VOLUME 2

TRANSPORTATION STUDY

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C O N T E N T S

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1. INTRODUCTION

In making the study concerning the feasibility of the projected refinery, one of the important factors is transportation.

There has been a remarkable trend toward construction of larger sized tankers in shipbuilding and transportation industries in recent years for the purpose of realizing the economy of scale. The trend was especially conspicuous in crude oil carriers. With regard to the produce carrier, however, probably because of the fact that refining in consuming areas has been predominant, and in case of product trading, cargo size for one shipment has not been so large, this trend has not been fully taken place. However, it is expected that requirement for larger sized product carriers will increase reflecting the increase in refining in oil producing countries. It is noted that freight cost difference between large size tanker and small one trends to increase reflecting increase in crew wages and bunker cost, etc.

It is also noted that several requirements must be met before accommodating larger product carriers. Such requirements are port conditions at loading and receiving terminals, and receiving facilities including tankage.

For the reference of transportation economics future freight cost by tanker size is estimated based on the newbuildings to be delivered in around 1983.

The report attached would provide valuable studies and informations concerning above mentioned problems for the technical/economic feasibility study for the whole project.

2. SUPPLY AND DEMAND FORECAST OF PRODUCT CARRIER

2.1 Tanker Demand

According to the estimates of the OECD and CIA, as shown below, world petroleum consumption is expected to increase at least up to around 1980 at a yearly rate of 3 to 4%.

Table 1

Increase Rate of Petroleum Consumption

Organization	Year	Yearly increase rate
OECD	1977 - 1980	3.4%
CIA	1976 - 1980	3.2 - 4.0%

However, on the other hand, on account of the expected increase of crude oil production in Alaska, the North Sea and Mexico, the ratio of petroleum production within the crude oil consumer zones is expected to increase, and therefore the transportation of petroleum is expected to increase at around 3% yearly, a rate substantially lower than that for petroleum consumption.

Although the ocean movement of petroleum products should be distinguished from those of petroleum, to be exact, they go with parallel in terms of rough trends. Table 2 shows the world petroleum ocean movements between 1970 and 1977.

On the basis of the foregoing data, in the tanker tonnage demand calculation in this study, the yearly increase of the ocean movement of petroleum products after 1978 is assumed to be 3%.

In Table 3, the yearly ocean movement of petroleum products based on the above assumption, and the yearly tanker tonnage demand required to transport this amount with each tanker assumed to make 13.5 voyages per year on an average, are shown up to 1985.

At present, petroleum product carriers are estimated to make 13 to 14 voyages each year on an average. The increase in the movement of petroleum products between the U. S. and the Caribbean countries, where

Table 2

World Petroleum Ocean Movement

Unit: Million tons

Year	Crude oil	Petroleum products	Total
1970	995	245	1,240
1971	1,068	247	1,315
1972	1,184	261	1,445
1973	1,365	274	1,639
1974	1,360	264	1,624
1975	1,259	233	1,492
1976	1,418	260	1,678
1977	1,480	280	1,760

Table 3

Petroleum Products Ocean Movements and Tanker Demand

Year	Ocean movements in million tons	Tonnage demand in million DWTs
1978	288	21.3
1979	297	22.0
1980	306	22.7
1981	315	23.3
1982	325	24.1
1983	334	24.7
1984	344	25.5
1985	355	26.3

more than 20 voyages are possible yearly, in the future, will raise the world average number of voyages per year but the expected full operation of many oil refineries for export products under plan in the Middle East will lower the world average figure due to the long voyage distance of the tankers involved.

On account of these two mutually cancelling factors, the average yearly number of voyages of tankers is assumed to remain at the present level of 13.5 for the next 8 years.

2.2 Tanker Supply

Navigable Product Tanker Tonnage

At present, the majority of petroleum products are transported over the oceans by tankers below 50,000 DWTs. As of January 1978, the world total tonnage of tankers between 10,000 and 49,999 DWTs was approximately 43 million DWTs. In Table 4, the world fleet of tankers between 10,000 and 49,999 DWTs is broken down by tonnage and year built.

Table 4

Breakdown of 10,000 - 49,999 DWT Tankers (Jan. 1978)

Unit: million DWTs

DWT class / Year	10,000 - 19,999	20,000 - 29,999	30,000 - 49,999	Yearly total
- 1950	1.0	0.2	-	1.2
1951 - 1955	1.9	1.0	0.5	3.4
1956 - 1960	2.3	2.9	8.1	13.3
1961 - 1965	0.5	1.9	4.8	7.2
1966 - 1970	0.8	2.0	1.9	4.7
1971 - 1975	1.0	3.1	4.5	8.6
1976 -	0.5	0.5	3.6	4.6
Total	8.0	11.6	23.4	43.0

In the above table, of the tankers in the 10,000 - 19,999 DWT class, most of those built in and after 1952, the year marked by the completion of many large crude oil carriers, can be thought of as product carriers. Similarly, in the 20,000 - 29,999 DWT class, most of those built in and after 1962 can be said to be product carriers, and of the 30,000 - 49,999

DWT class, the majority of those built in and after 1968 are product carriers. From these figures, the world total tonnage of so-called product carriers capable of transporting white oil is estimated to be approximately 20 million DWTs.

The remaining tankers, totaling around 23 million DWTs, are crude oil carriers but are mostly equipped with simple heating coil equipment to make them capable of also transporting black oil.

As of January 1978, the total tonnage of the large product carriers over 50,000 DWTs ordered but undelivered is only one million DWTs, and we cannot expect that products carriers above 50,000 DWTs will soon constitute a majority.

Therefore, in the present study, only tankers in the tonnage range between 10,000 and 49,999 DWTs will be considered as the object of calculation.

The world total demand for product carriers in 1977 is estimated to have been approx. 20 million DWTs. This means, that approx. 50% of the world total tankers in the 10,000 - 50,000 DWTs range were employed to transport petroleum products, but the remaining 50% were thought to have been either finding opportunities to transport crude oil or were simply moored. In this connection, it may be noted that as of January 1978, approx. 2.7 million DWTs of tankers in the 10,000 - 50,000 DWTs range are moored.

Estimate of Scrap Tonnage in the Future

During the period between December 1976 and January 1978, a total of 187 tankers of 5.26 million DWTs were scrapped, with the following breakdown:

10,000 - 20,000 DWTs class: 56 tankers, 940,000 DWTs
20,000 - 30,000 DWTs class: 50 tankers, 1,150,000 DWTs
30,000 - 50,000 DWTs class: 81 tankers, 3,170,000 DWTs

Of this total, approx. 65%, or 3.44 million DWTs, are tankers built in large numbers during the 1956 - 1960 period.

As of January 1978, of a total of 43 million DWTs of tankers between 10,000 and 50,000 DWTs, 42%, or approx. 18 million DWTs, are ones built in or before 1960, and 17%, or 7.2 million DWTs, are ones built between 1961 and 1965.

Therefore, there seems to be no lack of tankers suitable for scrapping, so that the present level of yearly scrapping of 4 - 5 million DWTs is expected to last for some time, despite the prevailing low demand for and price of scrap steel.

In addition, the obligatory plan of equipping a separate ballast tank (SBT) and an inert gas system (IGS) with tanker from 1978, as adopted by the February 1978 IMCO Tanker Safety and Ocean Pollution Control Pact Conference will further promote the scrapping of old tankers.

On the above assumptions, in the present study, the yearly tonnage of scrapped tankers up to 1985 is estimated as shown in Table 5. As can be seen, up to around 1980, as tankers built in large numbers during the 1956 - 60 period reach the age of 20 years in rapid succession, as much as 4.5 million DWTs is estimated to be scrapped yearly. However, after 1981, as tankers with over 20 years of service will decrease, the number of scrapped ones is also expected to decrease.

Table 5

Estimated Yearly Scrapped Tanker Tonnage

Year	Scrapped tonnage: in million DWTs
1978	4.5
1979	4.5
1980	4.5
1981	2.4
1982	1.9
1983	1.7
1984	1.6
1985	1.5

Supply of Newly Built Tankers

As of January 1978, the world total tonnage of undelivered ordered tankers is approx. 2.3 million DWTs, or 84 tankers, as shown in Table 6, and most of them are product carriers.

Table 6

Newbuilding on Order (As of Jan., 1978)

Delivery / Class	1978		1979		1979 or later		Total	
	No.	million DWTs	No.	million DWTs	No.	million DWTs	No.	million DWTs
10,000 - 19,999	16	0.2	3	0.05	1	0.02	20	0.3
20,000 - 29,999	11	0.3	4	0.1	3	0.08	18	0.4
30,000 - 49,999	39	1.3	4	0.14	3	0.1	46	1.6
Total	66	1.8	11	0.3	7	0.2	84	2.3

Estimated Tonnage of Product Tankers

From the data in Tables 4, 5 and 6, the world total tonnage of product carriers, without taking future new ships into consideration, are calculated for years up to 1985 as follows.

Table 7

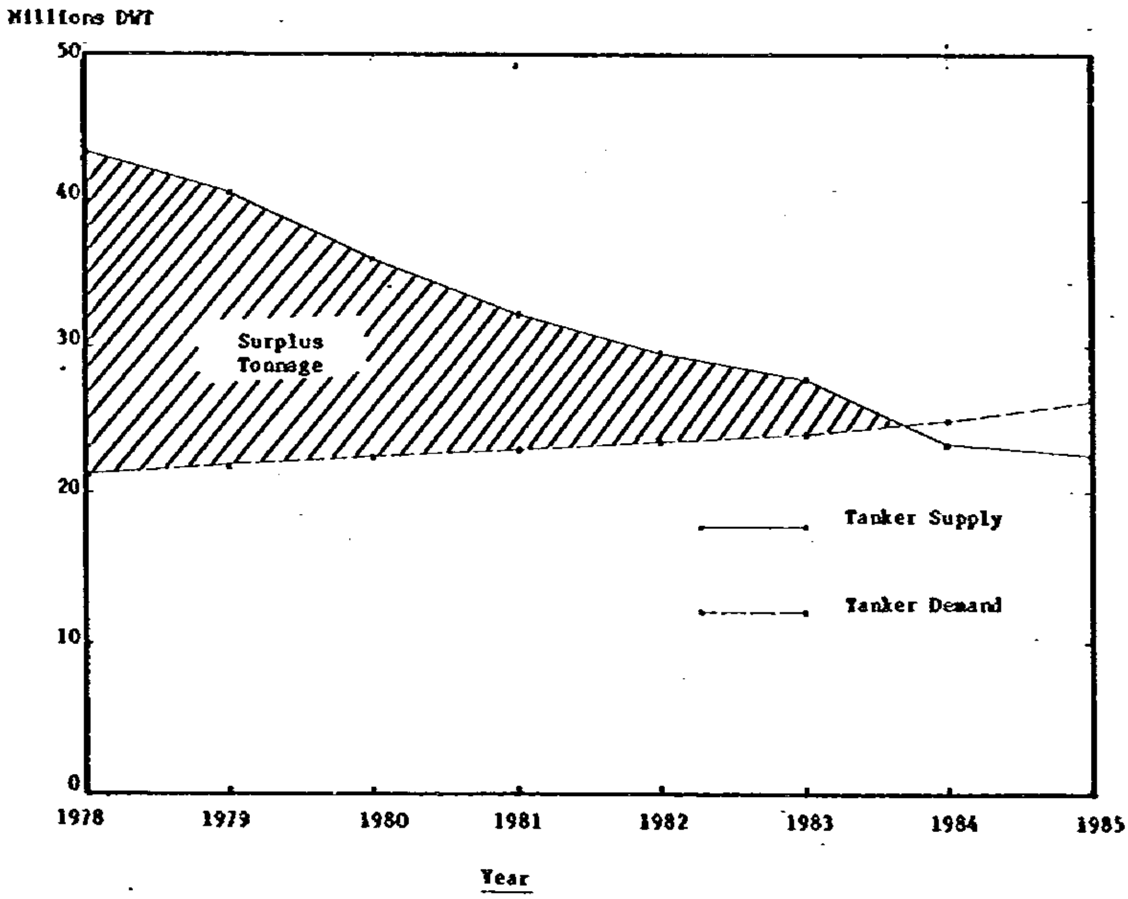
Estimated Products Carrier Tonnage

Year	Tonnage, in million DWTs
1978 beginning	43.0
1978 end	40.3
1979 end	36.1
1980 end	31.8
1981 end	29.4
1982 end	27.5
1983 end	25.8
1984 end	24.2
1985 end	22.7

2.3 Supply and Demand Forecast of Product Carrier

On the basis of the tanker demand estimate in Section 2.1, and the tanker supply estimate in Section 2.2, the future supply demand relationship of product carrier is shown in Fig. 1. As can be seen, the product carrier market is expected to recover only after 1983. However, as no future orders for new ships have been taken into consideration in this forecast, the actual market may take a longer time to recover, depending on the trend of future ship orders.

Figure 1 Supply and Demand Forecast of Product Carrier



3. SIZE OF PRODUCT CARRIER

3.1 Trend of Tanker Size

The trend of world total tonnage of crude oil carriers and product carrier is shown by size in Table 8.

Table 8

Size Distribution of Tanker Fleet From 1973 To 1976

(Million DWT)

Year / DWT class	end 1973	end 1974	end 1975	end 1976
10,000 - 20,000	12	11	10	9
20,000 - 40,000	32	33	31	31
40,000 - 60,000	24	24	22	19
60,000 - 80,000	19	19	19	19
80,000 - 100,000	16	18	21	23
100,000 - 150,000	18	23	30	33
150,000 - 200,000	7	7	8	11
200,000 - 300,000	81	110	130	144
300,000 -	5	7	17	30
Total	213	253	289	318

Although the exact tonnage of product carriers included in the above table is difficult to identify, most of the product carriers are estimated to be smaller than 50,000 DWTs.

The trend of undelivered ordered product carriers after May 1976 is as follows.

Table 9

Trend of Undelivered Product Carriers

in thousand DWTs (No.)

Year / DWT class	May 1976	Feb. 1977	Nov. 1977	Feb. 1978
10,000 - 19,999	334 (21)	224 (14)	223 (15)	207 (14)
20,000 - 29,999	394 (15)	146 (6)	122 (5)	166 (7)
30,000 - 39,999	2,915 (90)	1,734 (54)	1,078 (34)	885 (28)
40,000 - 49,999	87 (2)	393 (9)	481 (11)	481 (11)
50,000 - 59,999	1,255 (23)	925 (17)	878 (16)	923 (16)
60,000 -	369 (4)	132 (2)	132 (2)	132 (2)
Total	5,353 (155)	3,556 (102)	2,914 (83)	2,794 (78)

As can be seen, building plans are centered around 30,000 DWT class tankers, although larger tankers in the class 50,000 - 60,000 DWTs are also ordered to a certain extent.

3.2 Prevailing Size of Product Carrier

The order situation of new tankers above 10,000 DWTs as of February 1978 is extracted and shown in Table 10.

Table 10

Product Carriers on Order

(as of Feb. 1978)

DWT class	No. of tankers	Total DWTs
10,000 - 19,999	14	207,490
20,000 - 29,999	7	165,700
30,000 - 39,999	28	884,958
40,000 - 49,999	11	480,700
50,000 - 59,999	16	923,138
60,000 -	2	132,000
Total	78	2,793,986

Of the product tankers being built at present, of the 78 tankers amounting to 2.79 million DWTs, the majority are in the class between 30,000 and 40,000 DWTs, that is 28 tankers amounting to 880,000 DWTs, all below 35,000 DWTs. Of the 11 tankers in the 40,000 - 50,000 DWT class, 10 are ones ordered by PEMEX alone, and in the class above 60,000 DWTs, there are only two 66,000 DWT product carriers.

As the oil refineries planned in the Near and Middle East, Southeast Asia, Far East, and Caribbean countries for the export of products are mostly delaying construction from the initial schedules under the prevailing recession and low demand for petroleum, large product carriers for transporting the products of these refineries over long distances have not yet come to lead in the world's tanker building.

3.3 Current Situation of Product Import in Japan

According to the data published by the Agency of Natural Resources and Energy in April 1978, the record of imported petroleum products from 1972 to 1977 is as follows:

Table 11

Petroleum Products Imported by Japan

(in thousand kl)

Year / Products	1972	1973	1974	1975	1976	1977
Gasoline	2	13	13	-	-	-
Naphtha	6,103	6,222	7,138	5,939	7,994	8,528
Jet fuel	478	693	537	574	547	462
Kerosene	-	88	-	-	30	5
Gas oil	40	89	101	94	158	33
A fuel oil	2,634	2,819	3,302	2,321	1,797	1,854
B fuel oil	1,721	1,965	1,440	276	-	-
C fuel oil	12,611	11,249	9,010	8,890	11,712	12,480
Total	23,589	23,138	21,541	18,094	22,238	23,362

To break down the tankers used in importing these products into size classes exactly is very difficult. Almost all the products tanker berths in Japan can accommodate fully loaded handy class tankers (18,000 - 22,000 DWTs), and many of these berths are also capable of accommodating for tankers in the 30,000 - 50,000 DWT class. Consequently, the majority of product tankers for which demand in greatest will be between 20,000 and 50,000 DWTs.

Since fuel oil and naphtha constitute the coverwhelming majority of the petroleum products imported by Japan, large tankers for low grade products are mostly employed.

4. OCEAN FREIGHT ESTIMATES

4.1 Trend of Tanker Building Cost

Among the tankers built in the 1965-75 period between 100,000 and 400,000 DWTs, so-called VLCCs (Very Large Crude Oil Carriers) ranging between 200,000 and 280,000 DWTs are the ones built in the largest number and ones which have experienced least structural changes since.

Although some of the early tankers were not equipped with IGS (Inert Gas System), the price of the system, below 5% of the total contract price of a tanker, can be neglected in studying the trend of tanker prices.

Turbine engines of 34,000 - 40,000 HP used as the main drives of most of the tankers and diesel engine main drives used in a few tankers do not have substantially different initial prices.

On the basis of the above situation, 65 schedule-built VLCCs are selected out of the VLCCs built since 1969, and the trend of their building cost is shown in Table 12. According to this table, tanker costs rose at a yearly rate of 7.5 - 8% to 173.7 during the 7 years from 1969 to 1976 taking the 1969 level as 100.

Table 12

Trend of VLCC Building Cost

Built year	Q'ty	Total tonnage (DWTs)	Total cost (US$ million)	Average cost (US$/DWT)	Cost index
1969	4	822,700	93.9	114	100
1970	6	1,310,800	155.8	119	104.4
1971	10	2,250,500	269.5	120	104.8
1972	14	3,344,300	440.8	132	115.5
1973	12	2,917,000	499.7	171	150.2
1974	8	1,974,800	351.0	178	155.8
1975	6	1,475,500	273.2	185	162.2
1976	5	1,210,200	239.8	198	173.7

(Note) Actual data of 65 VLCCs (200,000 - 280,000 DWTs) built by 8 representative Japanese shipbuilders.

Exchange rate : 1 US$ = 220 Yen

4.2 Price of Newly Built Tankers

The estimated prices of product tankers built in 1978 by major Japanese shipbuilders are as shown in Table 13.

