CORR. ALLOW. SHELL NO HEADS NO

X-RAY STRESS RELIEF NO

WINDLOAD PER ASA 58.1

SEISMIC ZONE 3

MATERIALS

ROOF & BOTTOM STEEL

SHELL STEEL

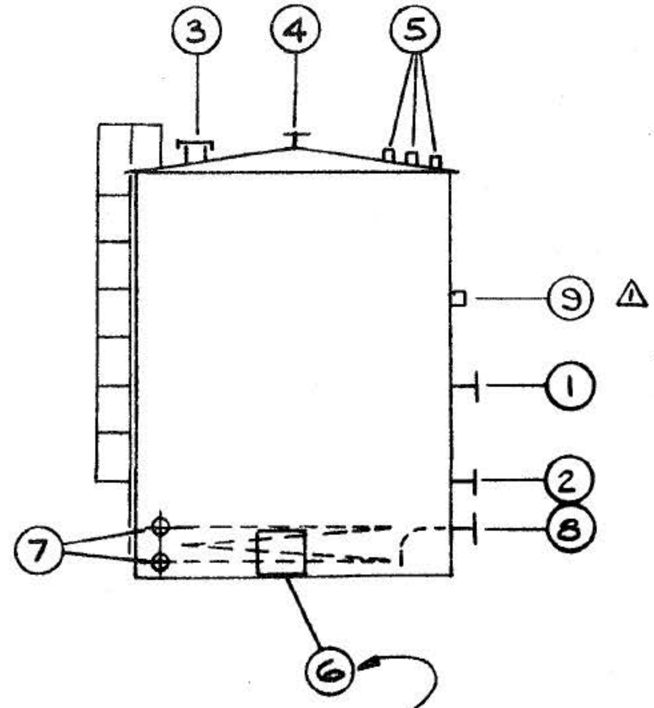
NOZZLES & FLANGES

GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. INLET	1	2"-150# RF
2. OUTLET	1	3"-150# RF
3. TOP MANWAY	1	20" API STD.
4. BLANKET GAS	1	3"-150# RF
5. TANK GAUGE	3	1½"-3000# CPLG.
6. FLUSH TYPE OPEN.	1	24" x 36" *
7. HEATING COIL	2	1"-150# RF NOTE (1)
8. DRAIN	1	2"-150# RF
9. TEMP. IND.	1	1" CPLG. ⚠
10.		
11.		
12.		
13.		
14.		
15.		

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM.	–	–
PACKING	–	–
INSUL. RINGS	–	–
LADDERS	YES	–
INTERNALS	YES	–

NO.	DATE	BY	REVISIONS
⚠	8/71	RTG	GEN. REV.



WEIGHT EMPTY ≅ 10,000 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.

(1) WELDED TANK COIL 1" SCH. 40 PIPE, 316 SS.

(2) WHITE SANDBLAST & ZINC-RICH PRIMER.

VESSEL AMINE STORAGE TANK

FOR HUMBLE OIL AND REFINING COMPANY

PLANT GAS PROCESSING STUDY

LOCATION SBC, CALIFORNIA

ORDER NO. 8-41449 ITEM NO. T-12

MFGR.

DATE 8-71 BY [signature]

Stearns-Roger

NO. VESSELS REQ'D. (HORZ.-[redacted].) ONE (1)	
SHELL DIA. I.D.-[redacted]. 48"	
SHELL THICKNESS ≅ 1/4"	
HEADS THICKNESS S.E.-[redacted]. ≅ 1/4"	
SHELL & HEAD THICKNESS INCLUDE C.A. YES	
SHELL LENGTH (SEAM TO SEAM) 10'-0"	
SUPPORT NONE	

DESIGN CONDITIONS

CODE ASME VIII STAMP NO

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)		10	
TEMP. (°F)		150	

CORR. ALLOW. SHELL 1/8" HEADS 1/8"

X-RAY SPOT STRESS RELIEF NO

WINDLOAD -

DRUM WILL BE BURIED (NOTE 2)

MATERIALS

HEADS A 285-C

SHELL A 285-C

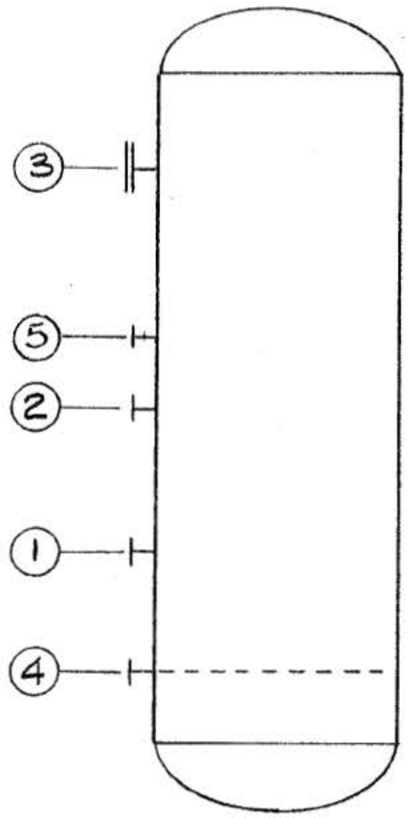
NOZZLES & FLANGES

GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. INLET & DRAIN	1	3"-150# RF
2. VENT	1	2"-150# RF
3. MANWAY & PUMP	1	18"-150# RF
4. STEAMOUT	1	2"-150# RF
5. LEVEL IND.	1	2"-150# RF
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM.	-	-
PACKING	-	-
INSUL. RINGS	-	-
LADDERS & PLATFORMS	-	-
INTERNAL PIPE	YES	-

NO.	DATE	BY	REVISIONS



WEIGHT EMPTY ≅ 2500 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.

(1) BOLTS SA 193-B7, NUTS SA 194-2H

(2) DRUM COATED W/TAR BY OTHERS.

VESSEL AMINE SUMP

FOR HUMBLE OIL AND REFINING COMPANY

PLANT GAS PROCESSING STUDY

LOCATION SBC, CALIFORNIA

ORDER NO. B-41449 ITEM NO. T-13

MFGR.

DATE 8-71 BY [signature]

Stearns-Roger

NO. VESSELS REQ'D. ([redacted].-VERT.) TWO(2)

SHELL DIA. I.D. [redacted]. 120"

SHELL THICKNESS ≅ 3/16"

HEADS THICKNESS CONE ROOF ≅ 3/16"

SHELL & HEAD THICKNESS INCLUDE C.A.

SHELL LENGTH 12'-0"

SUPPORT FLAT BOTTOM ≅ 1/4"

DESIGN CONDITIONS

CODE API 650 STAMP YES

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)		ATMOS.	
TEMP. (°F)		100	

⚠

CORR. ALLOW. SHELL NO HEADS NO

X-RAY STRESS RELIEF NO

WINDLOAD PER ASA 58.1

SEISMIC ZONE 3

MATERIALS

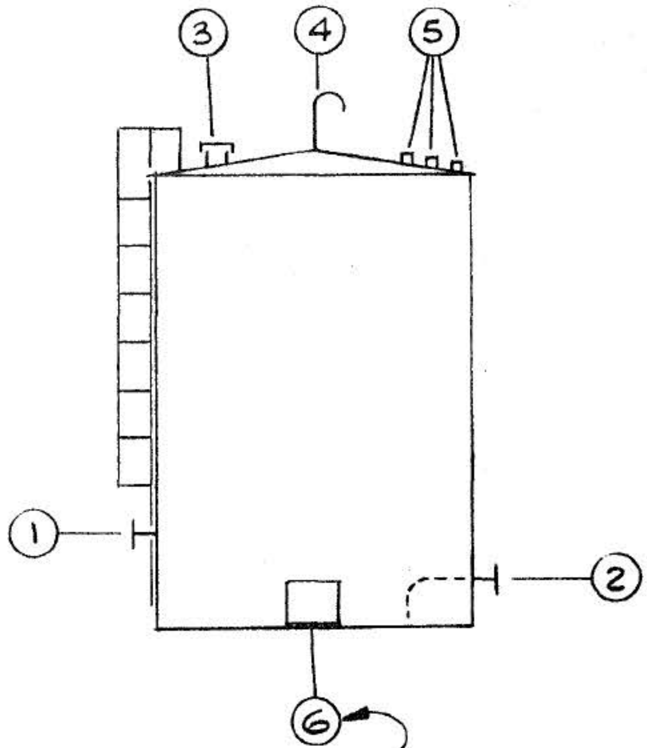
ROOF & BOTTOM STEEL

SHELL STEEL

NOZZLES & FLANGES

GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. CAT./SOLVENT IN	1	2"-150#RF
2. CAT./SOLVENT OUT	1	2"-150#RF
3. TOP MANWAY	1	20" API STD.
4. VENT W/SCREEN	1	2" API STD
5. TANK GAUGE	3	1½"-3000# CPLG.
6. FLUSH TYPE OPEN.	1	24"×36" *
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		



INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM.	–	–
PACKING	–	–
INSUL. RINGS	–	–
LADDERS	YES	–
INTERNAL PIPE	YES	–

WEIGHT EMPTY ≅ 9,800 LBS. EACH

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.

(1) WHITE SANDBLAST & ZINC-RICH PRIMER.

NO.	DATE	BY	REVISIONS
⚠1	8/71	RTG	GEN. REV.

VESSEL CATALYST/SOLVENT STORAGE TANKS

FOR HUMBLE OIL AND REFINING COMPANY

PLANT GAS PROCESSING STUDY

LOCATION SBC, CALIFORNIA

ORDER NO. B-41449 ITEM NO. T-21 & 22

MFGR.

DATE 8-71 BY [signature]

Stearns-Roger

NO. VESSELS REQ'D. ([redacted]Z.-VERT.) ONE	
SHELL DIA. [redacted].-O.D. 84"	
SHELL THICKNESS ≅ 3/16"	
HEADS THICKNESS CONE ROOF ≅ 3/16"	
SHELL & HEAD THICKNESS INCLUDE C.A. NO	
SHELL LENGTH (SEAM TO SEAM) 8'-0"	
SUPPORT FLAT BOTTOM ≅ 1/4"	

DESIGN CONDITIONS

CODE API 650 STAMP YES

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)		ATMOS.	
TEMP. (°F)		100	

CORR. ALLOW. SHELL NO HEADS NO

X-RAY STRESS RELIEF NO

WINDLOAD PER ASA 58.1

SEISMIC ZONE 3

MATERIALS

HEADS & BTM. CARB. STL.

SHELL CARB. STL.

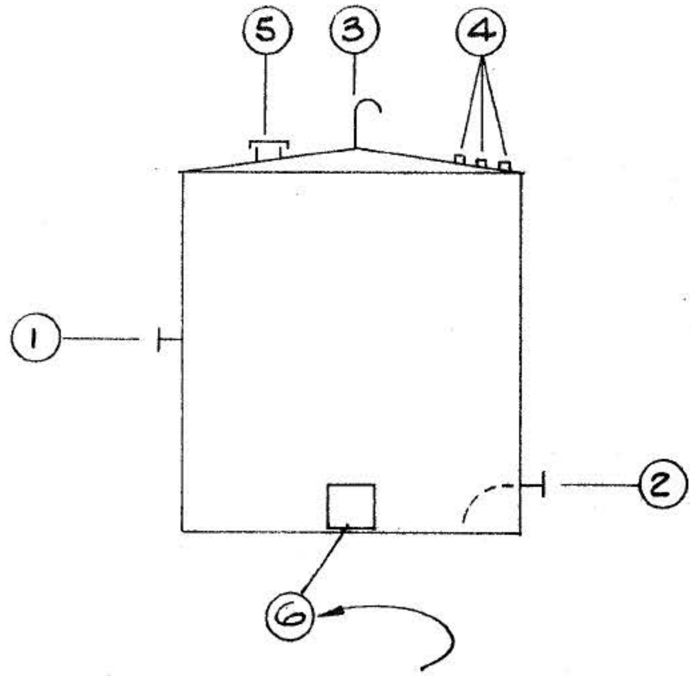
NOZZLES & FLANGES

GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. FILL	1	1½"-150# RF
2. PUMP SUCT.	1	2"-150# RF
3. VENT	1	2" API STD.
4. TANK GAUGE	3	1½" 3000# CPLG.
5. TOP MANWAY	1	20" API STD.
6. FLUSH OPEN	1	24" × 36" *
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM.	–	–
PACKING	–	–
INSUL. RINGS	–	–
LADDERS & PLATFORMS	–	–
INTERNAL PIPE	YES	–

NO.	DATE	BY	REVISIONS



WEIGHT EMPTY ≅ 2600 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
(1) WHITE SANDBLAST & ZINC-RICH PRIMER.

VESSEL TREATED WATER STORAGE TANK

FOR HUMBLE OIL AND REFINING COMPANY

PLANT GAS PROCESSING STUDY

LOCATION SBC, CALIFORNIA

ORDER NO. B-41449 ITEM NO. T-23

MFGR.

DATE 8-71 BY [illegible]

Stearns-Roger

NO. VESSELS REQ'D. (HORZ.-[redacted].) TWO
SHELL DIA. I.D.-[redacted]. 150"
SHELL THICKNESS ≃ 1/2"
HEADS THICKNESS HEMI ≃ 1/2"
SHELL & HEAD THICKNESS INCLUDE C.A. YES
SHELL LENGTH (TAN. TO TAN.) 89'-7"
SUPPORT SADDLES
DESIGN CONDITIONS NOTE (1)
CODE ASME VIII STAMP YES

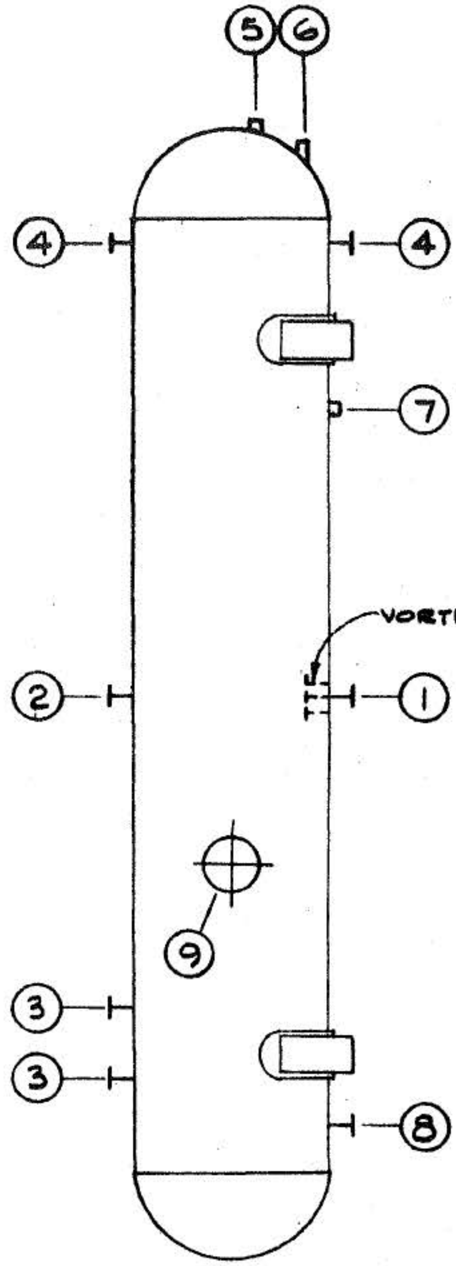
	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)		100	
TEMP. (°F)		150	

CORR. ALLOW. SHELL 1/16" HEADS 1/16"
X-RAY FULL STRESS RELIEF NO
WINDLOAD PER ASA 58.1
SEISMIC ZONE 3
MATERIALS
HEADS A515-70
SHELL A515-70
NOZZLES & FLANGES A106 B, A181 GR. 1
GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. LIQ. IN & OUT	1	6"-150#RF
2. EQUALIZING	1	3"-150#RF
3. PSV	2	4"-150#RF
4. LG BRIDLE	2	3"-150#RF
5. PRESS. IND.	1	3/4" CPLG.
6. TW	1	3/4" CPLG.
7. SAMPLE CONN.	1	1" CPLG.
8. DRAIN	1	2"-150#RF
9. MANWAY W/DAVIT	1	18"-150#RF
10.		
11.		
12.		
13.		
14.		
15.		

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM.	-	-
VORTEX BREAKER	YES	-
INSUL. RINGS	-	-
LADDERS & PLATFORM CLIPS	YES	-
PRIMER NOTE (2)	YES	-

NO.	DATE	BY	REVISIONS



WEIGHT EMPTY ≃ 104,600 LBS. EACH

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
(1) DESIGN & CONSTRUCTION SHALL COMPLY W/NFPA PAMPHLETS NO. 58 & 59.
(2) WHITE SANDBLAST & ZINC-RICH PRIMER.

VESSEL BUTANE-PLUS STORAGE TANKS
FOR HUMBLE OIL AND REFINING COMPANY
PLANT GAS PROCESSING STUDY
LOCATION SBC, CALIFORNIA
ORDER NO. B-41449 ITEM NO. T-52
MFGR.
DATE 8-71 BY [illegible]

Stearns-Roger

AIR DRYER
STUDY DATA SHEET

Stearns-Roger

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

ITEM NO. U-6
ACC'T. PAGE
S.R JOB B-41449
DATE August, 1971 BY DJM

SERVICE Instrument Air Dryer NO. REQ'D. 1 (1)
REVISIONS: a BY : b BY : c BY : d BY
MANUFACTURER SOURCE: QUOTE OF

One (1) - Kemp Dual Tower Adsorptive Dryer, Model 75-E completely packaged with all interconnecting piping, valves, fittings, electrical wiring etc., for fully automatic operation.

Desicant:	85# Sil. gel/tower
Reactivation Heat:	2.4 KW
Outlet Dew Point:	-40°
Dryer Cycle:	8 hours
Capacity:	250 cfm air
Weight:	1500 lbs. approximately

Stearns-Roger

PACKAGE UNITS
STUDY DATA SHEET

ITEM NO. U-21
ACC'T. PAGE
S.R JOB B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

DATE August, 1971 BY JW/DJM

SERVICE Tail Gas Clean-Up Unit NO. REQ'D. 1 (1)
REVISIONS: a 8/71 BY RTG :b BY :c BY :d BY
MANUFACTURER SOURCE: QUOTE OF

One (1) - I.F.P. (Institute Francais du Petrole) Claus Tail Gas Clean-up unit. General description, design and construction requirements, sulfur recovery and unit guarantees are summarized below.

A. General Description

The process is a proprietary (I.F.P.) design which utilizes an organic solvent and catalyst to continue the reaction of $H_2S + SO_2$ to form sulfur. The solvent and catalyst are non-toxic and non-corrosive. Carbon steel construction is used throughout. Liquid sulfur, bright yellow in color, with a purity of 99.5%+, is produced.

B. Design Basis

Tail gas flow rate	3 - 4.5 MMSCF/D
Temperature of gas	265°F
$H_2S + SO_2$ in gas	0.2 to 0.6 mol %

C. Sulfur Recovery

Design recovery	85%
Guaranteed recovery	82% (based on H_2S to SO_2 ratios between 1.9 and 2.1)

D. Process Design

I.F.P. will do all design work

E. Construction

Mechanical Engineering and construction by the prime contractor.

F. Size

The major piece of equipment in the unit is the absorber. This will be about 4 to 5 feet in diameter by 70-80 feet high.

NO. VESSELS REQ'D. (HORZ.-[redacted].) ONE (1)

SHELL DIA. I.D.-[redacted]. 84"

SHELL THICKNESS ≅ 2.61"

HEADS THICKNESS S.E.-[redacted] ≅ 2.54"

SHELL & HEAD THICKNESS INCLUDE C.A. YES

SHELL LENGTH (SEAM TO SEAM) 28'-0"

SUPPORT SADDLES

DESIGN CONDITIONS

CODE ASME VIII STAMP YES

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	900	1000	
TEMP. (°F)	60	100	

CORR. ALLOW. SHELL 1/8" HEADS 1/8"

X-RAY FULL STRESS RELIEF YES

WINDLOAD PER ASA 58.1

SEISMIC ZONE 3

MATERIALS

HEADS A516-70 TO A300

SHELL A516-70 TO A300

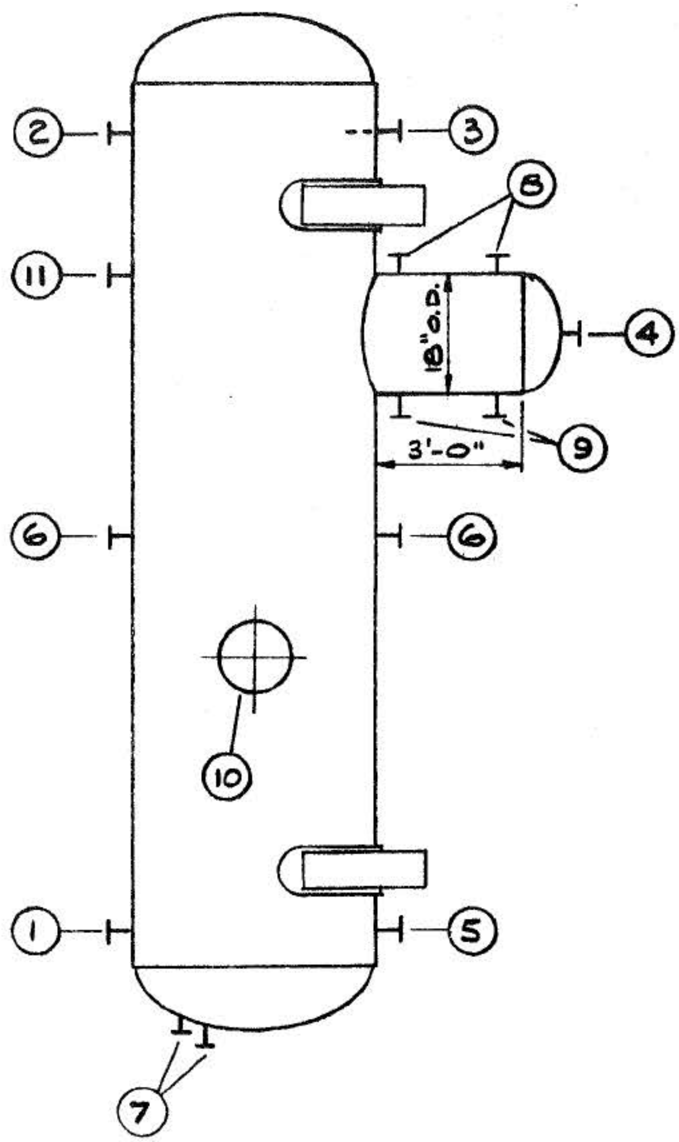
NOZZLES & FLANGES A333 GR6, A350 LF2

GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. GAS INLET	1	10"-600# RF
2. GAS OUTLET	1	10"-600# RF
3. CONDENSATE OUT	1	2"-600# RF
4. WATER OUT	1	1½"-600# RF
5. CONDENSATE OUT	1	3"-600# RF
6. LC BRIDLE	2	2"-600# RF
7. LC (EMERGENCY)	2	1½"-600# RF
8. LEVEL GAUGE	2	1½"-600# RF
9. LC	2	1½"-600# RF
10. MANWAY W/DAVIT	1	18"-600# RF
11. PSV	1	-600# RF
12.		
13.		
14.		
15.		

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM.	–	–
PACKING	–	–
INSUL. RINGS	–	–
LADDERS & PLATFORMS	–	–
INTERNAL PIPE NOZ. 3	YES	–

NO.	DATE	BY	REVISIONS
⚠1	8/71	RTG	GEN REV.



⚠1

WEIGHT EMPTY ≅ 88,300 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.

(1) EMERGENCY

(2) BOLTS SA193-B7, NUTS SA194-2H

(3) WHITE SANDBLAST & ZINC-RICH PRIMER.

VESSEL INLET SEPARATOR ⚠1

FOR HUMBLE OIL AND REFINING COMPANY

PLANT GAS PROCESSING STUDY

LOCATION SBC, CALIFORNIA

ORDER NO. B-41449 ITEM NO. V-2

MFGR.

DATE 8-71 BY [illegible]

Stearns-Roger

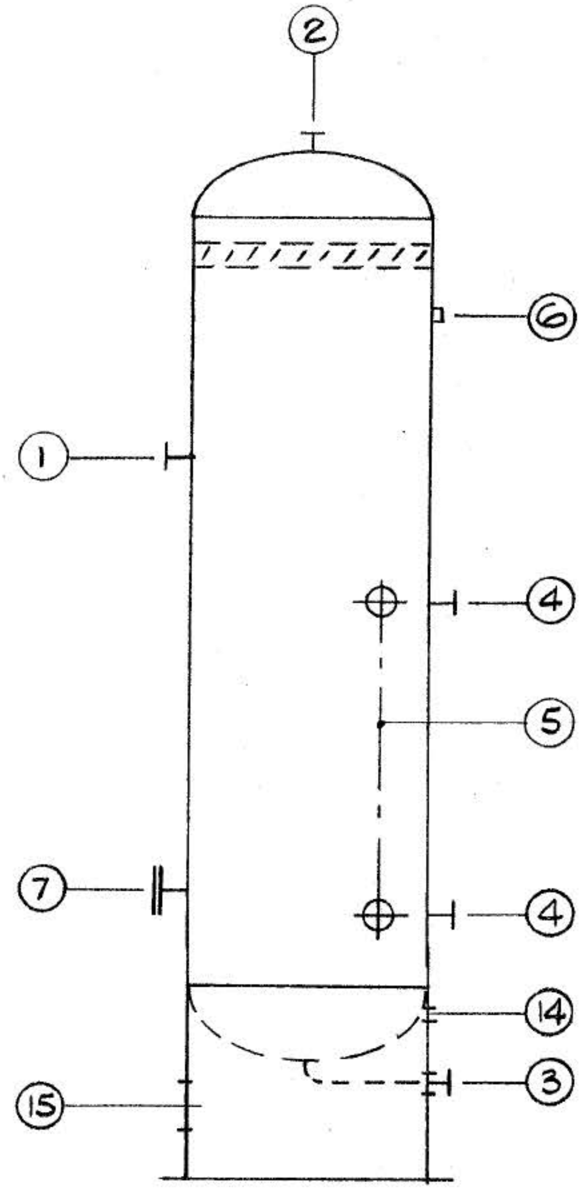
NO. VESSELS REQ'D. ([redacted].-VERT.) 1 (1)			
SHELL DIA. I.D.-[redacted]. 48"			
SHELL THICKNESS ≈ 1.6"			
HEADS THICKNESS S.E.-[redacted]. ≈ 1.6"			
SHELL & HEAD THICKNESS INCLUDE C.A.			
SHELL LENGTH (SEAM TO SEAM) 9'-0"			
SUPPORT SKIRT × 3'-0" HIGH			
DESIGN CONDITIONS			
CODE ASME VIII STAMP YES			
	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	880	1005	
TEMP. (°F)	100	125	
CORR. ALLOW. SHELL 1/8" HEADS 1/8"			
X-RAY FULL STRESS RELIEF YES			
WINDLOAD PER ASA 58.1			
SEISMIC ZONE 3			
MATERIALS			
HEADS A 515-70			
SHELL A 515-70			
NOZZLES & FLANGES A106 B, A181 GR1			
GASKETS			

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. INLET	1	10"-600# RF
2. OUTLET	1	10"-600# RF
3. DRAIN	1	2"-600# RF
4. LC	2	1½"-600# RF
5. LEVEL GAUGE	2	3/4"-CPLG.
6. PI	1	3/4" CPLG.
7. MANWAY W/DAVIT	1	18"-600# RF
8.		
9.		
10.		
11.		
12.		
13.		
14. SKIRT VENTS	4	3" SCH. 80 PIPE
15. SKIRT ACCESS	1	18" REINF.

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM. 12 LB/FT³ × 6" S.S.	YES	–
PACKING	–	–
INSUL. RINGS	–	–
LADDERS & PLATFORMS	–	–
PRIMER NOTE (1)	YES	–

NO.	DATE	BY	REVISIONS
⚠1	8/71	RTG	GEN. REV.

⚠1



WEIGHT EMPTY ≈ 14,000 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
(1) WHITE SANDBLAST & ZINC-RICH PRIMER
(2) BOLTS SA193-B7, NUTS SA 194 2H

VESSEL SOUR GAS FINAL SEPARATOR
FOR HUMBLE OIL AND REFINING COMPANY
PLANT GAS PROCESSING STUDY
LOCATION SBC, CALIFORNIA
ORDER NO. B-41449 ITEM NO. V-3
MFGR.
DATE 8-71 BY [signature]

Stearns-Roger

NO. VESSELS REQ'D. (HORZ.-[redacted].) ONE (1)

SHELL DIA. I.D.-[redacted]. 96"

SHELL THICKNESS ≈ 0.47"

HEADS THICKNESS S.E.-[redacted] ≈ 0.47"

SHELL & HEAD THICKNESS INCLUDE C.A. YES

SHELL LENGTH (SEAM TO SEAM) 32'-0"

SUPPORT SADDLES

DESIGN CONDITIONS

CODE ASME VIII STAMP YES

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	80	125	
TEMP. (°F)	110	500	

CORR. ALLOW. SHELL 1/8" HEADS 1/8"

X-RAY FULL STRESS RELIEF YES

WINDLOAD PER ASA 58.1

SEISMIC ZONE 3

MATERIALS

HEADS A515-70

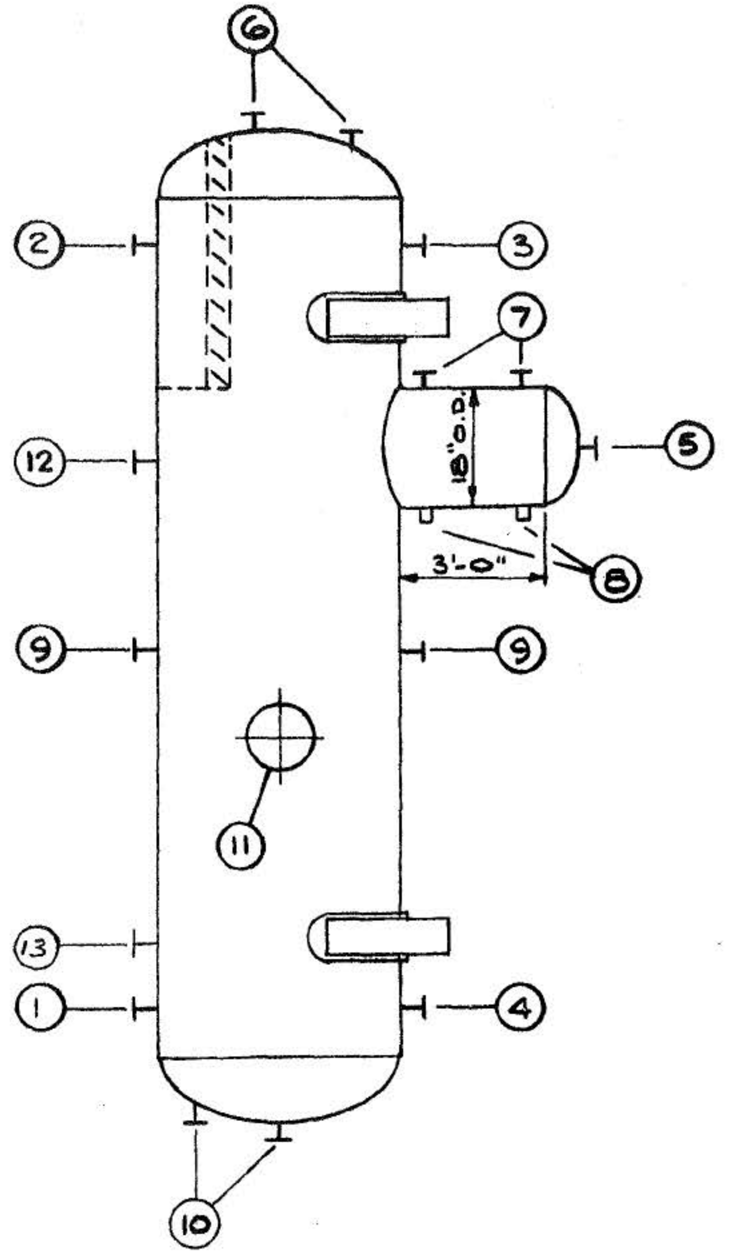
SHELL A515-70

NOZZLES & FLANGES A106B, A181 GR. 1

GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. LIQUID IN	1	3"-150# RF
2. GAS OUT	1	3"-150# RF
3. CONDENSATE OUT	1	3"-150# RF
4. CONDENSATE OUT	1	2"-150# RF
5. WATER OUT	1	2"-150# RF
6. LC	2	1 1/2"-150# RF
7. LC	2	1 1/2"-150# RF
8. LEVEL GAUGE	2	1 1/2" CPLG.
9. LG BRIDLE	2	2"-150# RF
10. LC	2	1 1/2"-150# RF
11. MANWAY W/DAVIT	1	18"-150# RF
12. PSV	1	-150# RF
13. LIQUID IN	1	2"-150# RF
14.		
15.		

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM. 12 LB/FT³ × 6"	YES	-
PACKING	-	-
INSUL. RINGS	-	-
LADDERS & PLATFORMS	-	-



WEIGHT EMPTY ≈ 23,600 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.

(1) EMERGENCY

(2) WHITE SANDBLAST & ZINC-RICH PRIMER.

(3) BOLTS SA193-B7, NUTS SA194-2H

NO.	DATE	BY	REVISIONS
⚠1	8/71	RTG	GEN. REV.

VESSEL LOW PRESSURE CONDENSATE SEPARATOR

FOR HUMBLE OIL AND REFINING COMPANY

PLANT GAS PROCESSING STUDY

LOCATION SBC, CALIFORNIA

ORDER NO. B-41449 ITEM NO. V-4

MFGR.

DATE 8-71 BY [signature]

Stearns-Roger

NO. VESSELS REQ'D. (HORZ.-[redacted].) ONE

SHELL DIA. I.D.-[redacted]. 96"

SHELL THICKNESS ≅ 3/8"

HEADS THICKNESS S.E.-[redacted]. ≅ 3/8"

SHELL & HEAD THICKNESS INCLUDE C.A. YES

SHELL LENGTH (SEAM TO SEAM) 16'-0"

SUPPORT NONE

DESIGN CONDITIONS

CODE ASME VIII STAMP NO

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)		10	
TEMP. (°F)		250	

CORR. ALLOW. SHELL 1/8" HEADS 1/8"

X-RAY SPOT STRESS RELIEF NO

WINDLOAD -

DRUM WILL BE BURIED (NOTE 2)

MATERIALS

HEADS A285-C

SHELL A285-C

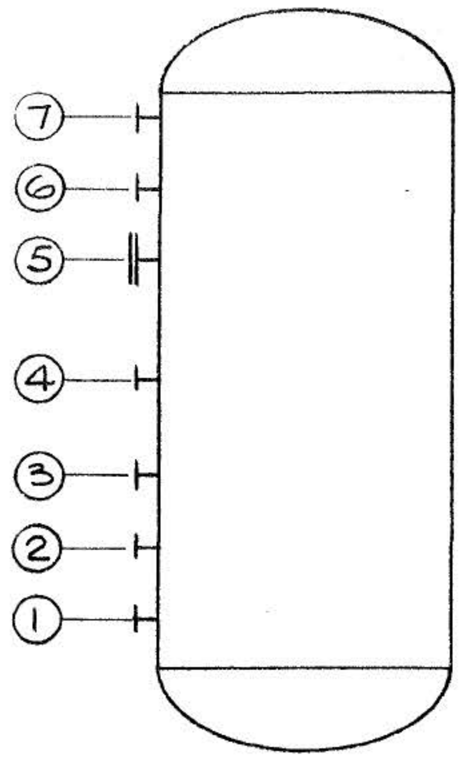
NOZZLES & FLANGES

GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. CLOSED HC DRAIN	1	4"-150# RF
2. CLOSED H_2O DRAIN	1	4"-150# RF
3. OPEN DRAIN	1	4"-150# RF
4. MANWAY & PUMP	1	18"-150# RF
5. LEVEL IND.	1	2"-150# RF
6. FLARE SEP. LIQ	1	3"-150# RF
7. BOILER BL'DWN.	1	2"-150# RF
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM.	-	-
PACKING	-	-
INSUL. RINGS	-	-
LADDERS & PLATFORMS	-	-

NO.	DATE	BY	REVISIONS



WEIGHT EMPTY ≅ 9800 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
(1) BOLTS SA 193-B7, NUTS SA 194-2H.
(2) DRUM COATED W/TAR BY OTHERS.

VESSEL HYDROCARBON VENT TANK

FOR HUMBLE OIL AND REFINING COMPANY

PLANT GAS PROCESSING STUDY

LOCATION SBC, CALIFORNIA

ORDER NO. B-41449 ITEM NO. V-7

MFGR.

DATE 8-71 BY

Stearns-Roger

NO. VESSELS REQ'D. ([redacted].-VERT.) ONE	
SHELL DIA. I.D.-[redacted]. 78"	
SHELL THICKNESS ≅ 5/16"	
HEADS THICKNESS S.E.-[redacted]. ≅ 1/4"	
SHELL & HEAD THICKNESS INCLUDE C.A. YES	
SHELL LENGTH (SEAM TO SEAM) 14'-0"	
SUPPORT SKIRT × 3'-0" HIGH	

DESIGN CONDITIONS

CODE ASME VIII STAMP YES

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)		50	
TEMP. (°F)		250	

CORR. ALLOW. SHELL 1/16" HEADS 1/16"

X-RAY SPOT STRESS RELIEF NO

WINDLOAD PER ASA 58.1

SEISMIC ZONE 3

MATERIALS

HEADS A 285-C

SHELL A 285-C

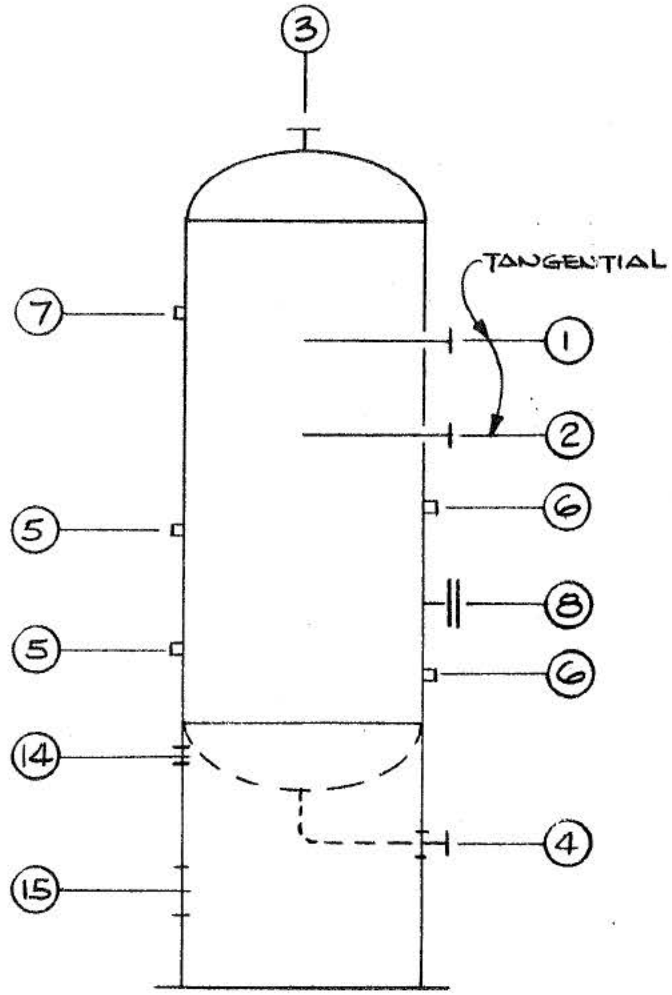
NOZZLES & FLANGES A53 B, A181 GR. I

GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. HP FLARE IN	1	12"-150# RF
2. LP FLARE IN	1	16"-150# RF
3. VAPOR OUT	1	30"-150# RF
4. LIQUID OUT	1	3"-150# RF
5. LLC	2	1 1/2" CPLG.
6. LEVEL GAUGE	2	3/4" CPLG.
7. PRESS. GAUGE	1	3/4" CPLG.
8. MANWAY W/DAVIT	1	18"-150# RF
9.		
10.		
11.		
12.		
13.		
14. SKIRT VENTS	4	2" SCH. 80 PIPE
15. SKIRT ACCESS	1	18" REINF.

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM.	–	–
PACKING	–	–
INSUL. RINGS	–	–
LADDERS & PLATFORMS	–	–

NO.	DATE	BY	REVISIONS



WEIGHT EMPTY ≅ 7050 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
(1) BOLTS SA 193-B7, NUTS SA 194-2H
(2) WHITE SANDBLAST & ZINC-RICH PRIMER.

VESSEL FLARE SEPARATOR

FOR HUMBLE OIL AND REFINING COMPANY

PLANT GAS PROCESSING STUDY

LOCATION SBC, CALIFORNIA

ORDER NO. B-41449 ITEM NO. V-8

MFGR.

DATE 8-71 BY [signature]

Stearns-Roger

NO. VESSELS REQ'D. ([redacted].-VERT.) 1 (2)	
SHELL DIA. I.D.-[redacted]. 54"	
SHELL THICKNESS ≈ 1 3/4"	
HEADS THICKNESS S.E.-[redacted]. ≈ 1 3/4"	
SHELL & HEAD THICKNESS INCLUDE C.A. YES	
SHELL LENGTH (SEAM TO SEAM) 53'-0"	
SUPPORT SKIRT × 5'-0" HIGH	

DESIGN CONDITIONS

CODE ASME VIII STAMP YES

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	880	1000	
TEMP. (°F)	160	200	

⚠

CORR. ALLOW. SHELL 1/8" HEADS 1/8"

X-RAY FULL STRESS RELIEF YES

WINDLOAD PER ASA 58.1

SEISMIC ZONE 3

MATERIALS

HEADS A516-70 TO A300

SHELL A516-70 TO A300

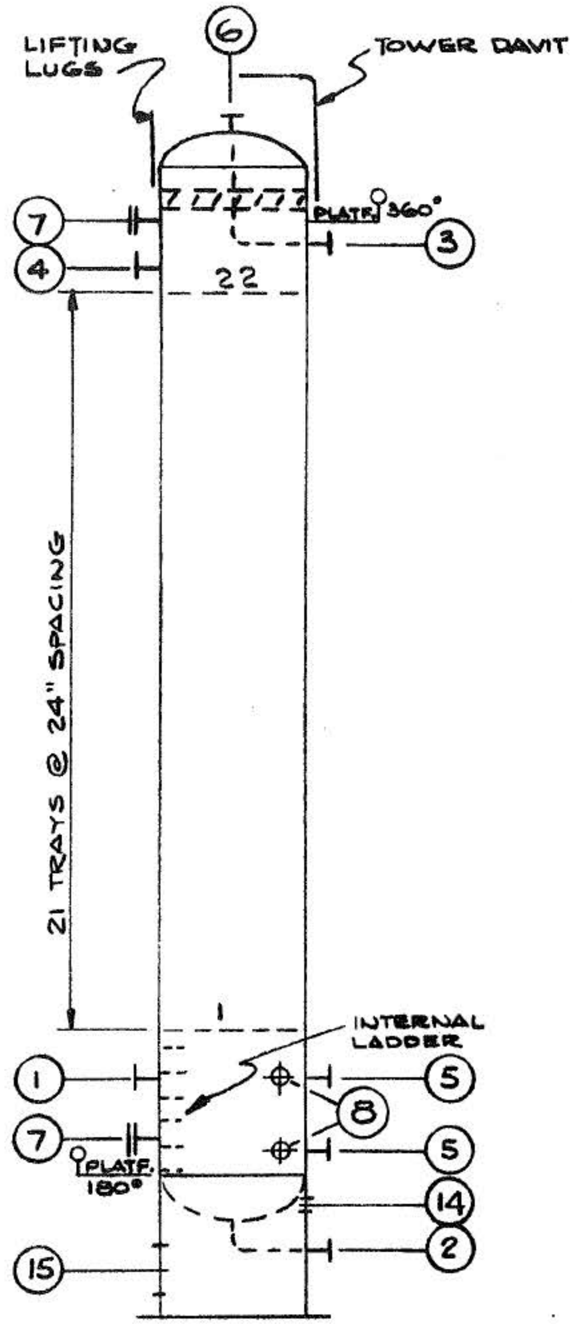
NOZZLES & FLANGES A333GR6, A350 LF2

GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. GAS IN	1	8"-600# RF
2. DEA OUT	1	6"-600# RF
3. GAS OUT	1	8"-600# RF
4. DEA IN	1	6"-600# RF
5. LC	2	1½"-600# RF
6. VENT	1	2"-600# RF
7. MANWAYS W/DAVIT	2	18"-600# RF
8. LEVEL GAUGE	2	1½"-600# RF
9.		
10.		
11.		
12.		
13.		
14. SKIRT VENTS	4	4" SCH. 80 PIPE
15. SKIRT ACCESS	1	18" REINF.