Although no 130,000 DWT clean tanker or 230,000 DWT dirty tanker have been built actually, their prices are estimated on the basis of the price of existing crude oil carriers of comparable size and the price of the 50,000 - 60,000 DWT class product carriers in the above table. These large products carriers could, needles to say, be built from the purely technical viewpoint.

On the basis of the yearly price increase of 7.5 - 8.0% of crude oil carriers, as estimated in the previous section, and the existing conditions in the shipbuilding industry, the price of product carriers is estimated to rise at a yearly rate of 5 - 6% during the 1978 - 83 period. The prices of product carriers to be completed in 1983 shown in Table 14 has been calculated with yearly price rise of 6.0%.

Table 13

Estimated Price of Product Carriers (built in 1978)

Tanker class	Tanker price (US$ million)
Clean tanker	
30,000 DWT class	16
50,000 DWT class	20
60,000 DWT class	21
130,000 DWT class	34
Dirty tanker	
80,000 DWT class	21
90,000 DWT class	23
230,000 DWT class	45

(Note) Exchange rate : 1 US$ = 220 Yen

Table 14

Estimated Prices of Product Carriers (built in 1983)

Tanker class	Price in US$ million
Clean tanker	
30,000 DWT class	21.3
50,000 DWT class	25.0
60,000 DWT class	28.0
130,000 DWT class	45.6
Dirty tanker	
80,000 DWT class	28.0
90,000 DWT class	30.4
200,000 DWT class	54.2
230,000 DWT class	60.8

(Note) Exchange rate : 1 US$ = 220 Yen

4.3 Bases for Ocean Transportation Cost Estimates

In the estimation of transportation cost based on the new tanker prices shown above, the following conditions have been assumed.

Structure of Transportation Cost

Transportation cost has been broken down into the three constituents, the capital related expenses, ship's expenses, and voyage expenses, as shown below:

Transportation cost	Capital related expenses	Depreciation
		Interest
	Ship's expenses	Crew expenses
		Supplies
		Lubricants
		Insurance
		Repair expenses
		Overhead
	Voyage expenses	Port charges
		Fuel cost
		Others

Estimation Basis

- Depreciation: On the assumption that tankers are registered in countries where depreciation is free, a yearly fixed amount depreciation of 10% of the tanker price, that is, 100% depreciation in 10 years, has been assumed.

- Interest: The whole ship price has been assumed to be borrowed and the principal has been assumed to be fully repaid in 10 years with a yearly interest rate of 9.5%.

- Crew expenses: Crew members are assumed to be recruited in Hong Kong, the Philippines, and other South East Asian countries, and the values have been determined without regard to ITF (International Transport-workers Federation) Standards, with a yearly escalation rate of 8%.

- Insurance: The yearly insurance premium is assumed to be 0.8% of the total price of tanker.

- The following expenses are estimated based on the accumulated actual data provided the yearly escalation rates as listed below:

Item	Yearly escalation rate
Supplies, lubricants	5%
Repair expenses	5%
Overhead	5%
Port charges	6%
Fuel cost	6%
Others (Communications, etc.)	5%

- Exchange rate: 1 US$ = 220 Yen

- An allowance of 5 percent is added on ship's costs to cover interest during shipbuilding period.

4.4 Transportation Cost Estimates by Tanker Calss

On the premises obtained so far, the transportation costs of each tanker class have been calculated for the three cases given below (refer to Tables 17 through 19).

(1) The first year transportation cost using 1978 new tankers
(2) The first year transportation cost using 1983 new tankers
(3) The 10 year mean transportation cost using 1983 new tankers

The summary of the calculation is given below.

Table 15

Transportation Cost Calculated
by Tanker Classes: $/LT

Tanker class	Yearly transport's 10^3 LT	1978 new tankers	1983 new tankers	
		first year cost	first year cost	10 year mean cost
Clean tankers				
30,000 DWT	221	24.03	32.68	33.93
50,000 DWT	374	16.60	22.53	23.31
60,000 DWT	450	15.47	20.96	21.53
130,000 DWT	1,002	10.67	14.41	14.37
Dirty tankers				
80,000 DWT	609	11.76	15.93	16.51
90,000 DWT	687	11.33	15.40	15.96
180,000 DWT	1,397	-	11.55	11.56
200,000 DWT	1,552	-	11.16	11.13
230,000 DWT	1,785	8.02	10.82	10.76

As shown in the table above, the transportation cost differes by 3 to 8$/LT between 1978 and 1983 new tankers, with the difference more marked in smaller tanker classes. This is due to the difference in the tanker building costs estimated on the basis of 6.0% yearly rise rate. The small difference of less than $1/LT between the 1983 tankers' first year cost and 10 years mean cost is due to the cancelling effect between the decreasing factor of interest burden and the increasing factors of repair expenses, personnel and fuel expenses with inflation. When the 10 years mean transportation cost is considered to be the ocean freight, the first year transportation cost can reasonably be taken as a criterion of the rate.

The breakdown of the transportation cost of a 60,000 DWT clean tanker, built in 1978 for the first year and for 1983, 5 years after the building is shown in Table 16.

Table 16

Change of Transportation Cost by Years

	Initial year (1978)	After 5 years (1983)	Difference (1978)-(1983)
Yearly cost in $1000			
(1) Capital related expenses			
Depreciation	2,196	2,196	0
Interest	2,033	988	1,045
Subtotal	4,229	3,184	1,045
(2) Ship's expenses			
Crew expenses	280	411	- 131
Repair expenses	289	622	- 333
Insurance	176	176	0
Others	265	339	- 74
Subtotal	1,010	1,548	- 538
(3) Voyage expenses			
Fuel	1,503	2,011	- 508
Port charges, etc.	219	290	- 71
Subtotal	1,722	2,301	- 579
Total of (1), (2) and (3)	6,961	7,033	- 72
Transportation Cost $/LT	15.47	15.63	-0.16

(Yearly transportation quantity: 450,000 LT)

Table 17

Calculation Table on Ocean Transportation Cost (1)
(Tankers build in 1978; Calculation for the initial year)

(Unit: 10^3 \$)

		Clean Tanker				Dirty Tanker		
Tanker size	10^3 DWT	30	50	60	130	80	90	230
Tanker cost		16,700	19,600	22,000	35,800	22,000	23,900	47,700
1. Capital related expenses								
Depreciation		1,673	1,955	2,196	3,582	2,196	2,386	4,773
Interest		1,549	1,810	2,033	3,318	2,033	2,210	4,421
Subtotal		3,222	3,765	4,229	6,900	4,229	4,596	9,194
2. Ship's expenses								
Crew expenses		280	280	280	280	280	280	280
Supplies		50	50	50	60	60	60	60
Lubricants		75	90	90	130	100	110	177
Insurance		134	156	176	287	176	191	382
Repair expenses		263	289	289	347	289	289	416
Overhead		117	122	125	140	128	133	165
Subtotal		919	987	1,010	1,244	1,033	1,063	1,480
3. Voyage expenses								
Port charges		103	147	169	349	214	242	530
Fuel		1,016	1,261	1,503	2,149	1,637	1,883	3,065
Others		50	50	50	50	50	50	50
Subtotal		1,169	1,458	1,722	2,548	1,901	2,125	3,645
Grand Total		5,310	6,210	6,961	10,692	7,163	7,784	14,319
Yearly transportation quantity	10^3 LT	221	374	450	1,002	609	687	1,785
Transportation cost	\$/LT.	24.03	16.60	15.47	10.67	11.76	11.33	8.02

Table 18

Calculation Table on Ocean Transportation Cost (2)
(Tankers build in 1983; Calculation for the initial year)

(Unit: 10^3 \$)

	Clean Tanker				Dirty Tanker				
Tanker size 10^3 DWT	30	50	60	130	80	90	180	200	230
Tanker cost	22,400	26,200	29,400	47,900	29,400	31,900	52,400	56,900	63,900
1. Capital related expenses									
Depreciation	2,241	2,615	2,938	4,792	2,938	3,193	5,244	5,692	6,386
Interest	2,076	2,422	2,720	4,438	2,720	2,957	4,875	5,272	5,913
Subtotal	4,317	5,037	5,658	9,230	5,658	6,150	10,101	10,964	12,299
2. Ship's expenses									
Crew expenses	411	411	411	411	411	411	411	411	411
Supplies	64	64	64	77	77	77	77	77	77
Lubricants	96	115	115	166	128	140	192	203	226
Insurance	179	209	235	383	235	255	420	455	511
Repair expenses	443	487	487	585	487	487	596	631	701
Overhead	150	156	160	179	164	170	179	190	211
Subtotal	1,343	1,442	1,472	1,801	1,502	1,520	1,875	1,967	2,137
3. Voyage expenses									
Port charges	138	197	226	467	286	324	603	638	709
Fuel	1,360	1,688	2,011	2,876	2,191	2,520	3,487	3,690	4,102
Others	64	64	64	64	64	64	64	64	64
Subtotal	1,562	1,949	2,301	3,407	2,541	2,908	4,154	4,392	4,875
Grand Total	7,222	8,428	9,431	14,438	9,701	10,578	16,130	17,323	19,311
Yearly transportation quantity 10^3 LT	221	374	450	1,002	609	687	1,397	1,552	1,785
Transportation cost \$/LT	32.68	22.53	20.96	14.41	15.93	15.40	11.55	11.16	10.82

Table 19

Calculation Table on Ocean Transportation Cost (3)
(Tankers build in 1983; Calculation for the average of 10 years)

(Unit: 10^3 $)

	Clean Tanker				Dirty Tanker				
Tanker size 10^3 DWT	30	50	60	130	80	90	180	200	230
Tanker cost	22,400	26,200	29,400	47,900	29,400	31,900	52,400	56,900	63,900
1. Capital related expenses									
Depreciation	2,241	2,615	2,938	4,792	2,938	3,193	5,244	5,692	6,386
Interest	1,118	1,297	1,451	2,391	1,465	1,594	2,616	2,838	3,186
Subtotal	3,359	3,912	4,389	7,183	4,403	4,787	7,860	8,530	9,572
2. Ship's expenses									
Crew expenses	596	596	596	596	596	596	596	596	596
Supplies	80	80	80	96	96	96	96	96	96
Lubricants	121	145	145	209	161	176	242	255	284
Insurance	179	209	235	383	235	255	420	455	511
Repair expenses	923	1,015	1,015	1,219	1,015	1,015	1,241	1,314	1,461
Overhead	187	196	201	225	206	214	224	239	265
Subtotal	2,086	2,241	2,272	2,728	2,309	2,352	2,819	2,955	3,213
3. Voyage expenses									
Port charges	182	259	298	616	377	427	795	841	935
Fuel	1,792	2,225	2,651	3,791	2,888	3,321	4,596	4,863	5,406
Others	80	80	80	80	80	80	80	80	80
Subtotal	2,054	2,564	3,029	4,487	3,345	3,828	5,471	5,784	6,421
Grand Total	7,499	8,717	9,690	14,398	10,056	10,967	16,150	17,269	19,206
Yearly transportation quantity 10^3 LT	221	374	450	1,002	609	687	1,397	1,552	1,785
Transportation cost $/LT	33.93	23.31	21.53	14.37	16.51	15.96	11.56	11.13	10.76

5. DISCUSSION ON LARGE PRODUCT CARRIERS

5.1 Economical Merits of Large Product Carriers

As can clearly be seen from the comparison of transportation costs by tanker classes, in the previous section, the larger the tanker, the lower becomes the transportation cost per ton, and hence the rate. On the other hand, however, with the increase of tanker size, the tanker price and daily cost become higher, and hence the risk of idle hours resulting from operation procedures becomes larger. This means, so as not to incur losses from idle hours, the operation systems on both the loading and unloading ports must be well controlled to eliminate waiting time in the offering and when berthed. For this reason, in determining the size class of the tankers to be employed, the loading capacity of the berth and other equipment at the loading port and the capacities of the tanks, berths and other unloading equipment in the unloading port should be given the highest priority as the determining factors, and the largest possible tanker class that can be satisfactorily employed under the existing port conditions should be employed.

5.2 Current Product Unloading Facilities in Japan

Listed in Table 17 are petroleum unloading sea berths in service today which are accommodating large vessels. The majority of these berths can accept large tankers over 200,000 DWTs alongside, and are equipped with large scale land facilities. However, since almost all of these facilities are directly connected to the crude oil tanks of refineries or crude oil receiving terminals, they cannot be utilized as the petroleum products receiving facilities.

On the other hand, as can be seen in Table 18, showing the maximum acceptable tanker classes at the major petroleum product unloading ports, there are only a small number of marine terminals for clean tankers, and the acceptable size of these tankers is limited to the medium class between 45,000 and 70,000 DWTs.

Table 20

Summary of Large Unloading Terminals in Japan

Area	No.	Range of Vessel Size (DWT)	Draft (m)	Total Crude Tanks (thousand Kℓ)	Total Product Tanks (thousand Kℓ)
Hokkaido	1	75,000 - 280,000	21.5	720	350
Tohoku	1	10,000 - 230,000	16.5	800	480
Keihin	1	10,000 - 110,000	13.1/15.2	320	490
	2	120,000 - 200,000	19.0	2,320	-
	3	100,000 - 260,000	19.2	6,080	3,680
	4	100,000 - 250,000	20.0	910	240
	5	60,000 - 200,000	19.5	2,490	1,290
	6	30,000 - 150,000	16.5	1,150	700
Chukyo	1	- 250,000	20.0	340	90
	2	70,000 - 280,000	23.0	1,920	520
	3	50,000 - 230,000	18.0	730	390
	4	80,000 - 275,000	20.0	1,900	450
Hanshin	1	30,000 - 245,000	21.0	500	230
	2	100,000 - 258,000	19.2	960	450
Chugoku	1	50,000 - 230,000	15.8	1,550	640
	2	70,000 - 275,000	19.5	1,040	760
Kyushu and Okinawa	1	33,000 - 500,0000	28.0	6,700	110
	2	20,000 - 400,000	26.0	1,200	-

Table 21

Summary of Product Unloading Terminal in Japan

Area	No.	Maximum Size of Vessel (DWT)		Draft (m)
		Clean Tanker	Dirty Tanker	
Tohoku	1	Not Avail.	234,000	
Keihin	1	70,000	70,000	13.3
	2	N.A.	N.A.	
	3	N.A.	150,000/50,000	16.5/12.0
	4	N.A.	33,000	10.5
	5	N.A.	80,000	
Chukyo	1	45,000	45,000	10.0
Hanshin	1	N.A.	50,000	11.8
	2	2,000	N.A.	
	3	N.A.	80,000	
	4	N.A.	60,000	
	5	N.A.	90,000	
Chugoku	1	50,000	50,000	
	2	45,000	45,000	12.5
Shikoku	1	70,000	70,000	
Kyushu and Okinawa	1	N.A.	95,000	15.5
	2	N.A.	N.A.	

N.A. : not available

With limited exceptions, marine terminals for dirty tankers can also accommodate the medium class of tankers between 45,000 and 90,000 DWTs.

6. SCALE OF TANKER FLEET FOR THIS PROJECT

The following two cases are conceivable as methods of transporting petroleum products from the refinery in Iran to Japan.

(1) Direct transportation

Petroleum products will be directly transported from the refinery to the Japanese ports of unloading with medium tankers, i.e., 60,000 DWT class clean tankers and 90,000 DWT class dirty tankers.

(2) Transportation via CTS

First, a petroleum products are transported to a central terminal system (CTS) capable of receiving large products carriers over 200,000 DWTs in Japan, and all the domestic markets will be supplied with products from this CTS.

For the primary transportation to the CTS, large clean tankers up to 130,000 DWTs, and dirty tankers up to 200,000 DWTs will be used, and for the secondary domestic transportation, clean tankers and dirty tankers both in the 50,000 DWT class will be used.

For 500,000 BPSD of the refinery capacity, the volumes of products to be transported are shown in Table 22 as per the examined both cases of the hydroskimming (case 1) and hydrocracking (case 2) type refineries.

With assumption that each ocean-going tanker makes 8 round trips between Iran and Japan every year, and that each domestic transportation tanker makes 59 round trips a year, the required fleet size has been calculated as shown in Table 23.

Table 22

Yearly Products Transportation

Volumes in thousand LT

Oil type	Case 1	Case 2
White oil	10,660	12,540
Black oil	7,900	5,760
Total	18,560	18,300

Table 23

Required Tanker Fleet

(for refinery capacity of 50,000 BPSD)

		Case 1	Case 2
Direct transportation	White oil	60,000 DWT x 24 tankers	60,000 DWT x 28 tankers
	Black oil	90,000 DWT x 12 tankers	90,000 DWT x 9 tankers
Transportation via CTS	Primary transportation		
	White oil	130,000 DWT x 10 tankers 60,000 DWT x 1 tanker	130,000 DWT x 12 tankers 50,000 DWT x 1 tanker
	Black oil	200,000 DWT x 5 tankers	200,000 DWT x 4 tankers.
	Secondary transportation		
	White oil	50,000 DWT x 4 tankers	50,000 DWT x 5 tankers
	Black oil	50,000 DWT x 3 tankers	50,000 DWT x 2 tankers

VOLUME 3

PLANT DEFINITION

VOLUME 3

PLANT DEFINITION

C O N T E N T S

1. INTRODUCTION

This volume is compiled to outline the individual facilities which are defined in Chapter 5 of Book II, Report.

The brief descriptions and illustrative drawings for the facilities will serve as an information to comprehend the technical bases of the defined facilities. Moreover, such basic information as climatic, maritime, soil and utility supply conditions are compiled and attached as a preliminary basic engineering design data and a list of codes and standards as well.

It is noticed that although the process units are defined among those having a proven record with several plants in successful commercial operation, their licensors are not selected and identified at this stage. Therefore, the descriptions for the individual process units are made limitedly to the identification of major process requirements. It is considered that the selection of the process licensors will be made in the subsequent phase of the project.

2. CRUDE OIL PIPELINE

The crude oils to be refined in the export refinery are to be transported through crude oil pipelines to be constructed between the crude oil pick-up point at the existing Gurreh pump station and the refinery sites.

The pipeline routes for the candidate four refinery sites are selected based on a map analysis and also an aerial survey and are shown in the attached Pipeline Route Map (DWG. No. 300-10-SK-001 (0-8)).

Gurreh, the starting point of this pipeline system, is a deposited table-land and alluvial cone with an altitude of about 30 to 40 m, traversed by many river gorges and wadis. The topography of the area between Ganaveh and Bushehr is relatively flat and the altitude is between 5 m and 12 m. The geology of this area is silt on sand and gravel deposits.
This area appears as a fan-shaped tableland. A number of large rivers including Rūd-e Shūr and Helleh run through this area. The area between the east part of Bushehr and west foot of Kūhe Mond is flat land or of tilted topography along the coast line, and the geology of this area is such that many rocks and bituminous soil are observed. There are a number of wadis, and it is considered that water flows in these wadis during the rainy season.

In addition, it is considered that this area is directly affected by the climate of the gulf, as this area is along the coastline

The pipeline is entirely buried under the ground except for the terminal where sphere launching/receiving and measurement of oil flow rate are made. As shown in the attached Simplified Flow Diagram for Crude Oil Pipeline (DWG. No. 300-10-SK-002 (1), (2)), the equipment attached to the pipeline are composed of intermediate stop valves, pressure safety valves, pressure control valves, sphere launcher and receiver, measuring instruments and other equipment which are required for safe operation of the pipeline and it is planned not to install intermediate pump stations.

Sizes of the pipeline for the four candidate sites are defined on the basis that the crude oils, 50 percent of Iranian light crude and 50 percent of Iranian heavy crude are transported through segregated two pipelines and no intermediate pump station is installed.

The sizes defined are summarized as follows:

Refinery Site	Length	Pipe Size for Capacity		
		125,000 BPSD	250,000 BPSD	500,000 BPSD
Farageh	95 Km	14 inches	18 inches	24 inches
Chughadak	140 Km	16 inches	20 inches	26 inches
Muhammad Ameri	165 Km	16 inches	20 inches	26 inches
Ameri	190 Km	16 inches	20 inches	26 inches

Refer to the attached figure (DWG. No. 300-10-SK-003) for pressure profile in planned crude oil pipeline.

3. REFINERY FACILITIES

Facilities which will constitute the export refinery are outlined along the following;

- Process Units
  - Atmospheric Crude Distillation
  - Vacuum Flasher
  - Gas Recovery
  - Naphtha Hydrodesulfurizer
  - Catalytic Reformer
  - Kerosene Hydrodesulfurizer
  - Gas Oil Hydrodesulfurizer
  - Vacuum Gas Oil Hydrodesulfurizer
  - Vacuum Gas Oil Hydrocracker
  - Atmospheric Residue Hydrodesulfurizer
  - Visbreaker
  - Hydrogen Generator
  - Gas Treater
  - Sulfur Recovery
  - Foul Water Stripper
- Utility Facilities
  - Steam Boilers
  - Electric Power Generators
  - Sea Water Desalinators
  - Potable Water Supply System
  - BFW Treatment System
  - Steam Condensate Recovery System
  - Cooling Water System
  - Refinery Fuel Oil System
  - Air System
  - Inert Gas System
- Off-site Facilities
  - Tankage
  - Product Loading Pipelines
  - Sulfur Handling and Shipping System

- Fire-fighting System
- Effluent Treatment System
- Waste Material Incineration System
- Instrument and Computor System
- Buildings and Equipment

3.1 Process Units

3.1.1 Atmospheric Crude Distillation

This unit processes two (2) different crude oils, namely, Iranian light and Iranian heavy crude oils, and separates them into such fractions as whole naphtha, kerosene, gas oil and two (2) types of residues.

For the refining capacity of 250,000 BPSD and 500,000 BPSD, each crude oil is distilled in respective train of the unit, while the dual flasher system is employed for 125,000 BPSD case.

Two (2) stages desalter is adopted in this unit and the foul water stripping facility is provided to treat waste water from the desalters.

The separation temperatures and estimated yields of this unit are as follows:

Separation Temperatures (Same for both crude oils)

Whole Naphtha	Less than 154°C
Kerosene	154 - 235°C
Gas Oil	235 - 371°C
Residue	Over 371°C

Yields (vol %)

	Iranian L't	Iranian H'y
Whole Naphtha (Unstabilized)	22.05	20.50
Kerosene	14.70	13.50
Gas Oil	22.75	21.35
Residue	40.50	44.65
Total	100.00	100.00

3.1.2 Vacuum Flasher

This unit processes the atmospheric residue from the crude distillation unit and separates it into vacuum gas oil and vacuum residue.

The separation ranges for vacuum gas oil and vacuum residue are 371-538°C and over 538°C, respectively.

The estimated yields and properties of this unit are as follows:

Yields (vol % on crude)

	IL	IH
Vacuum Gas Oil	24.60	22.85
Vacuum Residue	15.90	21.80
Total	40.50	44.65

Properties

	IL		IH	
	VGO	V.Res.	VGO	V.Res.
Specific Gravity (15/4°C)	0.918	1.016	0.921	1.024
Sulfur Content (wt %)	1.69	3.63	1.85	3.35
Viscosity @50°C (cst)	39	140,000	40	600,000
Pour Point (°C)	36	44	37	46

IL : Iranian light crude oil

IH : Iranian heavy crude oil

3.1.3 Gas Recovery

This unit processes the raw LPG from the naphtha hydrodesulfurizer, the catalytic reformer and the hydrocracker and separates them into off gas, propane and butane.

The recovery rates of propane and butane are 85 and 95 volume percent on feed, respectively.

3.1.4 Naphtha Hydrodesulfurizer

This unit processes the whole naphtha fractions obtained as condensed overhead products of the atmospheric crude distillation, and produces such hydrotreated products as LPG, high naphtha for gasoline and naphtha blending, heavy naphtha for the catalytic reformer feed and naphtha blending.

The hydrogen rich gas from the catalytic reformer is used as make-up gas and gathered as separator off gas to reuse as make-up gas for other hydrotreating units.

3.1.5 Catalytic Reformer

This unit processes the hydrotreated heavy naphtha and produces hydrogen rich gas, LPG and high octane reformate for gasoline blending.

The research octane number (clear) of reformate is 98 on a debutanized basis.

The waste heat boiler is provided to recover waste heat of flue gas from the fired heaters of reactor section by generating medium pressure steam.

The estimated yields and properties of products are as follows:

<u>Yields</u>

H_2	29.3	Nm^3/bbl
C_2^-	5.0	wt%
C_3	5.9	vol%
C_4	6.3	vol%
C_5^-	79.7	vol%

<u>Properties of reformate</u>

Specific Gravity (15/4°C)	0.806
Research Octane No. (clean)	98
Reid Vapor Pressure (psi)	3.0
Aromatics Content (vol%)	61

3.1.6 Kerosene Hydrodesulfurizer

This unit processes straight run kerosene from the atmospheric crude distillation unit and produces hydrotreated kerosene for product kerosene blending. The required hydrogen for this unit is estimated to be 100 SCF/BBL at average of run.

3.1.7 Gas Oil Hydrodesulfurizer

This unit desulfurizes the following feedstocks and separates the desulfurized product into gases, naphtha and gas oil meeting sulfur and other specifications for the product gas oil:

- Straight run gas oil
- Visbreaker cracked oils (naphtha, gas oil)

The hydrogen consumptions for straight run gas oil and visbreaker cracked gas oil are estimated to be 200 and 500 SCF/BBL, respectively.

The estimated yields and properties of products are as follows:

	SR GO	Cracked GO
Feedstock;		
Yields	SR GO	Cracked GO
H_2S (SCF/BBL)	33(IL), 42(IH)	61
Gas (vol%-EFO)	0.4	0.4
Naphtha (vol%)	2.4	8.0
Gas Oil (vol%)	98.0	94.5
Properties;		
Naphtha		
Specific Gravity (15.4°C)	0.755	0.735
Sulfur Content (wt%)	0.001	0.001
Reid Vapor Press. (psi)	3.0	3.0
Gas Oil		
Specific Gravity (15/4°C)	0.855	0.835
Sulfur Content (wt%)	0.05	0.10
Viscosity @50°C (cst)	3.4	2.0

3.1.8 Vacuum Gas Oil Hydrodesulfurizer

This unit desulfurizes straight run vacuum gas oil to produce low sulfur fuel oil blending stock with 0.1 wt. percent sulfur content on 375°F heavier basis.

Hydrogen from the hydrogen generator will be used for make-up hydrogen for treating the feedstock.

The hydrogen consumption in the unit is estimated to be 240 SCF/BBL for Iranian light VGO and 310 SCF/BBL for Iranian heavy VGO.

The estimated yields and properties of products are as follows:

Feedstock;	Iranian L't VGO	Iranian H'y VGO
Yields		
H_2S	61	67
Gas (vol%-EFO)	0.5	0.5
Naphtha (vol%)	1.5	1.5
Fuel Oil (vol%)	98.7	98.9
Properties;		
Naphtha		
Specific Gravity (15/4°C)	0.755	0.755
Sulfur Content (wt%)	0.001	0.001
Reid Vapor Press. (psi)	3.0	3.0
Fuel Oil		
Specific Gravity (15/4°C)	0.900	0.901
Sulfur Content (wt%)	0.1	0.1
Viscosity @50°C (cst)	14.5	17.0

3.1.9 Vacuum Gas Oil Hydrocracker

This unit converts straight run vacuum gas oil to such lighter products as naphtha, kerosene and gas oil.

The unit is designed to maximize middle distillates, i.e., kerosene and gas oil, and to extinguish the heavy feedstock.

Hydrogen from the hydrogen generator will be used for make-up hydrogen for the unit.

The hydrogen consumption in the unit is estimated to be 1,600 SCF/BBL at the average of run.

The estimated yields and properties products are as follows:

Feedstock;	IL VGO	IH VGO
Yields		
H_2S (SCF/BBL)	64	71
C_2^- (vol%-EFO)	1.0	1.0
C_3 (vol%)	3.3	3.3
C_4 (vol%)	6.1	6.1
Naphtha (vol%)	23.6	23.6
Kerosene (vol%)	42.1	42.1
Gas Oil (vol%)	42.2	42.2

Properties;

Naphtha

Specific Gravity (15/4°C)	0.714	0.714
Sulfur Content (wt%)	Nil	Nil
Reid Vapor Press. (psi)	4.5	4.5

Kerosene

Specific Gravity (15/4°C)	0.806	0.806
Sulfur Content (wt%)	0.0005	0.0005
Smoke Point (mm)	25	25

Gas Oil

Specific Gravity (15/4°C)	0.840	0.840
Sulfur Content (wt%)	0.0005	0.0005
Viscosity @50°C (cst)	3.6	3.6

3.1.10 Atmospheric Residue Hydrodesulfurizer

This unit desulfurizes atmospheric residue from the crude distillation unit to 0.1 wt. percent sulfur of fuel oil on the basis of a 375°F heavier product.

Because of the large catalyst requirement for treating the Iranian residual feedstocks, semiannual catalyst cycle will be adopted for the unit.

Hydrogen from the hydrogen generator will be used for make-up hydrogen for the unit and a cryogenic hydrogen purification unit will be provided to recover hydrogen from hydrogen rich flash gases.

On this basis, the hydrogen consumption in the unit is estimated to be 650 SCF/BBL for treating Iranian light residue and 800 SCF/BBL for Iranian heavy residue both at the average of run.

The estimated yields and properties of products are as follows:

Feedstocks;	IL Atm. Resid.	IH Atm. Resid.
Yields		
H_2S (SCF/BBL)	96	102
Gases (vol%-EFO)	0.8	0.9
Naphtha (vol%)	2.6	2.9
Fuel Oil(vol%)	99.2	99.7

Properties;		
Naphtha		
Specific Gravity (15/4°C)	0.771	0.771
Sulfur Content (wt%)	0.002	0.002
Reid Vapor Press. (psi)	3.0	3.0
Fuel Oil		
Specific Gravity (15/4°C)	0.917	0.926
Sulfur Content (wt%)	0.10	0.10
C. Carbon Resid. (wt%)	2.6	3.0
Viscosity @50°C (cst)	40	45

In the case of drawing off gas oil, the estimated yields and properties are as follows:

Feedstocks;	IL Atm. Resid.	IH Atm. Resid.
Yields		
H2S	2.6	2.7
Gases (wt%)	0.9	1.2
Naphtha (vol%)	2.6	2.9
Gas Oil (vol%)	8.9	9.8
Fuel Oil (vol%)	90.3	89.9
Properties;		
Naphtha		
Specific Gravity (15/4°C)	0.771	0.771
Sulfur Content (wt%)	0.002	0.002
Gas Oil		
Specific Gravity (15/4°C)	0.845	0.845
Sulfur Content (wt%)	0.05	0.05
Fuel Oil		
Specific Gravity (15/4°C)	0.925	0.936
Sulfur Content (wt%)	0.1	0.1

3.1.11 Visbreaker

This unit processes vacuum tower residue for its viscosity breaking and produces gases, naphtha, gas oil and fuel oil.

Most of the visbreaked gas oil and fuel oil will be used as blending stock for bunker fuel oil and refinery fuel oil.

The estimated yields and properties of products are as follows:

Feedstocks;	IL Vac. Resid.	IH Vac. Resid.
Yields		
H_2S (SCF/BBL)	11	4
Gases (vol%-EFO)	2.7	2.6
Naphtha (vol%)	10.8	10.3
Gas Oil (vol%)	14.0	13.2
Fuel Oil (vol%)	75.5	76.9
Properties;		
Naphtha		
Specific Gravity (15/4°C)	0.733	0.733
Sulfur Content (wt%)	0.6	0.6
Reid Vapor Press. (psi)	4.5	4.5
Gas Oil		
Specific Gravity (15/4°C)	0.863	0.863
Sulfur Content (wt%)	1.8	1.8
Viscosity @50°C (cst)	3.3	3.3
C. Carbon Resid. (wt%)	0.1	0.1
Fuel Oil		
Specific Gravity (15/4°C)	1.049	1.056
Sulfur Content (wt%)	4.0	3.8
Viscosity @50°C (cst)	15,000	36,000
C. Carbon Resid. (wt%)	23.9	25.2

3.1.12 Hydrogen Generator

This unit generates high purity hydrogen which is used in the vacuum gas oil hydrodesulfurizer, the vacuum gas oil hydrocracker and the atmospheric residue hydrodesulfurizer.

The unit will consist of sulfur removal, steam reforming, shift conversion, carbon dioxide removal and methanation sections and will use refinery off-gas or LPG as feedstock.

The purity of the generated hydrogen will be over 97 percent by dry volume.

3.1.13 Gas Treater

This unit treats sour off-gases from various units by a low pressure amine absorber and produces sweet gas for refinery fuel or hydrogen generator feedstock.

The acid gas absorbed in amine is removed in an amine regenerator and fed to the sulfur recovery unit.

3.1.14 Sulfur Recovery

The acid gas removed in the amine regenerator is treated in this unit to produce elemental sulfur.

The recovery rate of sulfur in the unit will be over 95 wt. percent.

The tail gas is to be burnt at the incinerator and discharged to the atmosphere.

3.1.15 Foul Water Stripper

This unit treats waste waters from various process units by a steam-reboiling column so that the treated water can be reused as the desalter make-up water in the crude distillation unit.

3.2 Utility Facilities

3.2.1 Steam Boiler

This facility generates 46 kg/cm^2-G of high pressure steam and supplies it to power generating turbines and major compressors of process units.

This facility consists of such major equipments as boilers, water supply installation, combustion facility, steam distributing installation and blow-down system.

Refer to the attached Simplified Flow Diagram for Steam Generating Facility (DWG No. 210-10-SK-001).

The water deionized by boiler feed water treatment facility is delivered to a deaerator for removing dissolved oxygen.
The deaerated water is pressurized by feed water pumps and delivered to boiler drums via boiler feed water heater.

Saturated steam generated in boiler drums is superheated by superheater and continuously supplied to users in the refinery after being cooled to the specified temperature.

Major specifications of boiler are as follows:

Type : Natural circulation water tube boiler

Operating conditions

Steam pressure	:	46 kg/cm^2-G (@ superheater outlet)
Steam temperature	:	410°C (@ superheater outlet)
Feed water temperature	:	125°C (@ boiler inlet)

3.2.2 Electric Power Generators

This facility generates electric power and middle pressure steam and supplies them to the facilities requiring them.

This facility consists of such major equipments as main generators, supporting generator for start-up and central control facilities.
Refer to the attached Simplified Flow Diagram for Power Generating Facility (DWG. No. 220-10-SK-001) for main generating system.

The power generators are driven by steam turbines which are of extracting - condensing type. Through the unit, a part of high pressure steam (43 kg/cm^2-G, 440°C) fed to the unit as motive steam is extracted at 15 kg/cm^2-G, 270°C as middle pressure steam to be supplied to other facilities, and remainder is routed to condensing stage and recovered as condensate.

Major specifications for main generating facility are as follows:

<u>Steam turbine</u>

Type : Single stage extracting - condensing type

Supplied steam conditions (@ turbine inlet)

Pressure	:	43 kg/cm^2-G
Temperature	:	400°C

Extracting conditions

Pressure : 15 kg/cm^2-G

Temperature : 270°C

Pressure at condenser : 110 mm Hg abs.

Generator

Voltage : 11 KV

3.2.3 Sea Water Desalinators

This facility desalinates sea water to produce raw water for boiler feed water, process water, jacket cooling water and drinking water required for the refinery.

This facility consists of such major equipments as multi-stage flash evaporator, chemical adding device and desalinated water tanks.
Refer to the attached Simplified Flow Diagram for Sea Water Desalinator (DWG No. 240-10-SK-001).

The quality of desalinated water is set as follows:

PH	6.0 - 7.0
Total Dissolved Solids	Max. 5 ppm
Fe	Max. 0.3 ppm
Cu	Max. 0.05 ppm
Electric conductivity	Max. 10 μv/cm
Temperature	Max. 45°C

The operating conditions of evaporator are as follows:

Water producing ratio	8.0
Brine temperature	Max. 120°C
Brine concentration	Max. 1.5
Chemicals	Sulfuric acid
	Scale preventive agent

3.2.4 Potable Water Supply System

This facility produces drinking water required for the refinery and supplies it to each user. The drinking water to be supplied shall satisfy the standard requirements provided by the World Health Organization (WHO).

This facility consists of such major equipments as calcium adding device, chlorine sterilizer and potable water tanks.
Refer to the attached Simplified Flow Diagram for Potable Water Facility (DWG. No. 241-10-SK-001).

Desalinated water supplied from the desalination facility is stored in potable water tanks after being added lime and chlorine at a controlled flow rate.

The potable water stored in tanks is pressurized by pumps and cooled to approx. 40°C with cooler before being continuously delivered to places where it is consumed.

3.2.5 Boiler Feed Water Treatment System

This facility treats the desalinated water supplied from the desalinator and the steam condensate recovered in the refinery to deionized water, and supplies it as boiler feed water and process water.

This facility consists of such major equipments as mixed bed ion exchanger, ion exchanging resin regenerator, regenerated waste neutralization unit and treated water tanks.
Refer to the attached Simplified Flow Diagram for BFW Treatment Facility (DWG. No. 250-10-SK-001).

Mixture of desalinated water and steam condensate is fed to the mixed bed ion exchangers, then the impurities are removed.
Purity of the treated water is measured by a water analyzer before being stored in the tanks.

Quality of the treated water is set as follows:

PH	Min.	7
Hardness (as $CaCo_3$)	Approx.	0
Electric conductivity	Max.	1μv/cm
Si	Max.	0.05 ppm

3.2.6 Steam Condensate Recovery System

This facility recovers condensate of steam used in equipments and facilities in the refinery and reuses it as boiler feed water and process water to make an effective use of available water resources.

This facility consists of such major equipments as condensate drum, condensate tanks and condensate filter.
Refer to the attached Simplified Flow Diagram for Condensate Recovery Facility (DWG. No. 251-10-SK-001).

Steam condensate received in condensate drums, which are provided at main points in the refinery, is delivered to condensate tanks with pump through recovery line after being checked for cleanness. If cleanness is below the standard, condensate is recovered through filters.

Recovered condensate is treated with boiler feed water treatment facility together with the desalinated water supplied from desalinator so as to be reused as boiler feed water and process water.