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM. 12 LB/FT³ × 6"	YES	–
TRAY SUPPORT RINGS	YES	–
INSUL. RINGS	–	–
LADDERS & PLATFORMS CLIPS	YES	–
TRAY INSTALLATION	YES	NOTE (1)

NO.	DATE	BY	REVISIONS
⚠	8/71	RTG	GEN. REV.



WEIGHT EMPTY ≈ 67,300 LBS. EACH
WEIGHT TRAYS ≈ 6,100 LBS. EACH

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
(1) TRAYS SUPPLIED BY OTHERS.
(2) BOLTS SA193-B7, NUTS SA194-2H
(3) WHITE SANDBLAST & ZINC-RICH PRIMER.

VESSEL H.P. AMINE CONTACTOR
FOR HUMBLE OIL AND REFINING COMPANY
PLANT GAS PROCESSING STUDY
LOCATION SBC, CALIFORNIA
ORDER NO. B-41449 ITEM NO. V-11 A & B
MFGR.
DATE 8-71 BY

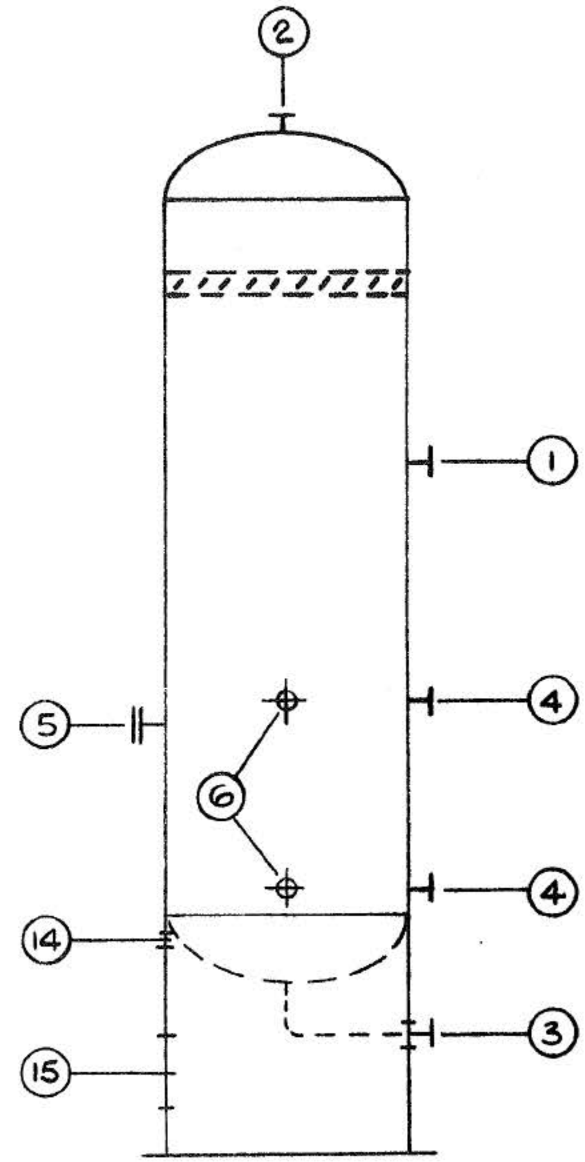
Stearns-Roger

NO. VESSELS REQ'D. ([redacted].-VERT.) ONE (1)			
SHELL DIA. I.D.-[redacted]. 42"			
SHELL THICKNESS ≈ 1.4"			
HEADS THICKNESS S.E.-[redacted]. ≈ 1.4"			
SHELL & HEAD THICKNESS INCLUDE C.A. YES			
SHELL LENGTH (SEAM TO SEAM) 9'-0"			
SUPPORT SKIRT × 3'-0" HIGH			
DESIGN CONDITIONS			
CODE ASME VIII STAMP YES			
	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	875	1000	
TEMP. (°F)	110	150	
CORR. ALLOW. SHELL 1/8" HEADS 1/8"			
X-RAY FULL STRESS RELIEF YES			
WINDLOAD PER ASA 58.1			
SEISMIC ZONE 3			
MATERIALS			
HEADS A515-70			
SHELL A515-70			
NOZZLES & FLANGES A106B, A181 GR1			
GASKETS			

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. GAS IN	1	10"-600# RF
2. GAS OUT	1	10"-600# RF
3. LIQ. OUT	1	3"-600# RF
4. LC	2	1½"-600# RF
5. MANWAY W/DAVIT	1	18"-600# RF
6. LEVEL GAUGE	2	3/4" CPLG.
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14. SKIRT VENTS	4	3" SCH. 80 PIPE
15. SKIRT ACCESS	1	18" REINF.

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM. 12 LB/FT³ × 6"	YES	–
PACKING	–	–
INSUL. RINGS	–	–
LADDERS	–	–
PRIMER NOTE (1)	YES	–

NO.	DATE	BY	REVISIONS
⚠	8/71	RTG	GEN. REV.



WEIGHT EMPTY ≈ 14,500 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
(1) WHITE SANDBLAST & ZINC RICH PRIMER
(2) BOLTS SA193-B7, NUTS SA194-2H.

VESSEL TREATED GAS SCRUBBER
FOR HUMBLE OIL AND REFINING COMPANY
PLANT GAS PROCESSING STUDY
LOCATION SBC, CALIFORNIA
ORDER NO. B-41449 ITEM NO. V-12
MFGR.
DATE 8-71 BY [signature]

Stearns-Roger

NO. VESSELS REQ'D. (HORZ.-[redacted].) 1 (2)			
SHELL DIA. I.D.-[redacted]. 54"			
SHELL THICKNESS ≈ 0.32"			
HEADS THICKNESS S.E.-[redacted]. ≈ 0.32"			
SHELL & HEAD THICKNESS INCLUDE C.A. YES			
SHELL LENGTH (SEAM TO SEAM) 14'-0"			
SUPPORT SADDLES			
DESIGN CONDITIONS			
CODE ASME VIII STAMP YES			
	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	75	125	
TEMP. (°F)	150	500	
CORR. ALLOW. SHELL 1/8" HEADS 1/8"			
X-RAY FULL STRESS RELIEF YES			
WINDLOAD PER ASA 58.1			
SEISMIC ZONE 3			

△

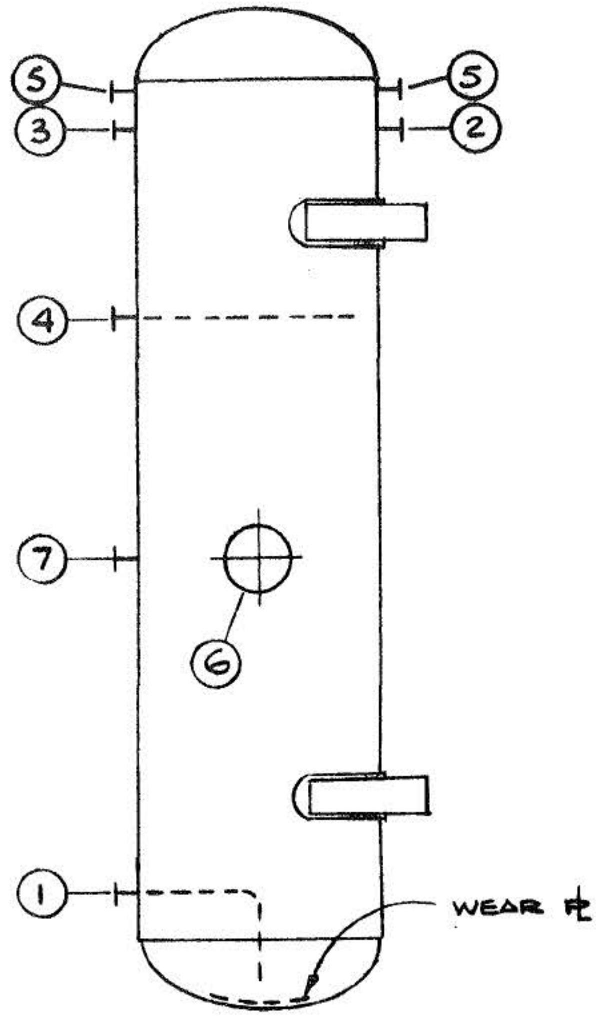
MATERIALS
HEADS A515-70
SHELL A515-70
NOZZLES & FLANGES A106 B, A181 GR. 1
GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. DEA IN	1	6"-150# RF
2. DEA OUT	1	6"-150# RF
3. GAS OUT	1	2"-150# RF
4. DEA FROM VENT C.	1	2"-150# RF
5. LC BRIDLE	2	2"-150# RF
6. MANWAY W/DAVIT	1	18"-150# RF
7. PRESS. IND.	1	1"-150# RF
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		

△

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM.	-	-
PACKING	-	-
INSUL. RINGS	-	-
LADDERS & PLATFORMS	-	-
INTERNAL PIPES & WEAR PL	YES	-

NO.	DATE	BY	REVISIONS
△	8/71	RTG	GEN. REV.



WEIGHT EMPTY ≈ 5,600 LBS. EACH

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
(1) WHITE SANDBLAST & ZINC-RICH PRIMER.
(2) BOLTS SA193-B7, NUTS SA194-2H.

VESSEL AMINE VENT TANK
FOR HUMBLE OIL AND REFINING COMPANY
PLANT GAS PROCESSING PLANT
LOCATION SBC, CALIFORNIA
ORDER NO. B-41449 ITEM NO. V-13
MFGR.
DATE 8-71 BY [illegible]

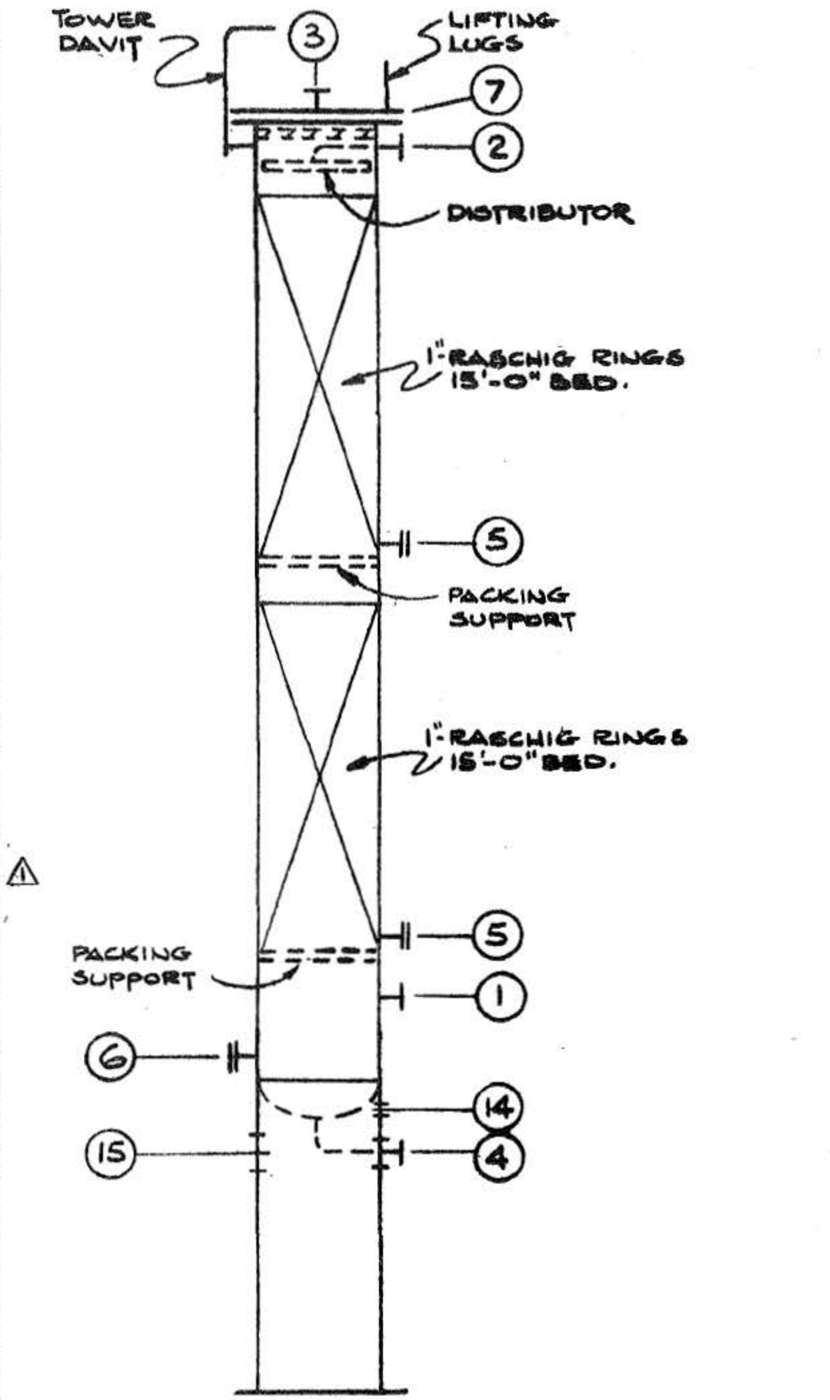
Stearns-Roger

NO. VESSELS REQ'D. ([redacted].-VERT.) ONE (1)			
SHELL DIA. [redacted].-O.D. 24"			
SHELL THICKNESS ≅ 1/4"			
HEADS THICKNESS S.E.-[redacted]. ≅ 1/4"			
SHELL & HEAD THICKNESS INCLUDE C.A. YES			
SHELL LENGTH (SEAM TO FLG.) 37'-0"			
SUPPORT SKIRT x 12'-0" HIGH			
DESIGN CONDITIONS			
CODE ASME VIII STAMP YES			
	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	75	125	
TEMP. (°F)	160	200	
CORR. ALLOW. SHELL 1/8" HEADS 1/8"			
X-RAY SPOT STRESS RELIEF YES			
WINDLOAD PER ASA 58.1			
SEISMIC ZONE 3			
MATERIALS			
HEADS A515-70			
SHELL A515-70			
NOZZLES & FLANGES A106 B, A181 GR. I			
BOLTS SA 193-B7, NUTS SA 194-2H			

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. GAS IN	1	3"-150# RF
2. LIQUID IN	1	1½"-150# RF
3. GAS OUT	1	2"-150# RF
4. LIQUID OUT	1	2"-150# RF
5. PACKING REMOVAL	2	10"-150# RF *
6. INSPECTION	1	6"-150# RF *
7. MANWAY	1	24"-150# RF *
8.		
9.		
10.		
11.		
12.		
13.		
14. SKIRT VENTS	4	2" SCH. 80 PIPE
15. SKIRT ACCESS	1	16" REINF.

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM. 12 LB/FT³ x 6" S.S.	YES	–
PACKING SUPT'S. & DISTRIB.	YES	–
INSUL. RINGS	–	–
LADDERS & PLATFORMS	–	–

NO.	DATE	BY	REVISIONS
⚠	8/71	RTG	GEN. REV.



WEIGHT PACKING ≅ 2500 LBS.
WEIGHT EMPTY ≅ 6,400 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
* W/BLIND FLANGES.
(1) PACKING BY OTHERS.
(2) WHITE SANDBLAST & ZINC-RICH PRIMER.

VESSEL LOW PRESSURE AMINE CONTACTOR
FOR HUMBLE OIL AND REFINING COMPANY
PLANT GAS PROCESSING STUDY
LOCATION SBC, CALIFORNIA
ORDER NO. B-41449 ITEM NO. V-15
MFGR.
DATE 8-71 BY [illegible]

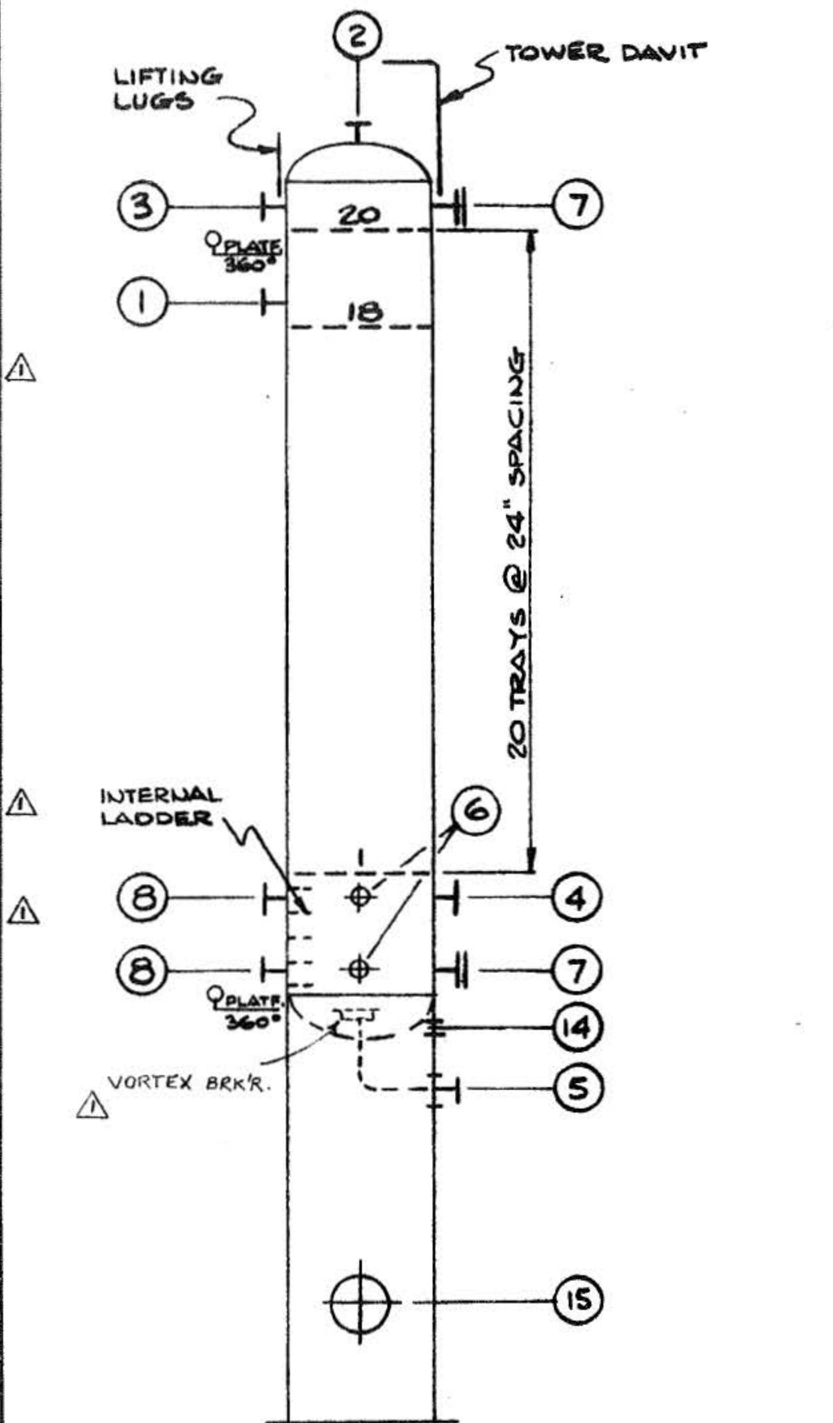
Stearns-Roger

NO. VESSELS REQ'D. ([redacted].-VERT.) 1 (2)			
SHELL DIA. I.D.-[redacted]. 66"			
SHELL THICKNESS ≅ 3/8"			
HEADS THICKNESS S.E.-[redacted]. ≅ 3/8"			
SHELL & HEAD THICKNESS INCLUDE C.A. YES			
SHELL LENGTH (SEAM TO SEAM) 46'-0"			
SUPPORT SKIRT × 15'-0" HIGH			
DESIGN CONDITIONS			
CODE ASME VIII STAMP YES			
	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	16	50	
TEMP. (°F)	250	650 ⚠	
CORR. ALLOW. SHELL 1/8" HEADS 1/8"			
X-RAY FULL STRESS RELIEF YES			
WINDLOAD PER ASA 58.1			
SEISMIC ZONE 3			
MATERIALS			
HEADS A515-70			
SHELL A515-70			
NOZZLES & FLANGES A106B, A181GR1			
GASKETS			

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. RICH DEA IN	1	6"-150# RF ⚠
2. O'HD. VAP. OUT	1	6"-150# RF
3. REFLUX	1	2"-150# RF
4. REBOILER VAP.	1	8"-150# RF ⚠
5. DEA TO REBOILER	1	6"-150# RF
6. LEVEL GAUGE	2	3/4" CPLG.
7. MANWAY W/DAVIT	2	18"-150# RF
8. LC	2	1½"-150# RF
9.		
10.		
11.		
12.		
13.		
14. SKIRT VENTS	4	4" SCH. 80 PIPE
15. SKIRT ACCESS	1	18" REINF.

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM.		
TRAY SUPPORT RINGS	YES	-
INSUL. RINGS	YES	-
LADDERS & PLATFORM CLIPS	YES	-
TRAY INSTALLATION	YES	NOTE(1)

NO.	DATE	BY	REVISIONS
⚠	8/71	RTG	GEN. REV.



WEIGHT EMPTY ≅ 19,700 LBS. EACH
WEIGHT TRAYS ≅ 8,470 LBS. EACH

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
(1) TRAYS SUPPLIED BY OTHERS.
(2) BOLTS SA193-B7, NUTS SA194-2H

VESSEL AMINE STILL
FOR HUMBLE OIL AND REFINING COMPANY
PLANT GAS PROCESSING PLANT
LOCATION SBC, CALIFORNIA
ORDER NO. B-41449 ITEM NO. V-16
MFGR.
DATE 8-71 BY [signature]

Stearns-Roger

NO. VESSELS REQ'D. ([redacted]Z.-VERT.)	1 (2)
SHELL DIA. I.D.-[redacted].	42"
SHELL THICKNESS	1/4" NOM.
HEADS THICKNESS S.E.-[redacted].	1/4" NOM.
SHELL & HEAD THICKNESS INCLUDE C.A.	YES
SHELL LENGTH (SEAM TO SEAM)	8'-0"
SUPPORT	SKIRT x 8'-0" HIGH

DESIGN CONDITIONS

CODE ASME VIII STAMP YES

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	10	50	
TEMP. (^{O}F)	110	650	

CORR. ALLOW. SHELL 1/8" HEADS 1/8"

X-RAY SPOT STRESS RELIEF YES

WINDLOAD PER ASA 58.1

SEISMIC ZONE 3

MATERIALS

HEADS A515-70

SHELL A515-70

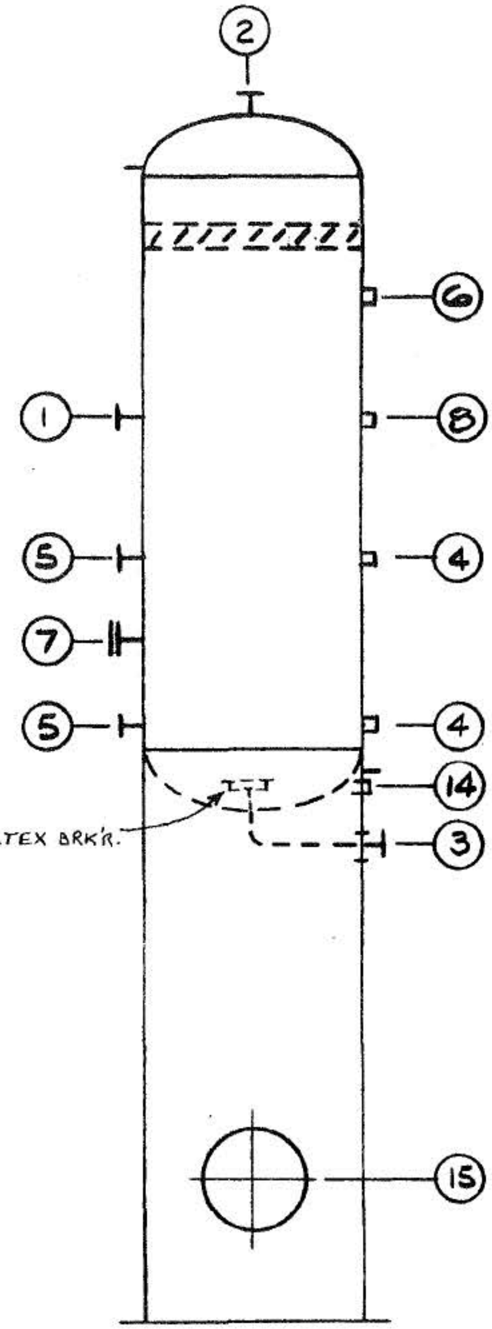
NOZZLES & FLANGES A106 B, A181 GR1

GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. INLET	1	6"-150# RF
2. ACID GAS OUT	1	10"-150# RF
3. REFLUX OUT	1	3"-150# RF
4. LEVEL GAUGE	2	3/4" CPLG'S.
5. LC	2	1 1/2"-150# RF
6. PRESS. IND.	1	3/4" CPLG.
7. MANWAY W/DAVIT	1	18"-150# RF
8. PI	1	3/4" CPLG.
9.		
10.		
11.		
12.		
13.		
14. SKIRT VENTS	4	2" SCH. 80 PIPE
15. SKIRT ACCESS	1	18" REINF.

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM. 12 LB/FT^{3} x 6"	YES	-
PACKING	-	-
INSUL. RINGS	-	-
LADDERS & PLATFORM CLIPS	YES	-

NO.	DATE	BY	REVISIONS
1	8/71	RTG	GEN. REV.



WEIGHT EMPTY ≅ 3,340 LBS. EACH

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.

(1) WHITE SANDBLAST & ZINC-RICH PRIMER.

(2) BOLTS SA193-B7, NUTS SA194-2H

VESSEL AMINE STILL REFLUX ACCUMULATOR ⚠1

FOR HUMBLE OIL AND REFINING COMPANY

PLANT GAS PROCESSING STUDY

LOCATION SBC, CALIFORNIA

ORDER NO. B-41449 ITEM NO. V-17

MFGR.

DATE 8-71 BY [illegible]

Stearns-Roger

NO. VESSELS REQ'D. ([redacted].-VERT.) ONE (1)	
SHELL DIA. [redacted].-O.D. 24"	
SHELL THICKNESS ≅ 1/4"	
HEADS THICKNESS S.E.-[redacted]. ≅ 1/4"	
SHELL & HEAD THICKNESS INCLUDE C.A. YES	
SHELL LENGTH (SEAM TO FLG.) 6'-0"	
SUPPORT LEGS 4-REQ'D. x 2'-0"	

DESIGN CONDITIONS

CODE ASME VIII STAMP YES

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	10	40	
TEMP. (°F)	110	150	

⚠

CORR. ALLOW. SHELL 1/8" HEADS 1/8"

X-RAY SPOT STRESS RELIEF YES

WINDLOAD PER ASA 58.1

SEISMIC ZONE 3

MATERIALS

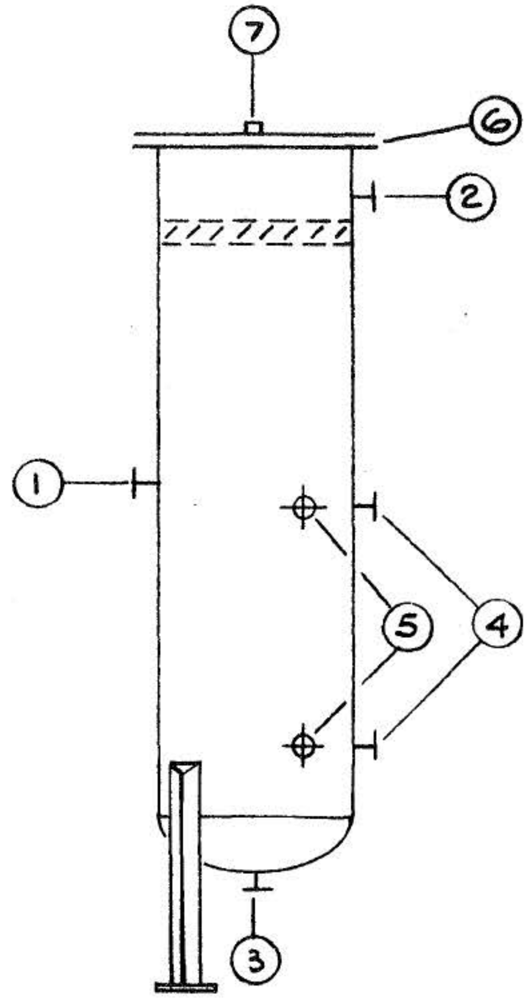
HEADS A515-70

SHELL A515-70

NOZZLES & FLANGES A106 B, A181 GR1

GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. INLET	1	10"-150# RF
2. OUTLET	1	10"-150# RF
3. DRAIN	1	2"-150# RF
4. LG	2	2"-150# RF
5. LC	2	2"-150# RF
6. MANWAY	1	24"-150# RF *
7. VENT	1	3/4" CPLG.
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		



INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM. 12 LB/FT³ x 6" S.S.	YES	–
PACKING	–	–
INSUL. RINGS	–	–
LADDERS & PLATFORMS	–	–

NO.	DATE	BY	REVISIONS
⚠	8/71	RTG	GEN. REV.

WEIGHT EMPTY ≅ 3,000 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.

* W/BLIND FLANGE.

(1) WHITE SANDBLAST & ZINC-RICH PRIMER.

(2) BOLTS SA 193-B7, NUTS SA 194 2H

VESSEL SULFUR UNIT INLET SCRUBBER

FOR HUMBLE OIL AND REFINING COMPANY

PLANT GAS PROCESSING STUDY

LOCATION SBC, CALIFORNIA

ORDER NO. B-41449 ITEM NO. V-21

MFGR.

DATE 8-71 BY [illegible]

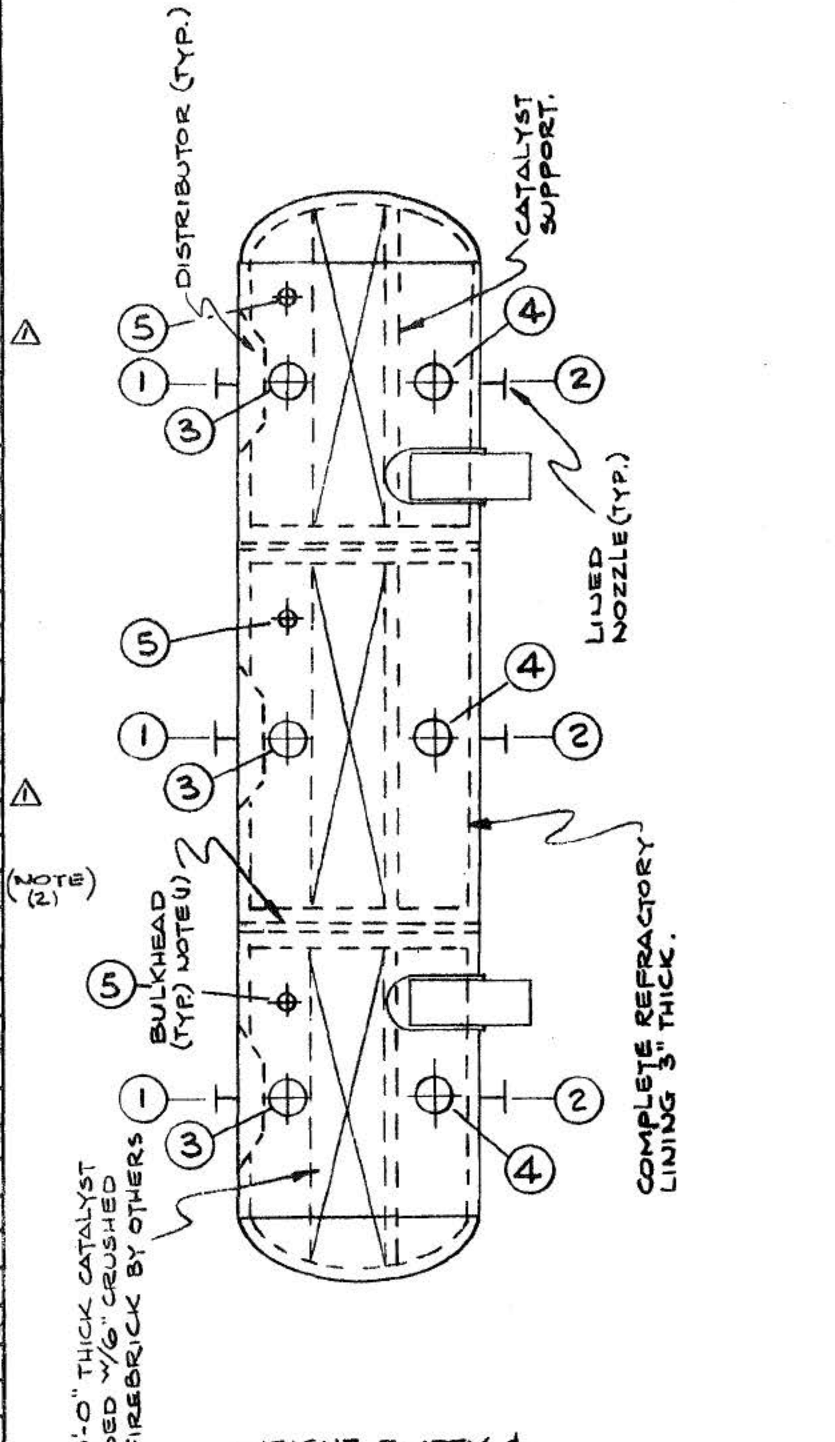
Stearns-Roger

NO. VESSELS REQ'D. (HORZ.-[redacted].) 1 (2)			
SHELL DIA. I.D.-[redacted]. 108"			
SHELL THICKNESS ≅ 3/8"			
HEADS THICKNESS S.E.-[redacted]. ≅ 3/8"			
SHELL & HEAD THICKNESS INCLUDE C.A. YES			
SHELL LENGTH (SEAM TO SEAM) 28'-0"			
SUPPORT SADDLES (4-REQ'D. EACH)			
DESIGN CONDITIONS			
CODE ASME VIII STAMP NO			
	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	7.1	15	
TEMP. (°F)	400-460	650	
CORR. ALLOW. SHELL 1/8" HEADS 1/8"			
X-RAY SPOT STRESS RELIEF NO			
WINDLOAD PER ASA 58.1			
SEISMIC ZONE 3			
MATERIALS			
HEADS A515-70			
SHELL A515-70			
NOZZLES & FLANGES A106B, A181 GR.1			
GASKETS			

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. GAS IN	3	10"-150# RF
2. GAS OUT	3	10"-150# RF
3. MANWAY W/DAVIT	3	18"-150# RF
4. MANWAY W/DAVIT	3	18"-150# RF
5. STEAM CONN.	3	2"-150# RF
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM.	–	–
PACKING	–	–
INSUL. RINGS	–	–
LADDERS & PLATFORMS	–	–
INTERNALS & SUPPORTS	YES	–

NO.	DATE	BY	REVISIONS
⚠1	8/71	RTG	GEN. REV.



WEIGHT EMPTY & EXCL. CATALYST ≅ 35,000 LBS. EACH

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.

(1) BULKHEAD DESIGN FOR ΔP = 5 PSI @ 650 °F

(2) TANGENTIAL TO BOTTOM OF SHELL.

(3) BOLTS SA 193-B7, NUTS SA 194-2H

VESSEL SULFUR CONVERTERS

FOR HUMBLE OIL AND REFINING COMPANY

PLANT GAS PROCESSING STUDY

LOCATION SBC, CALIFORNIA

ORDER NO. B-41449 ITEM NO. V-22, 23, 24

MFGR.

DATE 8-71 BY [signature]

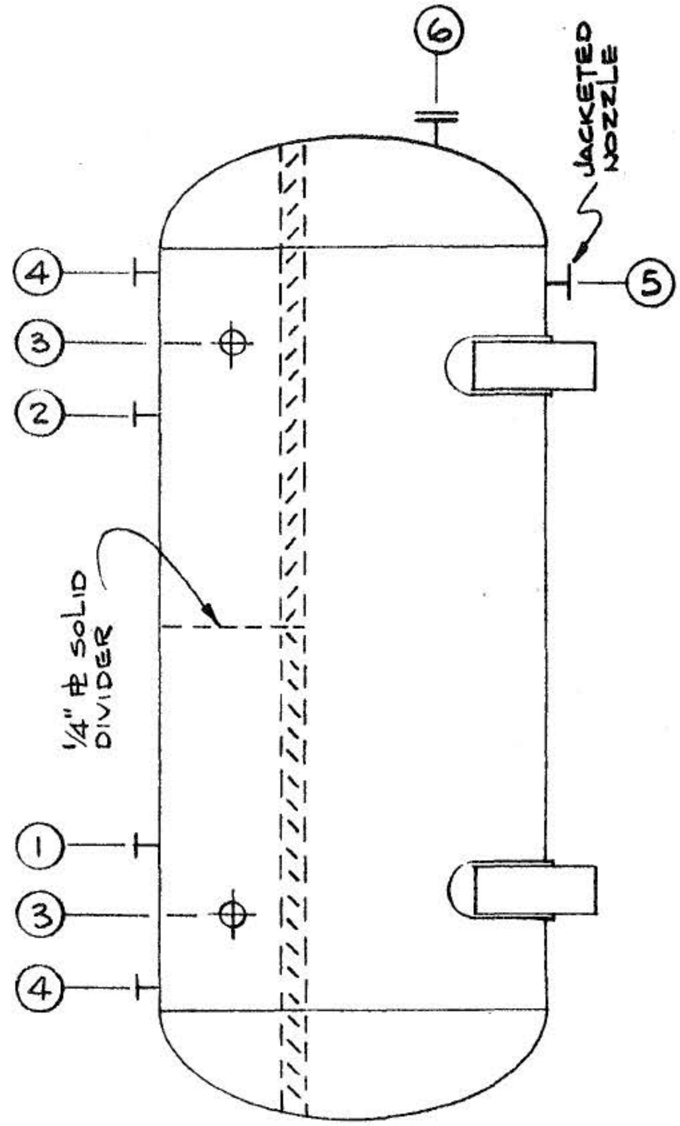
Stearns-Roger

NO. VESSELS REQ'D. (HORZ.-[redacted].) 1 (1)			
SHELL DIA. I.D.-[redacted]. 84"			
SHELL THICKNESS ≅ 1/4"			
HEADS THICKNESS S.E.-[redacted]. ≅ 1/4"			
SHELL & HEAD THICKNESS INCLUDE C.A. YES			
SHELL LENGTH (SEAM TO SEAM) 10'-0"			
SUPPORT SADDLES			
DESIGN CONDITIONS			
CODE ASME VIII STAMP NO			
	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	ATMOS.	15	
TEMP. (^{0}F)	260	300	
CORR. ALLOW. SHELL 1/8" HEADS 1/8"			
X-RAY SPOT STRESS RELIEF NO			
WINDLOAD PER ASA 58.1			
SEISMIC ZONE 3			
MATERIALS			
HEADS A515-70			
SHELL A515-70			
NOZZLES & FLANGES A106 B, A181 GR. 1			
GASKETS			

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. GAS IN	1	10"-150# RF ⚠
2. GAS OUT	1	14"-150# RF
3. INSPECTION	2	6"-150# RF *
4. STEAM CONN.	2	2"-150# RF
5. SULFUR DRAIN	1	1½"-150# RF ⚠
6. MANWAY W/DAVIT	1	18"-150# RF *
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM. 6" (NOTE 2)	YES	-
PACKING	-	-
INSUL. RINGS	-	-
LADDERS & PLATFORMS	-	-

NO.	DATE	BY	REVISIONS
⚠	8/71	KTG	GEN REV.



WEIGHT EMPTY ≅ 6,000 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
* W/BLIND FLANGES
(1) BOLTS SA 193-B7, NUTS SA 194-2H
(2) LIGHT WEIGHT NON-PLUGGING.

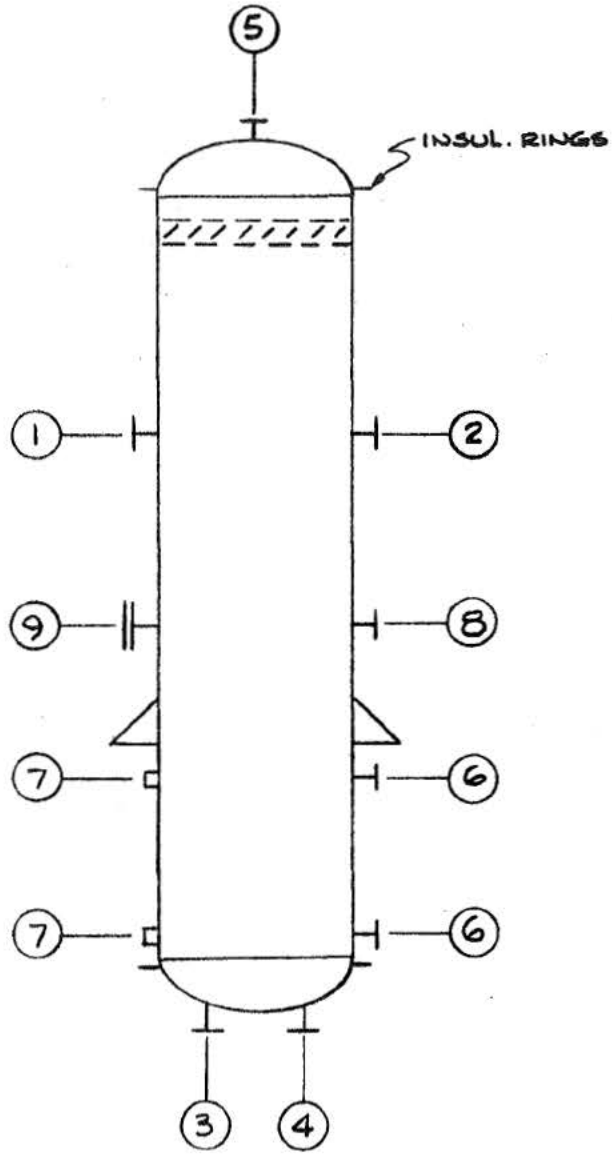
VESSEL TAIL GAS COALESCER
FOR HUMBLE OIL AND REFINING COMPANY
PLANT GAS PROCESSING STUDY
LOCATION SBC, CALIFORNIA
ORDER NO. B-41449 ITEM NO. V-25
MFGR.
DATE 8-71 BY [signature]

Stearns-Roger

NO. VESSELS REQ'D. ([redacted].-VERT.) 1(2)			
SHELL DIA. I.D.-[redacted]. 24"			
SHELL THICKNESS ≈ 1/4"			
HEADS THICKNESS S.E.-[redacted]. ≈ 1/4"			
SHELL & HEAD THICKNESS INCLUDE C.A. YES			
SHELL LENGTH (SEAM TO SEAM) 8'-0"			
SUPPORT LUGS 4 REQ'D.			
DESIGN CONDITIONS			
CODE ASME VIII STAMP YES			
	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	55	105	
TEMP. (°F)	302	350	
CORR. ALLOW. SHELL 1/16" HEADS 1/16"			
X-RAY SPOT STRESS RELIEF NO			
WINDLOAD PER ASA 58.1			
SEISMIC ZONE 3			
MATERIALS			
HEADS A-285 C			
SHELL A-285 C			
NOZZLES & FLANGES A106B, A181 GR.1			
GASKETS			

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. WATER FROM E-22	1	3"-150#RF
2. WATER FROM E-21	1	4"-150#RF
3. WATER TO E-22	1	2"-150#RF
4. WATER TO E-21	1	3"-150#RF
5. STEAM OUT	1	3"-150#RF
6. LC	2	1½"-150#RF
7. LG	2	3/4" CPLG.
8. MAKEUP WATER	1	2"-150#RF
9. MANWAY W/DAVIT	1	18"-150#RF
10.		
11.		
12.		
13.		
14.		
15.		