3.2.7 Cooling Water System

This facility recools the general purpose cooling water and jacket cooling water for rotary equipments in the cooling tower to the specified temperature and circulates the cooled water. Sea water is used as general purpose cooling water, while desalinated water for jacket cooling water.

This facility consists of such major equipments as cooling tower, cooling water pumps and chemical adding device.
Refer to the attached Simplified Flow Diagram for Sea Water Cooling Facility and for Jacket Water Cooling Facility (DWG. No. 260-10-SK-001 - 002).

Cooling water used in each facility is returned to the top of the cooling tower through cooling water return line.
The returned water is recooled by contact with air in falling down into the water basins at the bottom. After being supplied make-up water, the recooled water is pumped to each facility and recirculated in the refinery.

Design basis for the cooling towers are as follows:

	General Purpose	Jacket Cooling
Make-up water	Sea Water	Desalinated Water
Inlet temperature, °C	48	48
Outlet temperature, °C	34	34
Wet-bulb temperature, °C	30	30
Concentration ratio	1.2	3.0 - 5.0

3.2.8 Refinery Fuel Oil System

This facility receives home fuel oil produced in the refinery and supplies it to steam boilers, process furnaces and waste material incinerator.

This facility consists of such major equipments as home fuel oil tank, pumps, filter and heater for decreasing viscosity of fuel oil.
Refer to the attached Simplified Flow Diagram for Fuel Oil Facility (DWG. No. 270-10-SK-001 - 002).

Fuel oil delivered from the blending tank is stored in home fuel oil tank and supplied to each facility after being pressurized by pump and heated with fuel oil heater.

3.2.9 Air System

This facility supplies required air for instrument, nitrogen generation and miscellaneous use.

This facility consists of such major equipments as air compressor, air surge drum and air dryer.
Refer to the attached Simplified Flow Diagram for Compressed Air Facility (DWG. No. 280-10-SK-001).

Air is taken into the air compressor from an inlet equipped with a filter and a silencer.
After being compressed by multi-stage compression, it is led to the air surge drum through the after cooler.

From the air surge drum, the air for instruments is led to the air dryer for drying to the specified dew point and sent to pneumatic control equipments, while the air for nitrogen generation and miscellaneous use is sent directly to each facility without passing through the air dryer.

3.2.10 Inert Gas System

This facility generates and supplies nitrogen gas to be used for sealing, purging and maintenance required for the refinery.

This facility consists of such major equipments as a cooler and a refrigerator for cooling the compressed air, an adsorber for removing moisture, a heat exchanger and an expansion turbine for further cooling, a liquefier

for liquefying compressed air, a rectifying column for separating the liquefied air into waste air and nitrogen of required purity and an evaporator for gasifying the liquid nitrogen.
Refer to the attached Simplified Flow Diagram for Nitrogen Generator (DWG. No. 281-10-SK-001).

3.3 Offsite Facilities

3.3.1 Tankage

This facility consists of various tanks corresponding to following purposes.

- Crude oil tanks : Storage of crude oils transported through piepline
- Intermediate tanks : Intermediate storage required for operation and maintenance of process units
- Semi-product tanks : Storage of semi-products
- LPG tanks : Storage of LPG (Propane and Butane)
- Product tanks : Storage of final products
- Other service tanks : Storage of refinery fuel oil, slop oils, molten sulfur and various water

Major design basis are as follows:

(1) Non pressurized tanks

- Floating Roof Tank (FRT)
- Cone Roof Tank (CRT)
- Dome Roof Tank (DRT)

1. Height of tank : Max. 18 m
2. Dead space at top section

FRT	CRT*)	DRT
900 mm	750 mm	750 mm

*) 350 mm for a molten sulfur tank

3. Applied standards
   - API Std. 650 : Welded Steel Tanks for Oil Storage, April 1977
   - API Std. 620 : Large Welded, Low Pressure Storage Tanks, July 1977

. API Std. 2000 : Venting Atmospheric and Low-Pressure Storage Tanks, December 1973

. NFPA Std. No.11: Foam Extinguishing System, 1975

(2) Pressurized Tank (Spherical Tank (SPH))

1. Dead space at top section

   Dead space volume is 5% of total volume.

2. Applied standards

   . ASME Sec.VIII : Pressure Vessels, July 1977

   . ASME Sec. IX : Welding, 1977

   . ANSI B16, 5 : Steel Pipe Flanges and Flanged Fittings

   . API RP-520 : Pressure-Relieving System, December 1976

Refer to the attached drawing (DWG. No. 410-50-SK-001) for the foundation of tank.

3.3.2 Product Loading Pipelines

This facility is provided for the purpose of loading all product oils of the refinery into tankers at marine facilities.

This facility consists of such major equipments as product shipping pumps, pipelines and flow control system. Refer to the attached Simplified Flow Diagram for Product Shipping Facility (DWG. No. 440-10-SK-001).

Shipping pumps

Classification by use of pumps is as shown below from the similarity of properties, and pumps for bunker fuel oil are provided additionally. Pump capacities are determined as following table based on the assumption that tanker loading time at the sea berth is 18 hours for white oils and 24 hours for black oils.

Classification*)	G/N	K/GO	LS-FO/HS-FO
Tanker Size (DWT)	130,000	130,000	200,000
Loading Time (Hr)	18	18	24
Flow Rate (Kl/Hr)	9,900	8,700	9,400
Pump Capacity (m^3/Hr)	5,000x2	5,000x2	5,000x2

*) G/N : Gasoline/Naphtha
K/GO : Kerosene/Gas Oil
LS-FO/MS-FO: LS Fuel Oil/MS Fuel Oil

Pipelines

Three pipelines are provided for white oil loadings, i.e., one line for gasoline and naphtha, one line for kerosene and gas oil and one line for common use.

One common pipeline is provided for low sulfur fuel oil and medium sulfur fuel oil shipping.

The total distance of pipelines, in the case that the refinery is located at Muhammad Ameri, is about 19 km covering 4 km of on shore causeway and 15 km of submarine from the end of the causeway. The outer diameter of pipelines is 32 inches and 42 inches for white oils and black oils, respectively.

3.3.3 Sulfur Handling and Shipping System

This facility produces pelletized sulfur from molten sulfur recovered in refining process, and ships it after storing temporarily.

This facility consists of such major sections as pelletizing section, storage section, loading-shipping section.

Refer to the attached Simplified Flow Diagram for Sulfur Pelletizing and Loading Facility (DWG. No. 470-10-SK-002).

The high temperature molten sulfur is pelletized and cooled and then stored in the piled form. For shipping, the pelletized sulfur is taken out by reclaimer from the storage yard, transported by means of a series of belt conveyors along the causeway to the sulfur shipping wharf located at the end of the causeway and then loaded on boad by the ship loader.

Based on the operation schedule that operating hours of pelletizer are 8 hours per day and the maximum tonnage of a sulfur carrier is 10,000 DWT, the installed capacities of these facilities are defined as follows:

Refining Capacity	(BPSD)	125,000	250,000	500,000
Sulfur Pelletizer	(Ton/Hr)	20	40	80
Storage Yard	(m^2)	5,500	5,500	5,500
Belt Conveyor	(Ton/Hr)	500	500	500

3.3.4 Fire-fighting system

This facility is composed of a monitoring/communications system and fire extinguishing facilities for quick and effective fire fighting if a fire breaks out to secure safety of the refinery at all times.

This facility consists of the following fire fighting facilities:

- Site fire station
- Fire engines
  Foam fire engines, Powder fire engines, Foam generating solution tank trucks, Ordinary fire engines, Ambulances
- Fire fighting water supply system
  Fire pumps, Fire fighting water pipeline, Hydrants, Fire hose storage cabinets
- Water jet gun units
- Semi-stationary foam fire extinguishers
- Water spraying system (for spherical tanks)
- Power chemical fire extinguishers
- Sea berth fire fighting system
- Alarm system

Water for fire fighting is drawn from the sea water intake pit and pumped up to the water distribution header.
The capacity of fire pumps is 410 m^3/H per one unit and the hydraulic pressure at each hydrant is maintained at 7 kg/cm^2-G.

3.3.5 Effluent Treatment System

This facility treats waste water from process units, utility facilities and offsite facilities in the refinery, and treats rain water in the refinery, waste water from dining hall and other facilities and also deballasting water discharged from tankers.

This system consists of the following major facilities:

- Ballast water tanks and effluent reservoirs
- CPI oil separater
- Coagulation settler
- Filter
- Thickener
- Guard basin

Refer to the attached Simplified Flow Diagram for Waste Water Treatment Facility (DWG. No. 520-10-SK-001).

The process waste water is treated in the oil separator where oil is removed, and is then fed to the coagulation settler by pump. Most suspension in the waste water is removed in the coagulation settler and remaining suspension and oil are further removed by the filter. And then the waste water is sent to the guard basin.

Tanker deballasting water is stored in the tank where most of oil contained in it is separated by settlement, and is fed to the guard basin after being treated in the oil separator and the coagulation settler.

The clean waste water is sent directly to the guard basin, and discharged to the sea together with oily waste water after treatment.

The waste water quality from the refinery will be as follows:

PH	5.8 - 8.6
COD	Max. 60 ppm
Oil	Max. 5.0 ppm
SS	Max. 30 ppm

3.3.6 Waste Material Incineration System

This facility treats oily sludge, waste oil and general wastes produced in the refinery by incineration to remove contaminants, and protects the environment around the refinery.

This facility consists of the following major equipment:

- Sludge cake hopper
- Tank bottom sludge tank
- Intermediate hopper and crusher
- Rotary kiln
- Gas cooling chamber and dust collector
- Combustion chamber

Refer to the attached Simplified Flow Diagram for Waste Material Incineration Facility (DWG. No. 521-10-SK-001).

The waste materials drawn from each storage facility by conveyors and pumps are charged into the rotary kiln and incinerated under forced combustion. The ash is extracted from the kiln to the ash container and carried out properly. Exhaust gas is fed to the secondary combustion chamber for complete incineration of unburned gas and removal of bad odors. Off-gas from the secondary combustion chamber is fed to the dust collector for removal of dust after being cooled, and then released to the atmosphere through a stack.

Dust content in the off-gas is set to be 0.7 g/Nm^3 or less, and unburned carbon in the ash after incineration to be 15 wt.% or less.

3.3.7 Instrument and Computer System

This facility is provided to control a great number of process variables with each facility for establishing rationalized, laborsaved and safe operation of the refinery.

This system consists of the following major facilities:

- Instrument facilities
- Control facilities
  - On-site subsystem
  - Shipping control subsystem
  - Oil movement control subsystem
  - Equipment control subsystem
  - Cost control subsystem

Refer to the attached Flow Scheme (DWG. No. 540-10-SK-001 - 004) for on-site subsystem, shipping control subsystem, oil movement control subsystem and configuration of computer hardware.

Operation of the refinery is centrally controlled with instrument panels provided in the following control rooms:

- On-site control room
- Utility control room
- Off-site control room
- Shipping control room

The information control system uses electronic computers for the purpose of providing correct information related to the refinery operation and facilities status.

3.3.8 Buildings and Equipment

This facility provides buildings and the incidental equipments required for the refinery operation.

Each building consists of a building proper and such incidental facilities as air conditioning, water supply and drainage facilities, electrical installation and special facilities according to its purpose.
Refer to the following tables for detail of each facilities.

- Building proper : Outline of Buildings
- Air conditioning and water supply and drainage facilities : List of Building Mechanical Work
- Electrical installation : Specification for Equipment and Installation

As special facilities, medical facility and laboratory facility required for the operation and quality control in the refinery are provided.

Outline of Buildings (1)

No.	Name of Building	Structure	Req'd No.	Story	Floor Area (m^2)		
					125,000 BPSD	250,000 BPSD	500,000 BPSD
1.	Administration Building	R.C, Wall-Brick	1	2	3,000	3,000	3,400
2.	Cafeteria	R.C, Wall-Brick	1	1	1,260	1,260	1,600 (1,890)
3.	Clinic	R.C, Wall-Brick	1	1	300	300	300
4.	No. 1,2 ORE Rest House	R.C, Wall-Brick	2	1	Total 200	Total 200	Total 200
5.	No. 1 Gate House	Brick	1	1	100	100	100
6.	No. 2,3 Gate House	Brick	2	1	Total 40	Total 40	Total 40
7.	Change House	R.C, Wall-Brick	1	1	500 (540)	500 (540)	750 (800)
8.	Firehouse	Brick and Steel-Slate	1	1	600	600	600
9.	Laboratory	R.C, Wall-Brick	1	1	1,000	1,000	1,300
10.	Engineering Office	R.C, Wall-Brick	1	1	1,000	1,000	1,500
11.	Maintenance Shop	Steel-Slate	1	1	5,000	5,000	6,500
12.	General Warehouse	Steel-Slate	1	1	1,000	1,000	1,300
13.	Spare Parts Warehouse	Steel-Slate	1	1	2,000	2,000	2,650
14.	Catalyst Warehouse	Steel-Slate	1	1	1,000	1,000	1,300
15.	Chemical Warehouse	Steel, {Wall-Brick {Roof-Slate	1	1	500	500	600
16.	No. 1,2 Process Control Bldg.	R.C, Wall-Brick	2	1	Total 2,200 Total(2,600)	Total 2,200 Total(2,600)	Total 3,400 Total(4,100)
17.	Off-site Control Bldg.	R.C, Wall-Brick	1	1	350	350	570
18.	Shipping Control Bldg.	R.C, Wall-Brick	1	1	360	360	510
19.	Power House Gene. Hall- Control etc.	Steel-Slate R.C, Wall-Brick	1 1	1 1	1,000 } 1,545 545	1,260 } 1,950 690	1,800 } 2,786 986

Outline of Buildings (2)

No.	Name of Building	Structure	Req'd No.	Story	Floor Area (m^2)		
					125,000 BPSD	250,000 BPSD	500,000 BPSD
20.	Custom House	R.C, Wall-Brick	1	1	90	90	90
21.	Main Substation	R.C, Wall-Brick	1	1	190	300	550
22.	No. 1 Substation	R.C, Wall-Brick	1	1	720	1140	2090
23.	No. 2 Substation	R.C, Wall-Brick	1	1	790	1250	2290
24.	No. 3 Substation	R.C, Wall-Brick	1	1	860	1360	2490
25.	No. 4 Substation	R.C, Wall-Brick	1	1	890	1400	2570
26.	No. 5 Substation	R.C, Wall-Brick	1	1	50	90	180
27.	No. 5 A,B Load Center	R.C, Wall-Brick	2	1	Total 60	Total 60	Total 60
28.	No. 5 C,E Load Center	R.C, Wall-Brick	2	1	Total 160	Total 160	Total 300
29.	No.5 D Load Center	R.C, Wall-Brick	1	1	60	80	150
30.	No. 6 Substation	R.C, Wall-Brick	1	1	150	160	300
31.	No. 6 A D Load Center	R.C, Wall-Brick	4	1	Total 200	Total 320	Total 600
32.	No. 7 Substation	R.C, Wall-Brick	1	1	120	124	150
33.	No. 8 Substation	R.C, Wall-Brick	1	1	40	64	120
34.	No. 9 Substation	R.C, Wall-Brick	1	1	80	80	100
35.	No. 9 A D Load Center	R.C, Wall-Brick	4	1	Total 160	Total 192	Total 240
36.	No. 9 E Load Center	R.C, Wall-Brick	1	1	30	36	40
37.	No. 10 Substation	R.C, Wall-Brick	1	1	98	98	98

List of Building Mechanical Work

No.	Name of Building	Air. Con.	Ventilation	Pressu -rised	Sanitary	Septic Tank	Fire Fighting	
							Fire Extinguisher	Indoor Fire Hydrant
1.	Administration Building	o			o	o	o	o
2.	Cafeteria	o	o		o	o	o	
3.	Clinic	o			o	o	o	
4.	No.1,2 OPE Rest House	o			o	o	o	
5.	No.1 Gate House	o			o	o	o	
6.	No. 2,3 Gate House	o			o	o	o	
7.	Change House	o			o	o	o	
8.	Firehouse	o			o	o	o	
9.	Laboratory	o	o		o	o	o	o
10.	Engineering Office	o			o	o	o	
11.	Maintenance Shop	o	o		o	o	o	o
12.	General Warehouse		o					
13.	Spare Parts Warehouse	o	o		o	o	o	o Sprinkler
14.	Catalyst Warehouse		o				o	
15.	Chemical Warehouse		o				o	
16.	No. 1,2 Process Control Bldg.	o		o	o	o	o	
17.	Off-site Control Bldg.	o		o	o	o	o	
18.	Shipping Control Bldg.	o		o	o	o	o	
19.	Power House	o		o	o	o	o	
20.	Custom House	o			o	o	o	
21.	Substations	o		o			o	

Specification for Equipment and Installation

No.	Name of Building	Power Distri. Panel	Lighting Distri. Panel	Receptacle & Tumbler SW.	Lighting Fixture	Fire Alarm	Speaker	Conduit
1.	Administration Building	O	O	O	O	O	O	O
2.	Cafeteria	O	O	O	O	O	O	O
3.	Clinic	O	O	O	O	O	O	O
4.	No. 1,2 CRB Rest House	O	O	O	O	O	O	O
5.	No. 1 Gate House	O	O	O	O	O	O	O
6.	No. 2,3 Gate House	O	O	O	O	O	O	O
7.	Change House	O	O	O	O	O	O	O
8.	Firehouse	O	O	O	O	O	O	O
9.	Laboratory	O	O	O	O	O	O	O
10.	Engineering Office	O	O	O	O	O	O	O
11.	Maintenance Shop	O	O	O	O	O	O	O
12.	General Warehouse	X	O	O	O	O	O	O
13.	Spare Parts Warehouse	O	O	O	O	O	O	O
14.	Catalyst Warehouse	X	O	O	O	O	O	O
15.	Chemical Warehouse	X	O	O	O	O	O	O
16.	No. 1,2 Process Control Bldg.	O	O	O	O	O	O	O
17.	Off-site Control Bldg.	O	O	O	O	O	O	O
18.	Shipping Control Bldg.	O	O	O	O	O	O	O
19.	Power House	O	O	O	O	O	O	O
20.	Custom House	O	O	O	O	O	O	O
21.	Substations	O	O	O	O	O	O	O

Note

Equipment and installations are of general purpose type except for conduit which is of light gauge steel.

Summary of Electrical Installation for Buildings

No.	Name of Building	Power Wiring		Lighting		Telecommunication		
		Air-Con.	Plumbing	General	Emergency	Telephone	Public Address	Fire Alarm
1.	Administration Building	o	o	o	o	o	o	o
2.	Cafeteria	o	o	o	o	o	o	o
3.	Clinic	o	o	o	o	o	o	x
4.	No. 1,2 CRE Rest House	o	o	o	x	o	o	x
5.	No. 1 Gate House	o	o	o	o	o	o	x
6.	No. 2,3 Gate House	o	x	o	o	o	o	x
7.	Change House	o	o	o	o	x	o	x
8.	Firehouse	o	o	o	o	o	o	o
9.	Laboratory	o	o	o	o	o	o	o
10.	Engineering Office	o	o	o	o	o	o	o
11.	Maintenance Shop	o	o	o	o	o	o	o
12.	General Warehouse	x	x	o	x	o	o	o
13.	Spare Parts Warehouse	o	o	o	o	o	o	o
14.	Catalyst Warehouse	x	x	o	x	o	o	o
15.	Chemical Warehouse	x	x	o	x	o	o	x
16.	No. 1,2 Process Control Bldg.	o	o	o	o	o	o	o
17.	Off-site Control Bldg.	o	o	o	o	o	o	x
18.	Shipping Control Bldg.	o	o	o	o	o	o	x
19.	Power House	o	o	o	o	o	o	o
20.	Custom House	o	o	o	o	o	o	x
21.	Substations	o	x	o	o	o	o	o

4. MARINE FACILITIES

Marine facilities which will be constructed in the nearest sea area to the export refinery are outlined as follows:

- . Sea berth
- . Habor and dreged channel
- . Causeway
- . Sea water intake facility

4.1 Sea Berth

This facility is provided to accommodate large size product tankers up to 200,000 DWT and to ship most of product transported from the refinery through the product loading pipelines.

This facility consists of the following major equipments, and refer to the attached Grand View of Sea Berth and General Dimension of Sea Berth (DWG. No. 450-10-SK-001 - 003) for detail of this facility.

- . Loading platform
- . Breasting dolphin
- . Mooring dolphin
- . Mooring instrument
- . Marking device

This sea berth will be constructed at a point offshore 18.8 km from the coastline near the refinery with a water depth of 20 m.
Major items for this facility are as follows:

- . Tanker size : 50,000 DWT - 200,000 DWG
- . 125,000/250,000 BPSD : Single berth
- . 500,000 BPSD : Twin berth
- . Berth type : Fixed type sea berth
- . Supporting : Steel pipe pile method
- . Normal line : Nothwest - Southwest

Specifications of tankers are shown in the following table:

Unit : m

	Length	Width	Depth	Load draft
200,000 DWT	340	48.8	25.7	17.3
50,000 DWT	222	32.0	16.7	12.2

The superstructures for each structure are as follows:

- Loading platform : Steel Structure
- Breasting dolphin : Reinforced concrete
- Mooring dolphin : Steel structure

4.2 Harbor and Dredged Channel

This facility is provided to ship product sulfur and bunker fuel oil and to unload various materials to be used for construction, maintenance and operation of the refinery.

This facility consists of the following major facilities, and refer to the attached drawings (DWG. No. 460-50-SK-001 - 006) for detail.

- Sulfur loading wharf and common wharf
- Bunker fuel oil berth
- Small boat pier
- Anchorage
- Channel

The quaywall length and required water depth for each wharf are determined as follows considering carrier size.

	Tanker Size			Wharf Dimension	
	DWT	Length	Load Draft	Quay-Wall Length	Water Depth
Sulfur loading wharf	10,000	140 m	8.3 m	210 m	10 m
Common wharf	1,000	60 m	4.1 m	140 m	8 m
Bunker fuel oil berth	5,000	103 m	6.5 m		8 m
Small boat pier				185 m	8 m

As for the anchorage, 350m wide area of the turning basin is secured considering that a sulfur carrier turns in this area, and that two tugboats for arrival and one for departure is used at the normal steering of 10,000 DWT sulfur carrier.

A dredged channel with 10 m depth and 200 m width will be constructed to permit ships of maximum tonnage of 10,000 DWT to pass through it to the harbor.

3.3 Causeway

This facility is provided for the purpose of a access road between the refinery and the harbor, lanes for shipping pipelines and conveyor belt, and transportation roads for various materials required for construction of the refinery.

On the causeway, the following provisions are made, refer to the attached General Section of Causeway (DWG. No. 460-50-SK-002) for detail.

- Access road with 6 m width
- Lane for pipelines with 10 m width
- Lane for sulfur conveyor belt with 4 m width

The embankment is mounted by riprap and on which cobble and armor stones with 0.5 to 4 tons weight are covered to reinforce it.

The crown levee surface is paved with concrete to withstand possible overtopping waves.

3.4 Sea Water Intake Facility

This facility takes in sea water and supplies it to the séa water desalinator, sea water cooling facilities and fire hydrants.

This facility consists of the following major equipments, and refer to the attached Simplified Flow Diagram for Sea Water Intake Facility (DWG. No. 230-10-SK-001).

- Intake channel
- Bar screen and rotary screen
- Pump pit
- Intake pump
- Chlorine generator and injection unit
- Water pipes

Sea water is taken in to the pump pit through the extended intake channel or intake pipe. A bar screen and rotary screen are installed at the entrance of the pump pit to remove foreign matter. Sand is completely precipitated in the pump pit, clean sea water is pumped to facilities in the refinery through the main distribution line.
To protect the equipment from damage resulting from microbes and algae in sea water, electrolyzed sea water containing hypochlorite ion is continuously injected to the entrance of the intake.

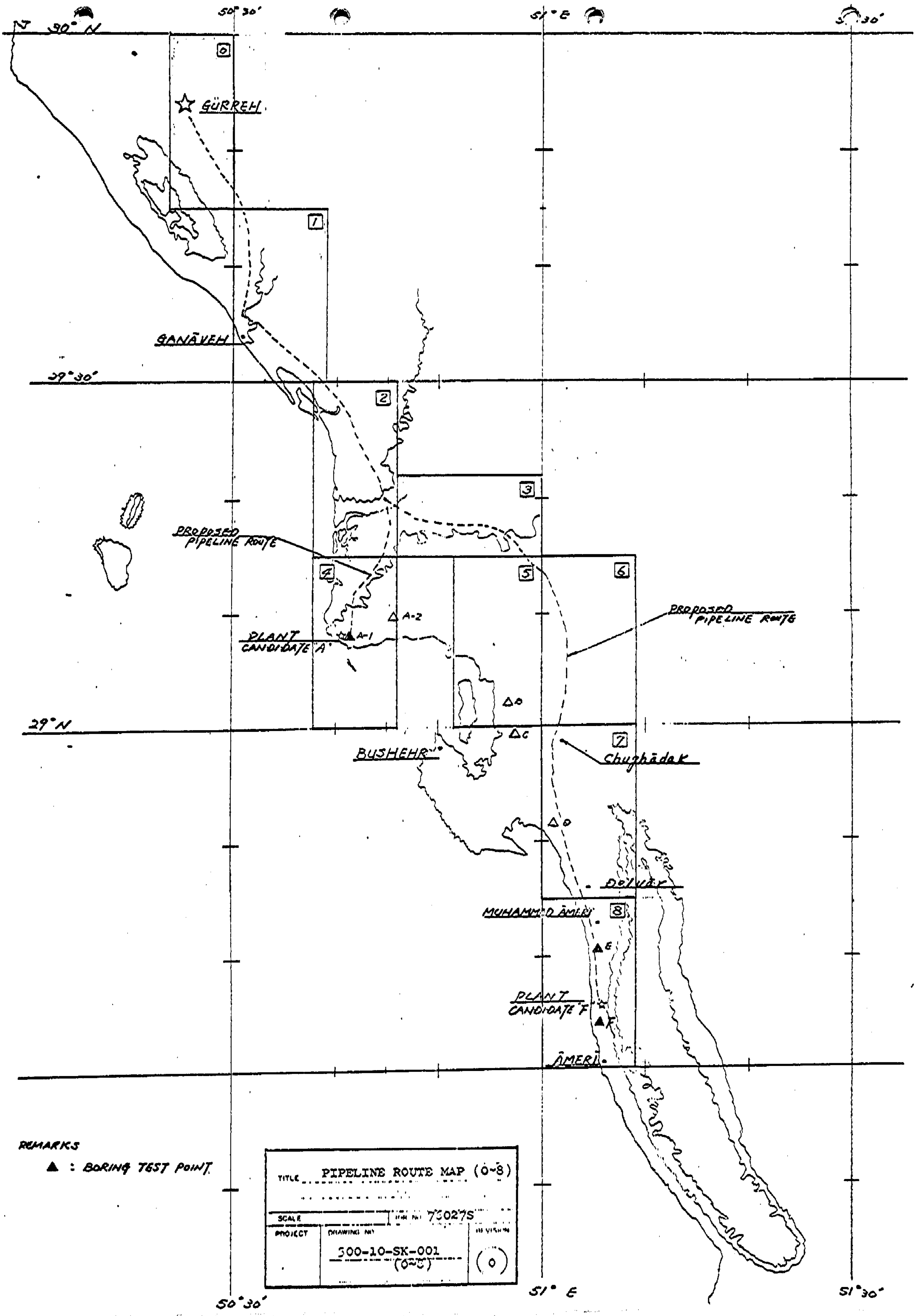
Attachment 1

Drawings for Crude Oil Pipeline

DRAWING LIST (1)

CRUDE OIL PIPELINE

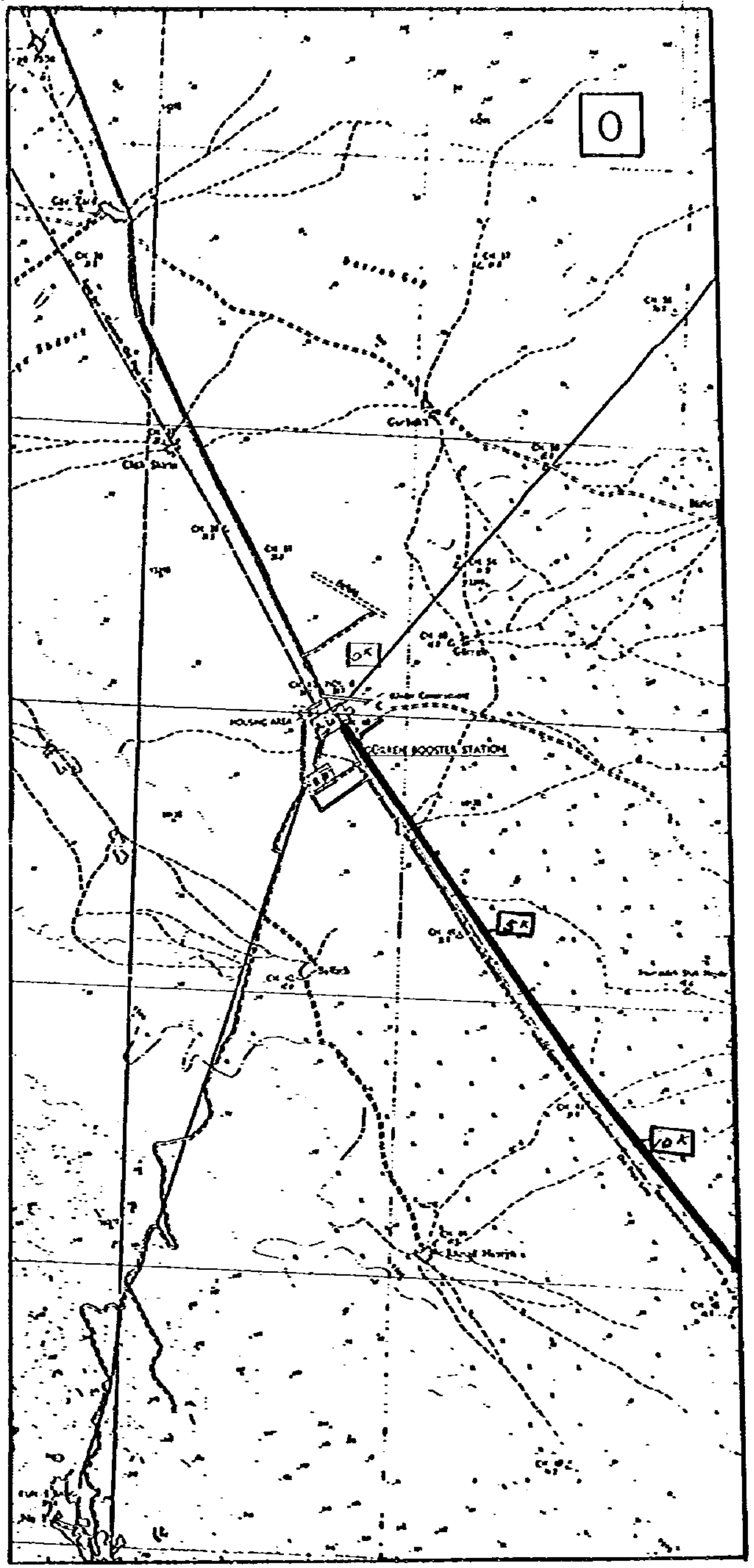
TITLE	DWG NO.
Pipeline Route Map (0-8)	300-10-SK-001 (0-8)
Simplified Flow Diagram for Onshore Crude Pipeline	300-10-SK-002 (1)
Simplified Flow Diagram for Onshore Crude Pipeline	300-10-SK-002 (2)
Pressure Profile in Crude Oil Pipeline	300-10-SK-003

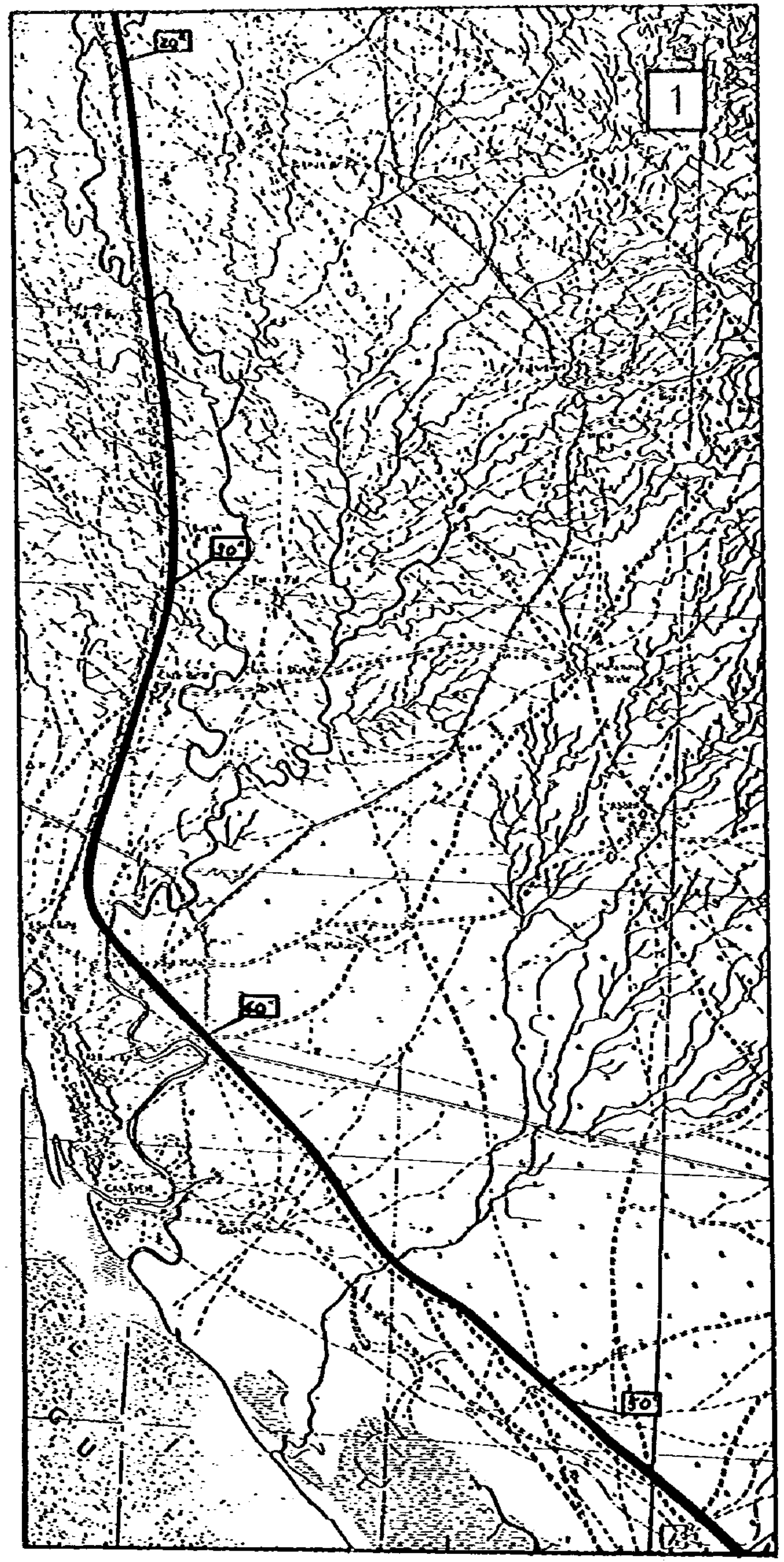


REMARKS

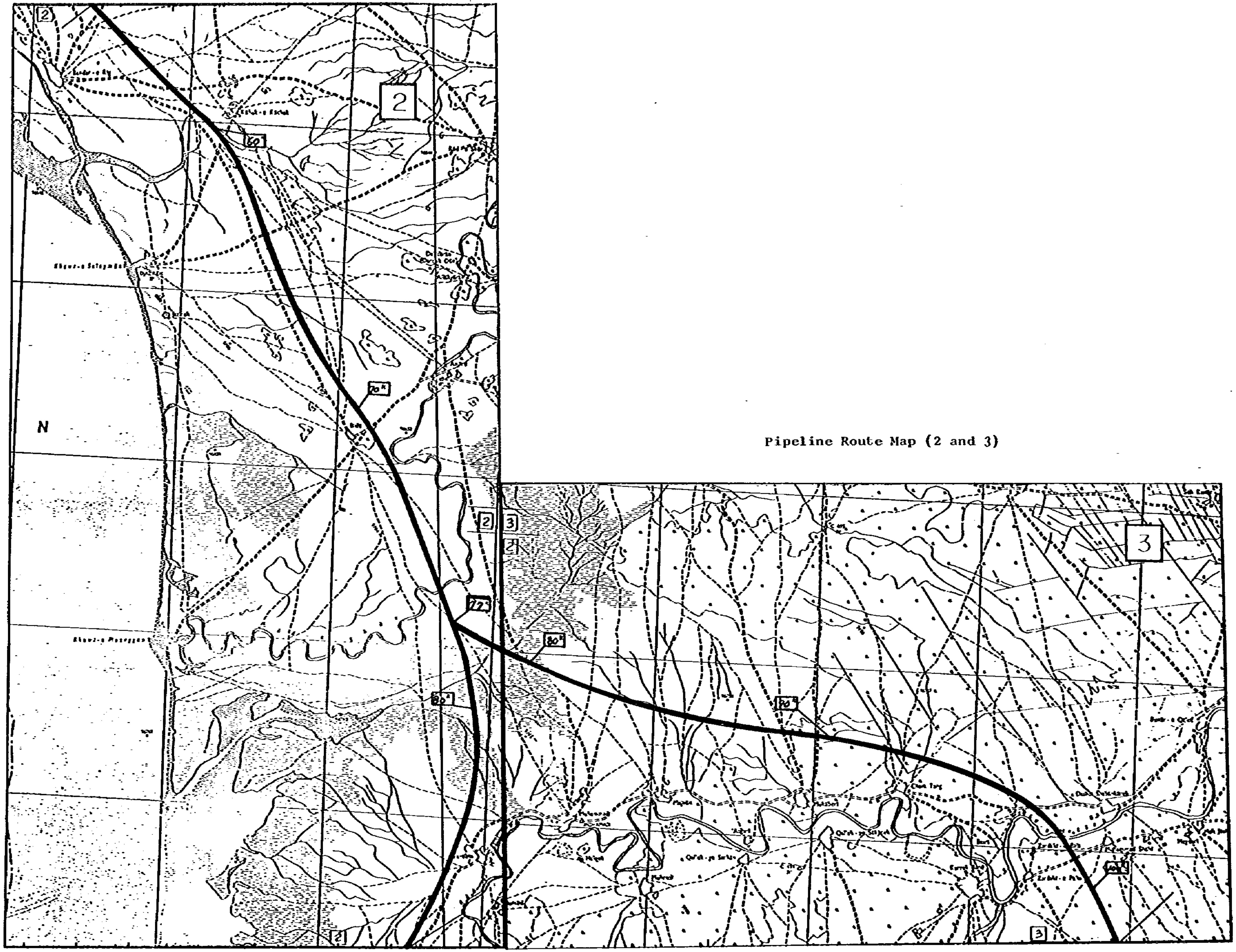
▲ : BORING TEST POINT

TITLE	PIPELINE ROUTE MAP (0~8)	
SCALE	73027S	
PROJECT	DRAWING NO. 300-10-SK-001 (0~8)	REVISION (0)