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM. 12 LB/FT³ x 6" S.S.	YES	-
PACKING	-	-
INSUL. RINGS	YES	-
LADDERS & PLATFORMS	-	-



WEIGHT EMPTY ≈ 2000 LBS. EACH

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
(1) BOLTS SA193-B7, NUTS SA194-2H

NO.	DATE	BY	REVISIONS

VESSEL 55 PSIG STEAM DRUM
FOR HUMBLE OIL AND REFINING COMPANY
PLANT GAS PROCESSING STUDY
LOCATION SBC, CALIFORNIA
ORDER NO. B-41449 ITEM NO. V-26
MFGR.
DATE 8-71 BY [illegible]

Stearns-Roger

NO. VESSELS REQ'D. (HORZ.-[redacted].) ONE
SHELL DIA. I.D.-[redacted]. 102"
SHELL THICKNESS ≅ 2.9"
HEADS THICKNESS S.E.-[redacted] ≅ 2.9"
SHELL & HEAD THICKNESS INCLUDE C.A. YES
SHELL LENGTH (SEAM TO SEAM) 25'-6"
SUPPORT SADDLES

DESIGN CONDITIONS

CODE ASME VIII STAMP YES

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	860	950	
TEMP. (°F)	0	-20/150 ⚠	

CORR. ALLOW. SHELL 1/16" HEADS 1/16"
X-RAY FULL STRESS RELIEF YES
WINDLOAD PER ASA 58.1
SEISMIC ZONE 3

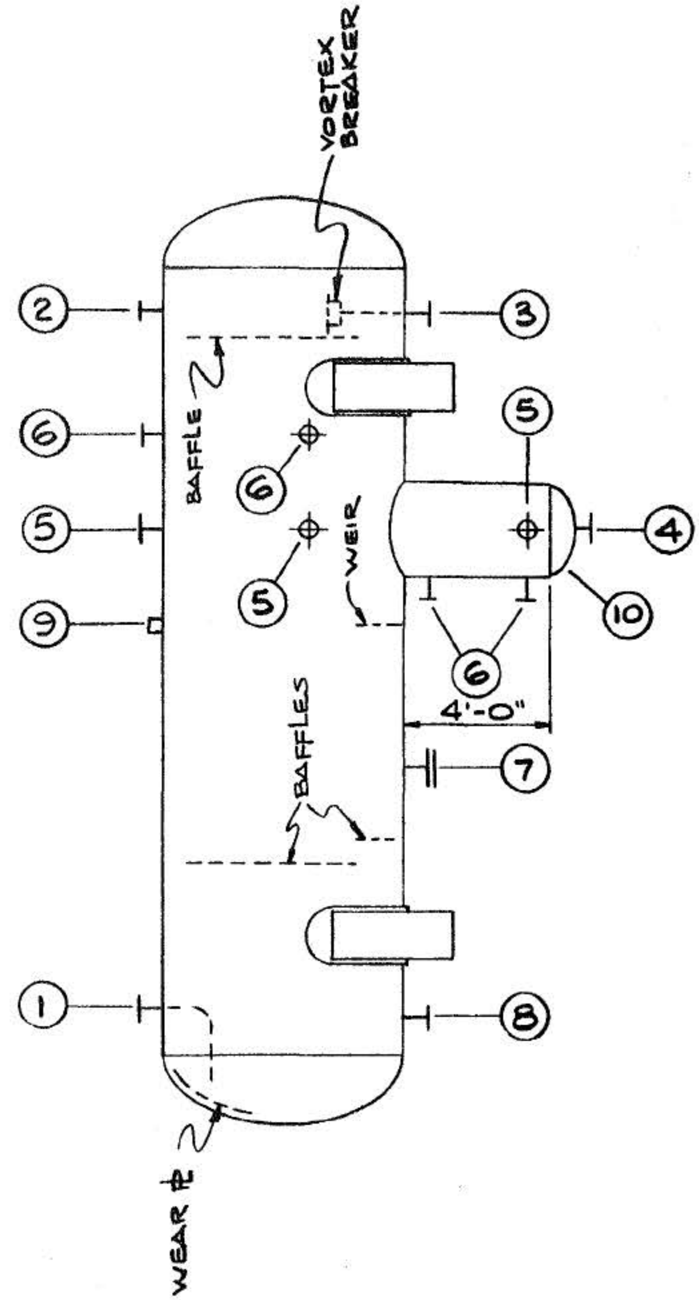
MATERIALS

HEADS A515-70
SHELL A515-70
NOZZLES & FLANGES A106 B, A181 GR.1
GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. INLET	1	10"-600# RF
2. GAS OUT	1	10"-600# RF
3. LIQUID OUT	1	3"-600# RF
4. GLYCOL OUT	1	1½"-600# RF
5. GAUGE COLUMN	3	2"-600# RF
6. LEVEL CONTROL	4	1½"-600# RF
7. MANWAY W/DAVIT	1	18"-600# RF
8. DRAIN	1	2"-600# RF
9. PRESS. GAUGE	1	3/4" CPLG.
10. BOOTLEG	1	18" PIPE W/CAP
11.		
12.		
13.		
14.		
15.		

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM.	–	–
PACKING	–	–
INSUL. RINGS	–	–
LADDERS & PLATFORMS	–	–
BAFFLES & VORTEX BRK'R.	YES	–

NO.	DATE	BY	REVISIONS
⚠	8/71	RTG	GEN. REV



WEIGHT EMPTY ≅ 74,600 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
(1) BOLTS SA 194-B7, NUTS SA 194-2H

VESSEL CHILLER SEPARATOR
FOR HUMBLE OIL AND REFINING COMPANY
PLANT GAS PROCESSING STUDY
LOCATION SBC, CALIFORNIA
ORDER NO. B-41449 ITEM NO. V-31
MFGR.
DATE 8-71 BY [signature]

Stearns-Roger

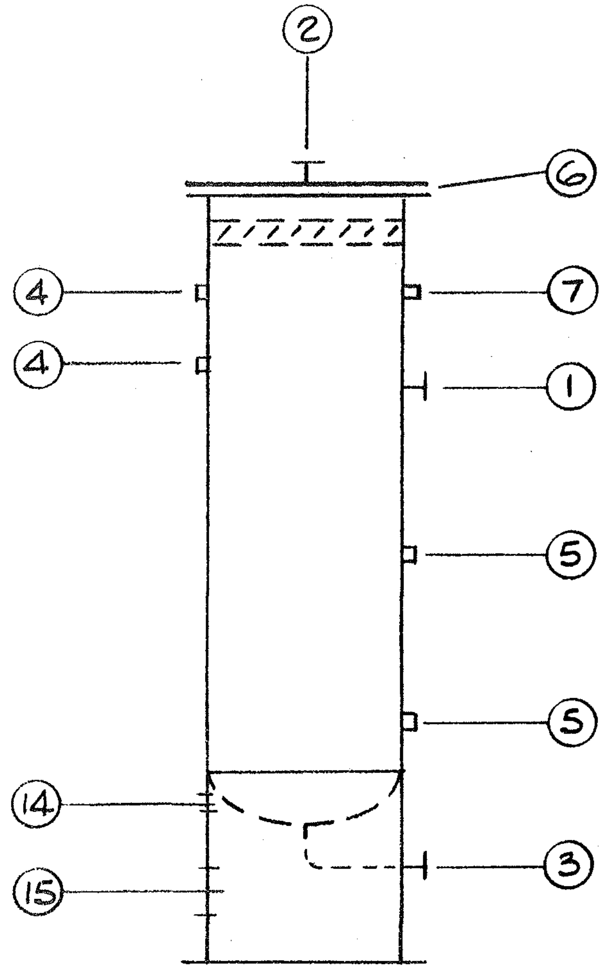
NO. VESSELS REQ'D. ([redacted]. -VERT.) ONE			
SHELL DIA. [redacted].-O.D. 18"			
SHELL THICKNESS ≅ 3/8"			
HEADS THICKNESS [redacted].-C.D. ≅ 3/8"			
SHELL & HEAD THICKNESS INCLUDE C.A. YES			
SHELL LENGTH (SEAM TO FLG.) 6'-0"			
SUPPORT SKIRT × 2'-0" HIGH			
DESIGN CONDITIONS			
CODE ASME VIII STAMP YES			
	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	370	420	
TEMP. (°F)	62	100	
CORR. ALLOW. SHELL 1/16" HEADS 1/16"			
X-RAY SPOT STRESS RELIEF NO			
WINDLOAD PER ASA 58.1			
SEISMIC ZONE 3			

MATERIALS
HEADS A515-70
SHELL A515-70
NOZZLES & FLANGES A106 B, A181 GR. 1
GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. VAPOR IN	1	6"-300# RF
2. VAPOR OUT	1	6"-300# RF
3. DRAIN	1	2"-300# RF
4. ALARM	2	1"-CPLG.
5. LEVEL GAUGE	2	3/4" CPLG
6. MANWAY W/BLIND	1	18"-300# RFSO
7. PRESS. GAUGE	1	3/4" CPLG.
8.		
9.		
10.		
11.		
12.		
13.		
14. SKIRT VENTS	2	2" SCH. 80 PIPE
15. SKIRT INSP.	2	6" REINF.

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM. 12 LB/FT³ × 6" S.S	YES	—
PACKING	—	—
INSUL. RINGS	—	—
LADDERS & PLATFORMS	—	—

NO.	DATE	BY	REVISIONS
⚠	8/71	RTG	GEN REV.



WEIGHT EMPTY ≅ 1700 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
(1) BOLTS SA 193-B7, NUTS SA 194-2H.
(2) WHITE SANDBLAST & ZINC-RICH PRIMER.
(3) DESIGNED FOR ULTIMATE CASE ⚠

VESSEL RECOMPRESSOR SUCTION SCRUBBER
FOR HUMBLE OIL AND REFINING COMPANY
PLANT GAS PROCESSING STUDY
LOCATION SBC, CALIFORNIA
ORDER NO. B-41449 ITEM NO. V-37
MFGR.
DATE 8-71 BY [illegible]

Stearns-Roger

NO. VESSELS REQ'D. ([redacted].-VERT.) ONE

SHELL DIA. I.D.-[redacted]. 30"

SHELL THICKNESS ≅ 5/8" AVERAGE

HEADS THICKNESS S.E.-[redacted]. ≅ 1/2"

SHELL & HEAD THICKNESS INCLUDE C.A. YES

SHELL LENGTH (SEAM TO SEAM) 113'-0"

SUPPORT SKIRT ≈ 4'-0" HIGH

DESIGN CONDITIONS

CODE ASME VIII STAMP YES

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	222	270	
TEMP. (°F)	219	450	

CORR. ALLOW. SHELL 1/16" HEADS 1/16"

X-RAY FULL STRESS RELIEF NO

WINDLOAD PER ASA 58.1

SEISMIC ZONE 3

MATERIALS

HEADS A515-70

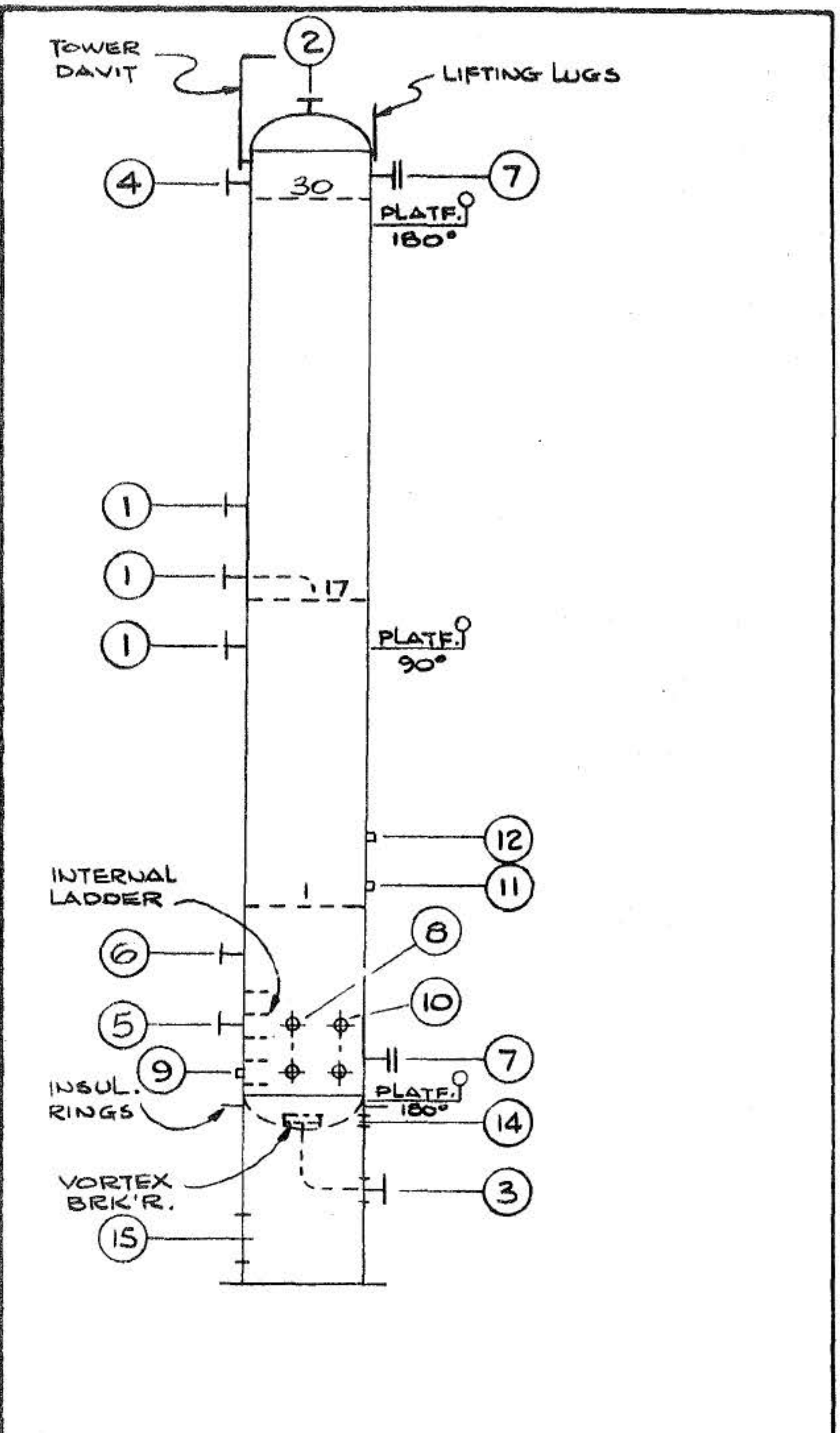
SHELL A515-70

NOZZLES & FLANGES A106 B, A181 GR. I

GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. COLUMN FEED	3	6"-300# RF
2. VAPOR OUT	1	6"-300# RF
3. LIQUID OUT	1	8"-300# RF
4. REFLUX	1	1½"-300# RF
5. PUMP AROUND	1	3"-300# RF
6. REBOILER RETURN	1	8"-300# RF
7. MANWAY W/DAVIT	2	18"-300# RF
8. GAUGE GLASS	2	2"-300# RF
9. PRESS. GAUGE	1	3/4" CPLG.
10. LEVEL CONTROL	2	1½"-300# RF
11. TEMP. IND.	2	1" CPLG.
12. TW	8	1" CPLG.
13.		
14. SKIRT VENTS	4	3" SCH. 80 PIPE
15. SKIRT ACCESS	1	18" REINF.

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
TRAY SUPPORT RINGS	YES	—
TRAY INSTALLATION	YES	NOTE (1)
INSUL. RINGS	YES	—
LADDERS & PLATFORM CLIPS	YES	—
LADDERS & PLATFORMS	—	YES



WEIGHT TRAYS ≅ 4,500 LBS.
WEIGHT EMPTY ≅ 28,000 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
(1) TRAYS SUPPLIED BY OTHERS.

NO.	DATE	BY	REVISIONS

VESSEL DEPROPANIZER

FOR HUMBLE OIL AND REFINING COMPANY

PLANT GAS PROCESSING STUDY

LOCATION SBC, CALIFORNIA

ORDER NO. B-41449 ITEM NO. V-47

MFGR.

DATE 8-71 BY [signature]

Stearns-Roger

NO. VESSELS REQ'D. (HORZ.-[redacted].)	ONE
SHELL DIA. I.D.-[redacted].	30"
SHELL THICKNESS	≅ 3/8"
HEADS THICKNESS S.E.-[redacted].	≅ 3/8"
SHELL & HEAD THICKNESS INCLUDE C.A.	YES
SHELL LENGTH (SEAM TO SEAM)	7'-6"
SUPPORT	SADDLES

DESIGN CONDITIONS

CODE ASME VIII STAMP YES

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	210	260	
TEMP. (°F)	36	75	

CORR. ALLOW. SHELL 1/16" HEADS 1/16"

X-RAY SPOT STRESS RELIEF NO

WINDLOAD PER ASA 58.1

SEISMIC ZONE 3

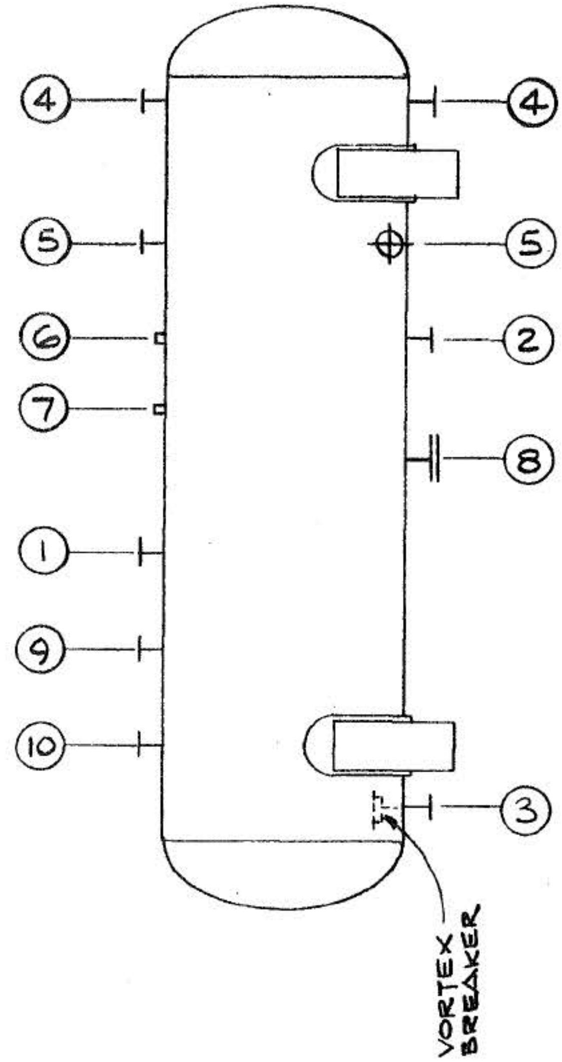
MATERIALS

HEADS	A515-70
SHELL	A515-70
NOZZLES & FLANGES	A106B, A181 GR. I
GASKETS	

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. FEED IN	1	6"-150#RF
2. DRAIN	1	2"-150#RF
3. REFLUX PUMP	1	3"-150#RF
4. GAUGE COLUMN	2	2"-150#RF
5. LC BRIDLE	2	1½"-150#RF
6. PC CONN.	1	1" CPLG.
7. PRESS. GAUGE	1	¾" CPLG.
8. MANWAY W/DAVIT	1	18"-150#RF
9. VAPOR BY-PASS	1	4"-150#RF
10. VAPOR OUT	1	6"-150#RF
11.		
12.		
13.		
14.		
15.		

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM.	–	–
PACKING	–	–
INSUL. RINGS	–	–
LADDERS & PLATFORMS	–	–

NO.	DATE	BY	REVISIONS



WEIGHT EMPTY ≅ 2200 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
(1) BOLTS SA193-B7, NUTS SA 194-2H
(2) WHITE SANDBLAST & ZINC-RICH PRIMER

VESSEL DEPROPANIZER REFLUX ACCUMULATOR
FOR HUMBLE OIL AND REFINING COMPANY
PLANT GAS PROCESSING STUDY
LOCATION SBC, CALIFORNIA
ORDER NO. B-41449 ITEM NO. V-48
MFGR.
DATE 8-71 BY [illegible]

Stearns-Roger

NO. VESSELS REQ'D. (HORZ. - ~~VERT.~~)	ONE
SHELL DIA. ~~I.D.~~ - O.D.	5'-0"
SHELL THICKNESS	5/16"
HEADS THICKNESS ~~SHELL~~. FLAT	5/16"
SHELL & HEAD THICKNESS INCLUDE C.A.	
SHELL LENGTH (SEAM TO SEAM)	16'-0"
SUPPORT	SADDLES (2)

DESIGN CONDITIONS

CODE ASME VIII STAMP NO

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	ATMOS	10	
TEMP. (°F)	150	200	

CORR. ALLOW. SHELL 1/16" HEADS 1/16"

X-RAY NO STRESS RELIEF NO

WINDLOAD PER ASA 58.1

SEISMIC ZONE 3

MATERIALS

HEADS SA-285

SHELL SA-285

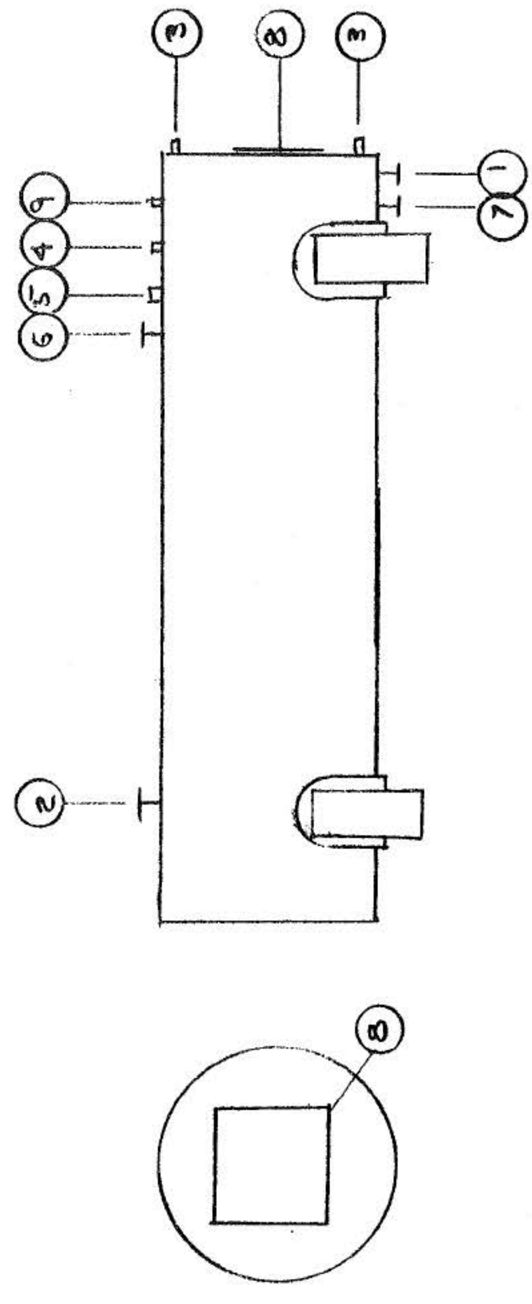
NOZZLES & FLANGES A106-B, A181-1

GASKETS "

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. GLYCOL IN/OUT	1	4"-150# RF
2. THIEF HATCH	1	2" - " "
3. GAGE GLASS	2	3/4" 6000# CPLG
4. GLYCOL BYPASS IN	1	1½" - " "
5. GLYCOL MAKEUP	1	1½" - " "
6. VENT	1	2"-150# RF
7. DRAIN	1	2" - " "
8. MANWAY	1	18" SQ. W/ COVER PL
9. FUTURE CONN.	1	8"-150# RF
10.		
11.		
12.		
13.		
14.		
15.		

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM.		
PACKING		
INSUL. RINGS		
LADDERS & PLATFORMS		

NO.	DATE	BY	REVISIONS
1	8/71	RTG	GEN. REV.



NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
2) WHITE SANDBLAST & ZINC RICH PRIMER
3) BOLTS SA 193-B7, NUTS SA 194-2H

VESSEL GLYCOL SURGE TANK

FOR HUMBLE OIL AND REFINING COMPANY

PLANT GAS PROCESSING STUDY

LOCATION SBC, CALIFORNIA

ORDER NO. B-41449 ITEM NO. V-50

MFGR.

DATE 8-71 BY LKMc

Stearns-Roger

NO. VESSELS REQ'D. ([redacted].-VERT.) ONE

SHELL DIA. [redacted].-O.D. 36"

SHELL THICKNESS 5/16"

HEADS THICKNESS S.E.-[redacted]. 5/16

SHELL & HEAD THICKNESS INCLUDE C.A. YES

SHELL LENGTH (SEAM TO SEAM) 14'-0"

SUPPORT SKIRT × 2'-6" HIGH

DESIGN CONDITIONS

CODE ASME VIII STAMP YES

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)		65	
TEMP. (°F)		200	

CORR. ALLOW. SHELL 1/16" HEADS 1/16"

X-RAY SPOT STRESS RELIEF NO

WINDLOAD PER ASA 58.1

SEISMIC ZONE 3

MATERIALS

HEADS A285-C

SHELL A285-C

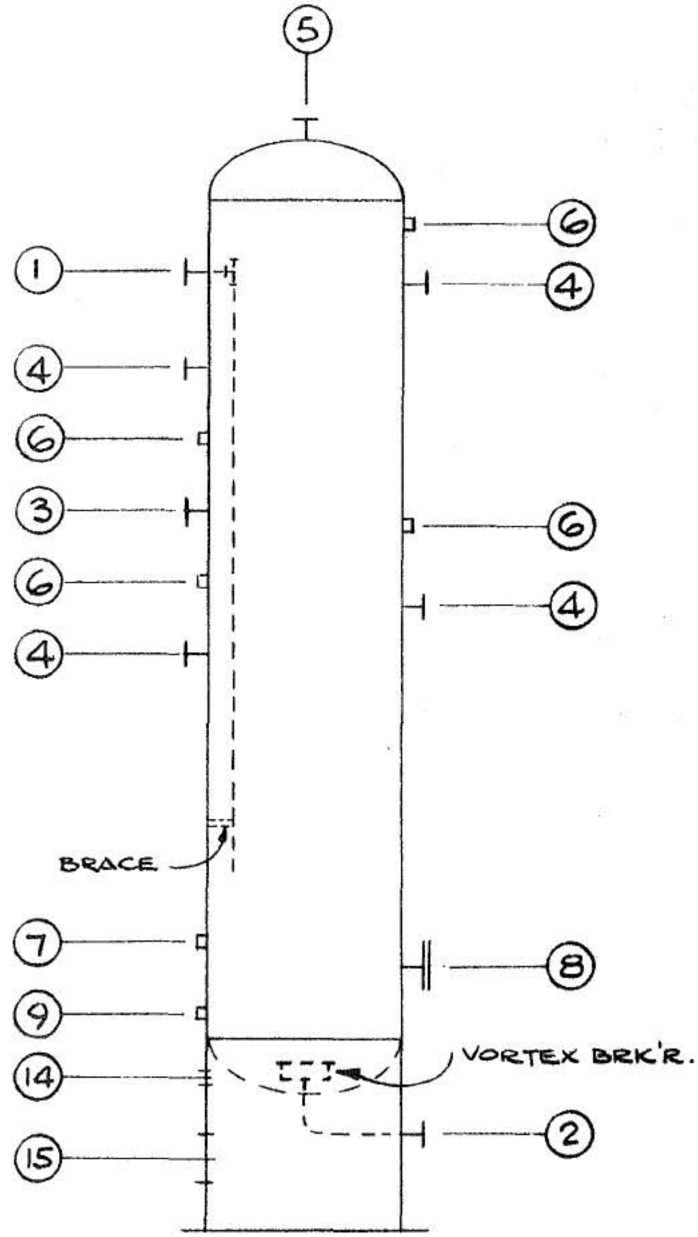
NOZZLES & FLANGES A53B, A181 GR.1

GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. RICH SOL'N. IN	1	2"-150# RF
2. GLYCOL OUT	1	2"-150# RF
3. HC OUT	1	2"-150# RF
4. LC	4	1½"-150# RF
5. VENT	1	3"-150# RF
6. LEVEL GAUGE	4	3/4" CPLG.
7. PRESS. GAUGE	1	3/4" CPLG.
8. MANWAY W/DAVIT	1	18"-150# RF
9. T.W.	1	1" CPLG.
10.		
11.		
12.		
13.		
14.		
15.		

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM.	–	–
PACKING	–	–
INSUL. RINGS 1½"	YES	–
LADDERS & PLATFORMS CLIPS	YES	–
INTERNAL PIPE		

NO.	DATE	BY	REVISIONS



WEIGHT EMPTY ≈ 3450 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
(1) BOLTS SA 193-B7, NUTS SA 194-2H.
(2) WHITE SANDBLAST & ZINC RICH PRIMER.

VESSEL GLYCOL FLASH TANK

FOR HUMBLE OIL AND REFINING COMPANY

PLANT GAS PROCESSING STUDY

LOCATION SBC, CALIFORNIA

ORDER NO. B-41449 ITEM NO. V-51

MFGR.

DATE 8-71 BY [signature]

Stearns-Roger

NO. VESSELS REQ'D. ([redacted].-VERT.) ONE

SHELL DIA. [redacted].-O.D. 18"

SHELL THICKNESS ≅ 3/8"

HEADS THICKNESS S.E.-[redacted]. ≅ 3/8"

SHELL & HEAD THICKNESS INCLUDE C.A. YES

SHELL LENGTH (SEAM TO SEAM) 21'-0"

SUPPORT SKIRT × 6'-0" HIGH

DESIGN CONDITIONS

CODE ASME VIII STAMP YES

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)		35	
TEMP. (°F)		300	

CORR. ALLOW. SHELL 1/16" HEADS 1/16"

X-RAY SPOT STRESS RELIEF NO

WINDLOAD PER ASA 58.1

SEISMIC ZONE 3

MATERIALS

HEADS A234 WPB CAPS.

SHELL A53B PIPE

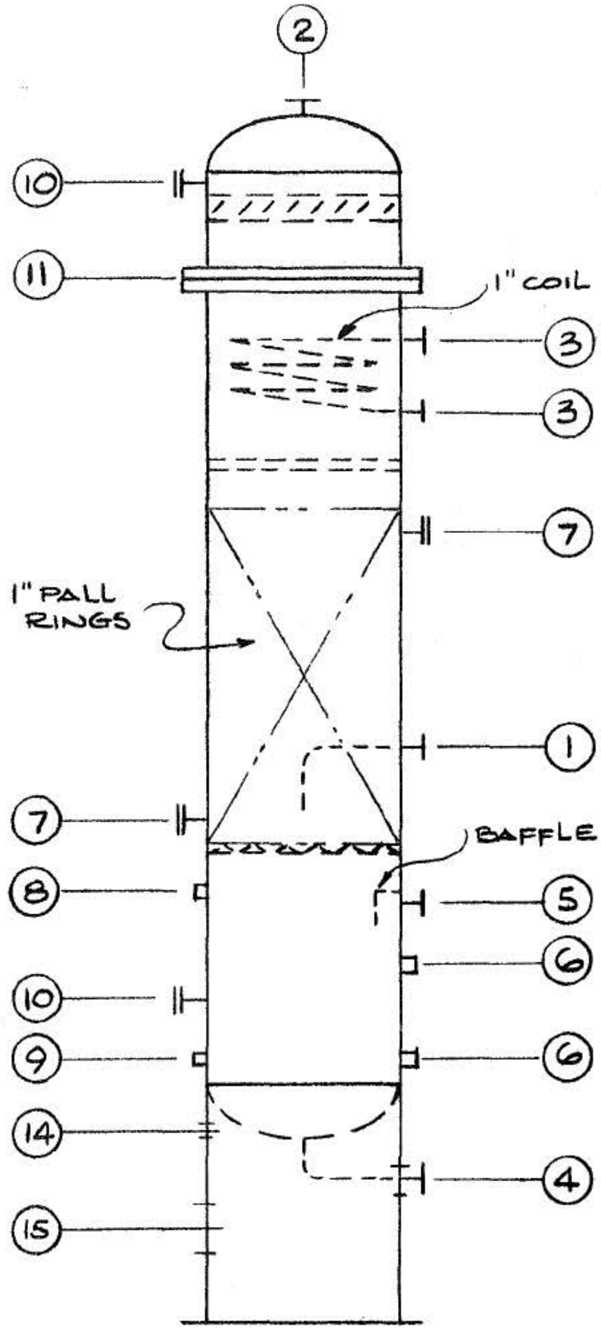
NOZZLES & FLANGES A53B, A181 GR. I

GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. FEED	1	2"-150# RF
2. OVERHEAD	1	3"-150# RF
3. REFLUX COIL	2	1"-150# RF
4. FLUID TO RBLR.	1	4"-150# RF
5. VAPOR FROM RBLR	1	6"-150# RF
6. LEVEL GAUGE	2	3/4" CPLG.
7. PACKING SERV.	2	6"-150# RF W/BLIND
8. PRESS. GAUGE	1	3/4" CPLG.
9. TW	1	1" CPLG.
10. INSP. OPEN.	2	3"-150# RF W/BLIND
11. SHELL FLANGES	2	18"-150# RFSO
12.		
13.		
14. SKIRT VENTS	2	2" SCH. 80 PIPE
15. SKIRT INSP.	2	6" REINF.

INTERNALS & ACCESSORIES	FURNISHED BY: VESSEL FAB.	FURNISHED BY: OTHERS
FILTER ELEM. 12 LB/FT³ × 6" S.S.	YES	–
PACKING SUP. & DISTRIB.	YES	–
INSUL. RINGS 1½"	YES	–
LADDERS & PLATFORMS CLIPS	YES	-
INTERNAL PIPE & COIL	YES	-

NO.	DATE	BY	REVISIONS



WEIGHT EMPTY ≅ 3000 LBS.

NOTES: 1.- ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.

(1) BOLTS SA 193-B7, NUTS SA 194-2H.

(2) WHITE SANDBLAST & ZINC-RICH PRIMER

VESSEL GLYCOL STILL

FOR HUMBLE OIL AND REFINING COMPANY

PLANT GAS PROCESSING STUDY

LOCATION SBC, CALIFORNIA

ORDER NO. B-41449 ITEM NO. V-52

MFGR.

DATE 8-71 BY [illegible]

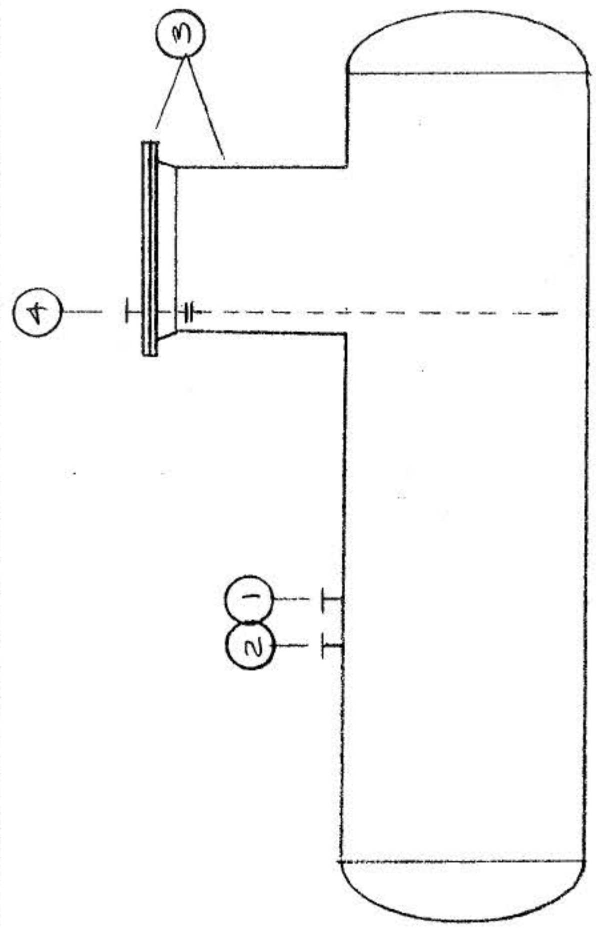
Stearns-Roger

NO. VESSELS REQ'D. (HORZ.-~~VERT.~~) ONE			
SHELL DIA. ~~I.D.~~-O.D. 36"			
SHELL THICKNESS 3/8"			
HEADS THICKNESS S.E.-~~C.D.~~ 3/8"			
SHELL & HEAD THICKNESS INCLUDE C.A.			
SHELL LENGTH (SEAM TO SEAM) 6'-0"			
SUPPORT NONE			
DESIGN CONDITIONS			
CODE ASME VIII STAMP NO			
	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	0	15	
TEMP. (°F)	60°-130°	200°	
CORR. ALLOW. SHELL 1/8" HEADS 1/8"			
X-RAY NO STRESS RELIEF			
WINDLOAD			
DRUM WILL BE BURIED (NOTE 3)			
MATERIALS			
HEADS A285-C			
SHELL A285-C			
NOZZLES & FLANGES			
GASKETS			

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. GLYCOL IN	1	4"-150# RF
2. VENT	1	4" - " "
3. PUMP FLANGE	1	18"x24" (NOTE 4)
4. FLOAT	1	4"-150# RF
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM.		
PACKING		
INSUL. RINGS		
LADDERS & PLATFORMS		
INTERNAL PIPE	X	

NO.	DATE	BY	REVISIONS



4) FLG. & COVER FROM 1/2" PL WITH ASA DIMENSIONS & MACHINE GASKET SURFACE.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
2) BOLTS SA193-B7, NUTS SA194-2H
3) VESSEL COATED W/TAR BY OTHERS

VESSEL GLYCOL SUMP
FOR HUMBLE OIL AND REFINING COMPANY
PLANT GAS PROCESSING STUDY
LOCATION SBC CALIFORNIA
ORDER NO. B-41449 ITEM NO. V-53
MFGR.
DATE 8-71 BY LKM

Stearns-Roger

NO. VESSELS REQ'D. ([redacted]Z.-VERT.) ONE			
SHELL DIA. I.D.-[redacted] 66"			
SHELL THICKNESS ≌ 1/2"			
HEADS THICKNESS S.E.-[redacted]. ≌ 1/2			
SHELL & HEAD THICKNESS INCLUDE C.A. YES			
SHELL LENGTH (SEAM TO SEAM) 7'-6"			
SUPPORT SKIRT × 4'-0" HIGH			
DESIGN CONDITIONS CODE ASME VIII STAMP YES			
	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	16	210	
TEMP. (°F)	-10	-20/100	
CORR. ALLOW. SHELL 1/16" HEADS 1/16"			
X-RAY SPOT STRESS RELIEF NO			
WINDLOAD PER ASA 58.1			
SEISMIC ZONE 3			

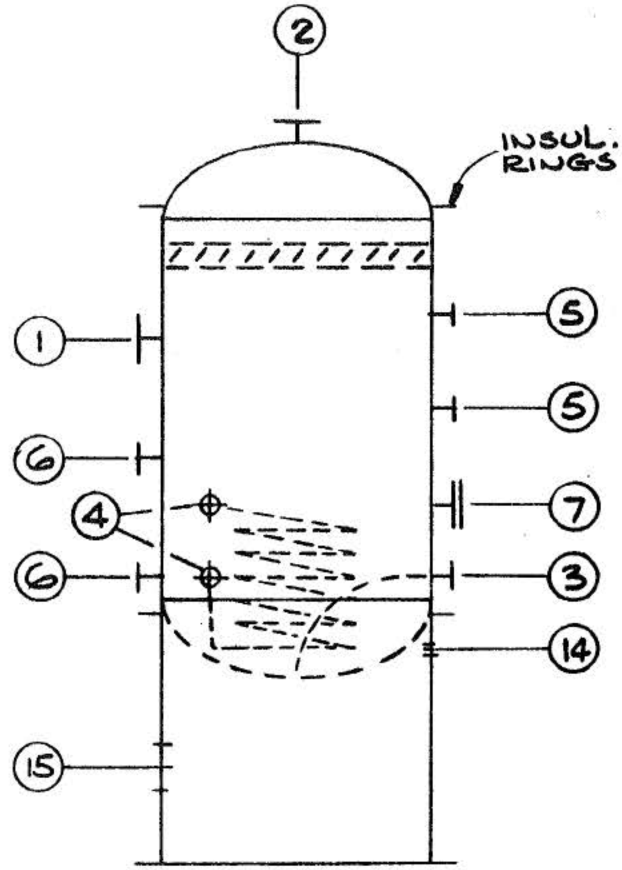
MATERIALS	
HEADS	A285-C
SHELL	A285-C
NOZZLES & FLANGES	
GASKETS	

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. VAPOR IN	1	18"-150# RF
2. VAPOR OUT	1	18"-150# RF
3. DRAIN	1	2"-150# RF
4. HOT OIL COIL	2	1"-150# RF NOTE (1)
5. LEVEL ALARM	2	2"-150# RF
6. LEVEL GAUGE	2	2"-150# RF
7. MANWAY W/DAVIT	1	18"-150# RF
8.		
9.		
10.		
11.		
12.		
13.		
14. SKIRT VENTS	4	2" SCH. 80 PIPE
15. SKIRT INSP.	1	10" REINF.

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	OTHERS
FILTER ELEM. 12 LB/FT³ × 6" S.S.	YES	-
PACKING	-	-
INSUL. RINGS FOR SHELL & BOTTOM HEAD	YES	-
LADDER CLIPS	YES	-

NO.	DATE	BY	REVISIONS
△1	8/71	RJG	GEN. REV.

△1



WEIGHT EMPTY ≈ 7,000 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
(1) WELDED TANK COIL 1" SCH. 80 PIPE.
(2) BOLTS SA193-B7, NUTS SA194-2H.

VESSEL PROPANE SUCTION SCRUBBER
FOR HUMBLE OIL AND REFINING COMPANY
PLANT GAS PROCESSING STUDY
LOCATION SBC, CALIFORNIA
ORDER NO. B-41449 ITEM NO. V-61
MFGR.
DATE 8-71 BY [signature]

Stearns-Roger

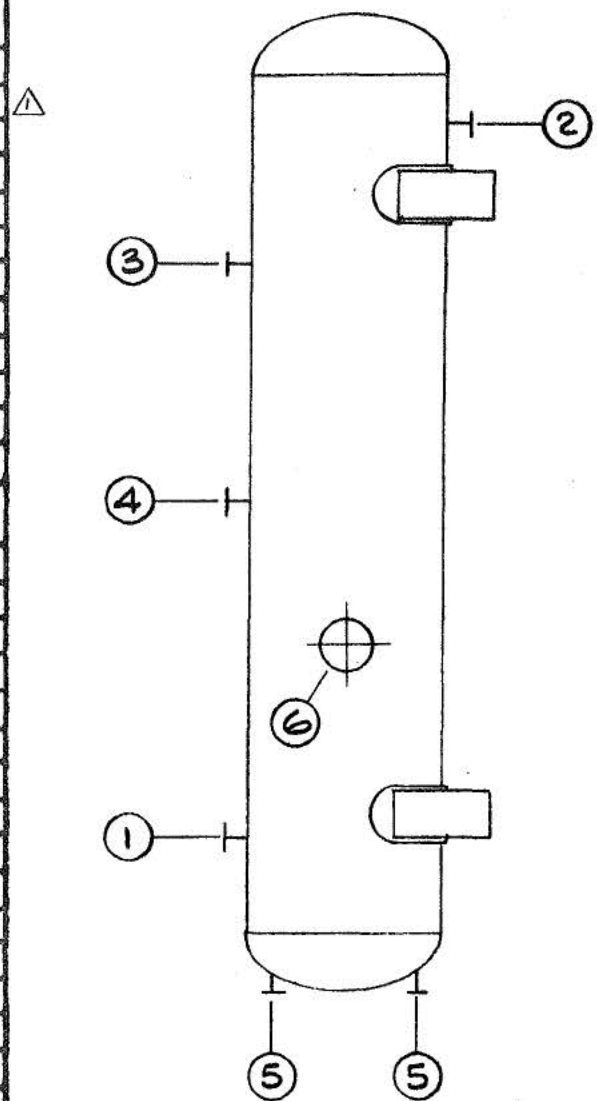
NO. VESSELS REQ'D. (HORZ.-[redacted].) ONE			
SHELL DIA. I.D.-[redacted]. 48"			
SHELL THICKNESS ≅ 9/16"			
HEADS THICKNESS S.E.-[redacted] ≅ 1/2"			
SHELL & HEAD THICKNESS INCLUDE C.A. YES			
SHELL LENGTH (SEAM TO SEAM) 12'-0"			
SUPPORT SADDLES			
DESIGN CONDITIONS			
CODE ASME VIII STAMP YES			
	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	187	255	
TEMP. (°F)	105	150	
CORR. ALLOW. SHELL 1/16" HEADS 1/16"			
X-RAY SPOT STRESS RELIEF NO			
WINDLOAD PER ASA 58.1			
SEISMIC ZONE 3			

MATERIALS
HEADS A285-C
SHELL A285-C
NOZZLES & FLANGES
GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. INLET	1	6"-150# RF
2. OUTLET	1	6"-150# RF
3. VENT	1	2"-150# RF
4. PSV	1	3"-150# RF
5. LEVEL BRIDLE	2	2"-150# RF
6. MANWAY W/DAVIT	1	18"-150# RF
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM.	–	–
PACKING	–	–
INSUL. RINGS	–	–
LADDERS & PLATFORMS	–	–

NO.	DATE	BY	REVISIONS
1 (△)	8/71	RTG	GEN. REV



WEIGHT EMPTY ≅ 6000 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
(1) BOLTS SA 193-B7, NUTS SA 194-2H.
(2) WHITE SANDBLAST & ZINC-RICH PRIMER.

VESSEL PROPANE RECEIVER
FOR HUMBLE OIL AND REFINING COMPANY
PLANT GAS PROCESSING STUDY
LOCATION SBC, CALIFORNIA
ORDER NO. B-41449 ITEM NO. V-62
MFGR.
DATE 8-71 BY [signature]

Stearns-Roger

NO. VESSELS REQ'D. (HORZ.-[redacted].) ONE
SHELL DIA. I.D.-[redacted]. 36"
SHELL THICKNESS ≈ 3/8"
HEADS THICKNESS S.F.-[redacted]. ≈3/8"
SHELL & HEAD THICKNESS INCLUDE C.A. YES
SHELL LENGTH (SEAM TO SEAM) 8'-0"
SUPPORT SADDLES

DESIGN CONDITIONS

CODE ASME VIII STAMP YES

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	64	210	
TEMP. (°F)	41	-20/100	

CORR. ALLOW. SHELL 1/16" HEADS 1/16"
X-RAY SPOT STRESS RELIEF NO
WINDLOAD PER ASA 58.1
SEISMIC ZONE 3

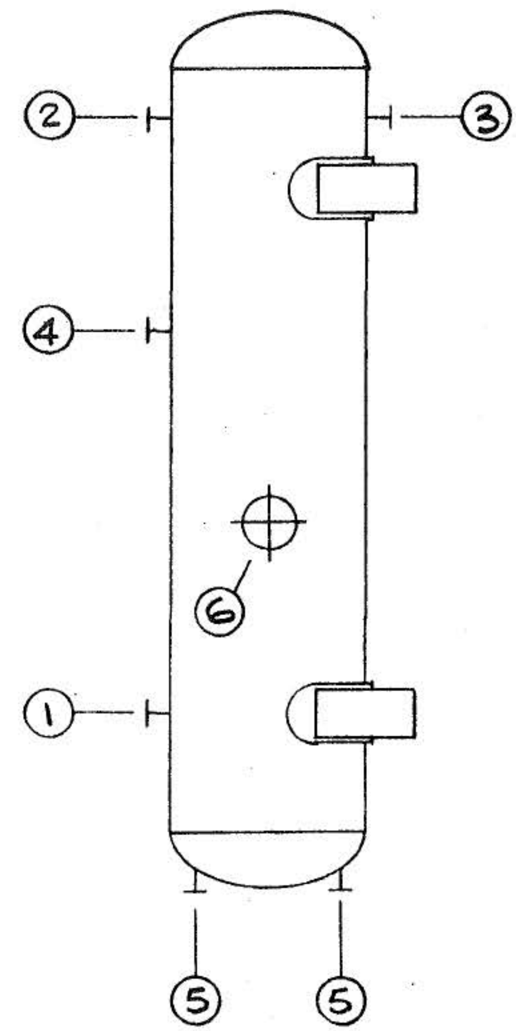
MATERIALS

HEADS A285-C
SHELL A285-C
NOZZLES & FLANGES
GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. INLET	1	6"-150# RF
2. VAPOR OUT	1	8"-150# RF
3. LIQUID OUT	1	6"-150# RF
4. PSV	1	2"-150# RF
5. LEVEL BRIDLE	2	2"-150# RF
6. MANWAY W/DAVIT	1	18"-150# RF
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM.	–	–
PACKING	–	–
INSUL. RINGS	–	–
LADDERS & PLATFORMS	–	–

NO.	DATE	BY	REVISIONS
			[redacted]



WEIGHT EMPTY ≈ 2600 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
(1) BOLTS SA193-B7, NUTS SA194-2H

VESSEL PROPANE ECONOMIZER
FOR HUMBLE OIL AND REFINING COMPANY
PLANT GAS PROCESSING STUDY
LOCATION SBC, CALIFORNIA
ORDER NO. B-41449 ITEM NO. V-63
MFGR.
DATE 8-71 BY [signature]

Stearns-Roger

NO. VESSELS REQ'D. ([redacted]Z.-VERT.) ONE

SHELL DIA. I.D.-[redacted]. 30"

SHELL THICKNESS ≅ 3/8

HEADS THICKNESS S.F.-[redacted]. ≅ 3/8"

SHELL & HEAD THICKNESS INCLUDE C.A. YES

SHELL LENGTH (SEAM TO SEAM) 6'-6"

SUPPORT SKIRT x 2'-0" HIGH

DESIGN CONDITIONS

CODE ASME VIII STAMP YES

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	64	255	
TEMP. (°F)	41	150	

CORR. ALLOW. SHELL 1/16" HEADS 1/16"

X-RAY SPOT STRESS RELIEF NO

WINDLOAD PER ASA 58.1

SEISMIC ZONE 3

MATERIALS

HEADS A285-C

SHELL A285-C

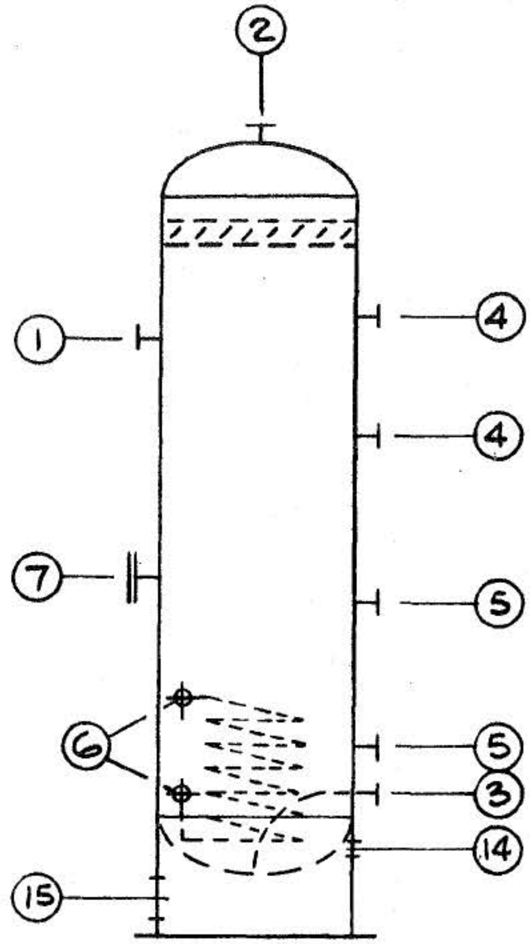
NOZZLES & FLANGES

GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. VAPOR IN	1	8"-150# RF
2. VAPOR OUT	1	8"-150# RF
3. DRAIN	1	2"-150# RF
4. LEVEL ALARM	2	2"-150# RF
5. LEVEL GAUGE	2	2"-150# RF
6. HOT OIL COIL	2	1"-150# RF NOTE (1)
7. MANWAY W/DAVIT	1	18"-150# RF
8.		
9.		
10.		
11.		
12.		
13.		
14. SKIRT VENTS	2	2" SCH. 80 PIPE
15. SKIRT INSP.	1	10" REINF.

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM. 12 LB/FT³ x 6" S.S.	YES	-
PACKING	-	-
INSUL. RINGS	-	-
LADDERS & PLATFORMS	-	-

NO.	DATE	BY	REVISIONS



WEIGHT EMPTY ≅ 2500 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.

(1) WELDED TANK COIL 1" SCH. 80 PIPE

(2) BOLTS SA 193-B7, NUTS SA 194-2H

(3) WHITE SANDBLAST & ZINC-RICH PRIMER

VESSEL PROPANE INTERSTAGE SCRUBBER

FOR HUMBLE OIL AND REFINING COMPANY

PLANT GAS PROCESSING STUDY

LOCATION SBC, CALIFORNIA

ORDER NO. B-41449 ITEM NO. V-64

MFGR.

DATE 8-71 BY [signature]

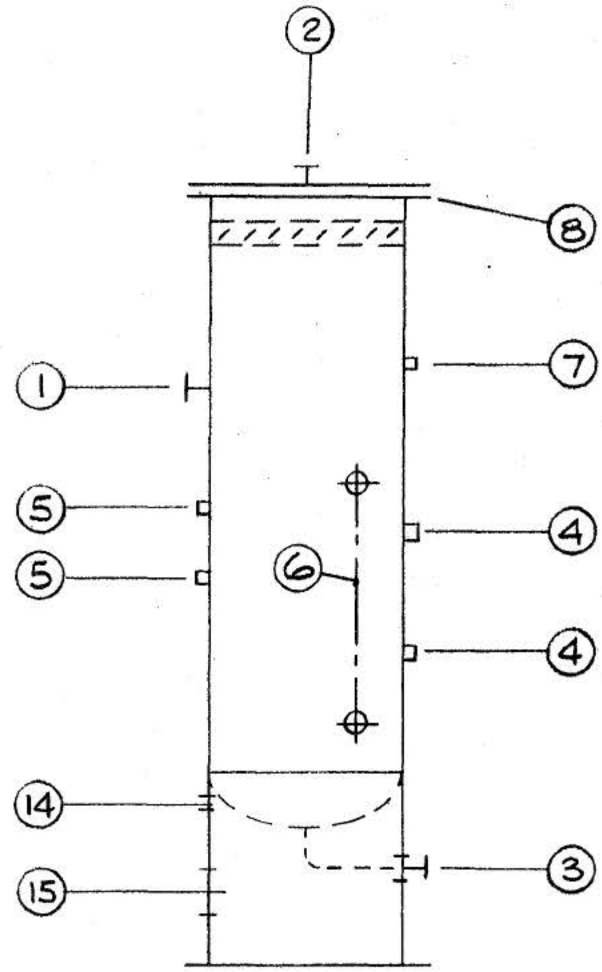
Stearns-Roger

NO. VESSELS REQ'D. ([redacted].-VERT.) ONE			
SHELL DIA. [redacted].-O.D. 18"			
SHELL THICKNESS ≈ 3/8"			
HEADS THICKNESS [redacted].-C.D. ≈ 3/8"			
SHELL & HEAD THICKNESS INCLUDE C.A. YES			
SHELL LENGTH (SEAM TO FLG.) 6'-0"			
SUPPORT SKIRT × 2'-0"			
DESIGN CONDITIONS CODE ASME VIII STAMP YES			
	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)		250	
TEMP. (°F)		150	
CORR. ALLOW. SHELL 1/16" HEADS 1/16"			
X-RAY SPOT STRESS RELIEF NO			
WINDLOAD PER ASA 58.1			
SEISMIC ZONE 3			
MATERIALS			
HEADS A515-70			
SHELL A515-70			
NOZZLES & FLANGES A106 B, A181 GR. 1			
GASKETS			

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. FUEL GAS IN	1	3"-150# RF
2. FUEL GAS OUT	1	3"-150# RF
3. LIQUID OUT	1	1½"-150# RF
4. LLC	2	1½" CPLG.
5. LS	2	1" CPLG.
6. LEVEL GAUGE	2	3/4" CPLG.
7. PRESS. GAUGE	1	3/4" CPLG.
8. MANWAY W/BLIND	1	18"-150# RFSO
9.		
10.		
11.		
12.		
13.		
14. SKIRT VENTS	2	2" SCH. 80 PIPE
15. SKIRT INSP.	2	6" REINF.

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM. 12 LB/FT³ × 6" S.S.	YES	-
PACKING	-	-
INSUL. RINGS	-	-
LADDERS & PLATFORMS	-	-

NO.	DATE	BY	REVISIONS



WEIGHT EMPTY ≈ 1700 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
(1) BOLTS SA 193-B7, NUTS SA 194-2H.
(2) WHITE SANDBLAST & ZINC-RICH PRIMER.

VESSEL HP FUEL GAS SCRUBBER.
FOR HUMBLE OIL AND REFINING COMPANY
PLANT GAS PROCESSING STUDY
LOCATION SBC, CALIFORNIA
ORDER NO. B-41449 ITEM NO. V-77
MFGR.
DATE 8-71 BY DB

Stearns-Roger

NO. VESSELS REQ'D. ([redacted]Z.-VERT.) ONE			
SHELL [redacted].-O.D. 18"			
SHELL THICKNESS ≅ 3/8"			
HEADS THICKNESS [redacted].-C.D. ≅ 3/8"			
SHELL & HEAD THICKNESS INCLUDE C.A. YES			
SHELL LENGTH (SEAM TO FLG.) 6'-0"			
SUPPORT SKIRT × 2'-0" HIGH			
DESIGN CONDITIONS			
CODE ASME VIII STAMP YES			
	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)		125	
TEMP. (°F)		150	
CORR. ALLOW. SHELL 1/16" HEADS 1/16"			
X-RAY SPOT STRESS RELIEF NO			
WINDLOAD PER ASA 58.1			
SEISMIC ZONE 3			

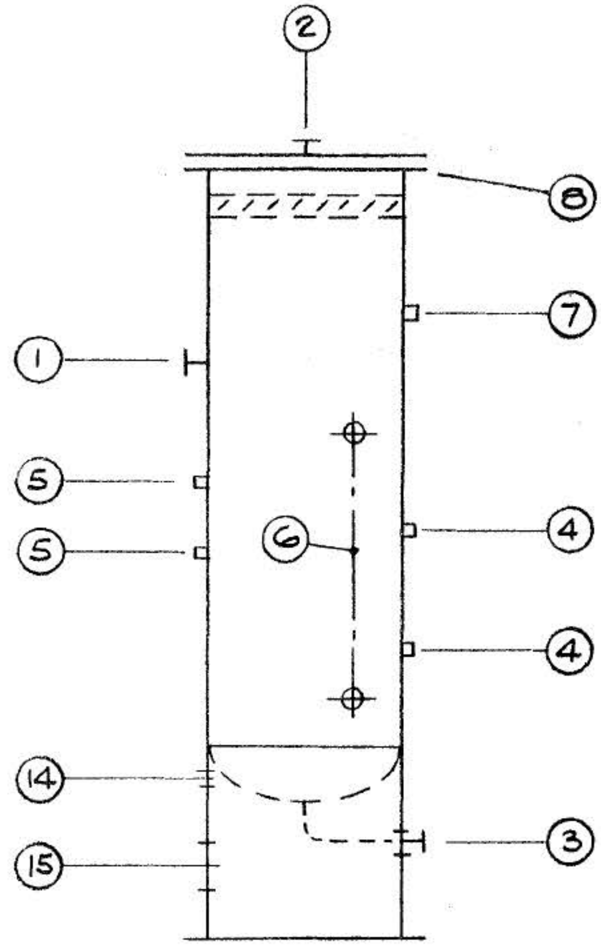
MATERIALS

- HEADS A515-70
- SHELL A515-70
- NOZZLES & FLANGES A106B, A181 GR. I
- GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. FUEL GAS IN	1	3"-150# RF
2. FUEL GAS OUT	1	3"-150# RF
3. LIQUID OUT	1	1½"-150# RF
4. LLC	2	1½" CPLG.
5. LS	2	1" CPLG.
6. LEVEL GAUGE	2	3/4" CPLG.
7. PRESS. GAUGE	1	3/4" CPLG.
8. MANWAY W/BLIND	1	18"-150# RFSO
9.		
10.		
11.		
12.		
13.		
14. SKIRT VENTS	2	2" SCH. 80 PIPE
15. SKIRT INSP.	2	6" REINF.

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM. 12 LB/FT³ × 6" S.S.	YES	–
PACKING	–	–
INSUL. RINGS	–	–
LADDERS & PLATFORMS	–	–

NO.	DATE	BY	REVISIONS



WEIGHT EMPTY ≅ 1700 LBS.

NOTES: 1.- ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
(1) BOLTS SA 193-B7, NUTS SA 194-2H.
(2) WHITE SANDBLAST & ZINC RICH PRIMER.

VESSEL LP FUEL GAS SCRUBBER.
FOR HUMBLE OIL AND REFINING COMPANY
PLANT GAS PROCESSING STUDY
LOCATION SBC, CALIFORNIA
ORDER NO. B-41449 ITEM NO. V-78
MFGR.
DATE 8-71 BY [illegible]

Stearns-Roger

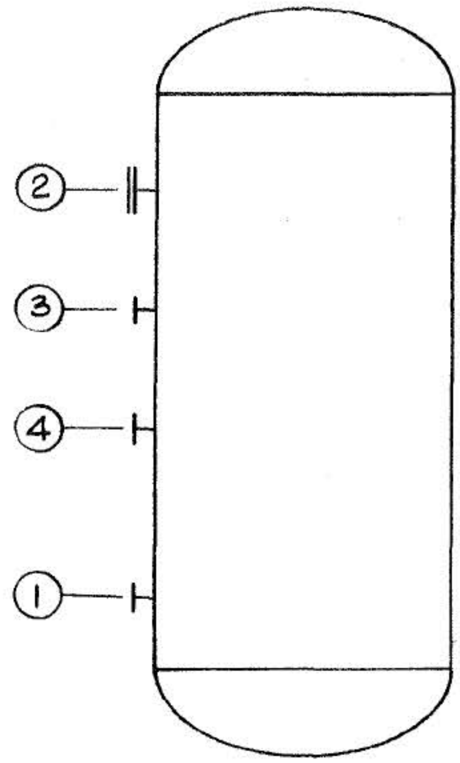
NO. VESSELS REQ'D. (HORZ.-[redacted].) ONE			
SHELL DIA. I.D.-[redacted]. 96"			
SHELL THICKNESS ≅ 3/8"			
HEADS THICKNESS S.E.-[redacted]. ≅ 3/8"			
SHELL & HEAD THICKNESS INCLUDE C.A. YES			
SHELL LENGTH (SEAM TO SEAM) 16'-0"			
SUPPORT NONE			
DESIGN CONDITIONS			
CODE ASME VIII STAMP NO			
	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)		10	
TEMP. (°F)		100	
CORR. ALLOW. SHELL 1/8" HEADS 1/8"			
X-RAY SPOT STRESS RELIEF NO			
WINDLOAD –			
DRUM WILL BE BURIED (NOTE 2)			

MATERIALS
HEADS A285-C
SHELL A285-C
NOZZLES & FLANGES
GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. LIQUID IN	1	4"-150#RF
2. MANWAY & PUMP	1	18"-150#RF
3. LEVEL IND.	1	2"-150#RF
4. VENT	1	4"-150#RF
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM.	–	–
PACKING	–	–
INSUL. RINGS	–	–
LADDERS & PLATFORMS	–	–

NO.	DATE	BY	REVISIONS
1 (triangle)	8/71	RTG	GEN. REV.



WEIGHT EMPTY ≅ 9800 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
(1) BOLTS SA 193-B7, NUTS SA 194-2H.
(2) DRUM COATED W/TAR BY OTHERS.

VESSEL AMINE FILTER DRAIN TANK (1)
FOR HUMBLE OIL AND REFINING COMPANY
PLANT GAS PROCESSING STUDY
LOCATION SBC, CALIFORNIA
ORDER NO. B-41449 ITEM NO. V-79
MFGR.
DATE 8-71 BY [signature]

Stearns-Roger

NO. VESSELS REQ'D. ([redacted].-VERT.) 1 (1)

SHELL DIA. I.D.-[redacted]. 72"

SHELL THICKNESS ≅ 1/2"

HEADS THICKNESS S.E.-[redacted]. ≅ 7/16"

SHELL & HEAD THICKNESS INCLUDE C.A. YES

SHELL LENGTH (SEAM TO SEAM) 19'-0"

SUPPORT SKIRT x 3'-0" HIGH

DESIGN CONDITIONS

CODE ASME VIII STAMP YES

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)		130	
TEMP. (°F)		125	

CORR. ALLOW. SHELL 1/16" HEADS 1/16"

X-RAY SPOT STRESS RELIEF NO

WINDLOAD PER ASA 58.1

SEISMIC ZONE 3

MATERIALS

HEADS A285-C

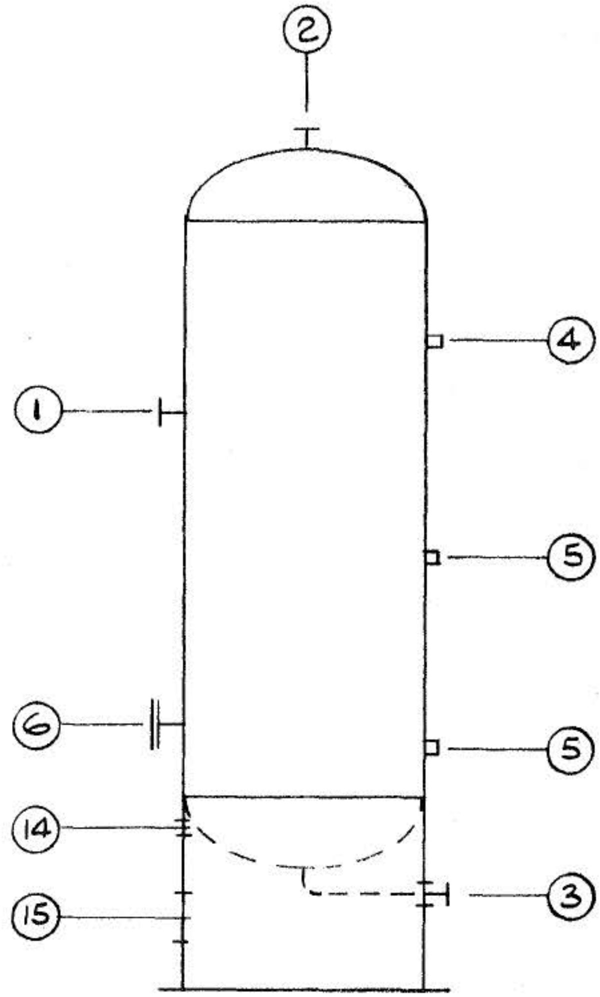
SHELL A285-C

NOZZLES & FLANGES A53 B, A181 GR. 1

GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. AIR IN	1	2"-150# RF
2. AIR OUT	1	2"-150# RF
3. LIQUID OUT	1	2"-150# RF
4. PRESS. IND.	1	3/4" CPLG.
5. LEVEL GAUGE	2	3/4" CPLG.
6. MANWAY W/DAVIT	1	18"-150# RF
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14. SKIRT VENTS	4	2" SCH. 80 PIPE
15. SKIRT ACCESS	1	18" REINF.

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM.	-	-
PACKING	-	-
INSUL. RINGS	-	-
LADDERS & PLATFORMS	-	-



WEIGHT EMPTY ≅ 10,900 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.

(1) WHITE SANDBLAST & ZINC-RICH PRIMER.

(2) BOLTS SA 193-B7, NUTS SA 194-2H

NO.	DATE	BY	REVISIONS

VESSEL INSTRUMENT AIR RECEIVER

FOR HUMBLE OIL AND REFINING COMPANY

PLANT GAS PROCESSING STUDY

LOCATION SBC, CALIFORNIA

ORDER NO. B-41449 ITEM NO. V-88

MFGR.

DATE 8-71 BY [signature]

Stearns-Roger

NO. VESSELS REQ'D. ([redacted].-VERT.) ONE	
SHELL DIA. I.D.-[redacted]. 60"	
SHELL THICKNESS ≅ 1/2"	
HEADS THICKNESS S.E.-[redacted]. ≅ 7/16"	
SHELL & HEAD THICKNESS INCLUDE C.A. YES	
SHELL LENGTH (SEAM TO SEAM) 19'-0"	
SUPPORT SKIRT × 3'-0" HIGH	

DESIGN CONDITIONS

CODE ASME VIII STAMP YES

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)		155	
TEMP. (°F)		125	

CORR. ALLOW. SHELL 1/16" HEADS 1/16"

X-RAY SPOT STRESS RELIEF NO

WINDLOAD PER ASA 58.1

SEISMIC ZONE 3

MATERIALS

HEADS A285-C

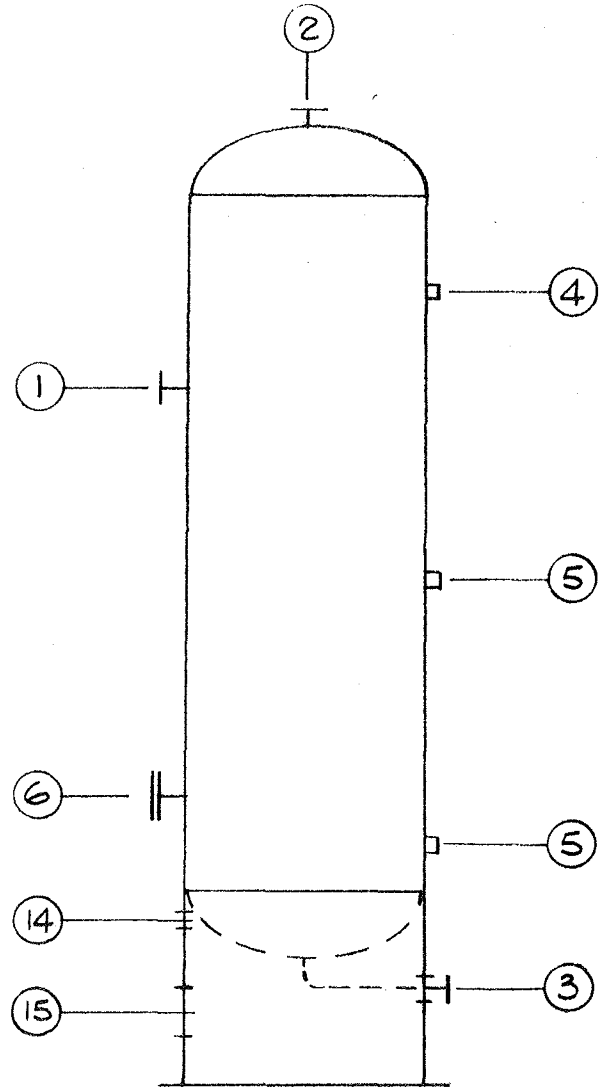
SHELL A285-C

NOZZLES & FLANGES A53 B, A181 GR.1

GASKETS

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. AIR IN	1	2" -150#RF
2. AIR OUT	1	2" -150#RF
3. LIQUID OUT	1	2"-150#RF
4. PRESS. IND.	1	3/4" CPLG.
5. LEVEL GAUGE	2	3/4" CPLG.
6. MANWAY W/DAVIT	1	18"-150#RF
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14. SKIRT VENTS	4	2" SCH. 80 PIPE
15. SKIRT ACCESS	1	18" REINF.

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	OTHERS
FILTER ELEM.	–	–
PACKING	–	–
INSUL. RINGS	–	–
LADDERS & PLATFORMS	–	–



WEIGHT EMPTY ≅ 9800 LBS.

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
(1) WHITE SANDBLAST & ZINC-RICH PRIMER.
(2) BOLTS SA 193-B7, NUTS SA 194-2H.

NO.	DATE	BY	REVISIONS

VESSEL UTILITY AIR RECEIVER
FOR HUMBLE OIL AND REFINING COMPANY
PLANT GAS PROCESSING STUDY
LOCATION SBC, CALIFORNIA
ORDER NO. B-41449 ITEM NO. V-89
MFGR.
DATE 8-71 BY [signature]

Stearns-Roger

NO. VESSELS REQ'D. (HORZ.-VERT.)	ONE
SHELL DIA. I.D.-O.D.	42"
SHELL THICKNESS	1/4"
HEADS THICKNESS S.F.-C.D.	1/4"
SHELL & HEAD THICKNESS INCLUDE C.A.	YES
SHELL LENGTH (SEAM TO SEAM)	5'-0"
SUPPORT	SKIRT x 4'-0" HIGH

DESIGN CONDITIONS

CODE ASME VIII STAMP YES

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)		75	
TEMP. (°F)		300	

CORR. ALLOW. SHELL 1/16" HEADS 1/16"

X-RAY SPOT STRESS RELIEF NO

WINDLOAD ASA 58.1

SEISMIC ZONE 3

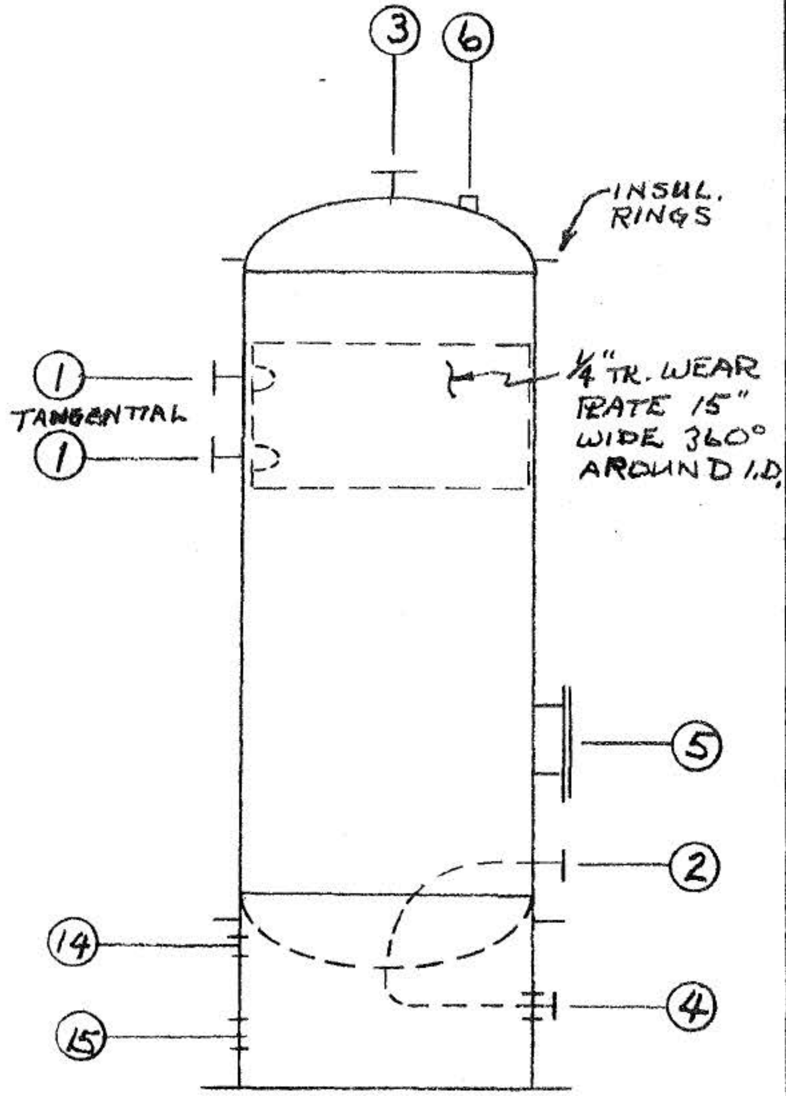
MATERIALS

HEADS	SA 285 C
SHELL	SA 285 C
NOZZLES & FLANGES	SA106B, SA181-1
GASKETS	

NOZZLES & CONNECTIONS	NO. REQ'D	SIZE-RATING-FACE
1. BOILER BLOWDOWN	2	1½"-150# RF
2. WATER OUT	1	2"-150# RF
3. VENT	1	4"-150# RF
4. DRAIN	1	1½"-150# RF
5. MANWAY w/DAVIT	1	18"-150# RF
6. COND. RETURN	1	3/4" CPLG.
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14. SKIRT VENTS	2	2" SCH. 80 PIPE
15. SKIRT INSP.	1	18" REINF.

INTERNALS & ACCESSORIES	FURNISHED BY VESSEL FAB.	FURNISHED BY OTHERS
FILTER ELEM.		
PACKING		
INSUL. RINGS	YES	
LADDERS & PLATFORMS		

NO.	DATE	BY	REVISIONS



WEIGHT EMPTY = 2350

NOTES: 1. ALL COUPLINGS 6000#, UNLESS OTHERWISE SPECIFIED.
(2) BOLTS SA194-B7, NUTS SA194-2H

VESSEL BOILER BLOWDOWN DRUM
FOR HUMBLE OIL AND REFINING COMPANY
PLANT GAS PROCESSING STUDY
LOCATION SBC, CALIFORNIA
ORDER NO. B4/449 ITEM NO. V-90
MFGR.
DATE 8/27/71 BY EJB

Stearns-Roger

REV.

Stearns-Roger

PACKAGE UNIT
STUDY DATA SHEET

ITEM NO. W-21
ACC'T. ______ PAGE ______
S.R JOB B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY
PROJECT GAS PROCESSING STUDY
LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

DATE August, 1971 BY JW/DJM

a SERVICE Make-up Water Treater NO. REQ'D. 1 (1)

REVISIONS: a 8/71 BY RTG :b BY :c BY :d BY

MANUFACTURER SOURCE: QUOTE OF

One (1) - dual tower zeolite water treating unit, complete with all necessary tower, controls, drivers and piping. Operation shall be cyclic and automatic.

General design conditions are as follows:

Flow Rate - 6 GPM maximum (3.0 normal)

Hardness Reduction - 99% minimum (based on inlet calcium, sodium and magnesium hardness of 50-100 ppm)

DEAERATOR HEATER

STUDY DATA SHEET

Stearns-Roger

ITEM No. W-22

ACC'T. ______ PAGE ______

S.R JOB B-41449

CUSTOMER HUMBLE OIL AND REFINING COMPANY

PROJECT GAS PROCESSING STUDY

LOCATION SANTA BARBARA CHANNEL, CALIFORNIA

DATE August, 1971 BY JEW/DJ

SERVICE D.A. HEATER NO. REQ'D. 1 (1)

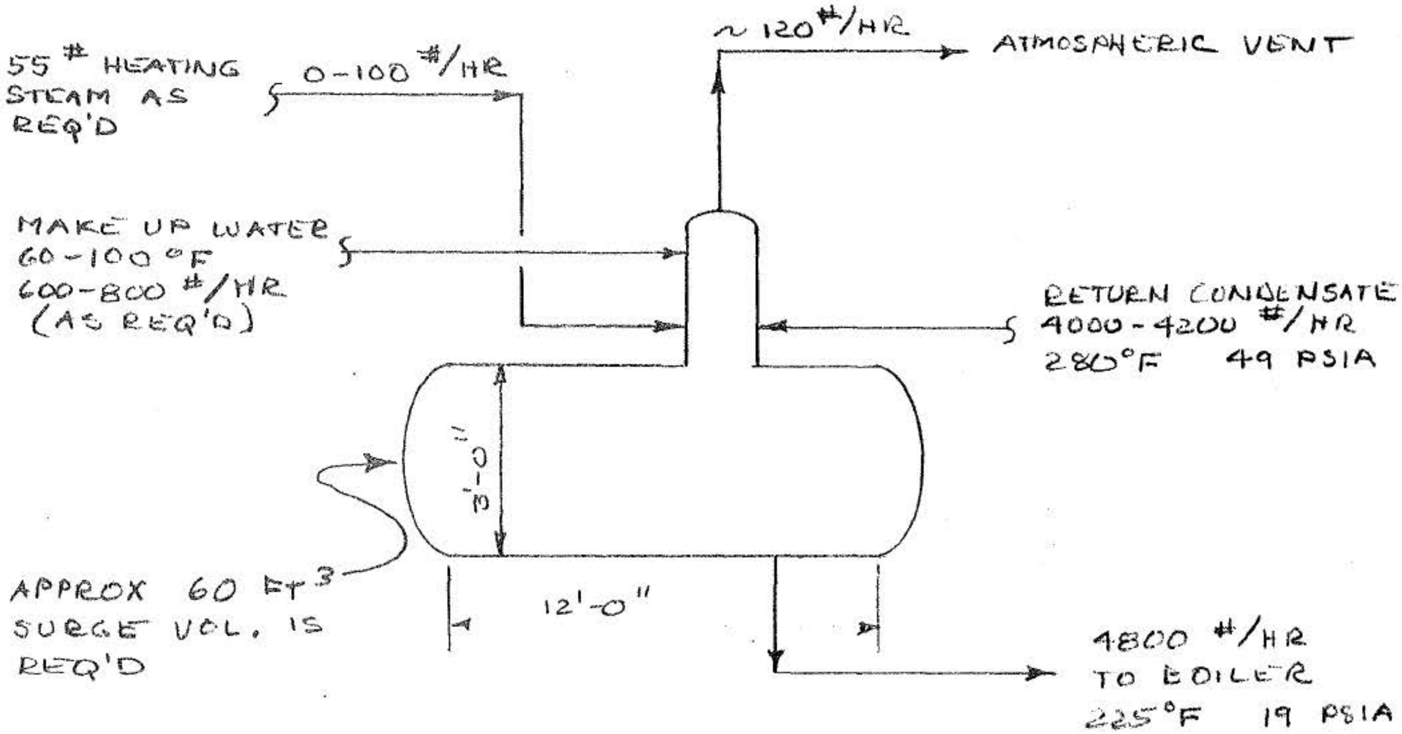
REVISIONS: a ______ BY ______ : b ______ BY ______ : C ______ BY ______ : d ______ BY ______

MANUFACTURER ______ SOURCE: QUOTE OF ______

ONE (1) D.A. HEATER TO HEAT & DEAERATE MAKE UP WATER & RETURN CONDENSATE.

RATES & CONDITIONS ARE NOTED BELOW. SIZES ARE FOR ESTIMATING ONLY

PURCHASED UNIT TO BE MFG. STD.



MATERIALS - SHELL - C.S.
INTERNAL SPRAYS, ECT. - SS.

DRAWINGS

PIPING AND INSTRUMENT SYMBOLS

BALL VALVE
BUTTERFLY VALVE
CHECK VALVE
GATE VALVE
GLOBE OR NEEDLE VALVE
PLUG VALVE
ANGLE VALVE

CONTROL VALVE (DIAPHRAM)

BODY SIZE — FO — VALVE ACTION; SELF CONTAINED; WITH HANDJACK; 3-WAY

SOLENOID VALVES

SV; 2-WAY; 3-WAY; 4-WAY; 2-WAY W/MANUAL RESET

MISCELLANEOUS VALVES

3"x4" SET@ 100# — INLET x OUTLET SET PRESS. — PSV: RELIEF & SAFETY VALVE
POWER GAS OR ELEC. OPER. — ROV: REMOTE OPERATED VALVE
HCV: HAND CONTROL VALVE
PSD: RUPTURE DISK

PIPING

FLANGES; SPECTACLE BLINDS; RO: FIXED RESTRICTION ORIFICE; F--: ORIFICE FLANGES; F--: SR FITTING: ORIFICE SENIOR FITTING; F--: ORIFICE FLANGES W/CALIBRATED METER TUBE

F--: ORIFICE FLANGES W/STRAIGHTENING VANES; EJ: EXPANSION JOINT; FG: SIGHT FLOW GLASS; 12"–10": REDUCER; TEMPORARY STRAINER; PLUGGED CPLG. & VALVE

HOSE CONNECTOR; OPEN DRAIN FUNNEL; Y-STRAINER; SPEC. SPEC.: PIPING MATERIAL SPEC. CHANGE; ROTAMETER; * ITEMS FURN. BY VENDOR

00-1-12: LINE CONTINUATION FLAG (SHOWS DWG. NO. WHERE PIPING IS CONT'D.)

00-1-12: LINE REFERENCE FLAG (FOR REFERENCE ONLY. PIPING DETAIL SHOWN ON LISTED DRAWING)

ABBREVIATIONS

BOE = BOTTOM OF EQUIPMENT
CSC = CAR SEAL-CLOSE
CSO = CAR SEAL OPEN
CV = CONTROL VALVE
ESD = EMERGENCY SHUTDOWN
FC = FAIL CLOSED
FO = FAIL OPEN
I.A. = INSTRUMENT AIR
L.O. = LOCK OPEN
(1) NILL = NORMAL INTERFACE LIQUID LEVEL
HILA = HIGH INTERFACE LEVEL ALARM
LILA = LOW INTERFACE LEVEL ALARM
HILSD = HIGH INTERFACE LEVEL SHUTDOWN
LILSD = LOW INTERFACE LEVEL SHUTDOWN
NLL = NORMAL LIQUID LEVEL
LAH = HIGH LEVEL ALARM
LAL = LOW LEVEL ALARM
HLSD = HIGH LEVEL SHUTDOWN
(1) LLSD = LOW LEVEL SHUTDOWN
PSIA = POUNDS PER SQUARE INCH ABSOLUTE
PSIG OR # = POUNDS PER SQUARE INCH GAUGE
LAHL = HIGH & LOW LEVEL ALARM

S.C. = SAMPLE CONNECTION
S-S = SEAM TO SEAM
T-T = TANGENT TO TANGENT

(1) HEIGHT GIVEN IN INCHES ABOVE INSIDE BOTTOM OF HORIZONTAL VESSELS AND ABOVE TRAY OR BOTTOM HEAD SEAM IN TOWERS AND VERTICAL VESSELS.