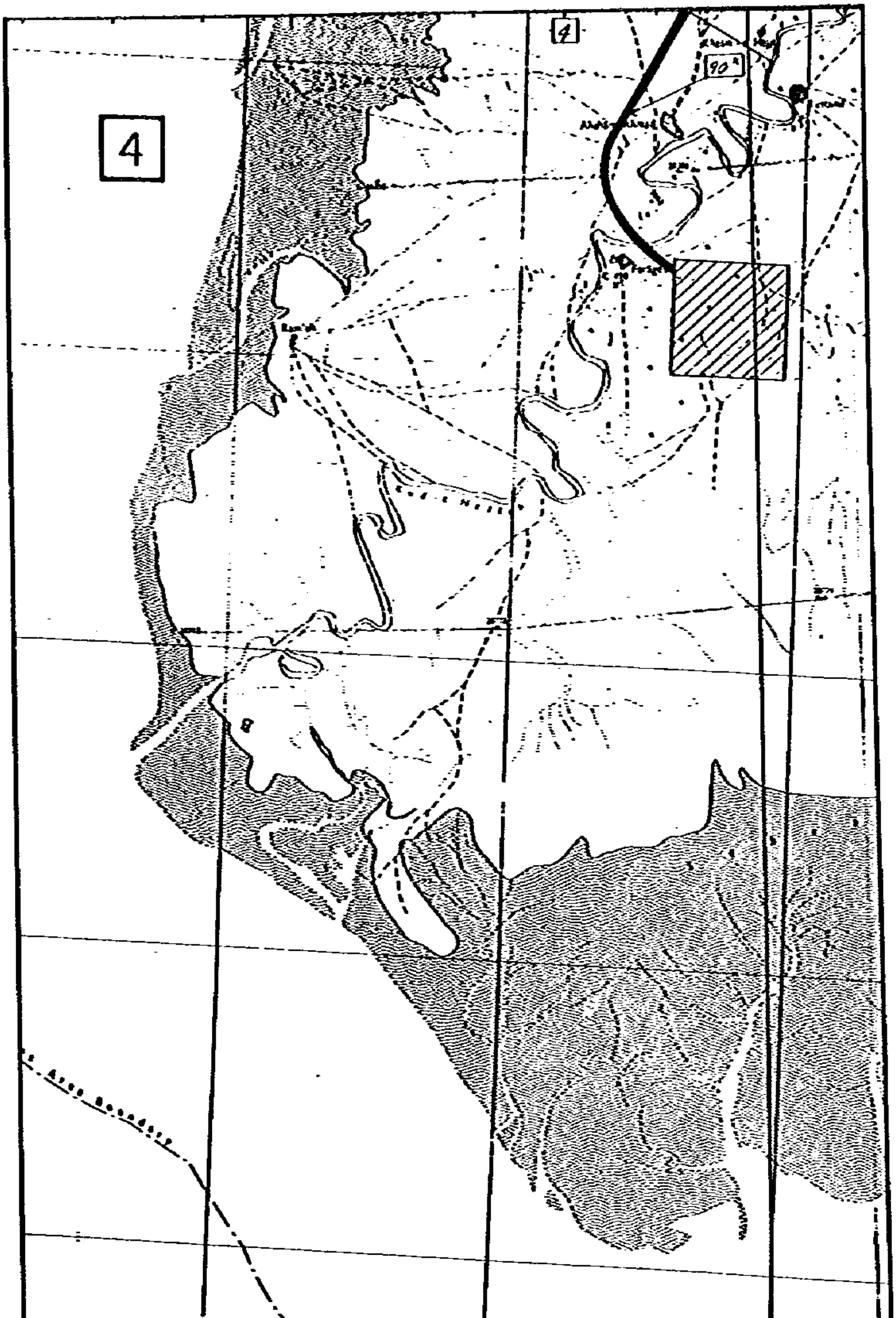




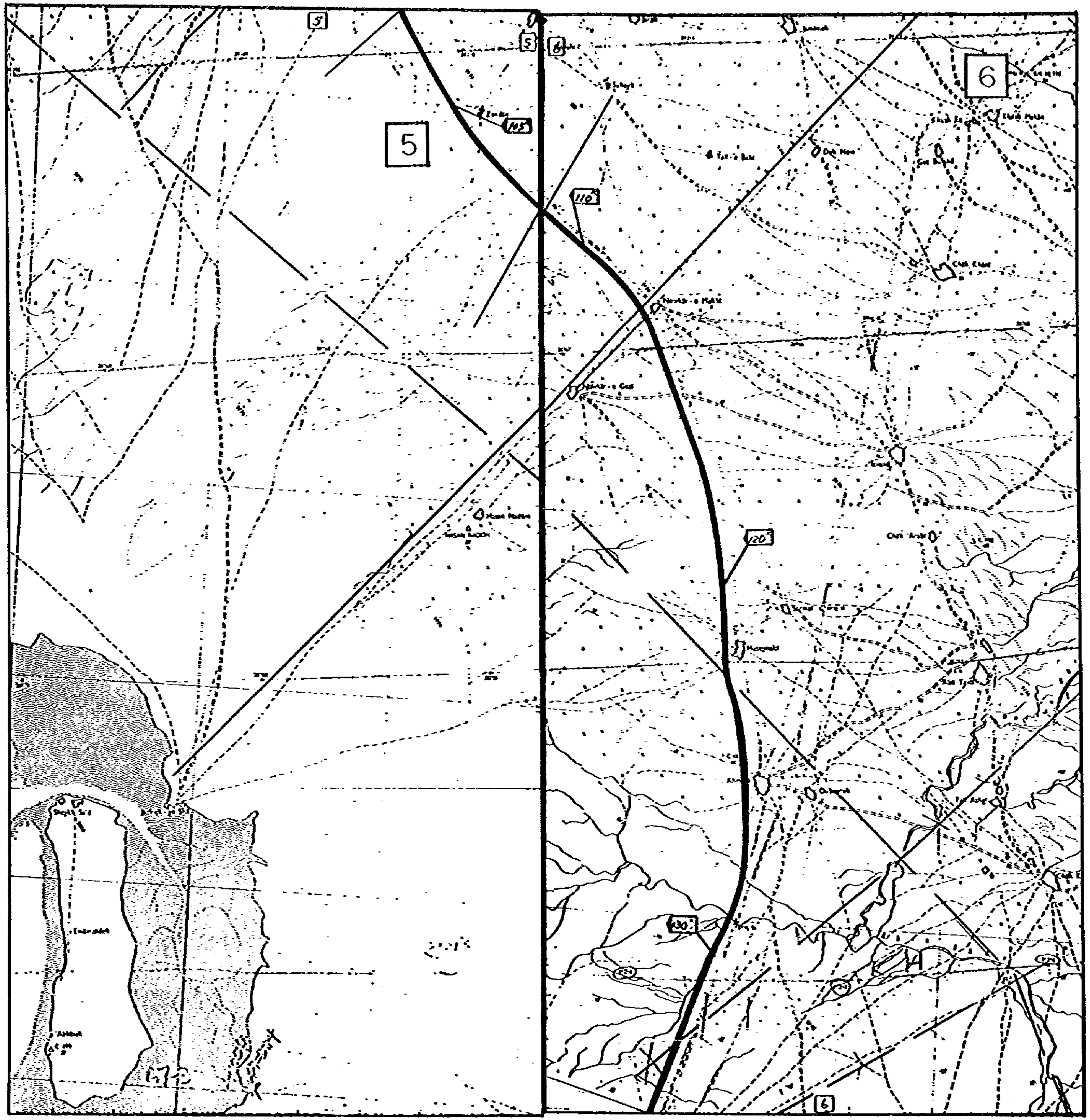
Pipeline Route Map (0 and 1)



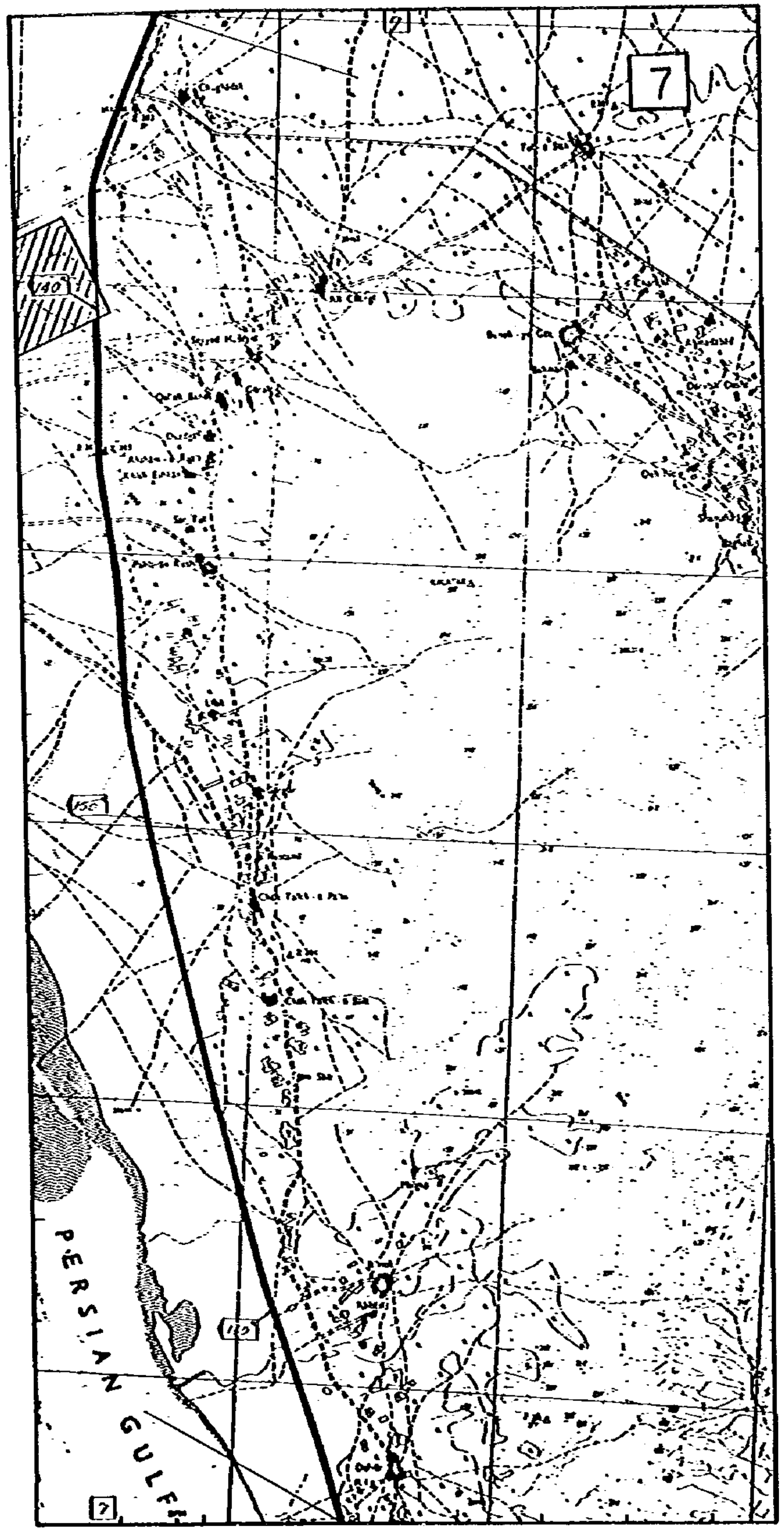
Pipeline Route Map (2 and 3)

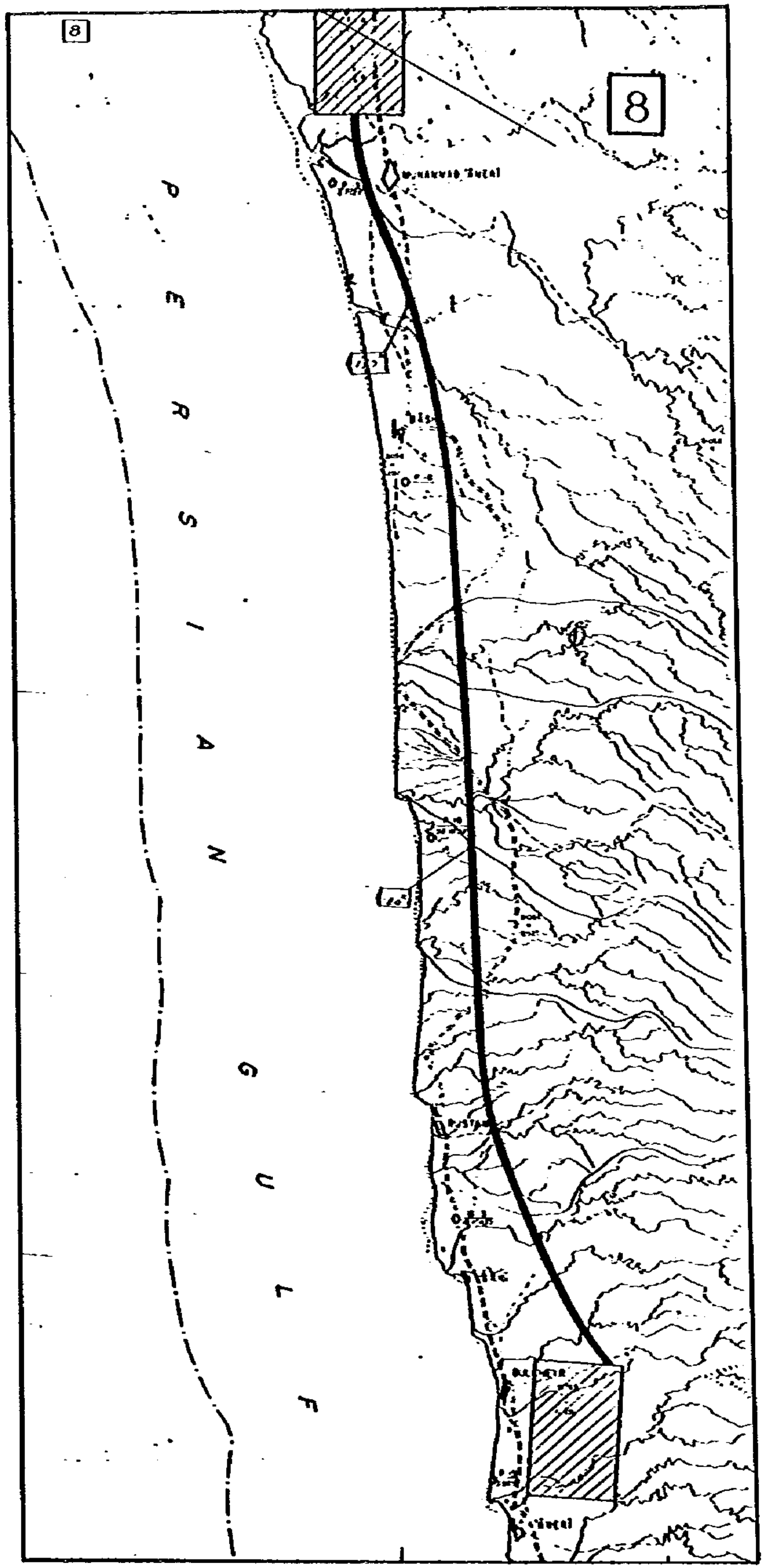


Pipeline Route Map (4)