MATERIAL SPECIFICATIONS

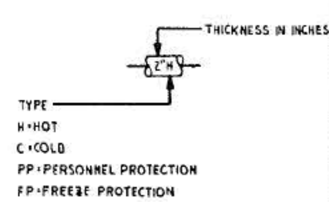
125# FF
- AA - INSTRUMENT AIR - 125# FF, CS W/C.I. VALVES
- ZW - DRINKING WATER - GALV. PIPE

150# RF CS
- BA - PLANT AIR
- BB - 150# & LESS STEAM, COND., BFW & STEAM TRACING
- BD - GLYCOL WATER
- BJ - LIQUID SULFUR (JACKETED)
- BP - SWEET H/C LIQUID & VAPOR & REFRIGERATION TO -10F
- BT - SOUR H/C LIQUID & VAPOR
- BU - ENGINE AIR INTAKE & EXHAUST
- BS - ACID GAS
- BW - WATER - COOLING, TREATED & RAW
- BX - FIREWATER
- BY - DRAINS
- BF - FLARE
- BR - SWEET H/C LIQUID & VAPOR FROM -21°F TO -50°F

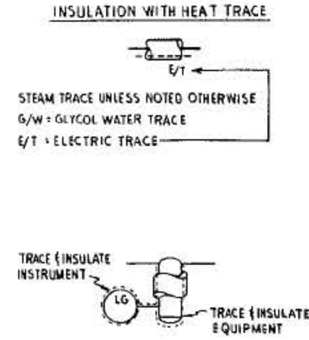
300# RF CS.
- DB - 300# STEAM, COND., BFW
- DD - GLYCOL - WATER
- DP - SWEET H/C LIQUID & VAPOR & REFRIGERANT TO -10F
- DT - SOUR H/C LIQUID & VAPOR
- DR - SWEET H/C LIQUID & VAPOR FROM -21°F TO -50°F

600# RF CS.
- FD - GLYCOL - WATER
- FP - SWEET H/C LIQUID & VAPOR & REFRIGERANT TO -10F
- FT - SOUR H/C LIQUID & VAPOR
- FR - SWEET H/C LIQUID & VAPOR FROM -21°F TO -50°F

INSULATION



INSULATION WITH HEAT TRACE



GENERAL INSTRUMENT SYMBOLS

PROCESS SENSING LINES TO INSTRUMENTS
PNEUMATIC SIGNAL
ELECTRIC SIGNAL
CAPILLARY TUBING
HYDRAULIC SIGNAL
ELECTROMAGNETIC OR SONIC SIGNAL
TRANSMITTER (LOCAL)
TRANSMITTER (MOUNTED BEHIND PANEL)
INSTRUMENT (LOCAL)
INSTRUMENT (MAIN PANEL MOUNTED)
INSTRUMENT (MOUNTED BEHIND MAIN PANEL)
INSTRUMENT (LOCAL PANEL MOUNTED)
(LOCAL PANELS ARE IDENTIFIED)
INSTRUMENT (MOUNTED BEHIND LOCAL PANEL)
DUAL PEN INSTRUMENT

FUNCTION DESIGNATIONS FOR RELAYS

SYMBOL	FUNCTION
1. 1-0 OR ON-OFF	AUTOMATICALLY CONNECT, DISCONNECT, OR TRANSFER ONE OR MORE CIRCUITS.
2. Σ OR ADD	ADD OR TOTALIZE
3. Δ OR DIFF.	SUBTRACT
4. ±, +, ⊟	BIAS
5. AVG.	AVERAGE
6. % OR 1:3 OR 2:1 (TYP)	GAIN OR ATTENUATE
7. ☒	MULTIPLY
8. ÷	DIVIDE
9. √ OR SQ.RT.	EXTRACT SQUARE ROOT
10. x^n OR $x^{1/n}$	RAISE TO POWER
11. f(x)	CHARACTERIZE
12. 1:1	BOOST
13. ▷ OR HIGHEST (MEASURED VARIABLE)	HIGH-SELECT
14. ◁ OR LOWEST (MEASURED VARIABLE)	LOW-SELECT
15. REV.	REVERSE
16. a. E/P OR P/I (TYP)	CONVERT. FOR INPUT/OUTPUT SEQUENCES OF THE FOLLOWING:
b. A/D OR D/A	FOR INPUT/OUTPUT SEQUENCES OF THE FOLLOWING:
17. ∫	INTEGRATE
18. D OR d/dt	DERIVATIVE OR RATE
19. 1/D	INVERSE DERIVATIVE
20. AS REQUIRED	UNCLASSIFIED

DESIGNATION	SIGNAL
E	VOLTAGE
H	HYDRAULIC
I	CURRENT (ELECTRICAL)
O	ELECTROMAGNETIC OR SONIC
P	PNEUMATIC
R	RESISTANCE (ELECTRICAL)
A	ANALOG
D	DIGITAL

INSTRUMENT IDENTIFICATION

VARIABLE	SYMBOL	MEASURING DEVICES: E PRIMARY ELEMENT	W WELL	R RECORDING	I INDICATING	T TRANSMITTER (BLIND)			OBSERVATION (LOCAL)	CONTROLLING DEVICES: R RECORDING	I INDICATING	BLIND	V SELF CONTAINED CONTROL VALVE			ALARMS (2): A BLIND			SWITCHES: I INDICATING	BLIND	(5) RELAY			MISCELLANEOUS	VALVES			
ANALYZER (6)	A			AR	AI	AT				ARC	AIC					AA												
BURNER FLAME	B															BA				BS								
CONDUCTIVITY	C			CR	CI	CT				CRC	CIC					CA												
DENSITY	D			DR	DI	DT				DRC	DIC					DA												
VOLTAGE (EMF)	E																											
FLOW	F	FE		FR	FI	FT			FG	FRC	FIC	FC	FCV			FA			FIS	FS	FX							
GAGING	G																											
HAND	H										HIC		HCV							HS								
CURRENT (ELECT.)	I																											
POWER	J																											
TIME	K																				KX							
LEVEL	L			LR	LI	LT			(3) LG	LRC	LIC	LC				LA			LIS	LS	LX							
MOISTURE	M			MR	MI	MT				MRC	MIC	MC				MA												
MISCELLANEOUS	N																											
MISCELLANEOUS	O																											
PRESS OR VAC. (7)	P	PE		PR	PI	PT			PI	PRC	PIC	PC	PCV			PA			PIS	PS	PX							
QUANTITY	Q			QR	QI																							
RADIOACTIVITY	R																											
SPEED	S			SR	SI	ST				SRC	SIC					SA												
TEMPERATURE	T	TE	TW	TR	TI	TT			TI	TRC	TIC	TC	TCV			TA			TIS	TS	TX							
MULTIVARIABLE	U																											
VISCOSITY	V																											
WEIGHT	W			WR	WI	WT				WRC	WIC	WC				WA			WIS	WS								
UNCLASSIFIED	X																				XR				XCV			
MISCELLANEOUS	Y																											
POSITION	Z				ZI															ZS								

(1) LOWER CASE LETTER FOLLOWING FIRST LETTER INDICATES USE OF PROCESS VARIABLE, d = DIFFERENTIAL AND r = RATIO i.e. PdR, PrRC.

(2) ALARMS ARE IDENTIFIED HIGH OR LOW THUS: LAH LAL LAHL

(3) LEVEL GAUGE NOMENCLATURE. QUANTITY (2) LG 251 ILLUMINATOR 46" CENTER TO CENTER MOUNTING LENGTH.

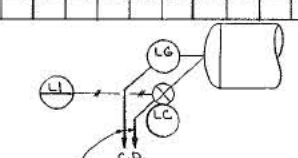
(4) CONTROL VALVES HAVE SAME IDENTIFICATION AS CONTROLLER WITH SUFFIX "V" ADDED i.e. FRC-110V.

(5) RELAYS ARE ELECTRIC OR PNEUMATIC. IDENTIFY WITH FUNCTION SUBSCRIPT.

(6) IDENTIFY ANALYZERS AND EQUIPMENT WITH SUBSCRIPT OUTSIDE OF CIRCLE i.e. = CO_2, PH, H_2S, ETC.

(7) FOR VACUUM OR DRAFT INSTRUMENTS - ADD SUBSCRIPT. PI VAC. PI DRAFT

(8) EXCEPTIONS TO ABOVE SCHEDULE:
LD = LIQUID DRAINER — SV = SOLENOID VALVE
PB = PUSH BUTTON — VS = VIBRATION SWITCH
ROV = REMOTE OPERATED VALVE
SS = SELECTOR SWITCH
ST = STEAM TRAP



TYPICAL LEVEL INSTRUMENT DRAINS
A.D. = AMINE DRAIN
C.D. = CLOSED DRAIN
G.D. = GLYCOL DRAIN

NO.	REVISIONS	DATE	BY	CH'D	APP'D	NO.	REFERENCE DRAWINGS

PRINT RECORD: DATE; FOR; REVISED; CUSTOMER; FIELD; INTRA CO.

ENG. RECORD		
DRAWN	SPIELMAN	7-26-71
CHECKED		
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		
PROCESS	[signature]	7-28-71

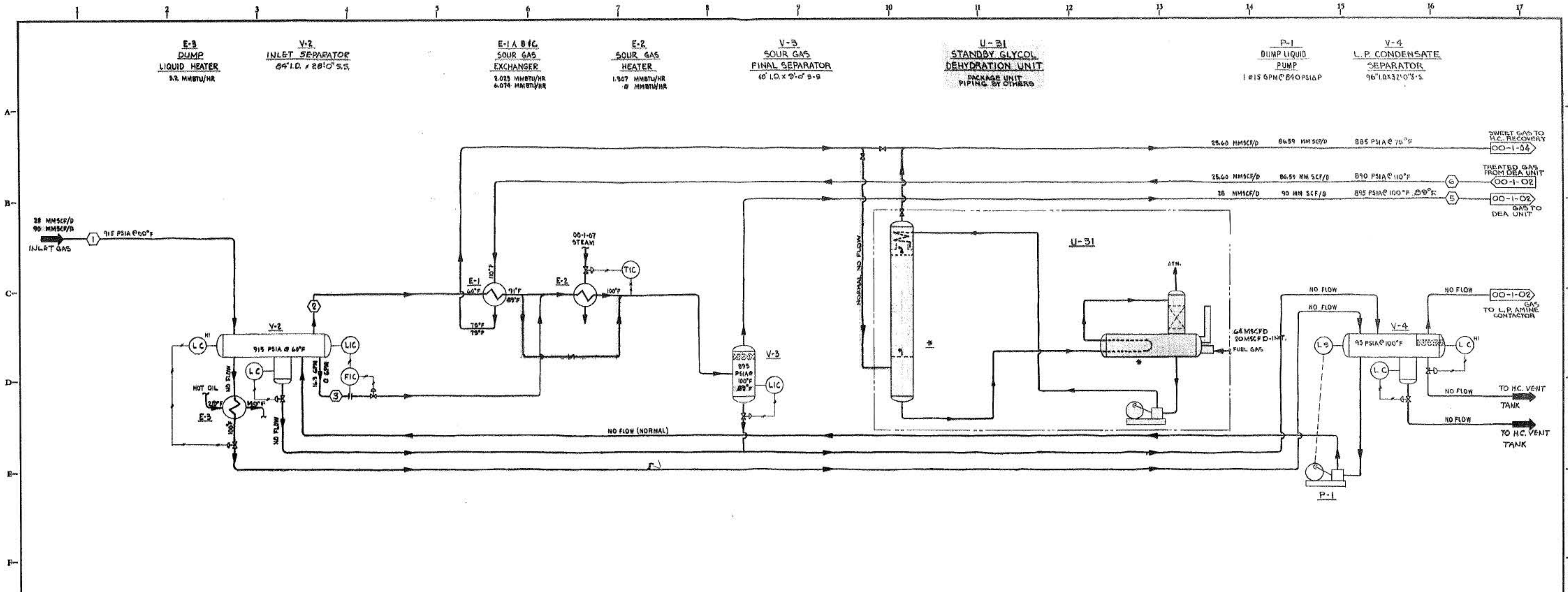
DRAWING STATUS: DRAWING	ISSUE NO.	DATE
DEVELOPMENT	1 2 3 ☒	7-26-71
PRELIMINARY ENGINEERING	4 5 6	8-27-71
APPROVED FOR CONSTRUCTION	☐	
REVISED & APPROVED FOR CONSTRUCTION	REV. 0	

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

MECHANICAL FLOW DIAGRAM
SYMBOLS AND INSTRUMENT LEGEND
GAS PROCESSING STUDY
HUMBLE OIL AND REFINING COMPANY
SBC, CALIFORNIA

SCALE NONE — Stearns-Roger CORPORATION — ORDER NO. B-41449

DWG. NO. 22070 — SHEET NO. 00-1-00 — REV. 0



INITIAL MATERIAL BALANCE										ULTIMATE MATERIAL BALANCE		
STREAM NUMBER					1	2	3	5	6	1	5	6
COMP.	GAL/MOL	MOL.WT.	T_c°R	P_c PSIA	INLET GAS TO UNIT	GAS FROM INLET SEPARATOR	LIQUID FROM INLET SEPARATOR	TOTAL FEED TO AMINE UNIT	SWEET GAS FROM AMINE UNIT	INLET GAS TO UNIT	TOTAL FEED TO AMINE UNIT	SWEET GAS FROM AMINE UNIT
N_2	4.16	28.016	227.1	492.0	66	66	—	66	65	1233	1,233	1,231
CO_2	6.38	44.010	547.5	1,071.0	5386	5,245	141	5,386	—	7660	7,660	—
H_2S	5.17	34.076	672.4	1,306.0	590	560	30	590	—	830	830	—
C_1	6.40	16.042	343.2	669.7	50873	50,358	515	50,873	50,544	185,955	185,955	185,489
C_2	9.56	30.068	549.8	708.3	6781	6,510	271	6,781	6,766	19,613	19,613	19,593
C_3	10.42	44.094	665.7	616.3	6028	5,489	539	6,028	6,026	13,376	13,376	13,373
IC_4	12.38	58.120	734.6	529.1	694	594	100	694	694	1,755	1,755	1,755
NC_4	11.93	58.120	765.3	550.7	2,700	2,221	479	2,700	2,699	5,004	5,004	5,003
IC_5	13.85	72.146	829.8	483.0	162	118	44	162	162	498	498	498
NC_5	13.71	72.146	845.6	489.5	207	145	62	207	207	498	498	498
C_6	15.57	86.172	914.1	440.0	185	100	85	185	185	403	403	403
F-1	16.40	100.000	994.5	449.6	111	37	74	111	111	352	352	351
TOTAL MOLS/DAY					73,783	71,443	2,340	73,783	67,459	237,157	237,157	228,174
LBS/HR					74,828	70,536	4,292	74,828	63,861	212,300	212,300	196,725
MOL. WT.					24.84	23.69	44.19	24.84	22.72	21.484	21.484	20.69
GALS/MIN (60°F)							16.82					
LBS/GAL (60°F)												
SP GR (60°F)							.5277					
MSCF/D					28,000	27,112		28,000	25,600	90,000	90,000	86,591
OPER TEMP °F					60	60	60	100	110	60	89	110
OPER PRESS PSIA					916	916	916	895	890	915	895	890

▨ INDICATES ULTIMATE CASE

NO.	REVISIONS	DATE	BY	CH'D	APP'D
△					
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NO.	REFERENCE DRAWINGS

PRINT RECORD	
DATE	
FOR	
REVISED	
CUSTOMER	
FIELD	
INTRA CO.	
PROCESS	

ENG. RECORD		
DRAWN	CLF	6-24-71
CHECKED		
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		
PROCESS		

DRAWING STATUS		
DRAWING	ISSUE NO.	DATE
DEVELOPMENT	1 2 3 ☒	7-21-71
PRELIMINARY ENGINEERING	4 5 6	8-27-71
APPROVED FOR CONSTRUCTION	☐	
REVISED & APPROVED FOR CONSTRUCTION	△0 REV.	

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE S/OR REVISION NO.

INITIAL & ULTIMATE

PROCESS FLOW DIAGRAM

INLET FACILITIES

GAS PROCESSING STUDY

HUMBLE OIL AND REFINING COMPANY

SBC, CALIFORNIA

SCALE NONE

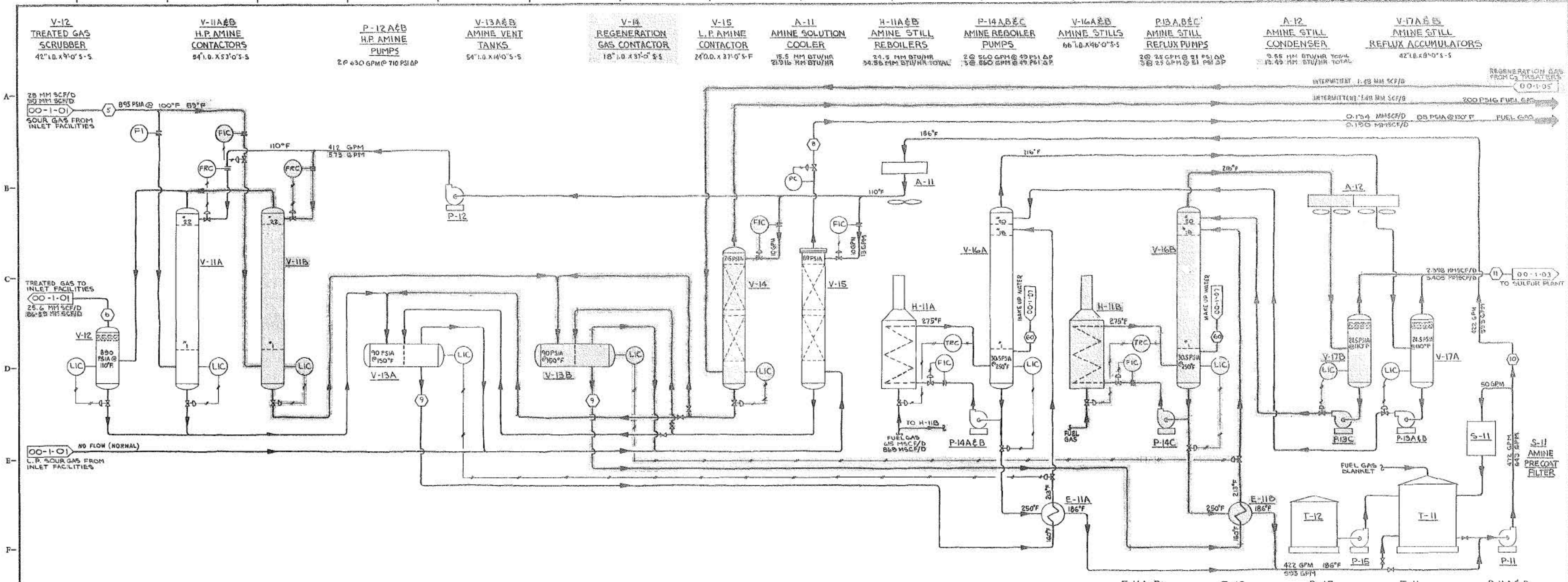
Stearns-Roger CORPORATION

ORDER NO. B-41449

DWG. NO. 22070

SHEET NO. 00-1-01

REV. △0



INITIAL MATERIAL BALANCE

STREAM NUMBER					(5)	(6)	(8)	(9)	(10)	(11)	(60)
COMP.	GAL/MOL	MOL. WT	T_c °R	P_c PSIA	SOUR GAS FEED	TREATED GAS TO FEED EXCHANGER	GAS FROM L.P. CONTACTOR	RICH AMINE FROM FLASH TANKS	LEAN AMINE (TOTAL)	ACID GAS TO SULFUR PLANT	MAKE-UP WATER
N_2	4.16	28.016	227.1	492.0	66	65				1	
CO_2	6.38	44.010	547.5	1,071.0	5,386	—		5386		5,386	
H_2S	5.17	34.076	672.4	1,306.0	590	—		590		590	
C_1	6.40	16.042	343.2	669.7	50,873	50,544	314	15		15	
C_2	9.56	30.068	549.8	708.3	6,781	6,766	13	1		1	
C_3	10.42	44.094	665.7	616.3	6,028	6,026	2				
IC_4	12.38	58.120	734.6	529.1	694	694					
NC_4	11.93	58.120	765.3	550.7	2,700	2,699	1				
IC_5	13.85	72.146	829.8	483.0	162	162					
NC_5	13.71	72.146	845.6	489.5	207	207					
C_6	15.57	86.172	914.1	440.0	185	185					
F-1	16.40	100.000	994.5	449.6	111	111					
DEA		105.14						13,037	13,037		
H_2O		18.0					22	228,410	228,454	328	312
TOTAL MOLS/DAY					73,785	67,460	352	247,447	241,491	6,321	372
LBS/HR					14,818	63,861	246	239,310	215,556	10,973	279
MOL. WT.					24.34	22.72	16.8			41.65	18.016
GALS/MIN (60°F)									422		0.6
LBS/GAL (60°F)									8.596		8.333
SP. GR (60°F)											
MSCF/D @ 16.696 PSIA & 60°F					28,000	25,600	134			2,398	
OPER TEMP °F					100	110	130	150	186	110	220-230
OPER PRESS PSIA					895	890	88	90	275	24.5	

ULTIMATE MATERIAL BALANCE

COMP.	(5) SOUR GAS FEED	(6) TREATED GAS TO FEED EXCHANGER	(8) GAS FROM L.P. CONTACTOR	(9) RICH AMINE FROM FLASH TANKS	(10) LEAN AMINE (TOTAL)	(11) ACID GAS TO SULFUR PLANT	(60) MAKE UP WATER
N_2	1,233	1,231		2		2	
CO_2	7,660	—		7,660		7,660	
H_2S	830	—		830		830	
C_1	185,955	185,489	446	20		20	
C_2	19,613	19,595	19	1		1	
C_3	13,376	13,373	3				
IC_4	1,755	1,755					
NC_4	5,004	5,008					
IC_5	498	498					
NC_5	498	498					
C_6	403	408					
F-1	332	331					
DEA				18,399	18,399		
H_2O			34	325,301	332,417	466	522
TOTAL MOLS/DAY	237,157	228,174	502	350,273	340,816	8,979	522
LBS/HR	212,300	196,725	361	340,578	372,000	15,592	392
MOL. WT.	21.484	20.69	16.8			41.68	18.016
GALS/MIN (60°F)					593		0.8
LBS/GAL (60°F)					8.596		8.333
SP. GR (60°F)							
MSCF/D	90,000	86,591	130		—	3,408	
OPER TEMP °F	89	110	130	160	186	110	220-230
OPER PRESS PSIA	895	890	88	90	275	24.5	

▒ INDICATES ULTIMATE CASE

REVISIONS

REFERENCE DRAWINGS

PRINT RECORD

INITIAL & ULTIMATE

PROCESS FLOW DIAGRAM
GAS TREATING
GAS PROCESSING STUDY

HUMBLE OIL AND REFINING COMPANY
SBC, CALIFORNIA

ENG. RECORD: DRAWN CG 6-24-71; PROCESS 7-26-71

DRAWING STATUS: DEVELOPMENT 1 2 3 — 7-21-71; PRELIMINARY ENGINEERING 4 5 6 — 8-27-71

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

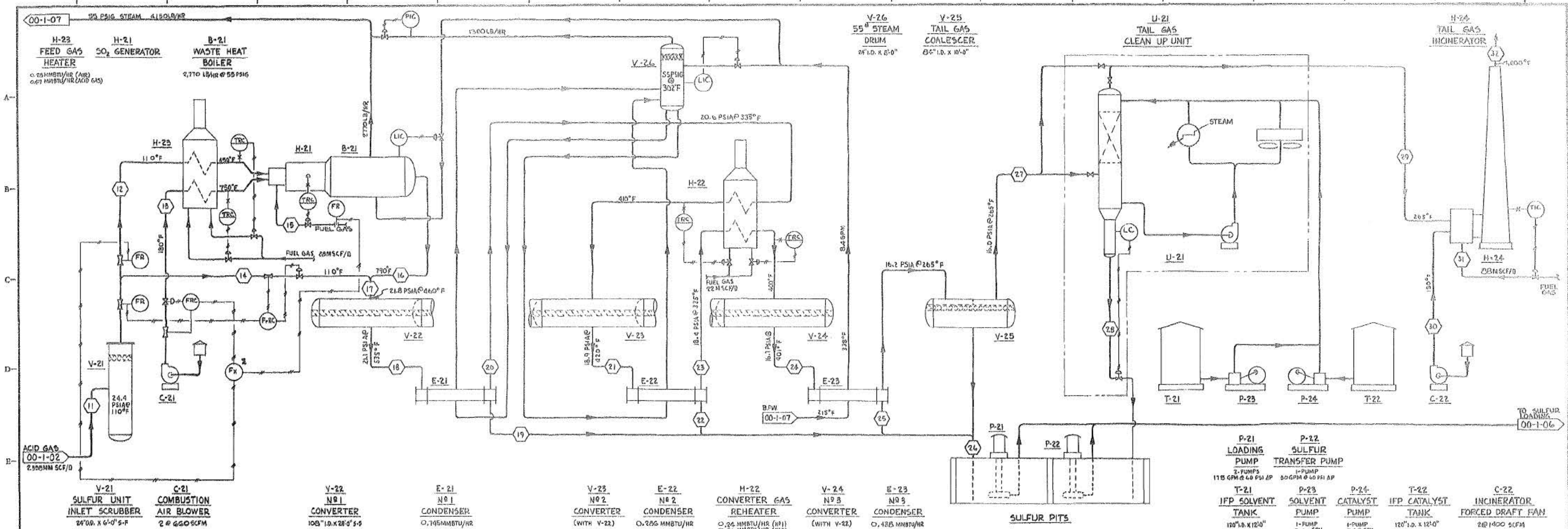
SCALE: NONE

Stearns-Roger CORPORATION

ORDER NO. B-41449

DWG. NO. 22070

SHEET NO. 00-1-02



INITIAL MATERIAL BALANCE

STREAM NUMBER			11	12	13	14	15	16	17	18	19	20
COMP.	MOL. WT.		ACID GAS FROM AMINE UNIT	ACID GAS TO SO_2 GENERATOR	AIR TO SO_2 GENERATOR	ACID GAS BYPASS	FUEL GAS TO SO_2 GENERATOR	SO_2 GENERATOR EFFLUENT	TOTAL VAPOR TO No 1 CONVERTER	EFFLUENT FROM No 1 CONVERTER	SULFUR FROM No 1 CONDENSER	VAPOR FROM No 1 CONDENSER TO REHEAT
H_2S	34.08		590	197		393			393	58		58
CO_2	44.01		5,386	1,795		3,591		1,881	5,472	5,472		5,472
SO_2	64.06							197	197	29		29
H_2O	18.02		328	109	72	219		540	759	1095		1095
O_2	32.00				464			1	1	1		1
N_2	28.02		1		1733	1		1733	1734	1734		1734
S_1 (L)	32.06									—	471	—
S_2 (V)	64.12									TRACE		—
S_6 (V)	192.36									29		TRACE
S_8 (V)	256.48									41		4
C_1	16.04		15	5		10	62		10	10		10
C_2	30.07		1	1			7					
C_3	44.09						1					
TOTAL MOLS/DAY			6,321	2,107	2,269	4,214	70	4,352	8566	8,469	471	8,403
LBS/HR			10,973	3,657	2,696	7,315	52	6,405	13,720	13,720	629	13,091
MOL. WT.			41.65	41.65	28.51	41.65	17.8	35.32	38.44	38.88	32.06	37.39
MMSCFD			2.398					1.652	3.251			
SCFM			1665	555	597	1110	19	1,147	2,258	2,232		2,215
OPER. TEMP. °F			110	110	180	110	100	790	460	535	335	335
OPER. PRESS PSIA			24.4	24.4	24.4	24.4	25.4	21.9	21.8	21.1	20.6	20.6

STREAM NUMBER		21	22	23	24	25	26	27	28	29	30	31	32
COMP.	MOL. WT.	EFFLUENT FROM No 2 CONVERTER	SULFUR FROM No 2 CONDENSER	VAPOR FROM No 2 CONDENSER TO REHEAT	EFFLUENT FROM No 3 CONVERTER	SULFUR FROM No 3 CONDENSER	TOTAL SULFUR FROM CLAUS UNIT	TAIL GAS TO CLEANUP UNIT	SULFUR FROM TAIL GAS UNIT	TAIL GAS TO STACK	AIR TO INCINERATOR	FUEL GAS TO INCINERATOR	INCINERATOR OUTLET GAS
H_2S	34.08	18		18	14			14		4			—
CO_2	44.01	5,472		5,472	5,472			5,472		5,472			5,743
SO_2	64.06	9		9	7			7		2			6
H_2O	18.02	1135		1135	1139			1139		1145	103		1,769
O_2	32.00	1		1	1			1		1	665		132
N_2	28.02	1734		1734	1734			1734		1734	2501		4,235
S_1 (L)	32.06	—	60	—	—	30	561		23				
S_2 (V)	64.12	TRACE			TRACE								
S_6 (V)	192.36	5		TRACE	1			TRACE					
S_8 (V)	256.48	8		4	4			1		TRACE			
C_1	16.04	10		10	10			10		10		206	
C_2	30.07											23	
C_3	44.09											3	
TOTAL MOLS/DAY		8,392	60	8,383	8,382	30	561	8,378	23	8,372	3,269	232	11,885
LBS/HR		13,091	80	13,011	13,011	40	749	12,971	31	12,940	3,884	172	16,996
MOL. WT.		37.44	32.06	37.25	37.25	32.06	32.06	37.16	32.06	37.10	28.51	17.8	34.32
MMSCFD										3.177		0.088	4.510
SCFM		2,212		2,209	2,209	—	—	2,208	—	2,206	862	61	3,132
OPER. TEMP. °F		420	335	395	401	265	265	265	265	265	180	100	1,000
OPER. PRESS PSIA		18.9	18.4	18.4	16.7	16.2	—	16.0	16.0	15.0	15.0	15.0	14.7

INITIAL ONLY

FOR ULTIMATE SEE 00-1-03 ULTIMATE

NO.	REVISIONS	DATE	BY	CHK'D	APP'D

NO.	REFERENCE DRAWINGS

PRINT RECORD: DATE / FOR / REVISED / CUSTOMER / FIELD / INTRA CO.

ENG. RECORD		
DRAWN	DES	6-24-71
CHECKED		
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		
PROCESS		

DRAWING STATUS	ISSUE No	DATE
DEVELOPMENT	1 2 3 X	7-22-71
PRELIMINARY ENGINEERING	4 5 6	8-27-71
APPROVED FOR CONSTRUCTION		
REVISED & APPROVED FOR CONSTRUCTION		

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

PROCESS FLOW DIAGRAM
SULFUR RECOVERY
GAS PROCESSING STUDY
HUMBLE OIL AND REFINING COMPANY
SBC, CALIFORNIA

SCALE: NONE

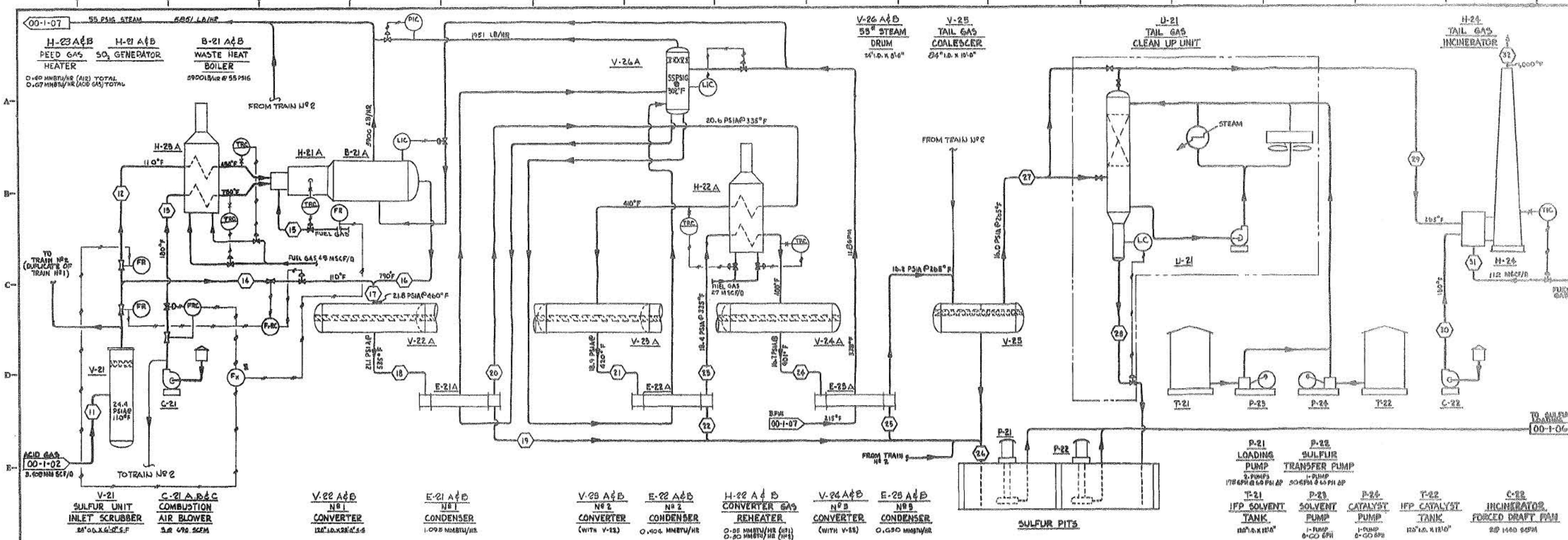
Stearns-Roger CORPORATION

SPEC. NO. 22070

DWG. NO. 00-1-03 INITIAL

ORDER NO. B-41119

REV.



ULTIMATE MATERIAL BALANCE

STREAM NUMBER		(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
COMP.	MOL. WT.	ACID GAS FROM AMINE UNIT	ACID GAS TO SO_2 GENERATOR	AIR TO SO_2 GENERATOR	ACID GAS BYPASS	FUEL GAS TO SO_2 GENERATOR	SO_2 GENERATOR EFFLUENT	TOTAL VAPOR TO Nº1 CONVERTER	EFFLUENT FROM Nº1 CONVERTER	SULFUR FROM Nº1 CONDENSER	VAPOR FROM Nº1 CONDENSER TO REHEAT
H_2S	34.08	890	277		553		—	553	84		84
CO_2	44.01	7,660	2,553		5,107		2658	7,765	7,765		7,765
SO_2	64.06	—					277	277	42		42
H_2O	18.02	466	155	97	311		728	1,039	1,509		1,509
O_2	32.00	—		622			1	1	1		1
N_2	28.02	2	1	2,334	1		2,335	2,336	2,336		2,336
S_1 (L)	32.06								—	656	—
S_2 (V)	64.12								TRACE		—
S_6 (V)	192.36								41		TRACE
S_8 (V)	256.48								57		6
C_1	16.04	20	7		13	77		13	13		13
C_2	30.07	1			1	9		1	1		1
C_3	44.09					1					
TOTAL MOLS/DAY		8,979	2,993	3,063	5,986	87	5,999	11,985	11,849	656	11,757
LBS/HR		15,592	5,197	3,627	10,395	65	8,889	19,284	19,284	876	18,408
MOL. WT.		41.68	41.68	28.51	41.68	17.0	35.56	38.61	39.05	32.06	37.57
MMSCFD		3.405	1.135	1.159	2.270	.033	2.277				
SCFM		2,365	788	805	1577	23	1,581	3,169	3,123	—	3,098
OPER. TEMP. °F		110	110	180	110	110	790	460	585	335	335
OPER. PRESS PSIA		24.4	24.4	24.4	24.4	23.4	21.9	21.8	21.1	20.6	20.6

STREAM NUMBER		(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)
COMP.	MOL. WT.	EFFLUENT FROM Nº2 CONVERTER	SULFUR FROM Nº2 CONDENSER	VAPOR FROM Nº2 CONDENSER TO REHEAT	EFFLUENT FROM Nº3 CONVERTER	SULFUR FROM Nº3 CONDENSER	TOTAL SULFUR FROM CLAUS UNIT	TAIL GAS TO CLEANUP UNIT	SULFUR FROM TAIL GAS UNIT	TAIL GAS TO STACK	AIR TO INCINERATOR	FUEL GAS TO INCINERATOR	INCINERATOR OUTLET GAS
H_2S	34.08	26		26	18			18		4			—
CO_2	44.01	7,765		7,765	7,765			7,765		7,765			8,106
SO_2	64.06	13		13	9			9		2			6
H_2O	18.02	1,567		1,567	1,575			1,575		1,589	135		2,974
O_2	32.00	1		1	1			1		1	871		202
N_2	28.02	2,336		2,336	2,336			2,336		2,336	3,276		5,612
S_1 (L)	32.06	—	87	—	—	52	795	—	29	—			
S_2 (V)	64.12	1		—	TRACE			—		—			
S_6 (V)	192.36	6		TRACE	2			TRACE		—			
S_8 (V)	256.48	12		6	6			1		TRACE			
C_1	16.04	13		13	13			13		13		259	
C_2	30.07	1		1	1			1		1		29	
C_3	44.09											3	
TOTAL MOLS/DAY		11,741	87	11,728	11,726	52	795	11,719	29	11,711	4,282	291	16,300
LBS/HR		18,408	116	18,292	18,292	70	1062	18,222	59	18,183	5,087	215	23,485
MOL. WT.		37.62	32.06	37.43	37.43	32.06	32.06	37.31	32.06	37.26	28.81	17.8	34.58
MMSCFD								4.45		4.444	1.625	0.112	
SCFM		3,094	—	3,091	3,090	—	—	3,088	—	3,086	1,128	77	4,296
OPER. TEMP. °F		420	335	335	401	265	265	265	265	265	180	100	1,000
OPER. PRESS PSIA		18.9	18.4	18.4	16.7	16.2	—	16.0	16.0	15.0	15.0	15.0	14.7

ULTIMATE ONLY

NOTES:
MATERIAL BALANCE FIGURES, FLOWS, AND DUTIES ARE TOTAL FOR TWO TRAINS.
FOR INITIAL CASE SEE 00-1-03 INITIAL.

REVISIONS | REFERENCE DRAWINGS | PRINT RECORD

ENG. RECORD: DRAWN DES 6-29-71; CHECKED; MECH. CH.; STRUCT. CH.; ELECT. CH.; PIPING CH.; PROCESS 7-14-71

DRAWING STATUS: DEVELOPMENT 1 2 3 X 7-22-71; PRELIMINARY ENGINEERING 4 5 6 8-27-71; APPROVED FOR CONSTRUCTION; REVISED & APPROVED FOR CONSTRUCTION 0

PROCESS FLOW DIAGRAM
SULFUR RECOVERY
GAS PROCESSING STUDY
HUMBLE OIL AND REFINING COMPANY
SBC, CALIFORNIA

SCALE NONE

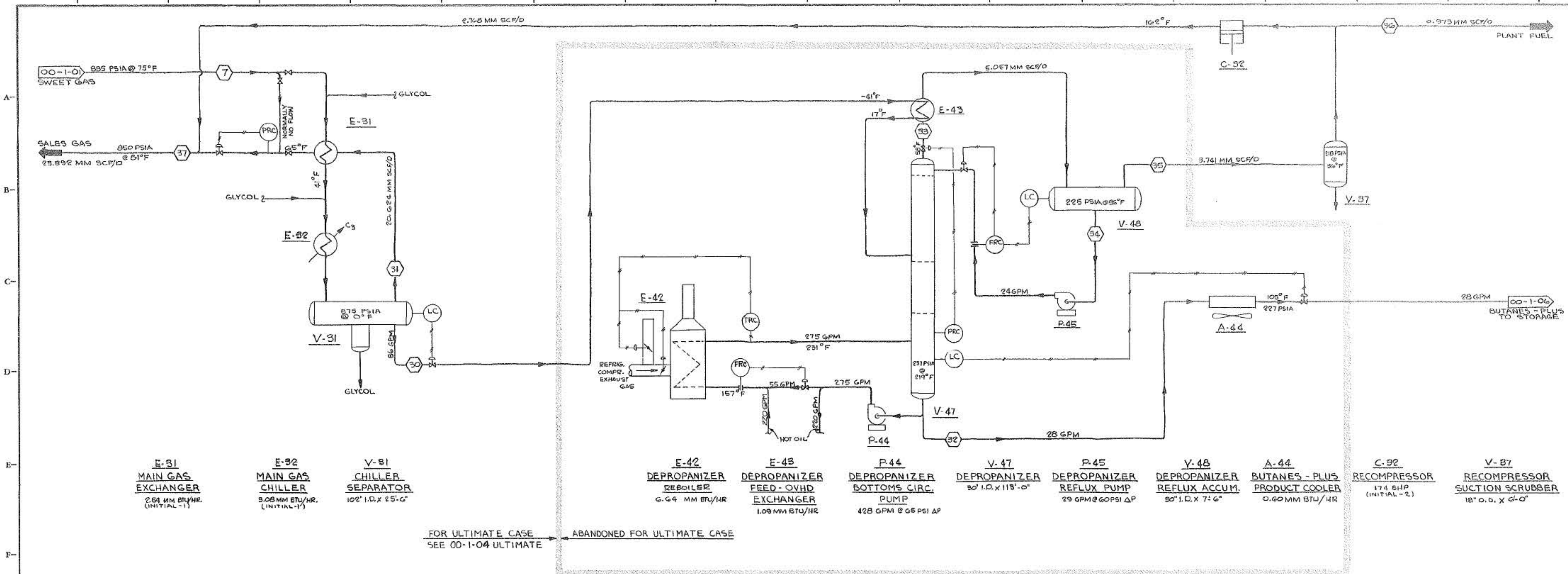
Stearns-Roger CORPORATION

22070

8-41449

00-1-03 ULTIMATE

REV. 0



MATERIAL BALANCE

STREAM NUMBER					7			30	31	32	33	34	35	36	37
					SWEET GAS To H.C. RECOVERY UNIT			CHILLER SEPARATOR		DEPROPANIZER					
COMP.	GAL/MOL	MOL. WT.	T_c °R	P_c PSIA	FEED	LIQUID	VAPOR	LIQUID	VAPOR	BOTTOMS	TOTAL OVHD	REFLUX	ACCUM OHV	PLANT FUEL	SALES GAS
N_2	4.16	28.016	227.1	492.0	66		66	2	64		2		2	1	65
C_1	6.40	16.042	343.2	669.7	50,544	154	50,390	4,471	46,073		4,631	160	4471	1,163	49,381
C_2	9.56	30.068	549.8	708.3	6,766	83	6,683	2,058	4,708		2,542	484	2,058	535	6,231
C_3	10.42	44.094	665.7	616.3	6,026	169	5,857	3,398	2,628	98	6,064	2,764	3,300	858	5,070
IC_4	12.38	58.120	734.6	529.1	694	32	662	493	201	473	61	41	20	5	216
NC_4	11.93	58.120	765.3	550.7	2699	158	2,541	2,080	619	2,074	26	20	6	2	623
IC_5	13.85	72.146	829.8	483.0	162	16	146	142	20	142					20
NC_5	13.71	72.146	845.6	489.5	207	23	184	185	22	185					22
C_6	15.57	86.172	914.1	440.0	185	35	150	177	8	177					8
F-1	16.40	100.000	984.5	449.6	111	40	71	109	2	109					2
TOTAL MOLS / DAY					67,460	710	66,750	13,116	54,345	3,258	13,326	3,469	9,857	2,564	61,638
LBS/HR					63,862	1,387	62,475	20,116	43,746	8,421	17,654	5939	11,695	3,042	52,999
MOL. WT.					22.72	46.89	22.46	36.81	19.32	62.03	31.76	41.09	28.48	28.48	20.40
GALS/MIN (60°F)						5		86		28		24			
LBS/GAL (60°F)						4.404		3.904		4.970		4.050			
SP. GR. (60°F)						0.528		0.468		0.596		0.486			
MSCF/D					25,601		25,392		20,624		5057		3,741	973	23,392
OPER. TEMP. °F					75	75	75	0	0	219	58	36	36	36	81
OPER. PRESS. PSIA					885	885	885	875	875	237	231	225	225	218	850

INITIAL ONLY

NO.	REVISIONS	DATE	BY	CH'D	APP'D	NO.	REFERENCE DRAWINGS

PRINT RECORD: DATE / FOR / REVISED / CUSTOMER / FIELD / INTRA CO.

ENG. RECORD		
DRAWN	ef	7-14-71
CHECKED		
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		
PROCESS	[signature]	7-28-71

DRAWING STATUS					
DRAWING	ISSUE NO.				DATE
DEVELOPMENT	1	2	3	X	7-21-71
PRELIMINARY ENGINEERING	4	5	6		8-27-71
APPROVED FOR CONSTRUCTION					
REVISED & APPROVED FOR CONSTRUCTION	REV.				