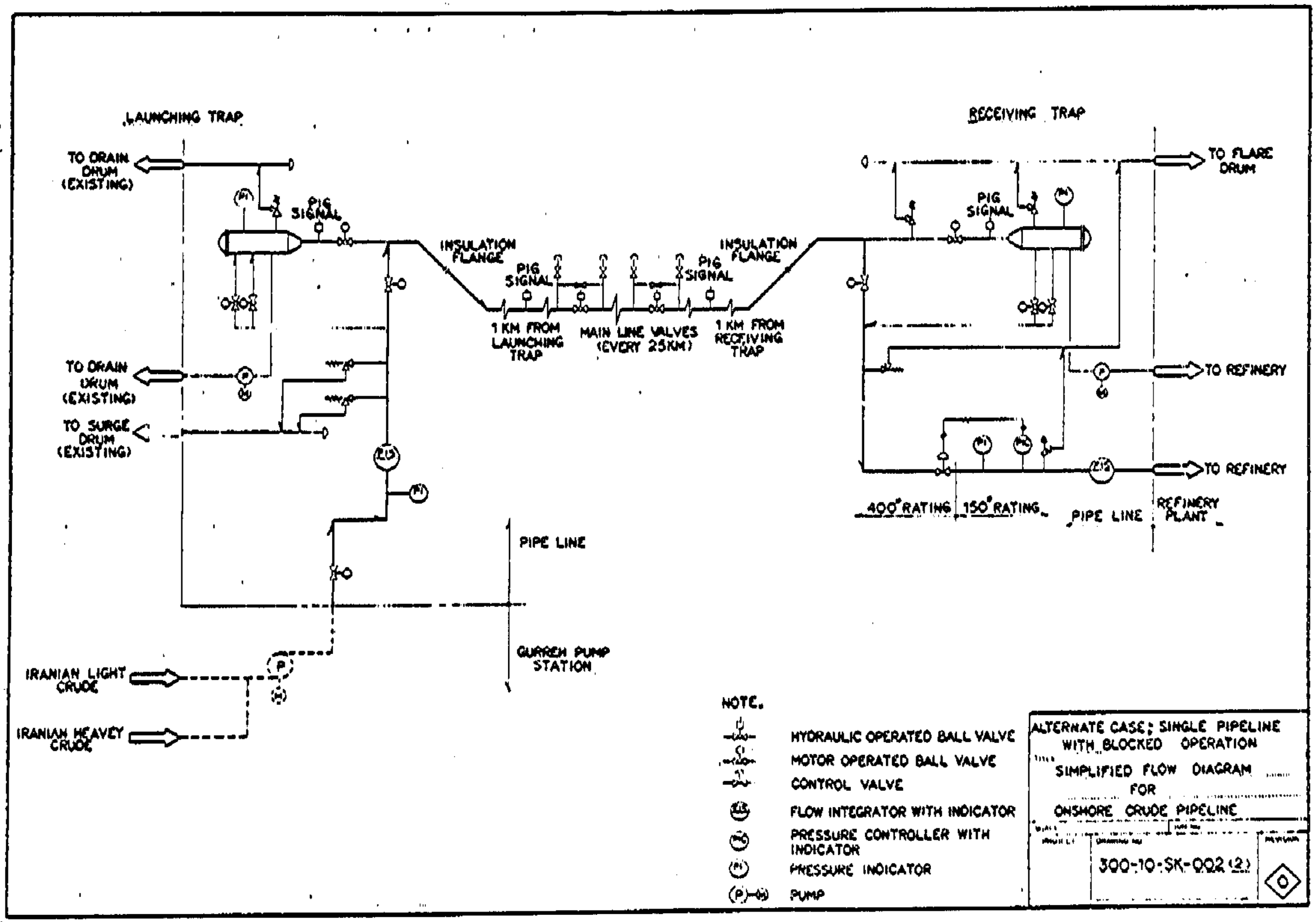


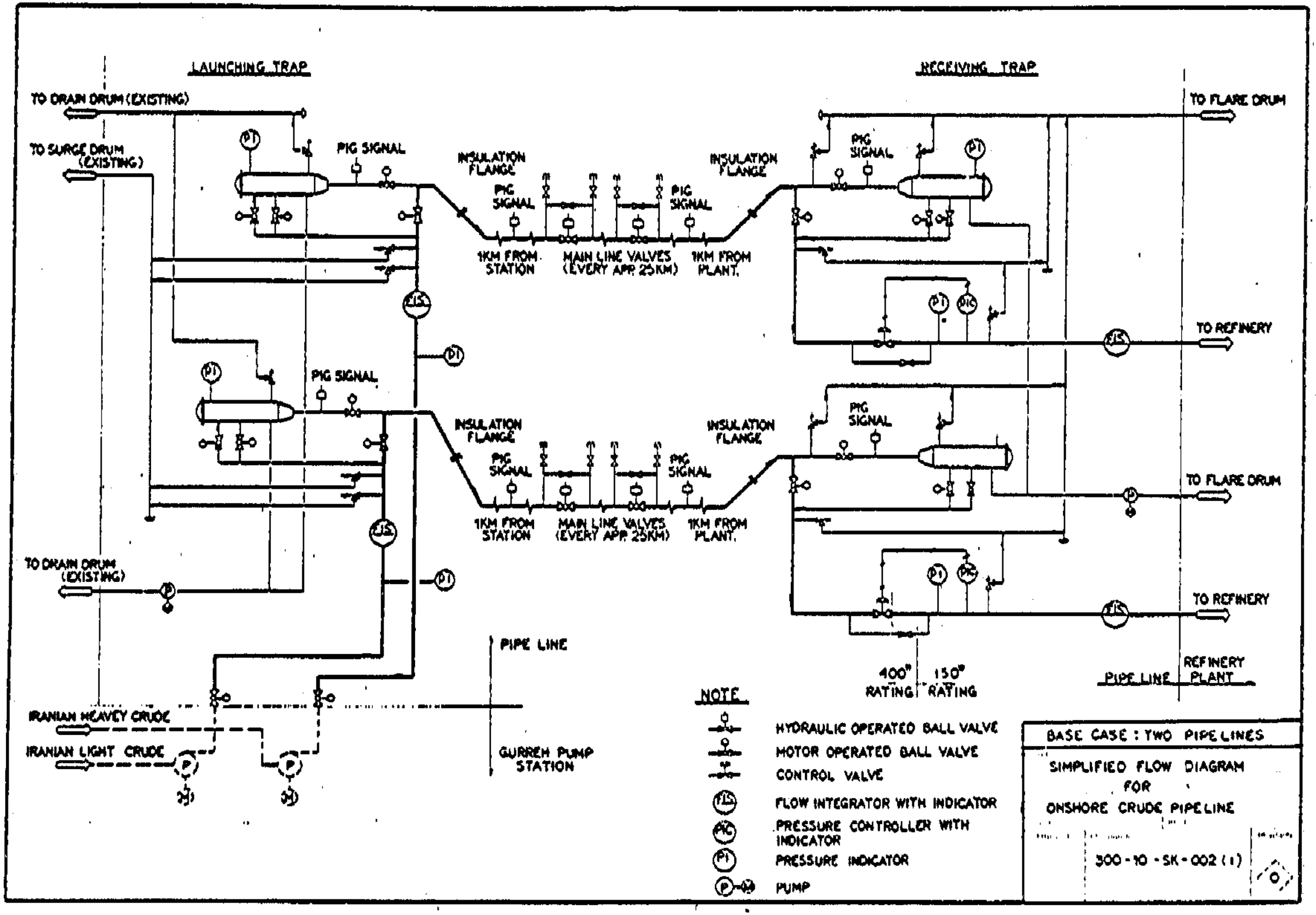
Pipeline Route Map (5 and 6)

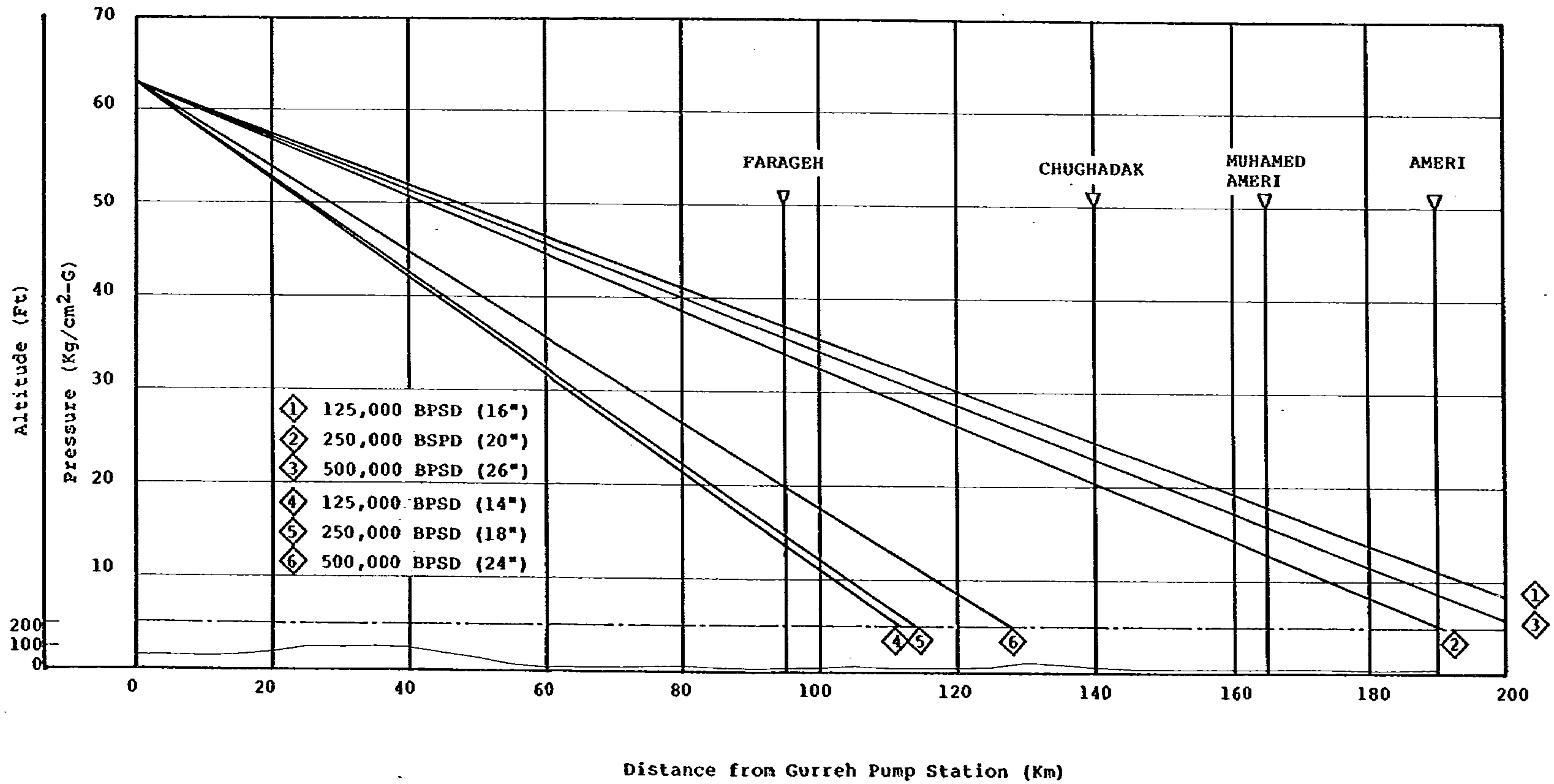




Pipeline Route Map (7 and 8)


LAUNCHING TRAP
RECEIVING TRAP
TO DRAIN DRUM (EXISTING)
TO DRAIN DRUM (EXISTING)
TO SURGE DRUM (EXISTING)
PIG SIGNAL
INSULATION FLANGE
PIG SIGNAL
1 KM FROM LAUNCHING TRAP
MAIN LINE VALVES (EVERY 25KM)
PIG SIGNAL
INSULATION FLANGE
1 KM FROM RECEIVING TRAP
PIG SIGNAL
TO FLARE DRUM
TO REFINERY
TO REFINERY
400# RATING
150# RATING
PIPE LINE
REFINERY PLANT
PIPE LINE
GURREH PUMP STATION
IRANIAN LIGHT CRUDE
IRANIAN HEAVEY CRUDE
NOTE.
HYDRAULIC OPERATED BALL VALVE
MOTOR OPERATED BALL VALVE
CONTROL VALVE
FLOW INTEGRATOR WITH INDICATOR
PRESSURE CONTROLLER WITH INDICATOR
PRESSURE INDICATOR
PUMP
ALTERNATE CASE; SINGLE PIPELINE WITH BLOCKED OPERATION
SIMPLIFIED FLOW DIAGRAM FOR ONSHORE CRUDE PIPELINE
300-10-SK-002 (2)


LAUNCHING TRAP
RECEIVING TRAP
TO DRAIN DRUM (EXISTING)
TO SURGE DRUM (EXISTING)
PIG SIGNAL
INSULATION FLANGE
1KM FROM STATION
MAIN LINE VALVES (EVERY APP. 25KM)
1KM FROM PLANT.
TO FLARE DRUM
TO REFINERY
TO DRAIN DRUM (EXISTING)
PIPE LINE
GURREH PUMP STATION
IRANIAN HEAVEY CRUDE
IRANIAN LIGHT CRUDE
400" RATING
150" RATING
PIPE LINE
REFINERY PLANT
NOTE
HYDRAULIC OPERATED BALL VALVE
MOTOR OPERATED BALL VALVE
CONTROL VALVE
FLOW INTEGRATOR WITH INDICATOR
PRESSURE CONTROLLER WITH INDICATOR
PRESSURE INDICATOR
PUMP
BASE CASE : TWO PIPE LINES
SIMPLIFIED FLOW DIAGRAM
FOR
ONSHORE CRUDE PIPE LINE
300-10-SK-002 (1)



PRESSURE PROFILE IN CRUDE OIL PIPELINES

DWG. NO. 300-10-SK-003

Attachment 2

Drawings for Refinery Facilities

DRAWING LIST (2)

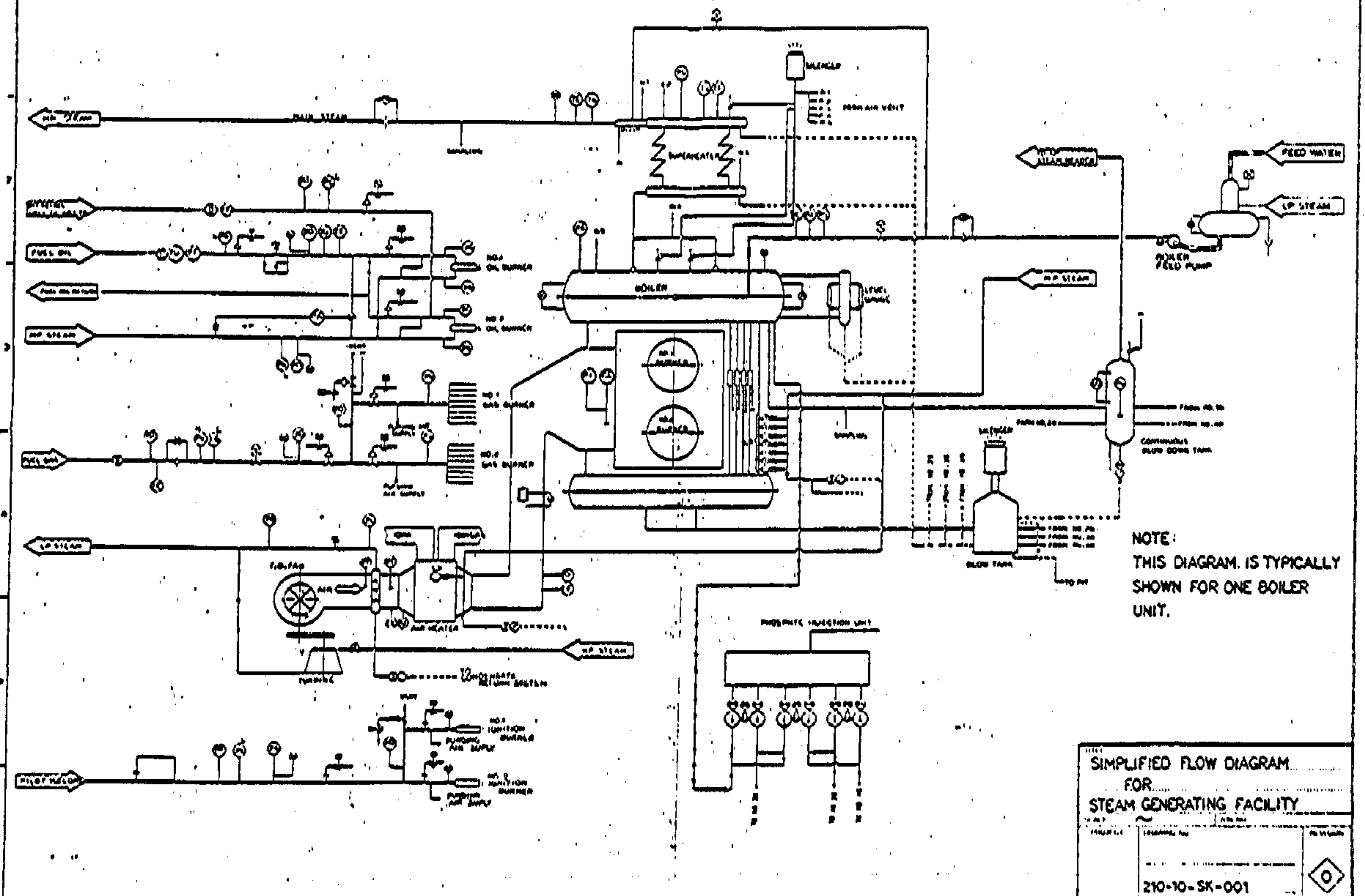
REFINERY FACILITIES

TITLE	DWG NO.
Simplified Flow Diagram for Steam Generating Facility	210-10-SK-001
Simplified Flow Diagram for Power Generating Facility	220-10-SK-001
Simplified Flow Diagram for Sea Water Desalinator	240-10-SK-001
Simplified Flow Diagram for Potable Water Facility	241-10-SK-001
Simplified Flow Diagram for BFW Treatment Facility	250-10-SK-001
Simplified Flow Diagram for Condensate Recovery Facility	251-10-SK-001
Simplified Flow Diagram for Sea Water Cooling Facility	260-10-SK-001
Simplified Flow Diagram for Jacket Water Cooling Facility	260-10-SK-002
Simplified Flow Diagram for Fuel Oil Facility	270-10-SK-001
Simplified Flow Diagram for Fuel Oil Facility	270-10-SK-002
Simplified Flow Diagram for Compressed Air Facility	280-10-SK-001
Simplified Flow Diagram for Nitrogen Generator	281-10-SK-001
One Line Diagram (125,000 BPSD)	290-80-SK-001
One Line Diagram (250,000 BPSD)	290-80-SK-002
One Line Diagram (500,000 BPSD)	290-80-SK-003
Typical One Line Diagram for Receiving System	290-80-SK-004
Typical One Line Diagram for Onsite Substation and Utility Substation	290-80-SK-005
Typical One Line Diagram for Off-Site Substation	290-80-SK-006
Typical One Line Diagram for Station Auxiliary Substation	290-80-SK-007
Foundation for Tank	410-50-SK-001
Simplified Flow Diagram for Product Shipping Facility	440-10-SK-001
Simplified Flow Diagram for Sulfur Pelletizing and Loading Facility	270-10-SK-002
Simplified Flow Diagram for Waste Water Treatment Facility	520-10-SK-001

DRAWING LIST (2)

REFINERY FACILITIES (Cont'd)

TITLE	DWG NO.
Simplified Flow Diagram for Waste Material Incineration Facility	521-10-SK-001
Flow Scheme for On-Site Subsystem	540-10-SK-001
Flow Scheme for Shipping Control Subsystem	540-10-SK-002
Flow Scheme for Oil Movement Control Subsystem	540-10-SK-003
Flow Scheme Configuration of Computer Hardware	540-10-SK-004