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

PROCESS FLOW DIAGRAM
HYDROCARBON RECOVERY
GAS PROCESSING STUDY

HUMBLE OIL AND REFINING COMPANY
SBC, CALIFORNIA

SCALE NONE

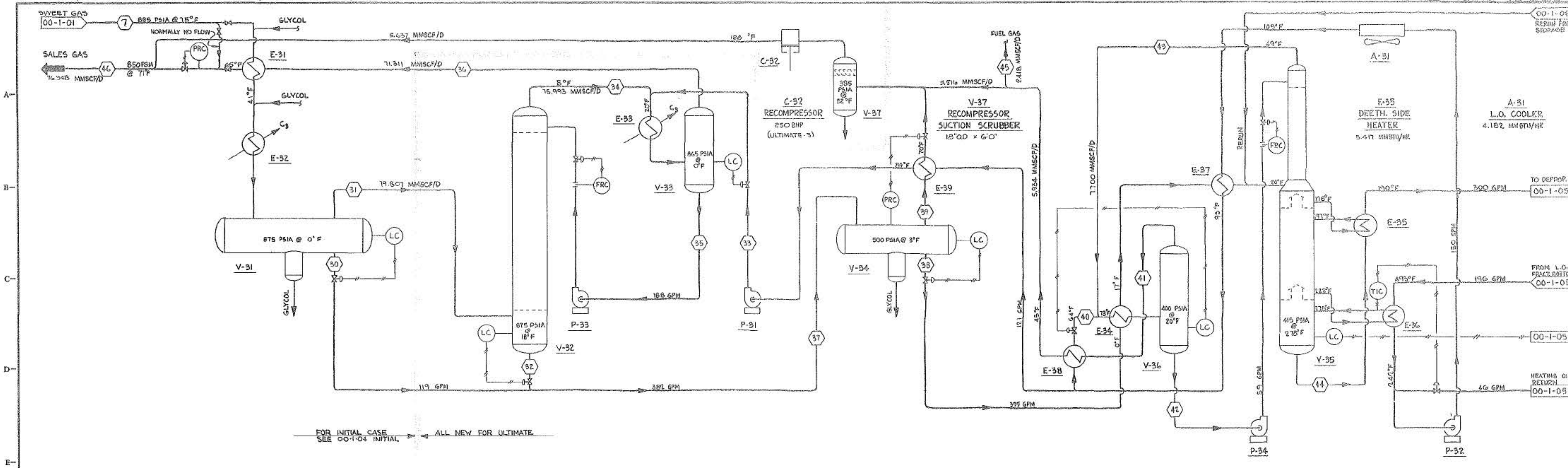
Stearns-Roger CORPORATION

ORDER NO. 8-41449

DWG. NO. 22070

SHEET NO. 00-1-04 INITIAL

REV. 0



E-31 MAIN GAS EXCHANGER	E-32 MAIN GAS CHILLER	V-31 CHILLER SEPARATOR	V-32 ABSORBER	P-33 ABSORBER PRESAT. PUMP	E-33 ABSORBER PRESAT. CHILLER	V-33 ABSORBER PRESAT. SEPARATOR	P-31 H.P. LEAN OIL PUMP	V-34 R.O. FLASH TANK	E-39 R.O. FLASH TANK VAPOR HEATER	E-38 DEETH. RESIDUE GAS HEATER	E-34 DEETH. PRESAT. EXCHANGER	V-36 DEETH. PRESAT. SEPARATOR	E-37 DEETH. FEED HEATER	P-34 DEETH. PRESAT. PUMP	V-35 DEETHANIZER	P-32 L.P. LEAN OIL PUMP	E-36 DEETH. REBOILER
6.086 MMBTU/HR (ULTIMATE-2)	8.262 MMBTU/HR (ULTIMATE-2)	102" I.D. × 25'-6"	54" I.D. × 57'-0"	222 GPM @ 50 PSI ΔP	4.087 MMBTU/HR	60" I.D. × 15'-0"	142 GPM @ 470 PSI ΔP	60" I.D. × 17'-0"	0.156 MMBTU/HR	0.172 MMBTU/HR	1.352 MMBTU/HR	48" I.D. × 12'-0"	0.248 MMBTU/HR	71 GPM @ 45 PSI ΔP	30"/66" I.D. × 125'-0"	195 GPM @ 385 PSI ΔP	11.881 MMBTU/HR

MATERIAL BALANCE

STREAM NUMBER					(7)			(30)	(31)	(32)	(33)
					SWEET GAS TO H.C. RECOVERY UNIT			MAIN GAS CHILLER SEPARATOR		ABSORBER	
COMP.	GAL/MOL	MOL. WT.	T_c °R	P_c PSIA	FEED	LIQUID	VAPOR	LIQUID	VAPOR	RICH OIL	LEAN OIL
N_2	4.16	28.016	227.1	492.0	1,233			16	1,217	15	
CO_2	6.38	44.010	547.5	1071.0							
H_2S	5.17	34.076	672.4	1306.0							
C_1	6.40	16.042	343.2	669.7	185,489			6,132	179,357	8,120	
C_2	9.56	30.068	549.8	708.3	19,593			2,616	16,877	3,929	
C_3	10.42	44.094	665.7	616.3	13,373			4,187	9,186	6,778	
IC_4	12.38	58.120	734.6	529.1	1,755			814	941	936	
NC_4	11.93	58.120	765.3	550.7	5,003			2,713	2,290	2,289	
IC_5	13.85	72.146	829.8	483.0	498			358	140	140	
NC_5	13.71	72.146	845.6	489.5	498			371	127	127	
C_6	15.57	86.172	914.1	440.0	403			359	44	44	
F-1	16.40	100.000	994.5	449.6	331			315	16	19	3
F-2	18.78	111.800	1025.8	373.3						20	20
F-3	19.97	123.900	1088.3	347.0						1,091	1,094
F-4	22.27	140.000	1151.6	293.7						5,548	5,552
F-5	22.69	145.500	1170.0	296.8						715	716
F-6	26.04	170.000	1216.6	272.4						478	478
TOTAL MOLS/DAY					228,176			17,881	210,295	30,249	7,863
LBS/HR					196,125			28,421	168,304	77,479	45,867
MOL. WT.					20.69			38.15	19.21	61.47	140.00
GALS/MIN (60°F)								119		263	121
LBS/GAL (60°F)								3.984		4.917	6.304
SP. GR. (60°F)								0.478		0.590	0.756
MSCF/D					86,591				19,807		
OPER. TEMP. °F					75			0	0	18	89
OPER. PRESS. PSIA					885			875	875	875	888

STREAM NUMBER	(34)	(35)	(36)	(37)	(38)	(39)	(40)	(41)	(42)	(43)	(44)	(45)	(46)
	ABSORBER			RICH OIL FLASH TANK			DEETHANIZER PRESAT. SEPARATOR			DEETHANIZER			
COMP.	OVHD. VAPOR	PRESAT. OIL	RESIDUE	INLET	LIQUID	VAPOR	LEAN OIL	VAPOR	PRESAT. OIL	RESIDUE	BOTTOMS	FUEL GAS	SALES GAS
N_2	1,216	14	1,202	31	10	21		10	TRACE	10		4	1,229
CO_2													
H_2S													
C_1	178,576	7,339	171,237	14,252	9,402	4,850		9,402	744	10,140		8,831	181,658
C_2	16,061	3,013	13,048	6,545	6,078	467		5,768	3,002	8,770	310	2,351	16,932
C_3	4,362	1,954	2,408	10,865	10,157	208		457	907	1,364	10,300	186	2,887
IC_4	15	10	9	1,750	1,736	14		TRACE	TRACE	TRACE	1,736	TRACE	19
NC_4	4	3	1	5,006	4,976	26		TRACE	TRACE	TRACE	4,976	TRACE	27
IC_5				498	497	1					497		1
NC_5				498	497	1					497		1
C_6				403	403	TRACE					403		TRACE
F-1		3		334	334	TRACE	1		1		335		TRACE
F-2	TRACE	20	TRACE	20	20		6	TRACE	6	TRACE	26	TRACE	TRACE
F-3	4	1,095	3	1,091	1,091		259	TRACE	259	TRACE	1,350	TRACE	3
F-4	6	5,554	14	5,548	5,548		1,316	TRACE	1,317	1	6,864	TRACE	4
F-5	1	716	1	715	715		170	TRACE	170	TRACE	885	TRACE	1
F-6	TRACE	478	TRACE	478	478		114	TRACE	114	TRACE	592	TRACE	TRACE
TOTAL MOLS/DAY	200,245	20,199	187,909	48,130	42,542	5,588	1,866	15,637	6,520	20,891	28,771	6,372	202,762
LBS/HR	149,027	58,202	136,692	105,900	101,564	4,336	10,884	14,362	16,815	20,893	98,086	5,852	149,538
MOL. WT.	17.86	69.15	17.46	52.81	57.30	18.62	140.00	22.04	61.89	24.00	81.82	22.04	17.70
GALS/MIN (60°F)		188		382	355		29		59		300		
LBS/GAL (60°F)		5.154		4.626	4.769		6.304		4.783		5.444		
SP. GR. (60°F)		0.618		0.555	0.572		0.756		0.574		0.653		
MSCF/D	75,993		71,311			2,121		5,934		7,700		2,418	76,948
OPER. TEMP. °F	5	0	0	3	3	3	64	20	20	49	278	45	71
OPER. PRESS. PSIA	871	865	865	500	500	500	410	400	400	410	416	385	850

ULTIMATE ONLY

NO.	REVISIONS	DATE	BY	CH'D	APP'D

NO.	REFERENCE DRAWINGS

PRINT RECORD: DATE / FOR / REVISED / CUSTOMER / FIELD / INTRA CO.

ENG. RECORD		
DRAWN	DES	6-24-71
CHECKED		
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		
PROCESS		

DRAWING STATUS	ISSUE NO.	DATE
DEVELOPMENT	1 2 3 X	7-20-71
PRELIMINARY ENGINEERING	4 5 6	8-27-71
APPROVED FOR CONSTRUCTION		
REVISED & APPROVED FOR CONSTRUCTION		

PROCESS FLOW DIAGRAM
HYDROCARBON RECOVERY
(ULTIMATE CASE)
GAS PROCESSING STUDY

HUMBLE OIL AND REFINING COMPANY
SBC, CALIFORNIA

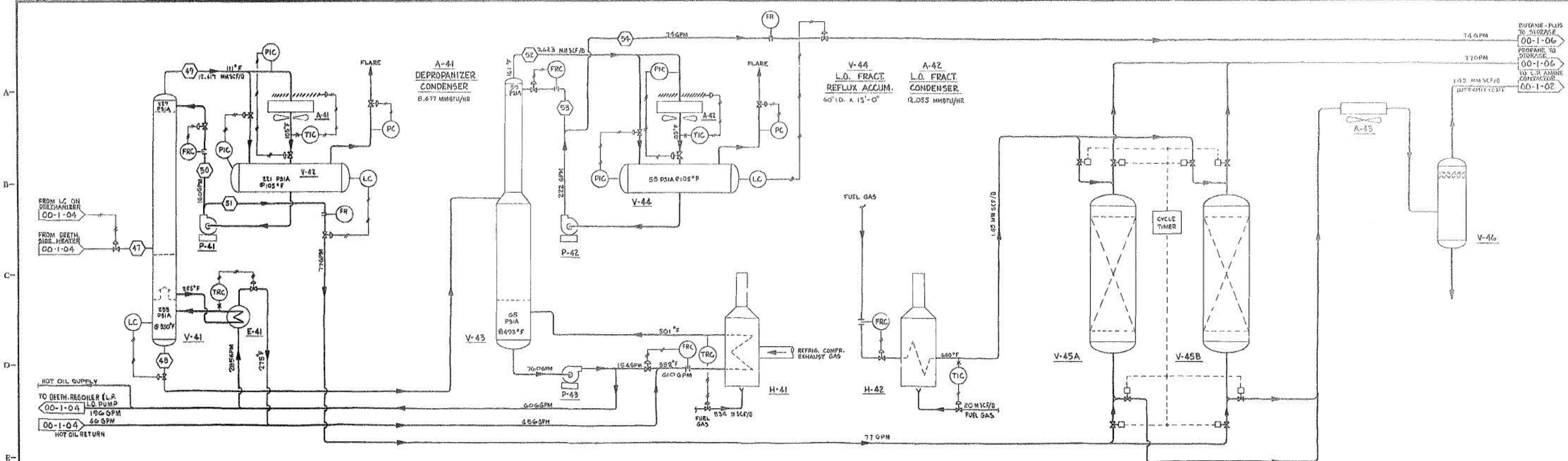
SCALE: NONE

Stearns-Roger CORPORATION

ORDER NO. 8-41449

DWG. NO. 22070

SHEET NO. 00-1-04 ULTIMATE



V-41 DEPROPANIZER 54" I.D. x 88'0"

P-41 DEPROPANIZER REFLUX PUMP 210 GPM @ 70 PSI ΔP

E-41 DEPROPANIZER REBOILER 15.346 MMBTU/HR

V-42 DEPROPANIZER REFLUX ACCUM. 60" I.D. x 17'-0"

V-43 LEAN OIL FRACTIONATOR 54" & 78" I.D. x 98'-0"

P-42 L.O. FRACT. REFLUX PUMP 293 GPM @ 60 PSI ΔP

P-43 L.O. FRACT. BOTTOMS PUMP 1500 GPM @ 65 PSI ΔP

H-41 L.O. FRACT. REBOILER 35.310 MMBTU/HR

H-42 REGEN. GAS HEATER 0.642 MMBTU/HR

V-45A & B PRODUCT TREATERS 54" I.D. x 24'-0"

A-43 REGEN. GAS COOLER 0.865 MMBTU/HR

V-46 REGEN. GAS SCRUBBER 36" I.D. x 9'-0"

MATERIAL BALANCE

STREAM NUMBER					47	48	49	50	51		52	53	54	
					DEPROPANIZER					LEAN OIL FRACTIONATOR				
COMP.	GAL/MOL	MOL. WT.	T_c °R	P_c PSIA	FEED	BOTTOMS	TOTAL OVHD.	REFLUX	TOP PRODUCT	BOTTOMS	TOTAL OVHD.	REFLUX	TOP PRODUCT	LEAN OIL MAKEUP TO BALANCE
N_2	4.16	28.016	227.1	492.0										
CO_2	6.38	44.010	547.5	1071.0										
H_2S	5.17	34.076	672.4	1306.0										
C_1	6.40	16.042	343.2	669.7										
C_2	9.56	30.068	549.8	708.3	310		956	646	310					
C_3	10.42	44.094	665.7	616.3	10,300	62	31,601	21,363	10,238		186	124	62	
IC_4	12.38	58.120	734.6	529.1	1,736	1688	148	100	48		5064	3376	1,688	
NC_4	11.93	58.120	765.3	550.7	4,976	4971	15	10	5		14913	9942	4,971	
IC_5	13.85	72.146	829.8	483.0	497	497					1491	994	497	
NC_5	13.71	72.146	845.6	489.5	497	497					1491	994	497	
C_6	15.57	86.172	914.1	440.0	403	403					1209	806	403	
F-1	16.40	100.000	994.5	449.6	335	335				4	993	662	331	
F-2	18.78	111.800	1025.8	378.3	26	26				23	9	6	3	3
F-3	19.97	123.900	1,088.3	347.0	1,350	1350				1350				3
F-4	22.27	140.000	1,151.6	293.7	6864	6864				6864				4
F-5	22.69	145.500	1,170.0	296.8	885	885				885				1
F-6	24.04	170.000	1,216.6	272.4	592	592				592				
TOTAL MOLS/DAY					28,771	18,170	32,720	22,119	10,601	9,718	25,356	16,904	8,452	11
LBS/HR					98,086	78,760	59,650	40,324	19,326	56,692	66,204	44,136	22,068	
MOL. WT.					81.82	104.03	43.75	43.75	43.75	140.01	62.66	62.66	62.66	
GALS/MIN (60°F)					300	224		160	77	150		148	74	0.16
LBS/GAL (60°F)					5.444	5.868		4.205	4.205	6.304		4.982	4.982	
SP. GR. (60°F)					0.653	0.704		0.504	0.504	0.756		0.597	0.597	
MSCF/D							12,417				9623			
OPER. TEMP. °F					190	350	111	105	105	493	161	105	105	
OPER. PRESS. PSIA					250	255	227	291	291	65	59	113	113	

NO.	REVISIONS	DATE	BY	CH'D	APP'D	NO.	REFERENCE DRAWINGS

PRINT RECORD: DATE / FOR / REVISED / CUSTOMER / FIELD / INTRA CO.

ENG. RECORD		
DRAWN	DES	6-24-71
CHECKED		
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		
PROCESS	IAS	7-21-71

DRAWING STATUS	ISSUE No	DATE
DEVELOPMENT	1 2 3 ☒	7-20-71
PRELIMINARY ENGINEERING	4 5 6	8-21-71
APPROVED FOR CONSTRUCTION	☐	
REVISED & APPROVED FOR CONSTRUCTION	REV. 0	

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

ULTIMATE ONLY

PROCESS FLOW DIAGRAM
FRACTIONATION
(ULTIMATE CASE)
GAS PROCESSING STUDY

HUMBLE OIL AND REFINING COMPANY
SBC, CALIFORNIA

SCALE: NONE

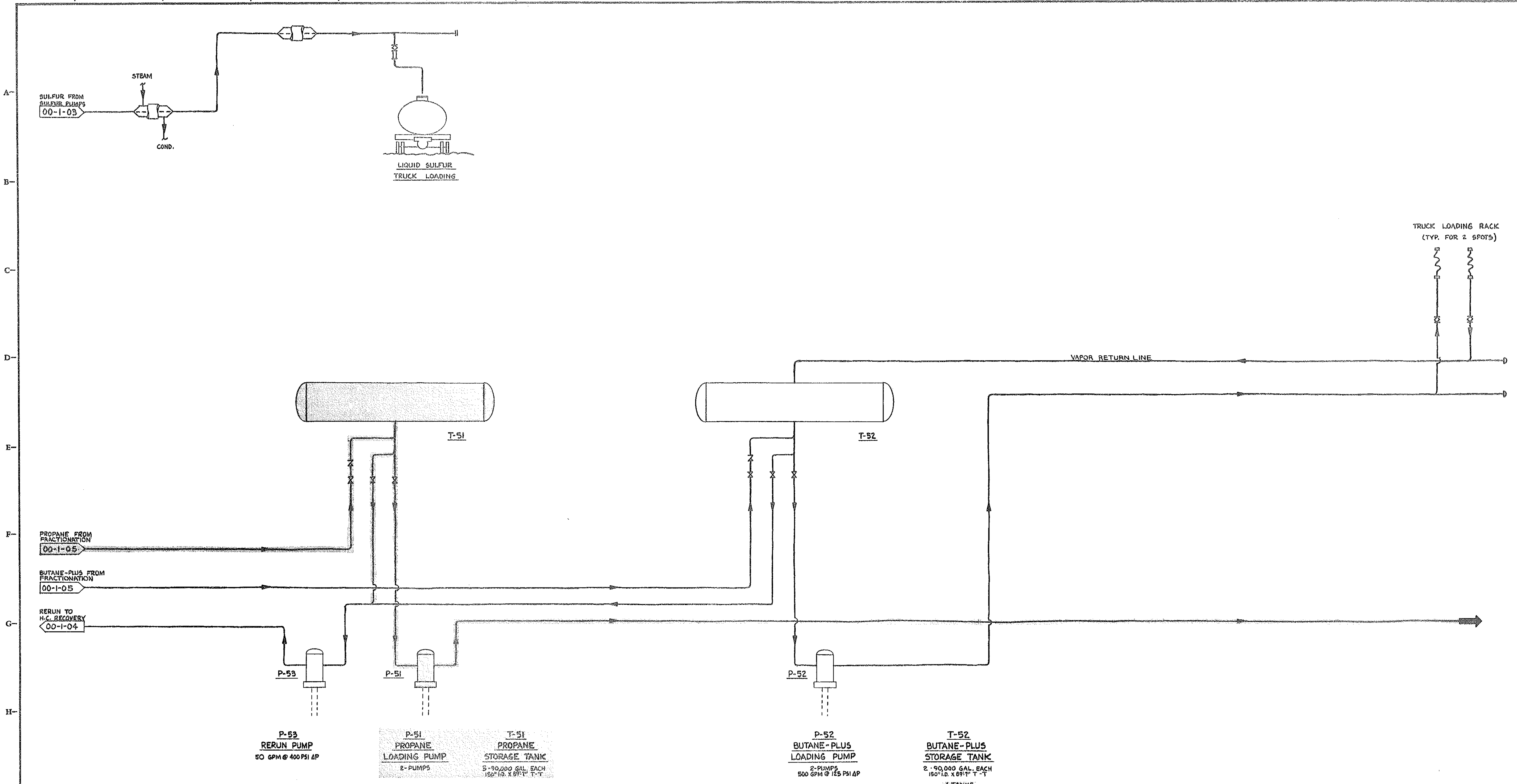
Stearns-Roger Corporation

ORDER NO. 8-41449

DWG. NO. 22070

SHEET NO. 00-1-05 ULTIMATE

REV. 0



= ULTIMATE CASE

INITIAL & ULTIMATE

NO.	REVISIONS	DATE	BY	CK'D	APP'D

NO.	REFERENCE DRAWINGS

PRINT RECORD: DATE / FOR / REVISED / CUSTOMER / FIELD / INTRA CO.

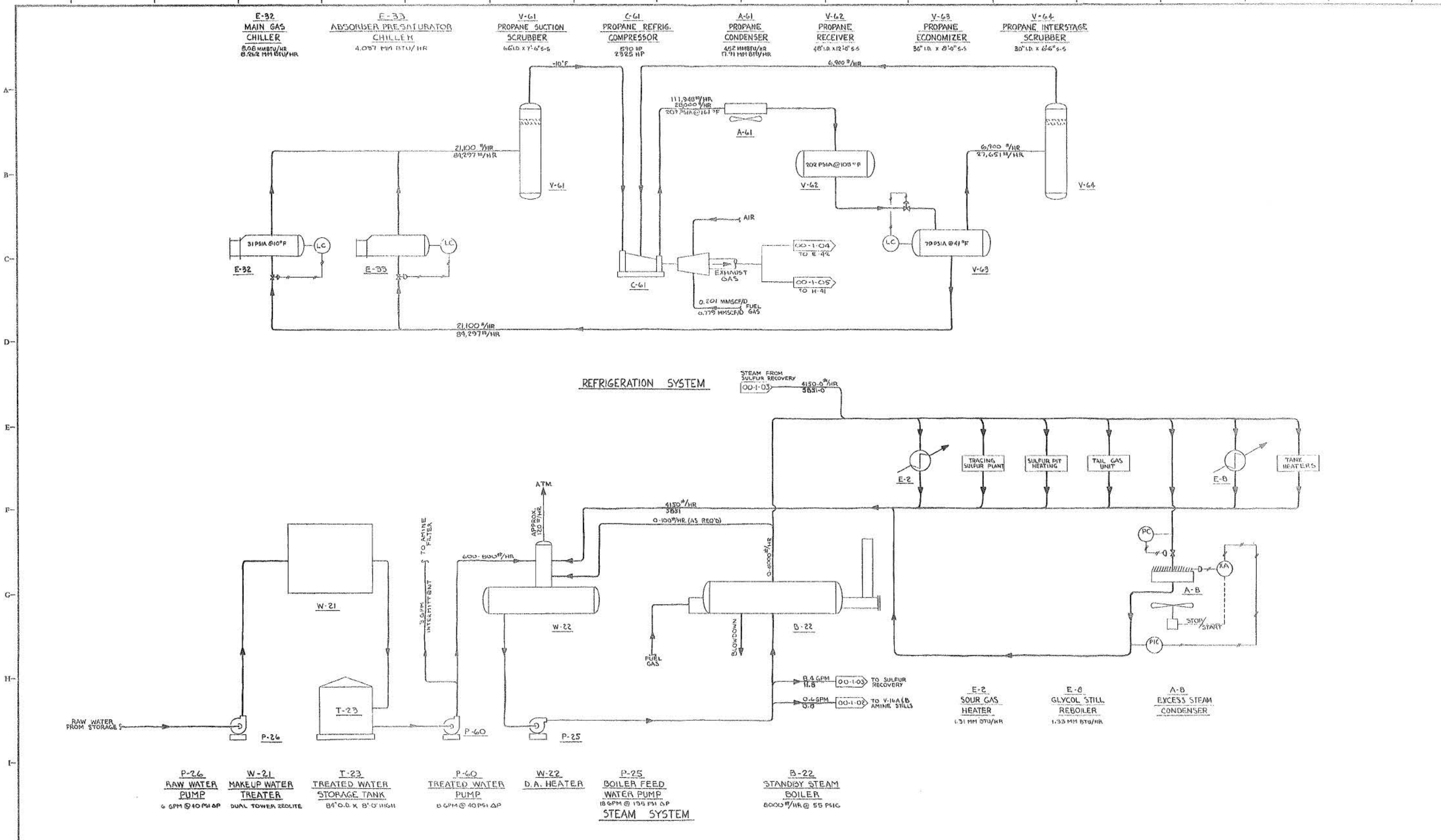
ENG. RECORD		
DRAWN	DES	6-24-71
CHECKED		
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		
PROCESS		7-28-71

DRAWING STATUS					
DRAWING	ISSUE NO.				DATE
DEVELOPMENT	1	2	3	X	7-22-71
PRELIMINARY ENGINEERING	4	5	6		8-27-71
APPROVED FOR CONSTRUCTION					
REVISED & APPROVED FOR CONSTRUCTION	REV. 0				

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

PROCESS FLOW DIAGRAM
STORAGE AND SHIPPING
GAS PROCESSING STUDY
HUMBLE OIL AND REFINING COMPANY
SBC, CALIFORNIA

SCALE: NONE
Stearns-Roger Corporation
ORDER NO. B-41449
DWG. NO. 22070
SHEET NO. 00-1-06
REV. 0



INITIAL & ULTIMATE

ULTIMATE CASE

NO.	REVISIONS	DATE	BY	CH'D	APP'D

REFERENCE DRAWINGS

PRINT RECORD: DATE / FOR / REVISED / CUSTOMER / FIELD / INTRA CO.

ENG. RECORD		
DRAWN	DES	6-24-71
CHECKED		
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		
PROCESS		

DRAWING STATUS		
DRAWING	ISSUE NO.	DATE
DEVELOPMENT	1 2 3	6-24-71
PRELIMINARY ENGINEERING	4 5 6	
APPROVED FOR CONSTRUCTION		
REVISED & APPROVED FOR CONSTRUCTION	0 REV.	

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

PROCESS FLOW DIAGRAM
STEAM AND REFRIGERATION
ALTERNATE CASE
GAS PROCESSING STUDY

HUMBLE OIL AND REFINING COMPANY
SBC, CALIFORNIA

SCALE NONE

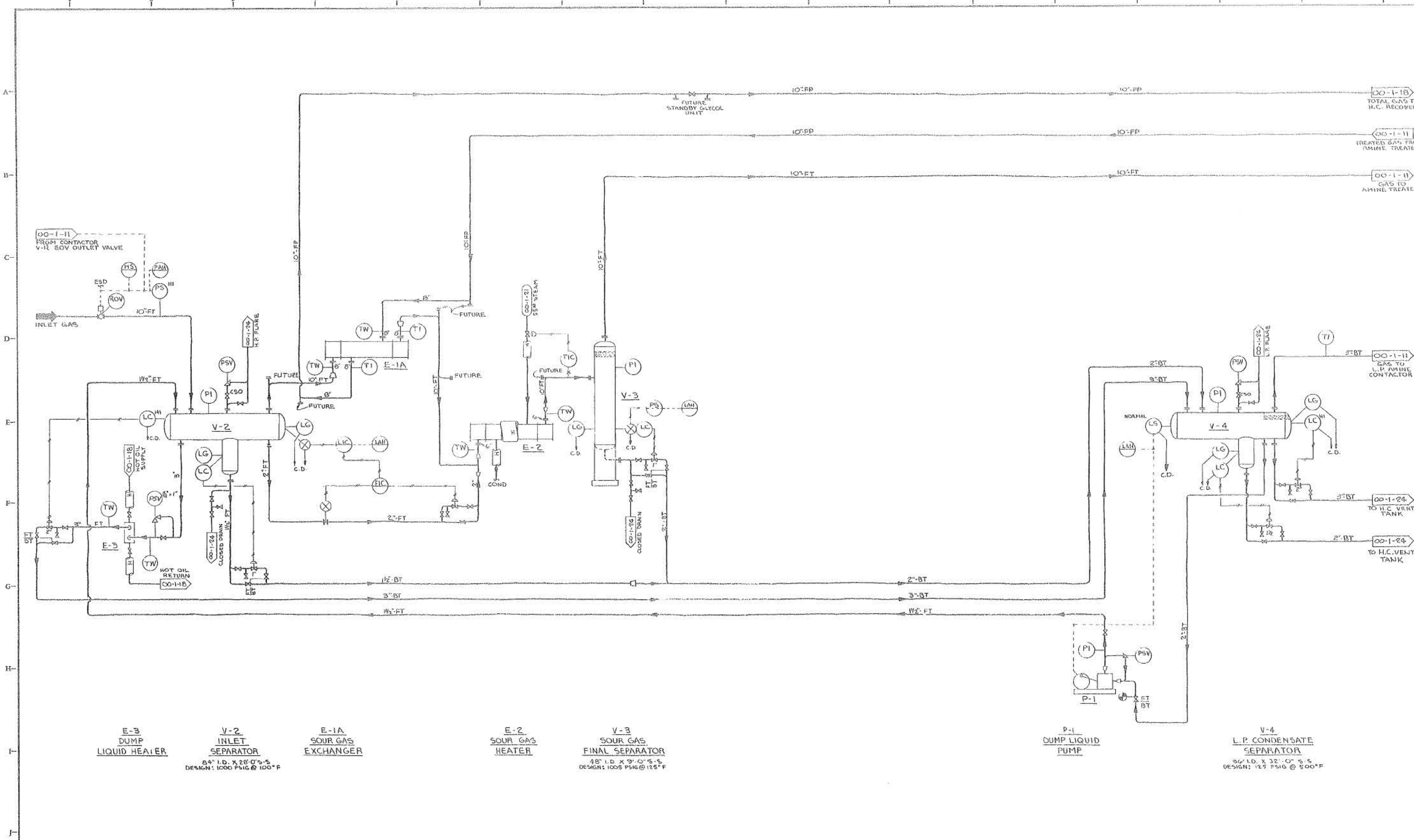
Stearns-Roger CORPORATION

ORDER NO. D-41899

DWG. NO. 22070

SHEET NO. 00-1-07

REV.



NO.	REVISIONS	DATE	BY	CHK'D	APP'D	NO.	REFERENCE DRAWINGS

PRINT RECORD: DATE / FOR / REVISED / CUSTOMER / FIELD / INTRA CO.

ENG. RECORD		
DRAWN	clf	7-12-71
CHECKED		
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		
PROCESS	[illegible]	7/1/71

DRAWING STATUS					
DRAWING	ISSUE NO				DATE
DEVELOPMENT	1	2	3	X	7-21-71
PRELIMINARY ENGINEERING	4	5	6		8-27-71
APPROVED FOR CONSTRUCTION					
REVISED & APPROVED FOR CONSTRUCTION				REV.	

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

MECHANICAL FLOW DIAGRAM

INLET FACILITIES

GAS PROCESSING STUDY

HUMBLE OIL AND REFINING COMPANY

SBC, CALIFORNIA

SCALE NONE

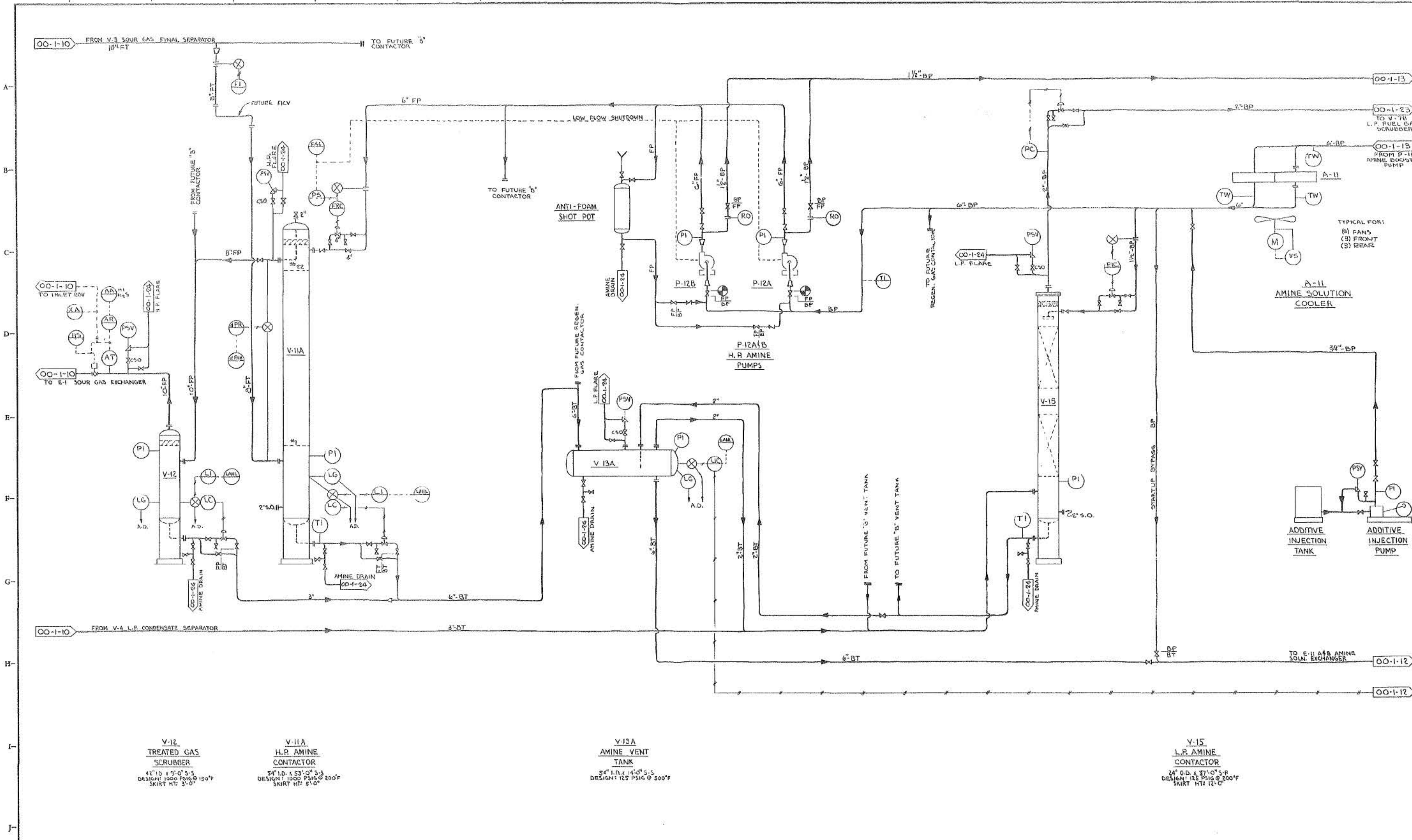
Stearns-Roger CORPORATION

ORDER NO. B-41449

DWG. NO. 22070

SHEET NO. 00-1-10

REV. 0



NO.	REVISIONS	DATE	BY	CH'D	APP'D	NO.	REFERENCE DRAWINGS

PRINT RECORD: DATE / FOR / REVISED / CUSTOMER / FIELD / INTRA CO.

ENG. RECORD		
DRAWN	DEB	7/15/71
CHECKED		
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		
PROCESS		

DRAWING STATUS	ISSUE NO			DATE
DEVELOPMENT	1	2	3	5-21-71
PRELIMINARY ENGINEERING	4	5	6	8-27-71
APPROVED FOR CONSTRUCTION				
REVISED & APPROVED FOR CONSTRUCTION				

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

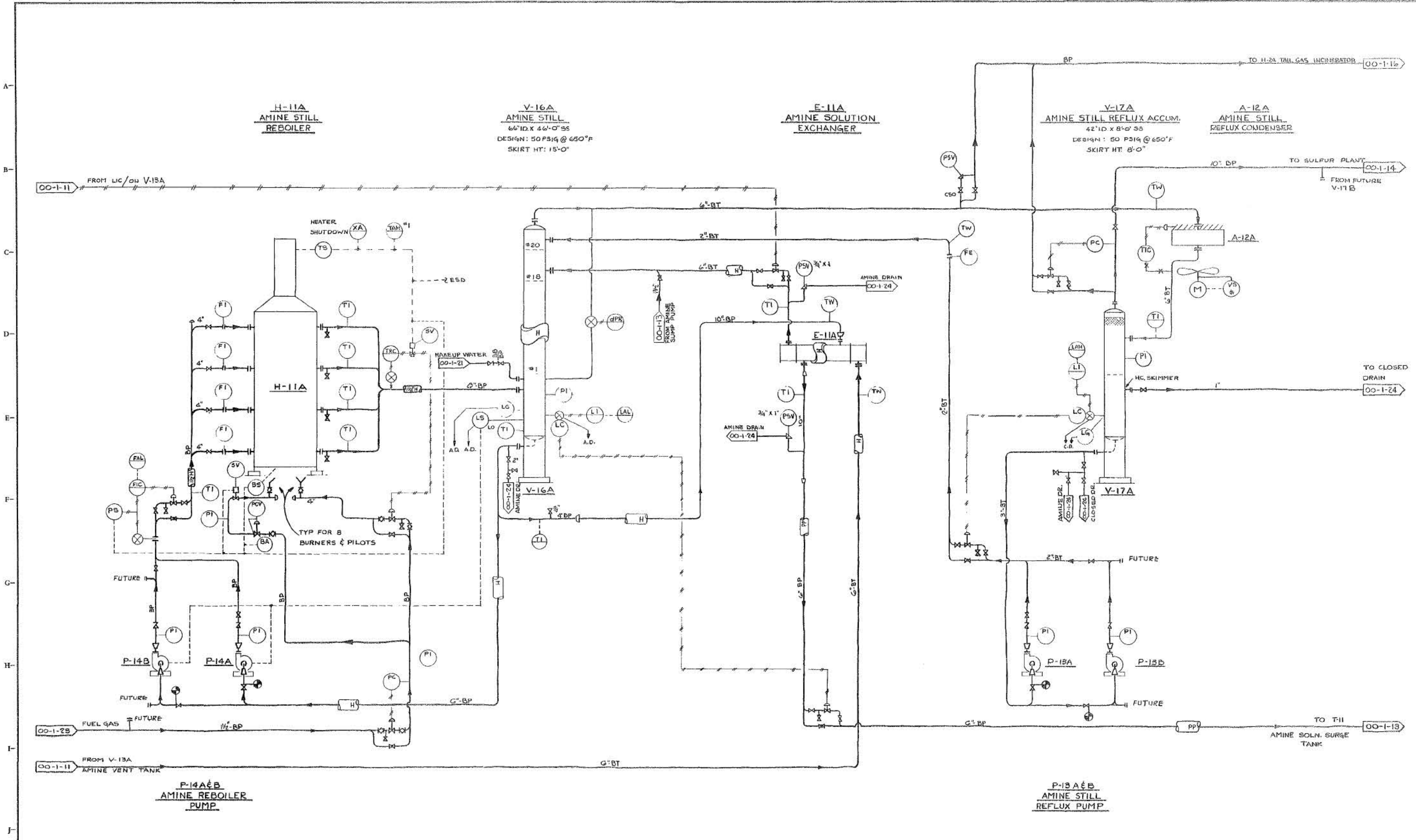
MECHANICAL FLOW DIAGRAM
AMINE CONTACTORS
GAS PROCESSING STUDY

HUMBLE OIL AND REFINING COMPANY
SBC, CALIFORNIA

SCALE: NONE

Stearns-Roger CORPORATION

DWG. NO. 22070
SHEET NO. 00-1-11
ORDER NO. B-41449
REV. 0



NO.	REVISIONS	DATE	BY	CH'D	APP'D	NO.	REFERENCE DRAWINGS

PRINT RECORD: DATE / FOR / REVISED / CUSTOMER / FIELD / INTRA CO.

ENG. RECORD		
DRAWN	CPH	7-20-71
CHECKED		
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		
PROCESS		

DRAWING STATUS					
DRAWING	ISSUE NO.				DATE
DEVELOPMENT	1	2	3	X	7-21-71
PRELIMINARY ENGINEERING	4	5	6		8-27-71
APPROVED FOR CONSTRUCTION					
REVISED & APPROVED FOR CONSTRUCTION	REV.				

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

MECHANICAL FLOW DIAGRAM

AMINE STILLS

GAS PROCESSING STUDY

HUMBLE OIL AND REFINING COMPANY

SBC, CALIFORNIA

SCALE NONE

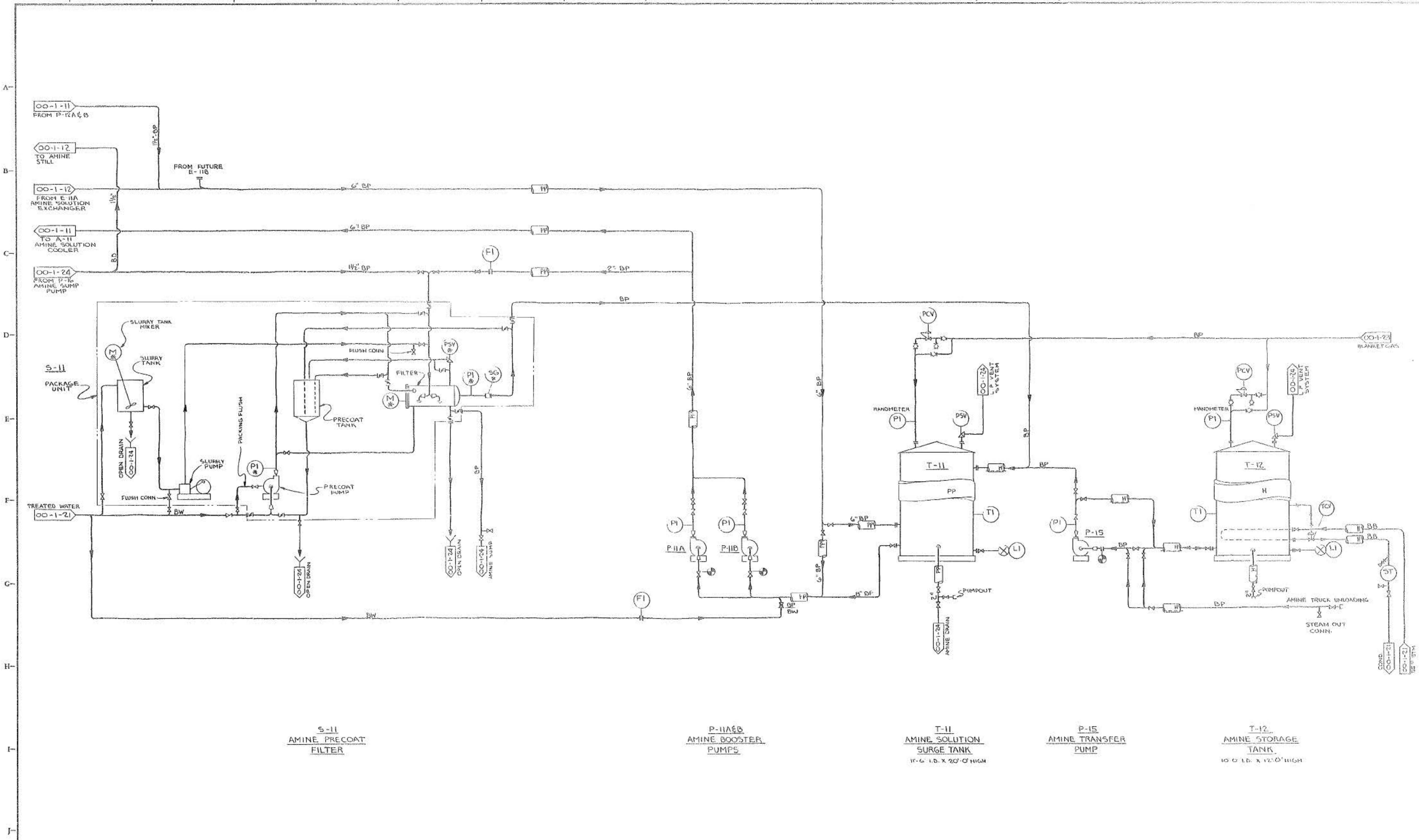
Stearns-Roger CORPORATION

DWG. NO. 22070

SHEET NO. 00-1-12

B-41349

REV. 0



NO.	REVISIONS	DATE	BY	CH'D	APP'D	NO.	REFERENCE DRAWINGS

PRINT RECORD: DATE / FOR / REVISED / CUSTOMER / FIELD / INTRA CO.

ENG. RECORD		
DRAWN	cq	7-23-71
CHECKED		
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		
PROCESS		

DRAWING STATUS					
DRAWING	ISSUE NO.				DATE
DEVELOPMENT	1	2		X	7-24-71
PRELIMINARY ENGINEERING	4	5	6		6-21-71
APPROVED FOR CONSTRUCTION					
REVISED & APPROVED FOR CONSTRUCTION					

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

MECHANICAL FLOW DIAGRAM

AMINE FILTER AND STORAGE

GAS PROCESSING STUDY

HUMBLE OIL AND REFINING COMPANY

SBC, CALIFORNIA

SCALE NONE

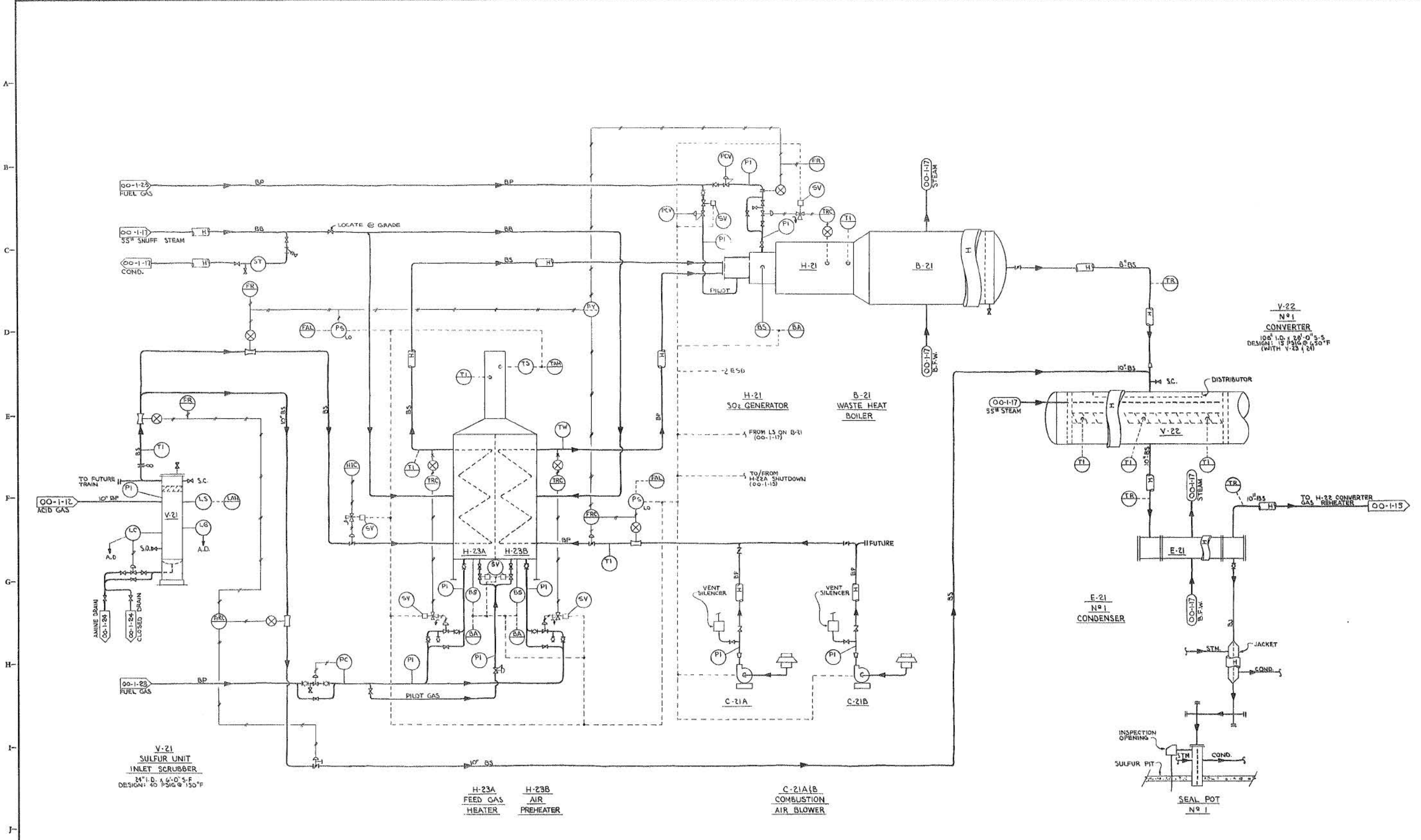
Stearns-Roger CORPORATION

ORDER NO. B-41449

DWG. NO. 22070

SHEET NO. 00-1-13

REV.



NO.	REVISIONS	DATE	BY	CHK'D	APP'D

REFERENCE DRAWINGS

PRINT RECORD: DATE / FOR / REVISED / CUSTOMER / FIELD / INTRA CO.

ENG. RECORD		
DRAWN	DEB	7-17-71
CHECKED		
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		
PROCESS	[illegible]	7-21-71

DRAWING STATUS					
DRAWING	ISSUE NO.				DATE
DEVELOPMENT	1	2	-	X	7-24-71
PRELIMINARY ENGINEERING	-	5	6		8-27-71
APPROVED FOR CONSTRUCTION					
REVISED & APPROVED FOR CONSTRUCTION	REV. 0				

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

MECHANICAL FLOW DIAGRAM

SO_2 GENERATOR AND NO. 1 CONVERTER

GAS PROCESSING STUDY

HUMBLE OIL AND REFINING COMPANY
SBC, CALIFORNIA

SCALE NONE

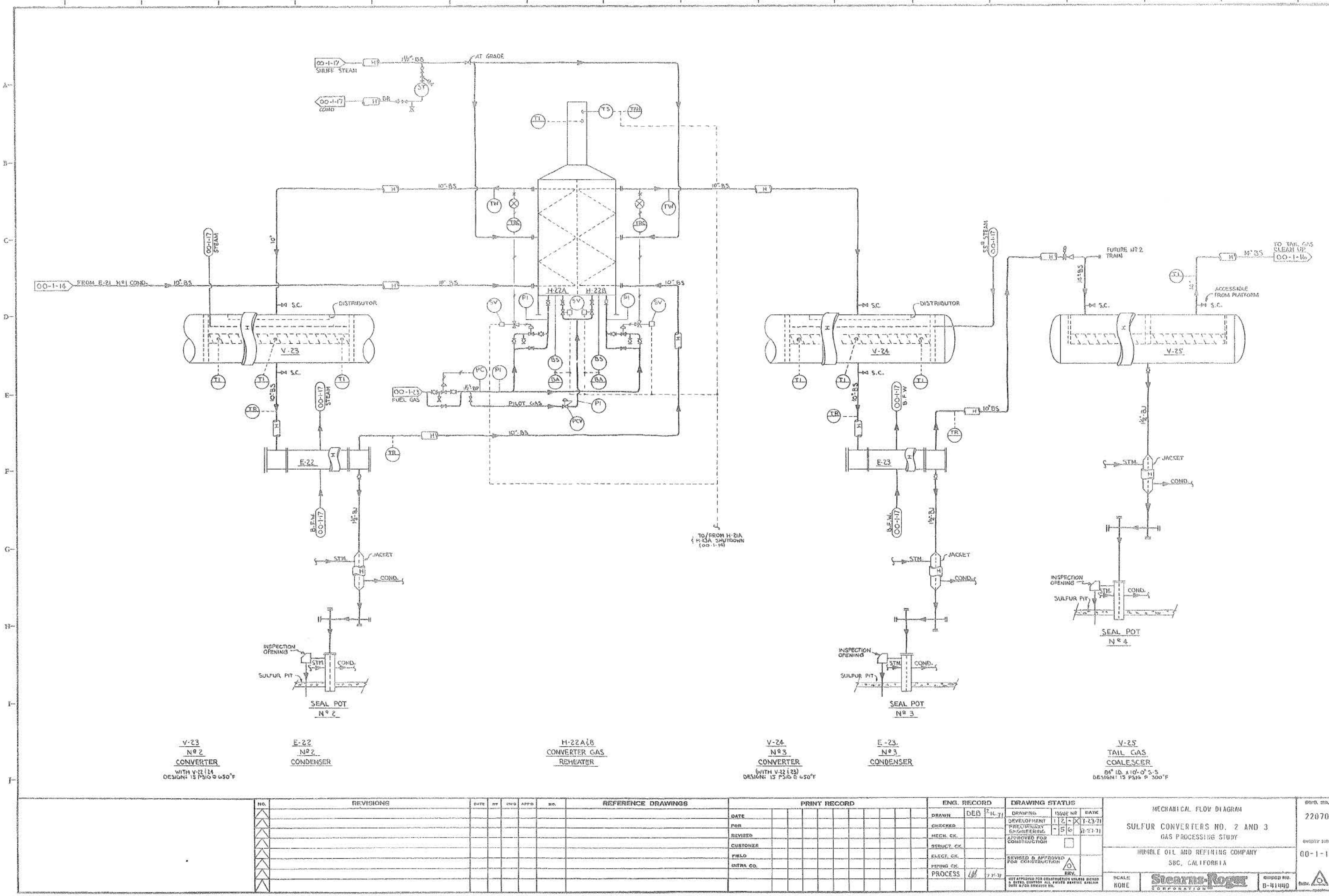
Stearns-Roger CORPORATION

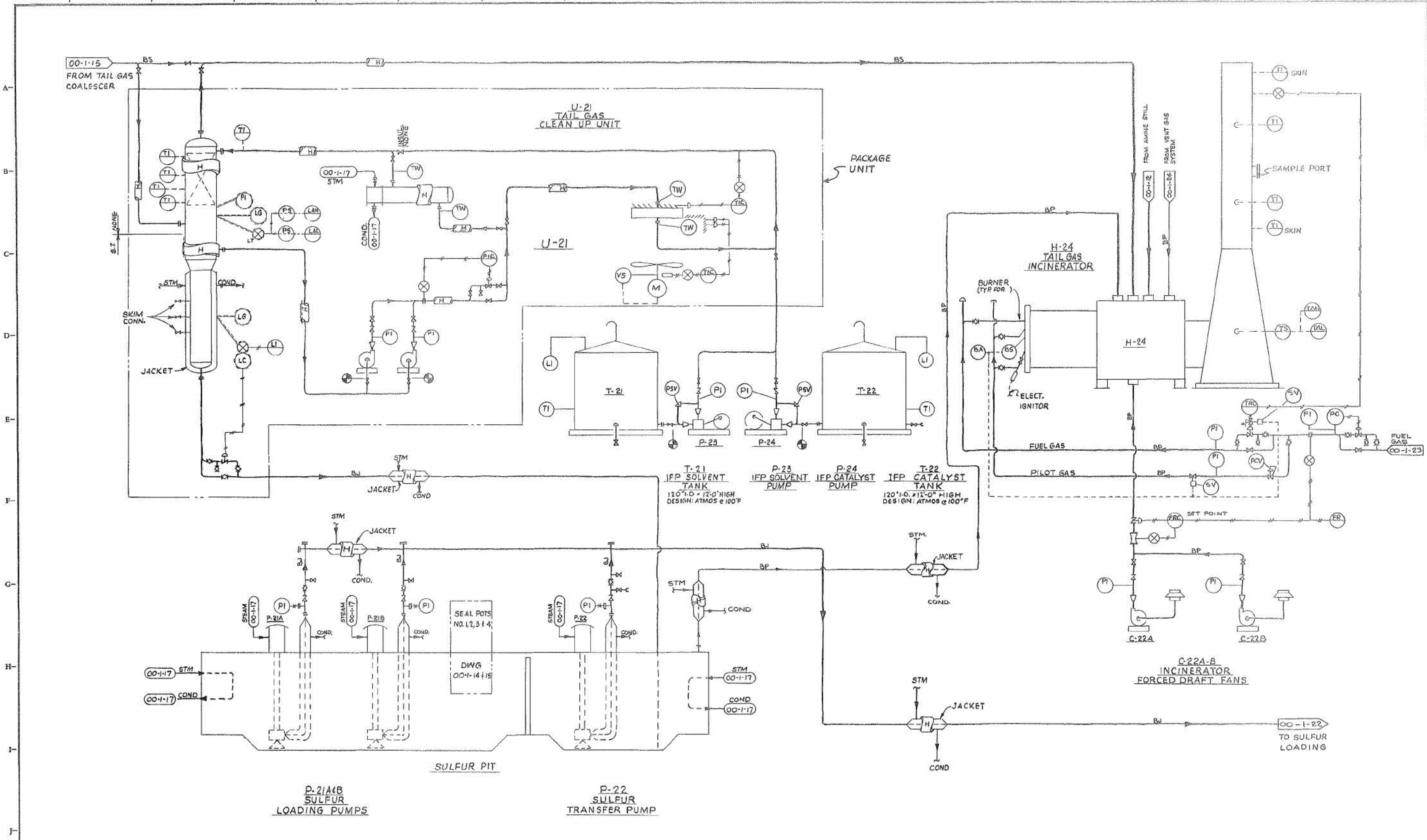
ORDER NO. B-41449

DWG. NO. 22070

SHEET NO. 00-1-14

REV. 0


00-1-17 SNUFF STEAM
AT GRADE
00-1-17 COND
00-1-14 FROM E-21 Nº1 COND.
10" BS
00-1-17 STEAM
DISTRIBUTOR
S.C.
V-23
E-22
B.F.W. 00-1-17
STM.
JACKET
COND.
INSPECTION OPENING
SULFUR PIT
SEAL POT Nº 2
H-22A
H-22B
00-1-13 FUEL GAS
PILOT GAS
PCV
TO/FROM H-21A & H-23A SHUTDOWN (00-1-14)
V-24
E-23
SEAL POT Nº 3
FUTURE Nº 2 TRAIN
TO TAIL GAS CLEAN UP 00-1-16
ACCESSIBLE FROM PLATFORM
V-25
SEAL POT Nº 4
V-23 Nº 2 CONVERTER
WITH V-22 & 24 DESIGN: 15 PSIG @ 650°F
E-22 Nº 2 CONDENSER
H-22A & B CONVERTER GAS REHEATER
V-24 Nº 3 CONVERTER
(WITH V-22 & 23) DESIGN: 15 PSIG @ 650°F
E-23 Nº 3 CONDENSER
V-25 TAIL GAS COALESCER
84" I.D. x 10'-0" S-S DESIGN: 15 PSIG @ 300°F
REVISIONS
REFERENCE DRAWINGS
PRINT RECORD
ENG. RECORD
DRAWN DEB 7-16-71
CHECKED
MECH. CK.
STRUCT. CK.
ELECT. CK.
PIPING CK.
PROCESS 7-21-71
DRAWING STATUS
DEVELOPMENT 7-23-71
PRELIMINARY ENGINEERING 8-27-71
APPROVED FOR CONSTRUCTION
REVISED & APPROVED FOR CONSTRUCTION
MECHANICAL FLOW DIAGRAM
SULFUR CONVERTERS NO. 2 AND 3
GAS PROCESSING STUDY
HUMBLE OIL AND REFINING COMPANY
SBC, CALIFORNIA
SCALE NONE
Stearns-Roger CORPORATION
22070
00-1-15
B-41449



NO.	REVISIONS	DATE	BY	CH'D	APP'D	NO.	REFERENCE DRAWINGS

PRINT RECORD: DATE / FOR / REVISED / CUSTOMER / FIELD / INTRA CO.

ENG. RECORD		
DRAWN	RLS	7-17
CHECKED		
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		
PROCESS	[illegible]	7-26-71

DRAWING STATUS					
DRAWING	ISSUE NO				DATE
DEVELOPMENT	1	2	-	X	7-23-71
PRELIMINARY ENGINEERING	-	5	6		8-27-71
APPROVED FOR CONSTRUCTION					
REVISED & APPROVED FOR CONSTRUCTION				REV.	

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

PROCESS FLOW DIAGRAM

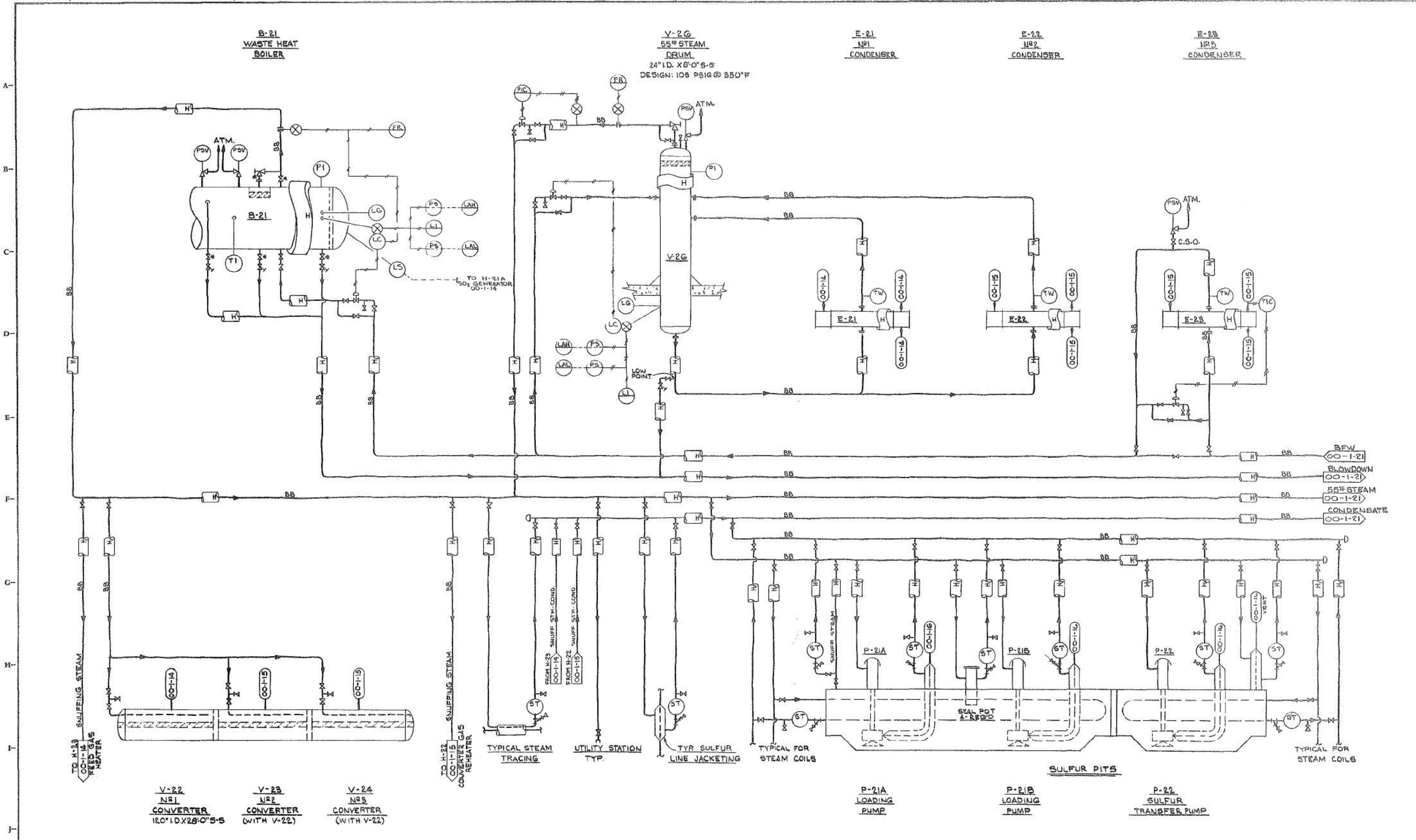
SULFUR PIT AND INCINERATOR

GAS PROCESSING STUDY

HUMBLE OIL AND REFINING CO.
SBC, CALIFORNIA

SCALE NONE | Stearns-Roger Corporation | ORDER NO. B-41449

DWG. NO. 22070
SHEET NO. 00-1-16
REV. 0



ENG. RECORD			
DRAWN	AL ALVAREZ	7-19-71	
CHECKED			
MECH. CK.			
STRUCT. CK.			
ELECT. CK.			
PIPING CK.			
PROCESS			

DRAWING STATUS			
DRAWING	ISSUE No		DATE
DEVELOPMENT	1 2 - X		7-23-71
PRELIMINARY ENGINEERING	- 5 6		8-27-71
APPROVED FOR CONSTRUCTION			
REVISED & APPROVED FOR CONSTRUCTION	REV. 0		

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

MECHANICAL FLOW DIAGRAM
SULFUR AREA STEAM
GAS PROCESSING STUDY

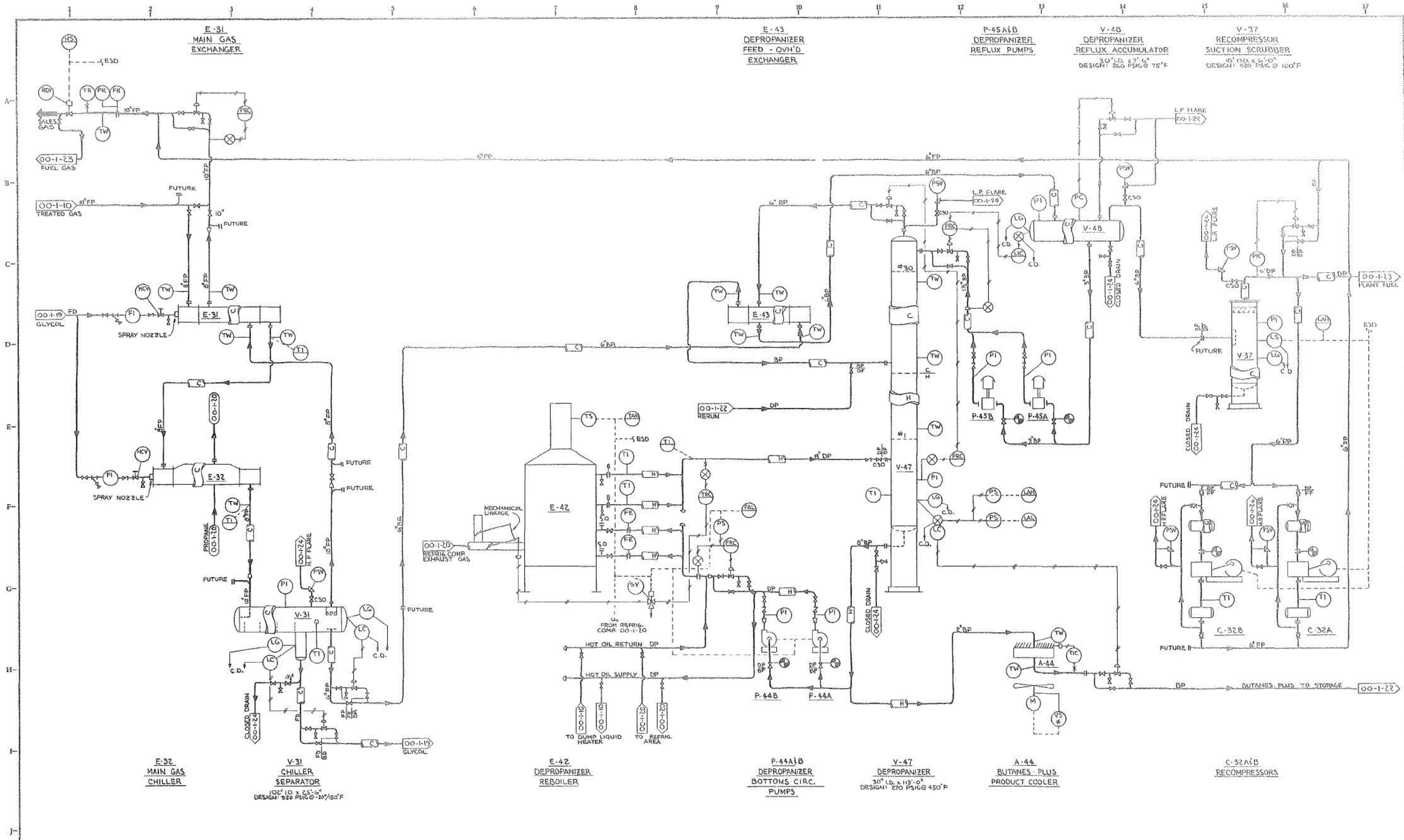
HUMBLE OIL AND REFINING COMPANY
GAS PROCESSING STUDY

SCALE NONE

Stearns-Roger CORPORATION

DWG. NO. 22070
SHEET NO. 00-1-17
ORDER NO. B-41449
REV. 0

REVISIONS | REFERENCE DRAWINGS | PRINT RECORD: DATE, FOR, REVISED, CUSTOMER, FIELD, INTRA CO.



REVISIONS	REFERENCE DRAWINGS	PRINT RECORD
		DATE
		FOR
		REVISED
		CUSTOMER
		FIELD
		INTRA CO.

ENG. RECORD		
DRAWN	DEB	7-19-71
CHECKED		
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		
PROCESS		7-21-71

DRAWING STATUS		
DRAWING	ISSUE Nº	DATE
DEVELOPMENT	1 2 3 ☒	7-26-71
PRELIMINARY ENGINEERING	4 5 6	27-71
APPROVED FOR CONSTRUCTION	☐	
REVISED & APPROVED FOR CONSTRUCTION	REV.	

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

MECHANICAL FLOW DIAGRAM

HYDROCARBON RECOVERY

GAS PROCESSING STUDY

HUMBLE OIL AND REFINING COMPANY

SBC, CALIFORNIA

SCALE NONE

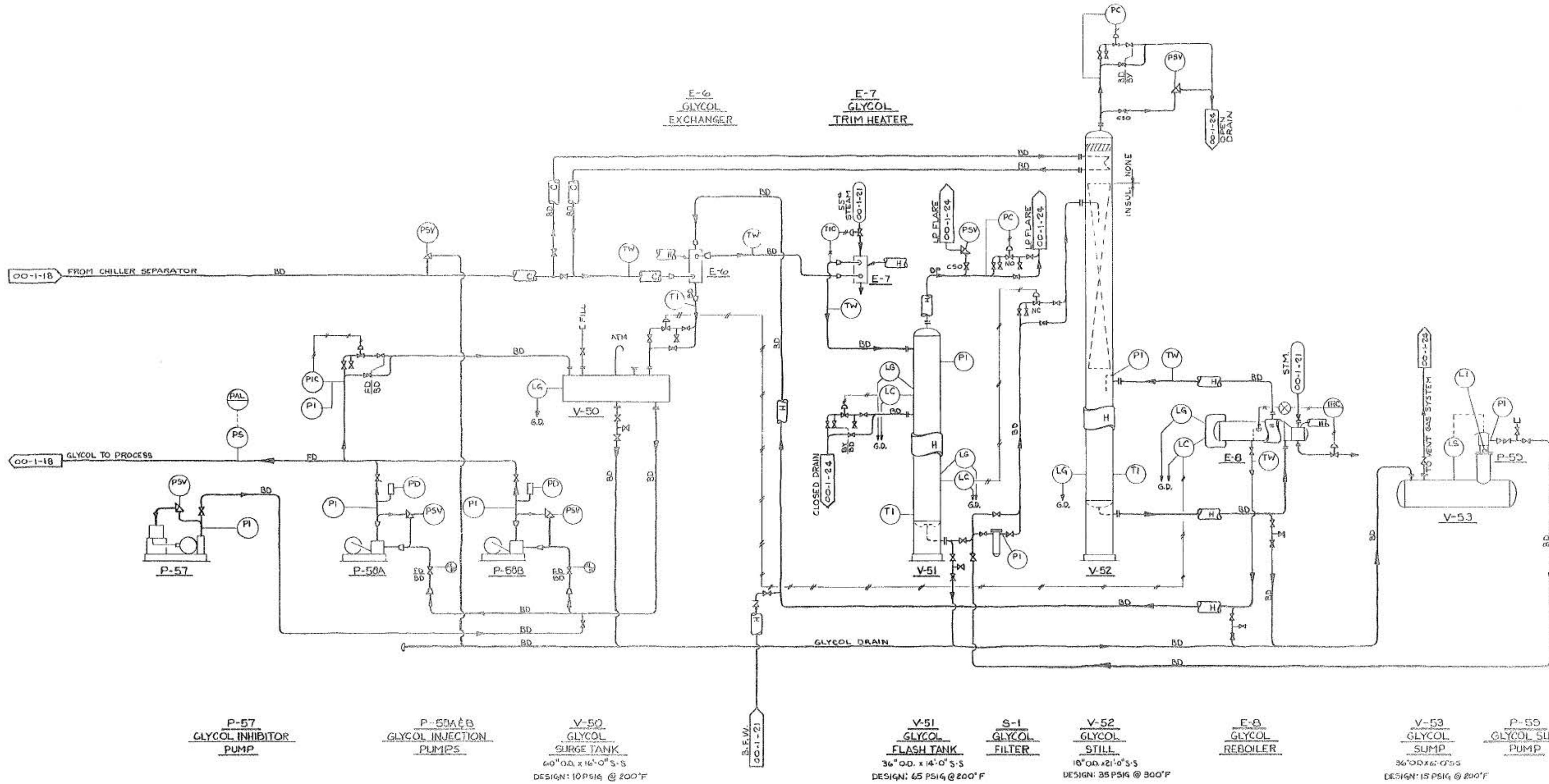
Stearns-Roger CORPORATION

ORDER NO. B-41449

DWG. NO. 22070

SHEET NO. 00-1-18

REV.



NO.	REVISIONS	DATE	BY	CH'D	APP'D	NO.	REFERENCE DRAWINGS

PRINT RECORD: DATE / FOR / REVISED / CUSTOMER / FIELD / INTRA CO.

ENG. RECORD		
DRAWN	DWMA	7-19-71
CHECKED		
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		
PROCESS	[illegible]	7-71

DRAWING STATUS					
DRAWING	ISSUE NO.				DATE
DEVELOPMENT	1	2	-	X	7-22-71
PRELIMINARY ENGINEERING	-	5	6		8-27-71
APPROVED FOR CONSTRUCTION					
REVISED & APPROVED FOR CONSTRUCTION	REV. 0				

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

MECHANICAL FLOW DIAGRAM

GLYCOL STILL

GAS PROCESSING STUDY

HUMBLE OIL AND REFINING COMPANY

SBC, CALIFORNIA

SCALE: NONE

Stearns-Roger CORPORATION

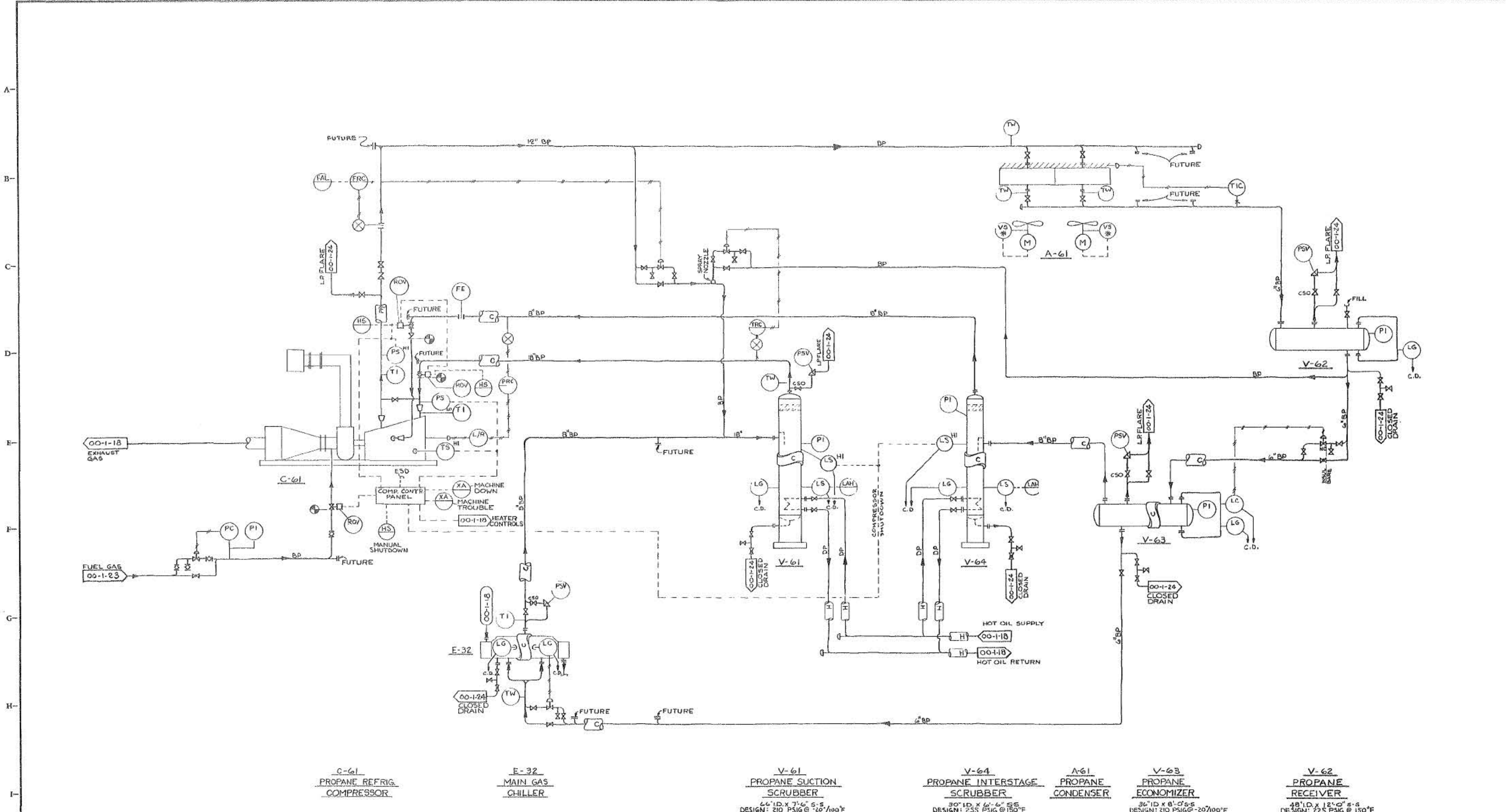
ORDER NO. 8-41449

DWG. NO. 22070

SHEET NO. 00-1-19

REV. 0

Form 22250-52



NO.	REVISIONS	DATE	BY	CHD	APP'D	NO.	REFERENCE DRAWINGS

PRINT RECORD: DATE / FOR / REVISED / CUSTOMER / FIELD / INTRA CO.

ENG. RECORD		
DRAWN	DWALA	7-20-71
CHECKED		
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		
PROCESS		

DRAWING STATUS					
DRAWING	ISSUE NO				DATE
DEVELOPMENT	1	2	-	X	7-22-71
PRELIMINARY ENGINEERING	-	5	6		8-27-71
APPROVED FOR CONSTRUCTION					
REVISED & APPROVED FOR CONSTRUCTION	REV. 0				

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

MECHANICAL FLOW DIAGRAM

REFRIGERATION

GAS PROCESSING STUDY

HUMBLE OIL AND REFINING COMPANY

SBC, CALIFORNIA

SCALE NONE

Stearns-Roger Corporation

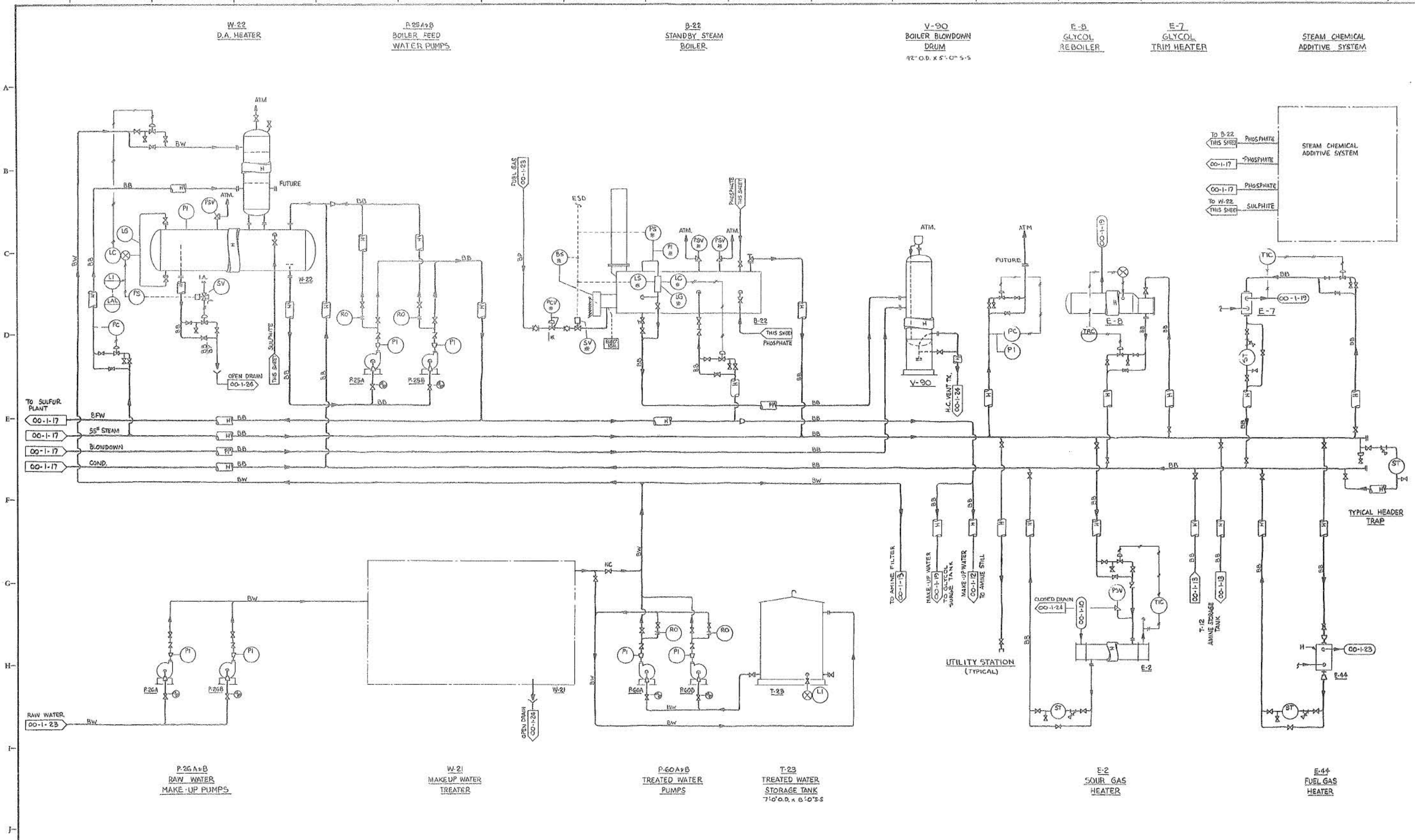
ORDER NO. B-41449

DWG. NO. 22080

SHEET NO. 00-1-20

REV. 0

Form 22205-52



NO.	REVISIONS	DATE	BY	CHD	APPD	NO.	REFERENCE DRAWINGS

PRINT RECORD	
DATE	
FOR	
REVISED	
CUSTOMER	
FIELD	
INTRA CO.	

ENG. RECORD		
DRAWN		7-24-71
CHECKED		
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		
PROCESS		

DRAWING STATUS					
DRAWING	ISSUE Nº				DATE
DEVELOPMENT	1	-	-	X	7-24-71
PRELIMINARY ENGINEERING	-	5	6		8-27-71
APPROVED FOR CONSTRUCTION					
REVISED & APPROVED FOR CONSTRUCTION				0 REV.	

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

MECHANICAL FLOW DIAGRAM

STEAM GENERATION AND WATER TREATING

GAS PROCESSING STUDY

HUMBLE OIL AND REFINING COMPANY

SBC, CALIFORNIA

SCALE NONE

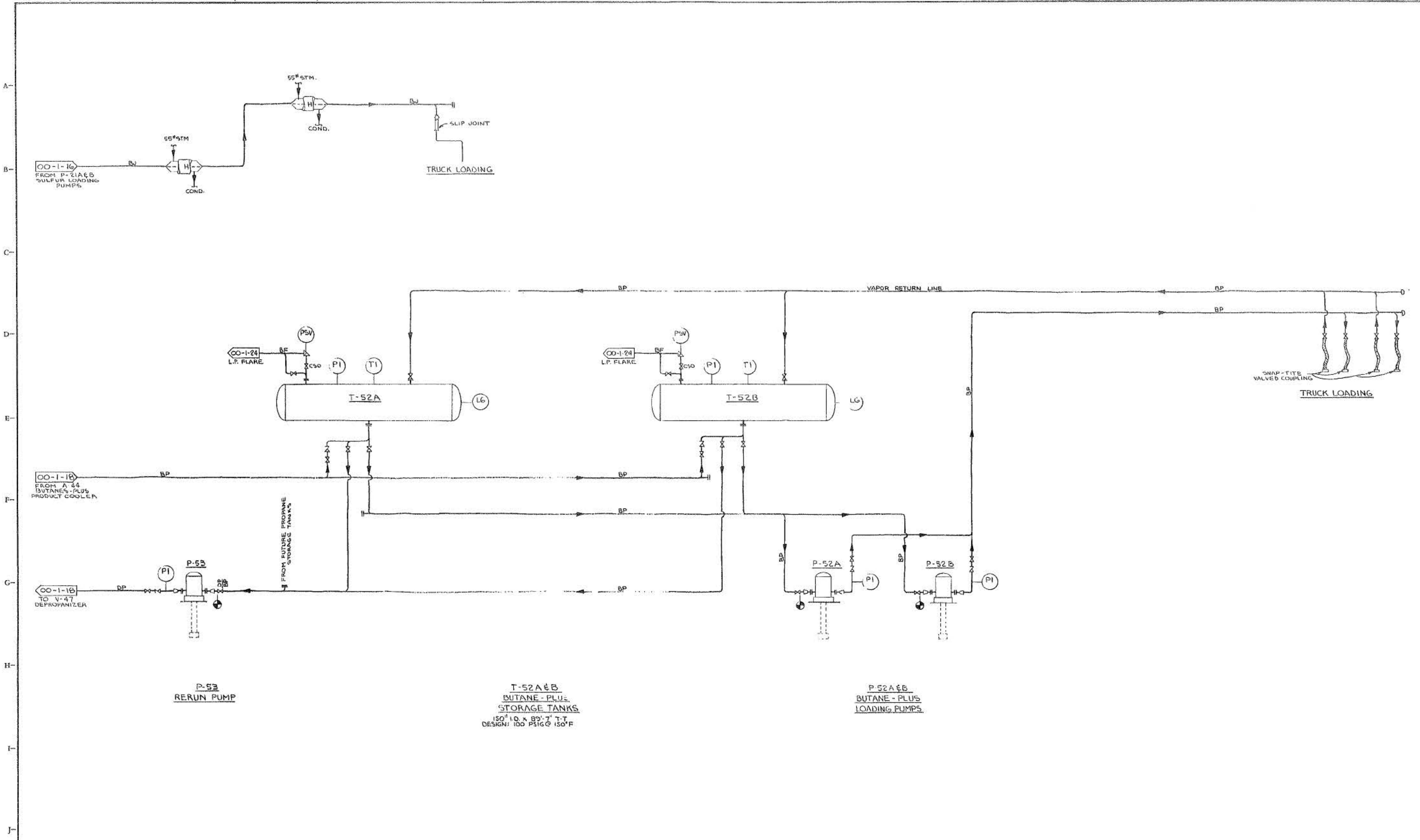
Stearns-Roger CORPORATION

ORDER NO. 8-41449

DWG. NO. 22070

SHEET NO. 00-1-21

REV. 0



NO.	REVISIONS	DATE	BY	CH'D	APP'D	NO.	REFERENCE DRAWINGS

PRINT RECORD: DATE / FOR / REVISED / CUSTOMER / FIELD / INTRA CO.

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PROCESS	[illegible]	7-?-71

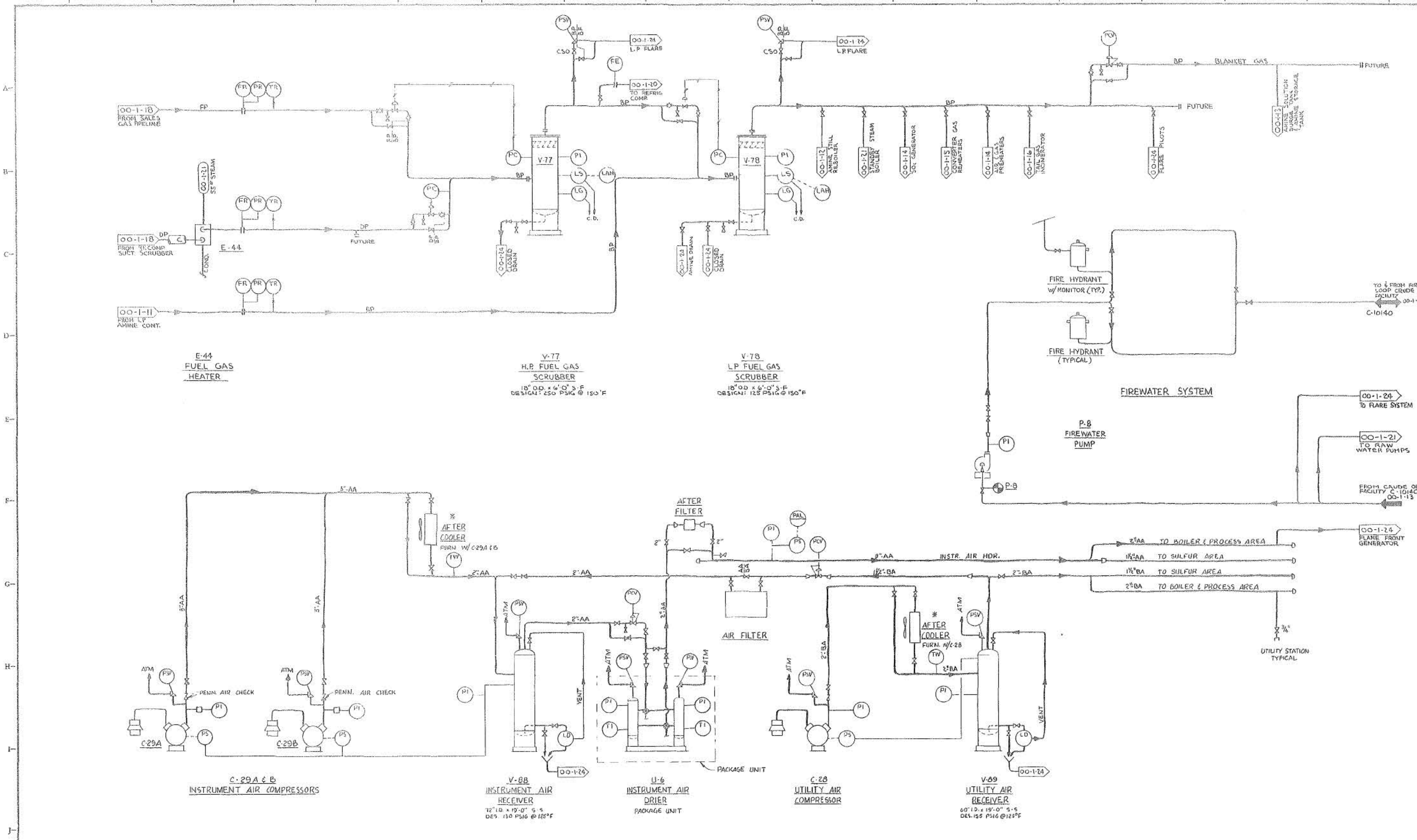
DRAWING STATUS					
DRAWING	ISSUE NO				DATE
DEVELOPMENT	1	-	-	X	7-26-71
PRELIMINARY ENGINEERING	-	5	6		8-27-71
APPROVED FOR CONSTRUCTION					
REVISED & APPROVED FOR CONSTRUCTION — REV. 0					

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

MECHANICAL FLOW DIAGRAM
STORAGE AND SHIPPING
GAS PROCESSING STUDY

HUMBLE OIL AND REFINING COMPANY
SBC, CALIFORNIA

SCALE: NONE
Stearns-Roger CORPORATION
ORDER NO. B-41449
DWG. NO. 22070
SHEET NO. 00-1-22
REV. 0



NO.	REVISIONS	DATE	BY	CHD	APP'D	NO.	REFERENCE DRAWINGS

PRINT RECORD: DATE, FOR, REVISED, CUSTOMER, FIELD, INTRA CO.

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ELECT. CK.		
PIPING CK.		
PROCESS	[illegible]	7-7-71

DRAWING STATUS					
DRAWING	ISSUE Nº				DATE
DEVELOPMENT	1	2	-	X	7-22-71
PRELIMINARY ENGINEERING	-	5	6		8-27-71
APPROVED FOR CONSTRUCTION					
REVISED & APPROVED FOR CONSTRUCTION	0 REV.				

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

MECHANICAL FLOW DIAGRAM

FUEL GAS AND AIR SYSTEMS

GAS PROCESSING STUDY

HUMBLE OIL AND REFINING COMPANY

SBC, CALIFORNIA

SCALE NONE

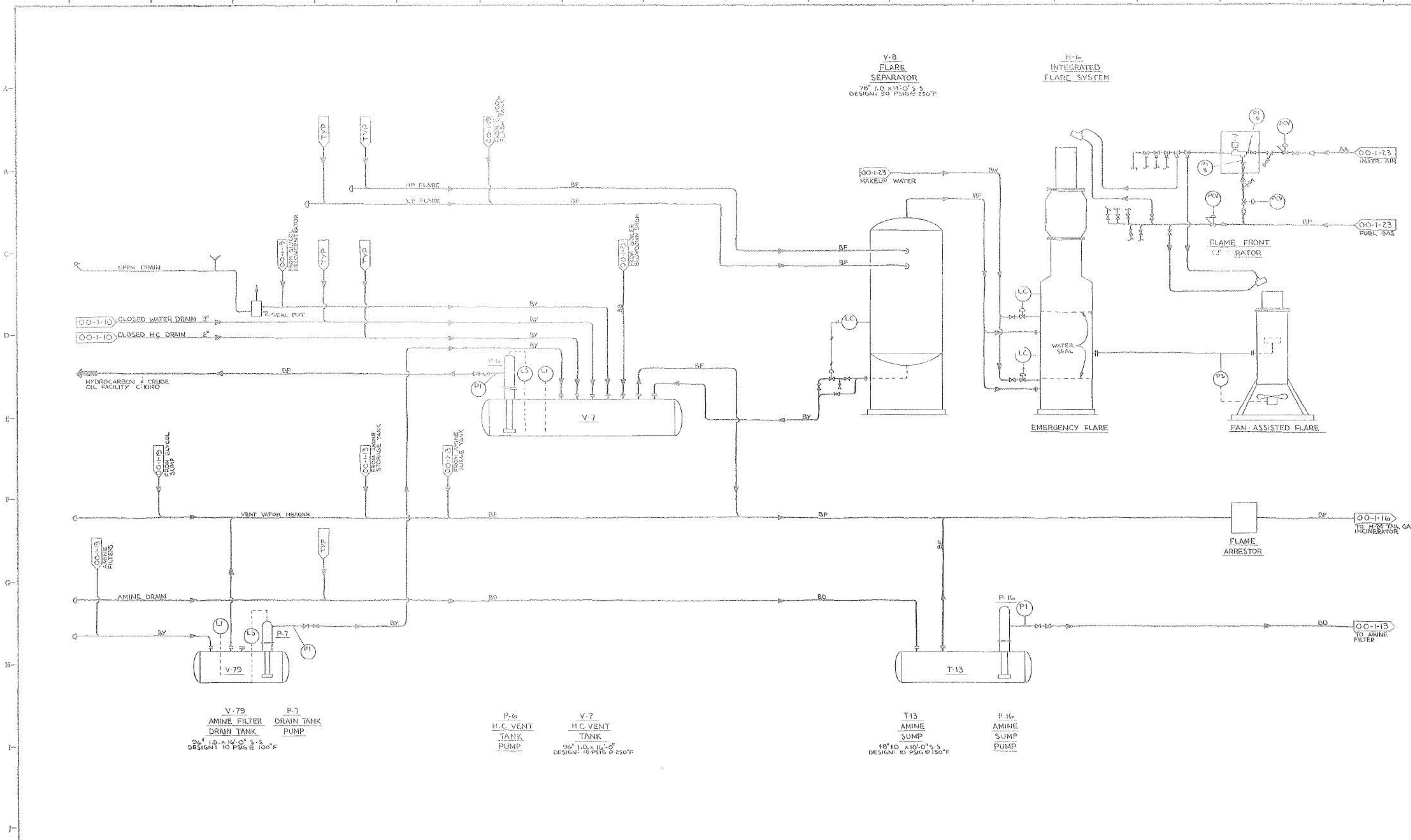
Stearns-Roger CORPORATION

ORDER NO. 8-41449

DWG. NO. 22070

SHEET NO. 00-1-23

REV. 0



ENG. RECORD		
DRAWN	DEB	7-21-71
CHECKED		
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		
PROCESS		

DRAWING STATUS: DEVELOPMENT 1 2 3 X 7-23-71; PRELIMINARY ENGINEERING 4 5 6 — 6-27-71; APPROVED FOR CONSTRUCTION; REVISED & APPROVED FOR CONSTRUCTION

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

MECHANICAL FLOW DIAGRAM
FLARE AND DRAIN
GAS PROCESSING STUDY

HUMBLE OIL AND REFINING COMPANY
SBC, CALIFORNIA

SCALE: NONE | Stearns-Roger Corporation | ORDER NO. B-41449

DWG. NO. 22070 | SHEET NO. 00-1-24 | REV. 0

SHUTDOWNS

Items shut down (matrix columns):

1. CLOSE INLET BLOCK VALVE
2. CLOSE CONTACTOR OUTLET BLOCK VALVE
3. STOP H.P. AMINE PUMPS
4. CLOSE FUEL GAS TO AMINE STILL REBOILER H-11A
5. CLOSE PILOT GAS TO AMINE STILL REBOILER H-11A
6. STOP AMINE REBOILER PUMPS P-14
7. CLOSE ACID GAS VALVE TO H-23A
8. CLOSE FUEL GAS TO ACID GAS SIDE H-23A
9. CLOSE PILOT GAS TO ACID GAS SIDE H-23A
10. CLOSE FUEL GAS TO AIR SIDE H-23A
11. CLOSE PILOT GAS TO AIR SIDE H-23A
12. STOP COMB. AIR BLOWERS C-21
13. SHUT DOWN CONVERTER GAS RE-HEATER H-22A
14. CLOSE FUEL GAS TO SO_2 GEN. H-21A
15. CLOSE PILOT GAS TO SO_2 GEN H-21A
16. SHUT DOWN FEED GAS HTR H-2 A
17. CLOSE FUEL GAS TO H-22A-1
18. CLOSE PILOT GAS TO H-22A-1
19. CLOSE FUEL GAS TO H-22A-2
20. CLOSE PILOT GAS TO H-22A-2
21. CLOSE FUEL GAS TO INCIN. H-24
22. CLOSE PILOT GAS TO INCIN H-24
23. CLOSE RESIDUE GAS TO SALES ROV
24. STOP DEPROP. BTM CIRC PUMP P-44
25. CLOSE/VENT HOT GAS INLET TO E-42
26. SHUT DOWN RECOMPRESSORS C-32
27. SHUT DOWN REFRIG. COMPR. C-61
28. CLOSE FUEL GAS TO C-61
29. CLOSE REFRIG COMPR SUCTION ROV
30. CLOSE REFRIG COMPR INTERSTAGE ROV
31. CLOSE FUEL GAS TO BLR. B-22

EVENTS CAUSING SUTDOWN	INITIATING DEVICE	ALARM
ELECTRICAL POWER FAILURE	BREAKER CONTACT	———
FIRE	MANUAL ESD SW	ESD
MANUAL ESD SWITCH	MANUAL	YES
HIGH INLET PRESSURE	PS	PAH
HIGH H_2S	AT	XA
CLOSE CONTACTOR OUTLET ROV	HS AT	———
LOW FLOW- AMINE TO H.P. CONTACTOR V-11A	PS	FAL
LOW FLOW-AMINE TO AMINE STILL REBOILER H-11A	PS	FAL
FLAME FAILURE- AMINE STILL REBOILER H-11A	BS	BA
HIGH STACK TEMP- AMINE STILL REBOILER H-11A	TS	TAH
LOW LEVEL-AMINE STILL V-16A	LS	NONE
LOW FLOW- ACID GAS TO HEATER H-23A	PS	FAL
FLAME FAILURE-ACID GAS SIDE H-23A	BS	BA
FLAME FAILURE-AIR SIDE H-23B	BS	BA
HIGH STACK TEMP.- HEATER H-23	TS	TAH
LOW FLOW-COMB. AIR TO H-23B	PS	FAL
SHUTDOWN- FEED GAS HTR. H-23		
SHUTDOWN-CONVERTER GAS REHTR. H-22		
LOW LEVEL-WASTE HEAT BLR. B-21	LS	NONE
FLAME FAILURE-SO_2 GENERATOR H-21A	BS	BA
FLAME FAILURE-CONVERTER GAS REHTR H-22A1	BS	BA
FLAME FAILURE-CONVERTER GAS REHTR H-22A2	BS	BA
HIGH STACK TEMP-CONVERTER GAS REHTR H-22A	TS	TAH
FLAME FAILURE - TAIL GAS INCIN. H-24	BS	BA
LOW FLOW- DEPROP BTMS. TO REBOILER E-42	PS	FAL
HIGH STACK TEMP- DEPROP REBOILER E-42	TS	TAH
HIGH LEVEL-RECOMPR. SUCT SCR V-37	LS	LAH
MANUAL SHUTDOWN- REFRIG. COMPR. C-61	HS	XA
HIGH PRESS.- DISCH. REFRIG. COMPR. C-61	PS	NONE
MANUAL OPERATION- REFRIG. COMPR. INTERSTAGE INLET ROV	HS	NONE
MANUAL OPERATION- REFRIG. COMPR SUCTION ROV	PS	NONE
LOW SUCTION PRESS.- REFRIG. COMPR C-61	PS	NONE
HIGH TEMP.- REFRIG. COMPR. C-61	TS	NONE
HIGH LEVEL- PROPANE SUCT. SCR. V-61	LS	NONE
HIGH LEVEL- PROPANE INTERSTAGE SCR.V-64	LS	NONE
FLAME FAILURE- STANDBY STM. BLR. B-22	BS	NONE
LOW DRUM LEVEL- STANDBY STM. BLR. B-22	LS	NONE
HIGH PRESS.- STANDBY STM. BLR. B-22	PS	NONE

ALARMS ONLY

FAULT CAUSING ALARM	INITIATING DEVICE	ALARM
HIGH LEVEL- INLET SEPARATOR V-2	LIC	LAH
HIGH LEVEL- SOUR GAS FINAL SEPARATOR V-3	PS	LAH
HIGH LEVEL- L.P. CONDENSATE SEPARATOR V-4	LS	LAH
HIGH H_2S- CONTACTOR OUTLET	AR	AA
HIGH/LOW LEVEL- TR. GAS SCRUBBER V-12	LI	LAHL
HIGH/LOW LEVEL- H.P. AMINE CONTACTOR V-11A	LI	LAHL
HIGH/LOW LEVEL- AMINE VENT TANK V-18A	LIC	LAHL
HIGH DIFF PRESS - H.P. AMINE CONTACTOR V-11A	dPR	dPAH
LOW LEVEL - AMINE STILL V-16A	LI	LAL
HIGH LEVEL- AMINE STILL REFLUX ACCUM V-17A	LI	LAH
HIGH LEVEL- SULFUR UNIT INLET SCRUBBER V-41	LS	LAH
HIGH LEVEL- TAIL GAS CLEAN UP UNIT U-2	PS	LAH
LOW LEVEL- TAIL GAS CLEAN UP UNIT U-2	PS	LAL
HIGH TEMP. - INCINERATOR H-24	TS	TAH
LOW TEMP. - INCINERATOR H-24	TS	TAL
HIGH LEVEL - WASTE HEAT BOILER B-21	PS	LAH
LOW LEVEL - WASTE HEAT BOILER B-21	PS	LAL
HIGH LEVEL- 55# STM. DRUM V-26	PS	LAH
LOW LEVEL- 55# STM. DRUM V-26	PS	LAL
HIGH LEVEL- DEPROPANIZER V-47	PS	LAH
LOW LEVEL- DEPROPANIZER V-47	PS	LAH
LOW PRESS. - GLYCOL TO PROCESS	PS	PAL
TROUBLE- PROPANE REFRIG. COMPR. C-61	COMPR. PANEL	XA
SHUT-DOWN - PROPANE REFRIG. COMPR. C-61	COMPR. PANEL	XA
LOW FLOW - DISCH. REFRIG. COMPR. C-61	FRC	FAL
HIGH LEVEL - PROPANE SUCT. SCR. V-61	LS	LAH
HIGH LEVEL - PROPANE INTERSTAGE SCR V-64	LS	LAH
LOW LEVEL - D. A. HEATER W-38	LI	LAL
LOW PRESS. INST. AIR SYSTEM	PS	PAL
HIGH LEVEL H.P. FUEL GAS SCRUBBER V-77	LS	LAH
HIGH LEVEL L.P. FUEL GAS SCRUBBER V-78	LS	LAH

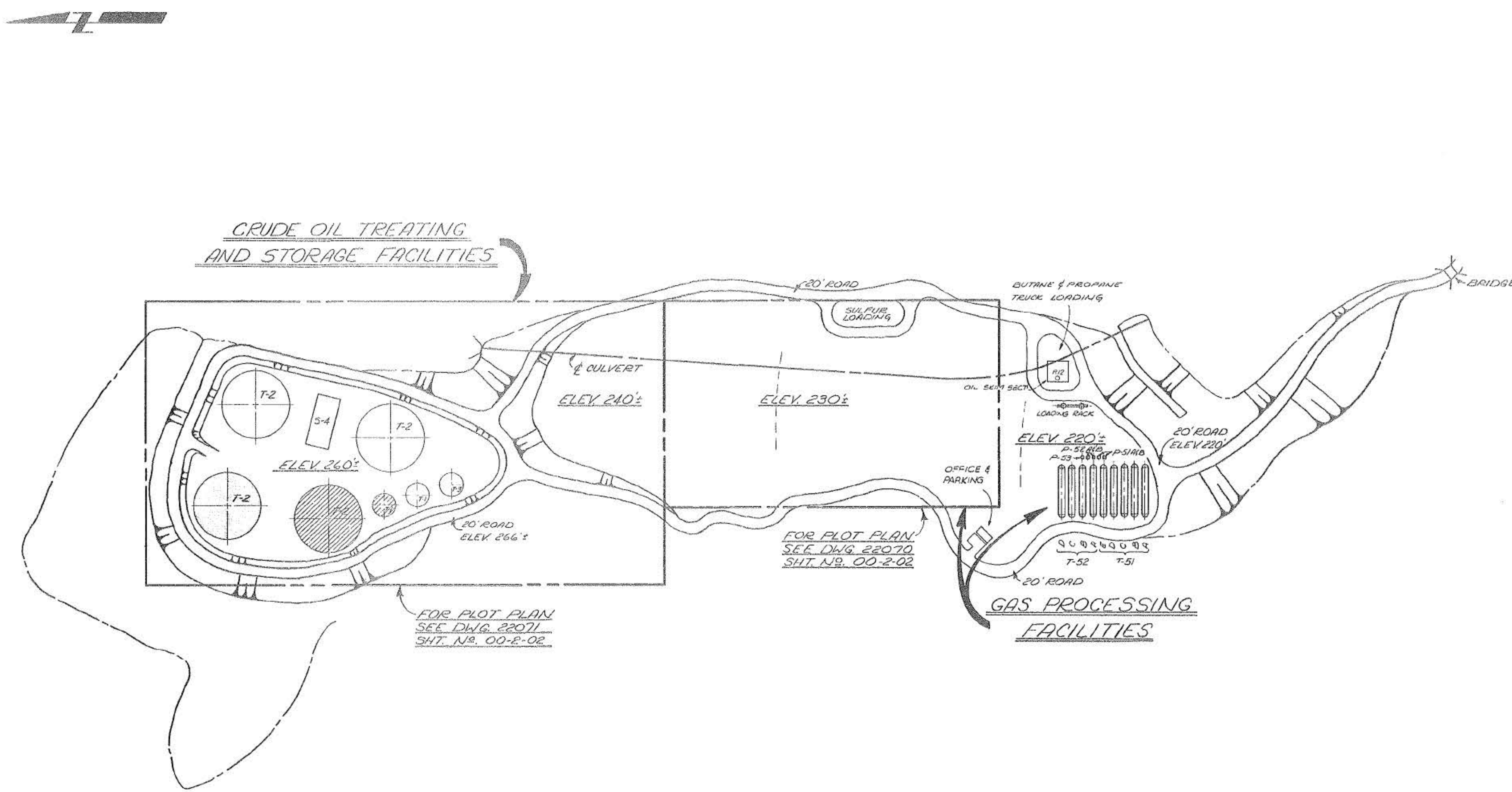
REVISIONS | REFERENCE DRAWINGS | PRINT RECORD

ENG. RECORD: DRAWN; CHECKED; MECH. CK.; STRUCT. CK.; ELECT. CK.; PIPING CK.; PROCESS 7-15-71

DRAWING STATUS: PRELIMINARY ENGINEERING — ISSUE NO. 5, 6 — DATE 8-27-71

MECHANICAL FLOW DIAGRAM
EMERGENCY SHUTDOWN SYSTEM
GAS PROCESSING STUDY
HUMBLE OIL AND REFINING COMPANY
SBC, CALIFORNIA

DWG. NO. 22070
SHEET NO. 00-1-25
SCALE NONE
ORDER NO. 8-41440
Stearns-Roger Corporation



DENOTES PHASE II = ▨
DENOTES PHASE III OR ULTIMATE CONDITION = ☐

NO.	REVISIONS	DATE	BY	CHK'D	APP'D

NO.	REFERENCE DRAWINGS

PRINT RECORD	
DATE	
FOR	
REVISED	
CUSTOMER	
FIELD	
INTRA CO.	

ENG. RECORD		
DRAWN	DWALN	8-27-71
CHECKED		
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		

DRAWING STATUS ISSUED	DATE
PRELIMINARY	
FOR COMMENTS AND/OR APPROVAL	
APPROVED FOR CONSTRUCTION	
REVISED & APPROVED FOR CONSTRUCTION △ REV.	

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

KEY PLOT PLAN

GAS PROCESSING STUDY

HUMBLE OIL AND REFINING COMPANY
SBC, CALIFORNIA

SCALE 1" = 100'

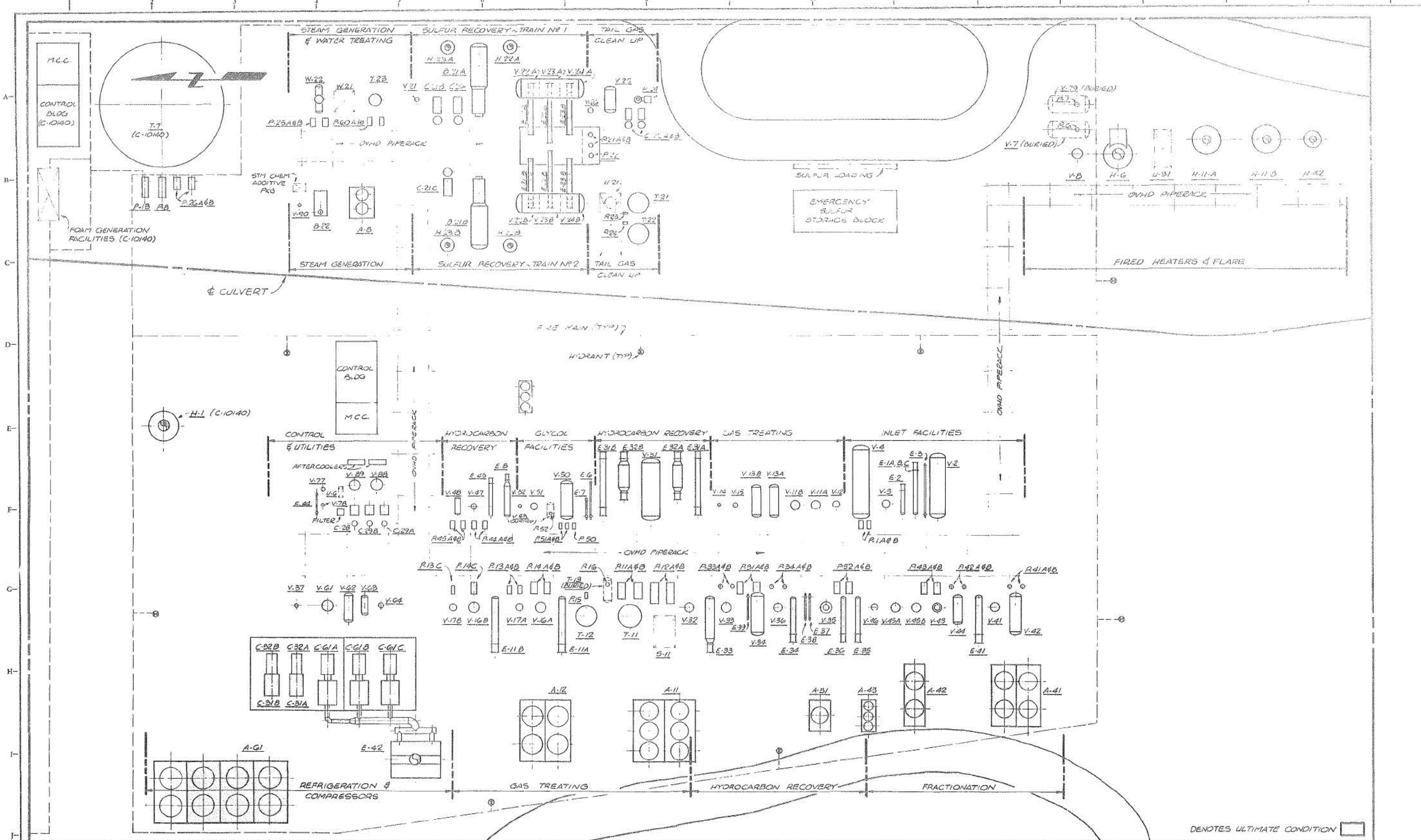
Stearns-Roger CORPORATION

ORDER NO. 8-41449

DWG. NO. 22070

SHEET NO. 00-2-01

REV. △



NO.	REVISIONS	DATE	BY	CH'D	APP'D

NO.	REFERENCE DRAWINGS

PRINT RECORD: DATE / FOR / REVISED / CUSTOMER / FIELD / INTRA CO.

ENG. RECORD: DRAWN / CHECKED / MECH. CK. / STRUCT. CK. / ELECT. CK. / PIPING CK.

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FOR COMMENTS AND/OR APPROVAL	
APPROVED FOR CONSTRUCTION	
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PLOT PLAN
GAS PROCESSING FACILITIES
GAS PROCESSING STUDY

HUMBLE OIL AND REFINING COMPANY
SBC, CALIFORNIA

SCALE 1" = 20'

Stearns-Roger CORPORATION

ORDER NO. B-41449

DWG. NO. 22070

SHEET NO. 00-2-02

REV. △

PLANT CONSTRUCTION

B-41449
August 1971

HUMBLE OIL AND REFINING COMPANY
GAS PROCESSING FACILITY
SANTA BARBARA CHANNEL

PLANT CONSTRUCTION

GENERAL

As mentioned previously in this report, the gas processing facility will be located in Las Flores Canyon approximately 1-1/4 miles north of U.S. Highway 101 and 15 miles west of the city of Santa Barbara in Santa Barbara County, California.

Preliminary schedules indicate the period of plant construction as being approximately 34 weeks (or 8 months). The attached "bar-chart" schedule gives a preliminary picture of various phases of engineering and construction.

Based on a preliminary field manhour estimate to perform the work, a peak construction crew of approximately 140 men is indicated plus a field supervisory staff of 7-10 people. The attached craft manpower curve gives the prediction of craft requirements during the course of construction. This curve indicates the peak will occur at approximately the 75% point in the schedule.

PROCEDURES AND TECHNIQUES

The construction crew will include a supervisory staff of 7-10 people, including a superintendent, an assistant, field engineer, material man/field purchasing agent, accountant, timekeepers, cost engineer, and technical supervisors as required. Craft personnel, averaging 65 in number with a peak of approximately 140, will be employed.

A temporary field office for use during the construction phase will be provided along with a materials warehouse, craft change rooms, and sanitary facilities. The requirements of the "Safety and Health Regulations for Construction" as published by the Department of Labor, in regard to drinking water and sanitary facilities, will be met as well as the requirements of any local codes. The criteria for the type of sewage disposal system selected as discussed in the "Plant Design" section of this report will also apply for construction requirements.

PROCEDURES AND TECHNIQUES - continued

Electrical power feeders will be brought into the plantsite area prior to the start of construction. This power will be used on a temporary basis during construction; and then installed in a permanent manner to supply plant requirements. Electrically powered small tools and small construction equipment (such as motor driven air compressors) will be utilized wherever possible. Temporary building heating, if required, will be either electrical or from commercial propane or butane. Other fuel requirements for construction purposes are minimum; therefore, the danger of fire or explosion is minimized.

Heavy construction equipment required will include medium sized cranes, hydraulic cranes (cherry pickers), bulldozers, front end loaders, flatbed and pickup trucks, etc. Tall vertical vessels or towers will be erected either with large hi-lift cranes or utilizing a "gin-pole" arrangement.

Ready-mix concrete will be used for all major foundation work in this plant. Ready-mix will be obtained from a nearby existing source (possible 15 miles away) requiring concrete trucks to utilize the highways in the area. A period of approximately three months will be required to complete the majority of concrete work.

The majority of piping work, 2-1/2" size and larger, will be fabricated in a fabricating shop in a city remote to the plant, and hauled to the plantsite for installation. Smaller piping, 2" size and under, will be fabricated in a temporary shop set up at the plantsite. Electrical welding machines will be used (rather than gas engines) in most cases for fabrication and installation.

Most plant process and operating equipment will be fabricated in shops remote to the plant area and hauled to the plantsite for installation, with the exception of large storage tanks which will be erected in place in the field. This field erection will require a certain amount of construction equipment and welding machines.

During the course of construction, daily cleanup of trash and debris will be carried on; and disposal of this trash will be made as required at areas designated by the county authorities.

In general, all construction work will be carried on as rapidly as practical in accordance with the recommended practices and codes established for the industry and in accordance with the requirements of local authorities.

EQUIPMENT/MATERIAL DELIVERY

As mentioned above, most of the process and operating equipment in this plant (with the exception of storage tanks) will be fabricated or manufactured at locations remote to the plant area; and then shipped to the plantsite for installation. Some of the larger and heavier items may be shipped by rail to the nearest siding; then hauled by contract truck to the plantsite. However, the majority of items will be hauled direct from the manufacturer's shops by truck (contract hauler or commercial carrier). Other general materials including piping, electrical, structural steel, concrete reinforcing steel, etc. will be delivered by truck, generally a commercial carrier. Miscellaneous materials purchased locally will be delivered by the supplier's truck or picked up by one of the contractor's vehicles.

ENVIRONMENTAL IMPACT

Every precaution necessary to minimize the impact of plant construction on the existing environment will be taken during the course of construction.

Most construction projects are susceptible to a dust problem from loose disturbed soil, excavating equipment, and frequent vehicular traffic throughout the site area. To minimize the dust problem a number of steps will be taken including periodically laying down a coat of road oil on the access road from Highway 101 to the plantsite. At completion of the project, a permanent treatment to this road will be made. Another step will be daily sprinkling of the plantsite with water.

The "Safety and Health Regulations for Construction" prescribe limits of noise exposure for construction personnel. Feasible administrative or engineering controls will be utilized to reduce sound levels to the limits noted. If all such controls fail, then personal protective equipment will be provided. The relatively secluded location of the plantsite with the buffering effect of the surrounding hills should be ideal for minimizing the noise level at the surrounding property lines.

It is anticipated that fresh water wells will be drilled at the plantsite and that this water will be available for use during construction. As mentioned earlier, contamination of the flowing stream through the plantsite area will be avoided. Construction waste materials will not be allowed to be dumped or discharged into this stream without proper treatment.

ENVIRONMENTAL IMPACT - continued

The sewage disposal system installed for construction purposes, as well as the permanent installation, will be a totally enclosed system.

Most of the major construction equipment to be used have either gasoline or diesel engine drives which will emit the usual exhaust vapors associated with this type of equipment. However, studies on air currents through this canyon area indicate that an excellent dispersal of this type of vapor will occur.

Traffic congestion on the local highways will be increased to a small degree during the course of construction from a number of causes. Construction personnel, driving to and from the plantsite in early mornings and mid-afternoons, will contribute perhaps the heaviest congestion. However, with a peak crew of only 140 men, this will not be appreciable. During the working day, periodic deliveries to the plantsite of equipment, concrete, general materials, etc., will be made with large trucks.

Electrical power will be the main utility for operation of construction tools and small equipment. Gasoline and diesel fuels for heavy construction equipment and vehicles will be stored in minimum quantities; and steps will be taken to prevent spills, fire, etc., from occurring during loading or unloading. Other types of fuel for heating purposes, if required, will be commercial bottled propane or butane; and proper equipment and supervision of installation will be utilized to prevent any accidents occurring.

INSPECTION - CODE COMPLIANCE

During the course of construction, inspectors will regularly be on the job to confirm that the plant is being built strictly in accordance with specifications and construction drawings; and that all applicable codes, regulations, restrictions, etc., are being met. They will also regularly be alert to assure that environmental controls are being adhered to.

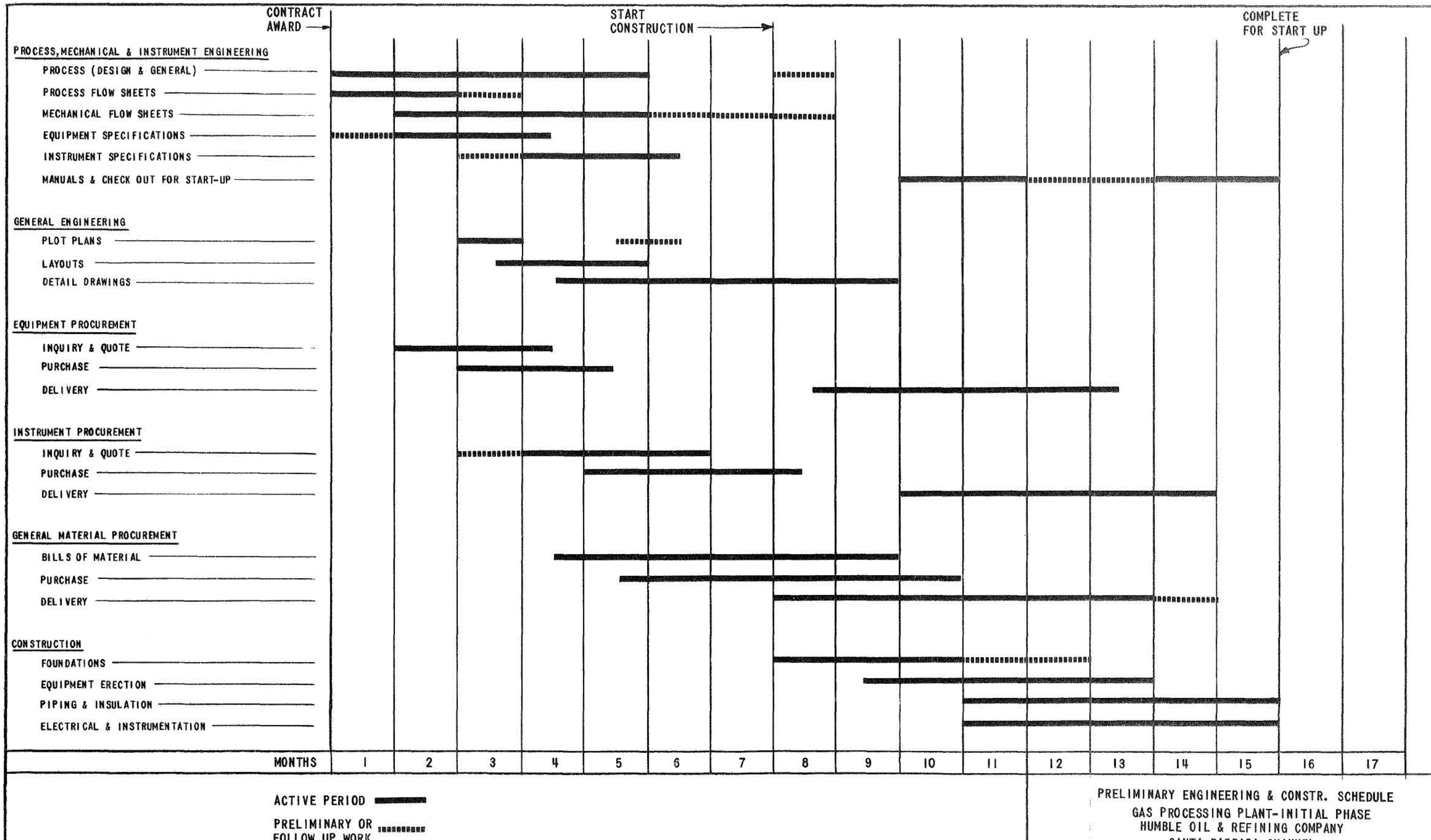
Field engineers will keep a close check on concrete quality control through numerous normally prescribed test procedures; and will maintain proper methods of curing to assure minimum design strengths are attained.

Welding inspectors will check all piping welds made in the field; and x-ray technicians will be used as required by codes to assure welding quality control.

INSPECTION - CODE COMPLIANCE - continued

Miscellaneous engineering technicians will be utilized to assure that the proper piping and electrical materials, fittings, etc., are installed in the proper locations. An instrument supervisor will check out the installation of all instruments, and will check the setting and calibration of all applicable instruments.

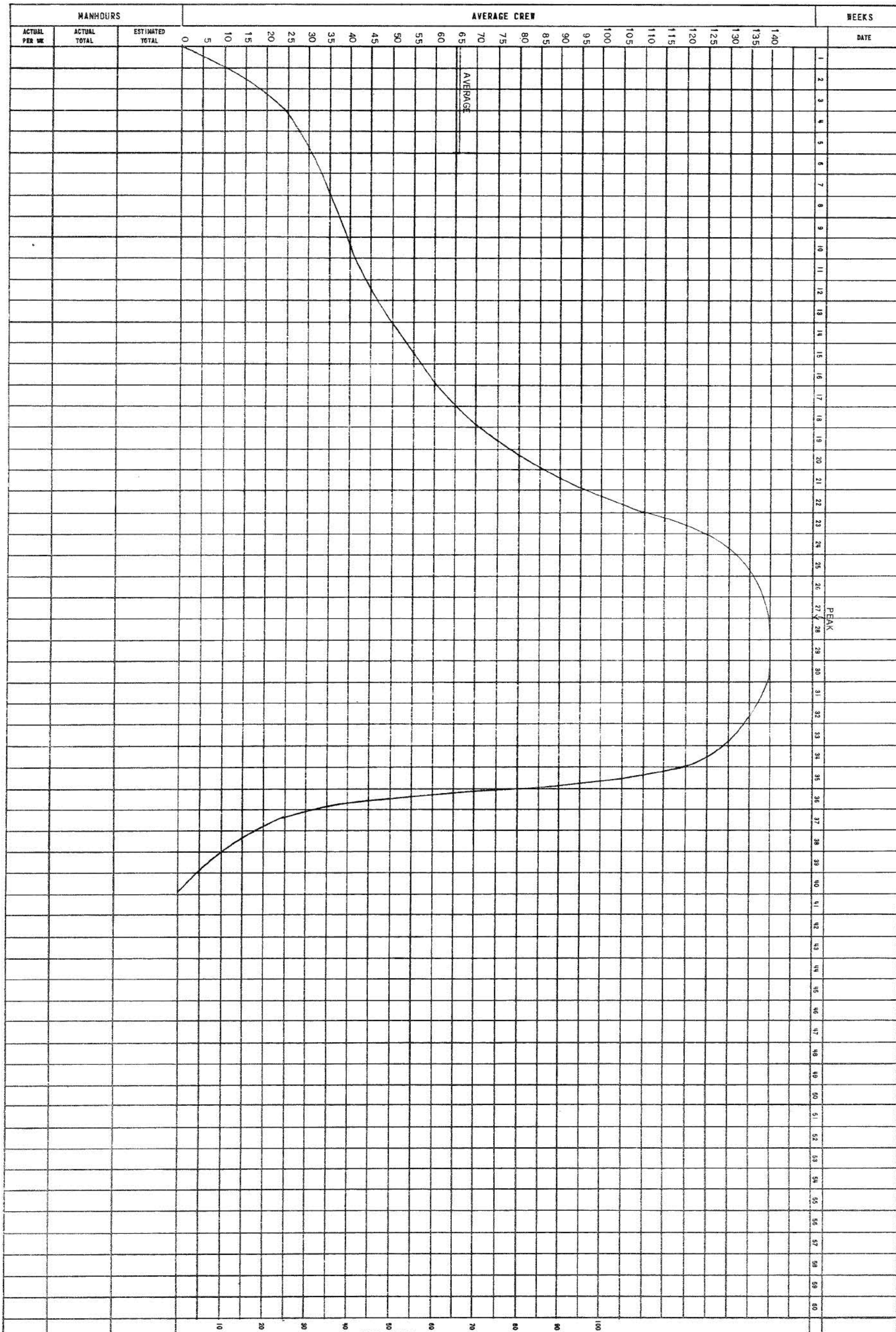
The various inspectors and technicians mentioned above will also assist in establishing certain test procedures of many systems prior to plant startup. Testing and startup is discussed in the following section of this report on "Plant Operation."



PRELIMINARY ENGINEERING & CONSTR. SCHEDULE
GAS PROCESSING PLANT-INITIAL PHASE
HUMBLE OIL & REFINING COMPANY
SANTA BARBARA CHANNEL

Stearns-Roger CORPORATION

B-41449



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NOTES:

PRELIMINARY FIELD CONSTRUCTION CRAFT MANPOWER CURVE
GAS PROCESSING PLANT - INITIAL PHASE
HUMBLE OIL & REFINING COMPANY
SANTA BARBARA CHANNEL

JOB NO.	DATE
B-41449	August 1971

PLANT OPERATION

Stearns-Roger

B-41449
August 1971

HUMBLE OIL AND REFINING COMPANY
GAS PROCESSING FACILITY
SANTA BARBARA CHANNEL

PLANT OPERATIONS

TESTING, STARTUP AND DEBUGGING

After construction of the facility is complete and all lines and equipment have been hydrostatically tested in accordance with the applicable codes, the units are considered ready for operation.

The facilities are then given a final check by process and operating personnel before purging. The first step in putting the plant into operation is to purge all air from the lines and equipment. This purge is usually accomplished by using sweet, dry natural gas or an inert gas such as nitrogen to displace all air from the system. All units are then brought up to operating pressure with the purge medium, and all joints and seals checked for leaks.

After it has been established that the facility is free of any leaks, other systems can be started up and checked out prior to gas processing. The sulfur recovery unit should be dried out and warmed up. Treating solution circulation should be established and brought up to temperature. The refrigeration unit should be filled, checked out and readied for operation. The glycol unit should be brought to operating temperatures.

With all systems ready for operation, sour inlet gas, at reduced rates, can be admitted into the plant, treated, and when sweet, passed through the hydrocarbon recovery unit and on to sales. Acid gases from the treating unit can be started through the sulfur recovery unit. As units are successfully put in operation, the inlet gas rate can be increased up to design capacity.

While any initial startup will produce periods of intermittent gas flaring, the use of a carefully thought-out procedure, based on a program such as described above, can hold this flaring to a minimum period of time. Starting at reduced inlet gas rates will also hold the total quantity of gas flared to a minimum. A procedure such as this should keep the time for startup flaring to 24 hours or less.

TESTING, STARTUP AND DEBUGGING - continued

After the facility is started up, final adjustments and fine tuning of the unit should be accomplished without major upset of the units, and should result in no additional flaring.

NORMAL OPERATIONS

In normal operation, the facility should operate at design rates of inlet and sales gas, and produce products as shown in the "Material and Utility Balances" section of this report.

Measured process variables of temperature, pressure, flow, some levels and some compositions will be transmitted to the central control room where they can be monitored by the plant operators and adjustments to control set points made as necessary. The operating personnel in the control room will have complete control of the major plant operating variables. In case of upsets in plant operations, the operator can shut down and bypass various plant units and, if necessary, shut down the entire plant operation.

Liquid products produced in the hydrocarbon recovery section of the facility will be stored under pressure and shipped from the initial facility by pressure tank truck. Loading of the trucks will be by solid hose connection to the truck with a pressure tight vapor return system to the tanks. The volume of products produced by the initial facility will require eight truckloads per day on the basis of shipping only during the day shift for five days per week.

Sulfur produced in the sulfur recovery unit will be shipped as a liquid in tank trucks. The volume of sulfur produced in the initial plant should require only about one or two trucks per week.

ENVIRONMENTAL IMPACT

In normal operation the facility should release no odors. Emissions to the air will be limited to the products of combustion from burning 970 MSCF/DAY of sweet natural gas in process heaters and gas turbines, plus about 12#/HR of sulfur dioxide from the incinerator. Except for normal rainfall or incidental irrigation (of landscaping) no water will be discharged to surface drainage. All plant waste liquids will be collected and injected, along with produced water from the Crude Oil Facility, into the formation.

ENVIRONMENTAL IMPACT - continued

Proper silencing of equipment will keep noise levels to minimum levels. Because of the very limited use of reciprocating equipment, there will be no measureable vibrations of the earth at the plant boundries.

EMERGENCY CONTROLS AND OPERATIONS

Pressure equipment, by codes, requires pressure relieving devices. All these devices are tied into closed flare, vent and drain systems. In all operations, emergencies can occur due to human errors or mechanical failures. In case of emergencies in the facility, pressure will be relieved into the flare and vent systems and the released hydrocarbon vapors burned in smokeless flares.

All combustion equipment is protected with flame failure devices to shut down individual units in case of flame failure. These devices protect against fire box explosions and prevent venting of unburned gases.