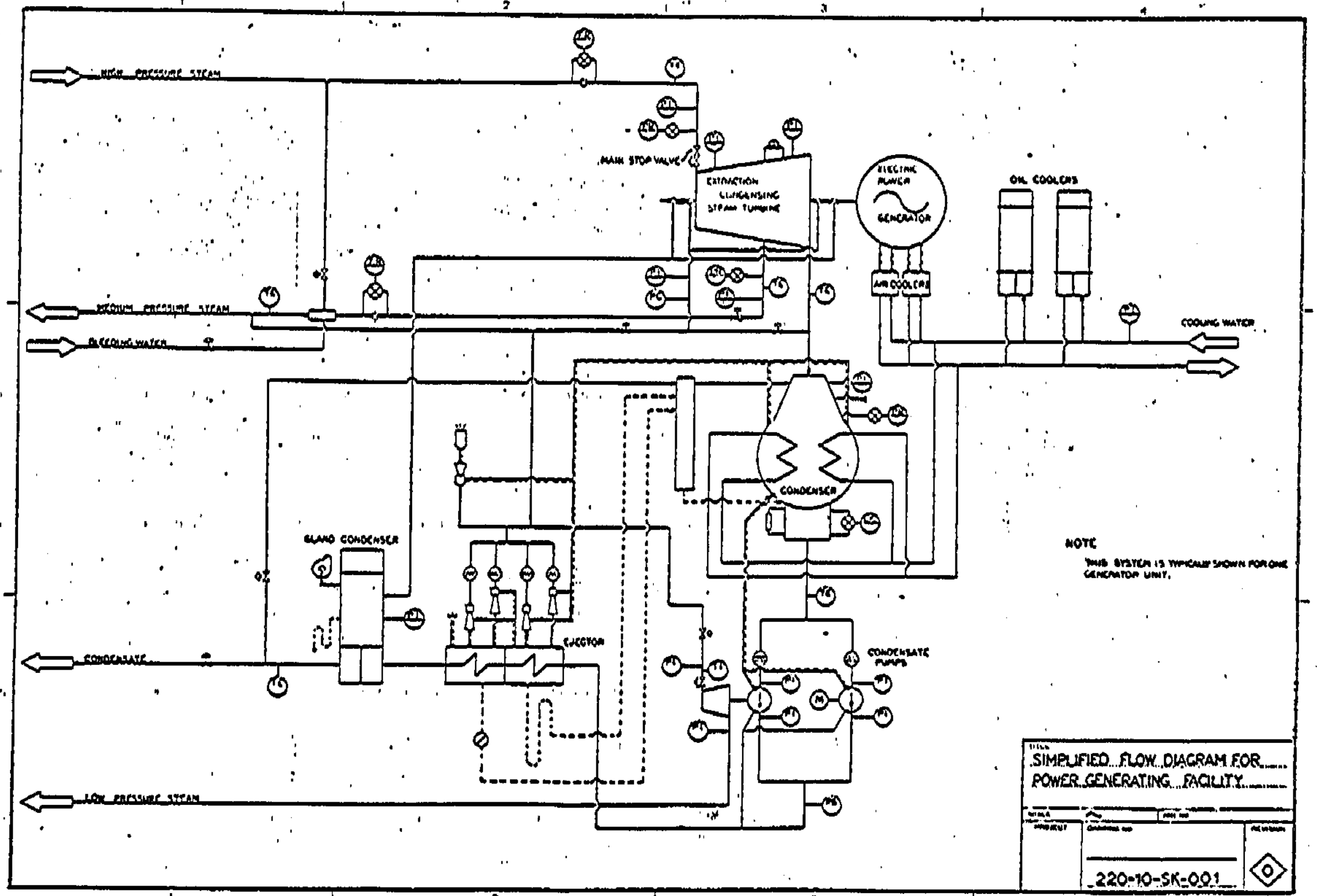


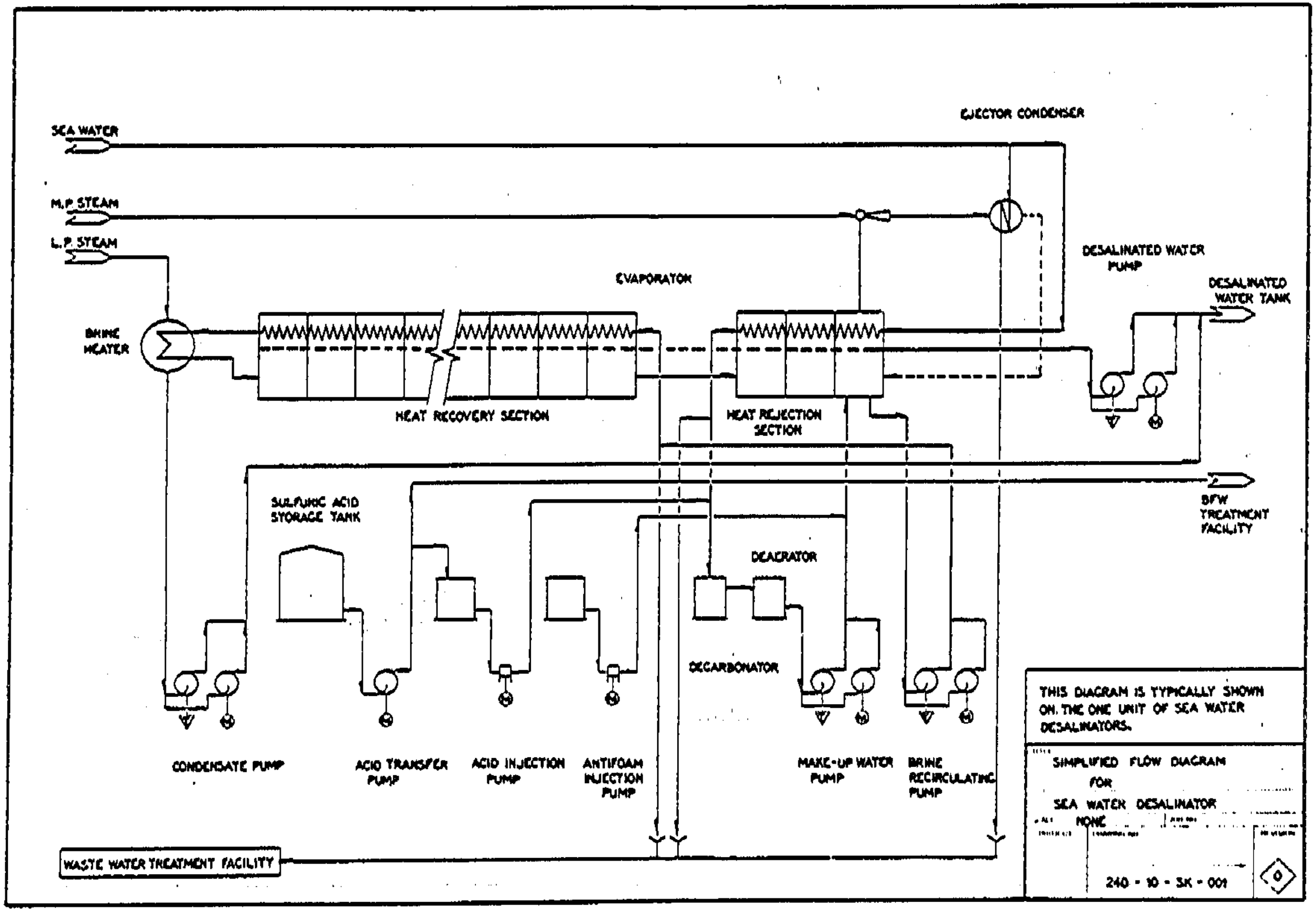
NOTE:
THIS DIAGRAM IS TYPICALLY SHOWN FOR ONE BOILER UNIT.

SIMPLIFIED FLOW DIAGRAM
FOR
STEAM GENERATING FACILITY

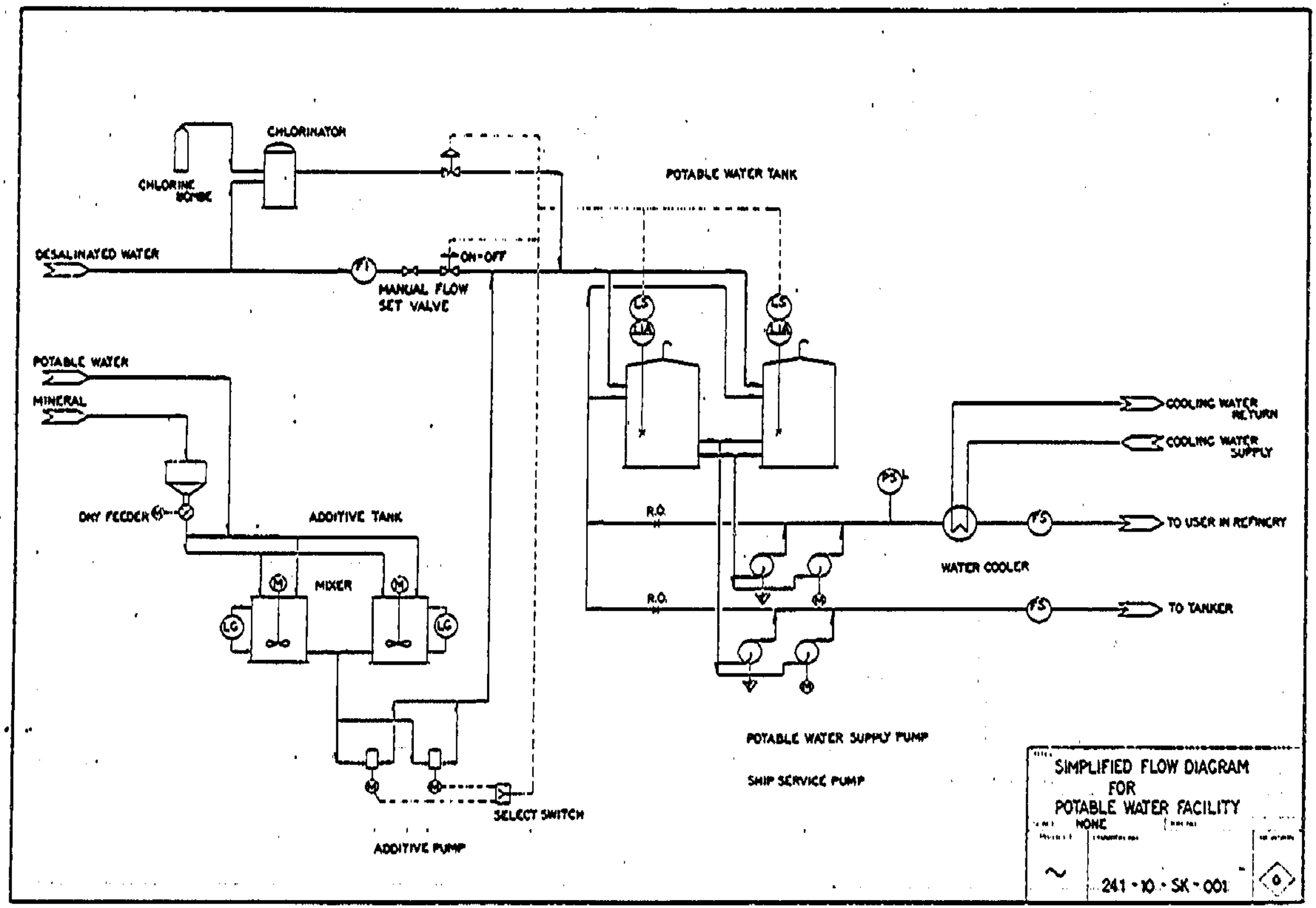
210-10-SK-001

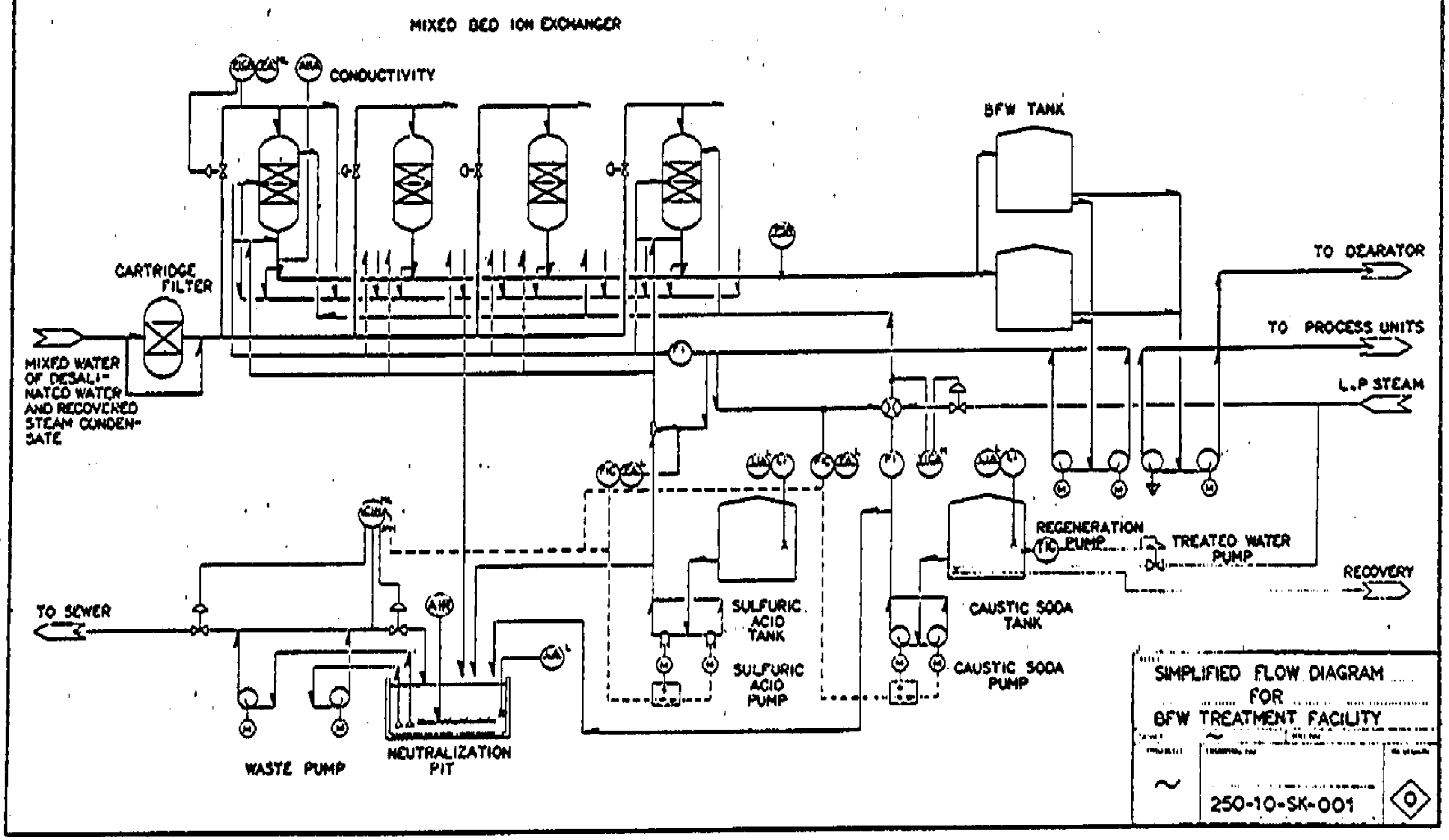
0


HIGH PRESSURE STEAM
MEDIUM PRESSURE STEAM
BLEEDING WATER
CONDENSATE
LOW PRESSURE STEAM
MAIN STOP VALVE
EXTRACTION CONDENSING STEAM TURBINE
ELECTRIC POWER GENERATOR
OIL COOLERS
AIR COOLERS
COOLING WATER
CONDENSER
GLAND CONDENSER
EJECTOR
CONDENSATE PUMPS
NOTE
THIS SYSTEM IS TYPICALLY SHOWN FOR ONE GENERATOR UNIT.
SIMPLIFIED FLOW DIAGRAM FOR
POWER GENERATING FACILITY
220-10-SK-001



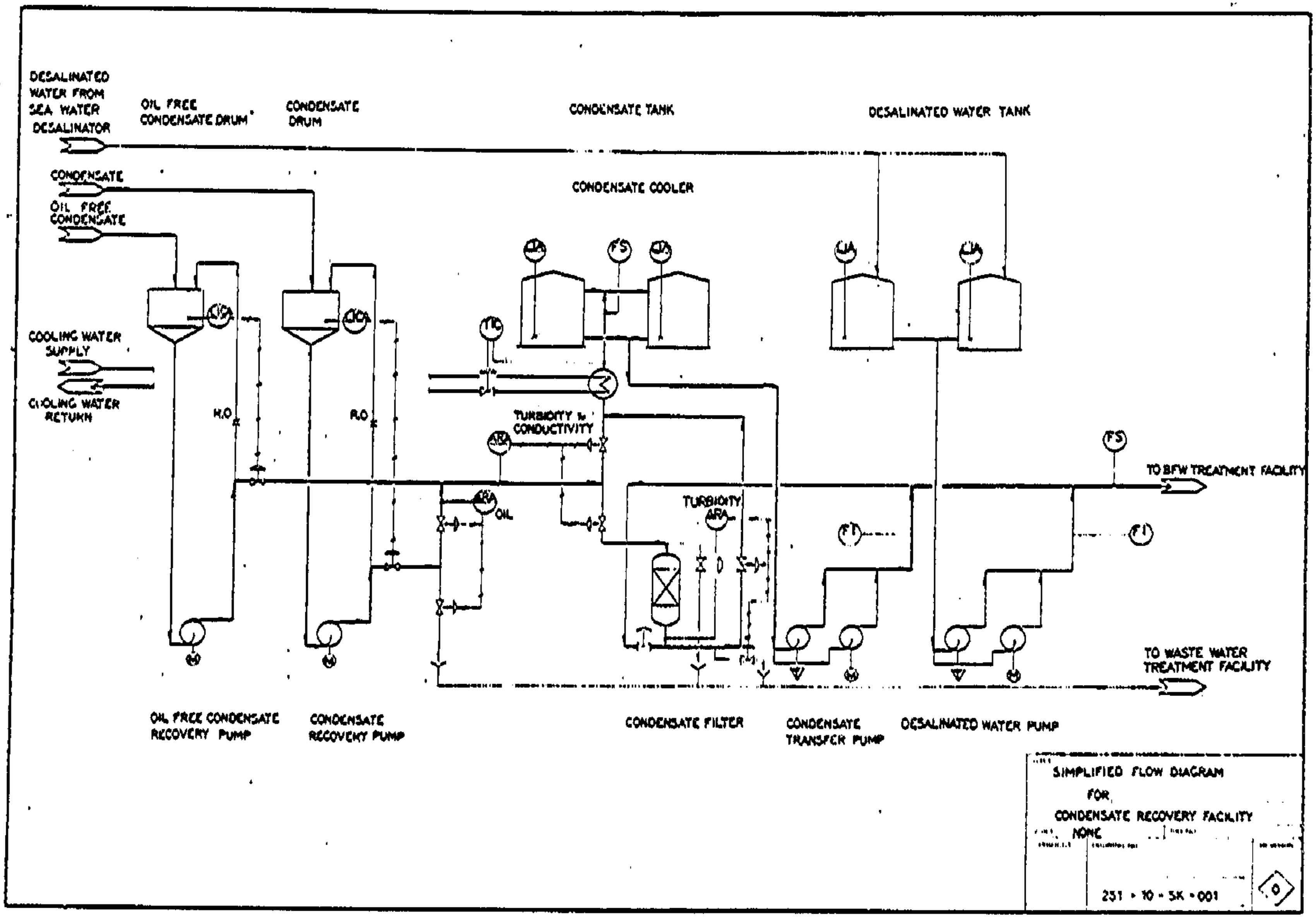
SEA WATER
M.P. STEAM
L.P. STEAM
BRINE HEATER
EVAPORATOR
HEAT RECOVERY SECTION
HEAT REJECTION SECTION
EJECTOR CONDENSER
DESALINATED WATER PUMP
DESALINATED WATER TANK
BFW TREATMENT FACILITY
SULFURIC ACID STORAGE TANK
DEAERATOR
DECARBONATOR
CONDENSATE PUMP
ACID TRANSFER PUMP
ACID INJECTION PUMP
ANTIFOAM INJECTION PUMP
MAKE-UP WATER PUMP
BRINE RECIRCULATING PUMP
WASTE WATER TREATMENT FACILITY
THIS DIAGRAM IS TYPICALLY SHOWN ON THE ONE UNIT OF SEA WATER DESALINATORS.
SIMPLIFIED FLOW DIAGRAM
FOR
SEA WATER DESALINATOR
NONE
240 - 10 - SK - 001
0

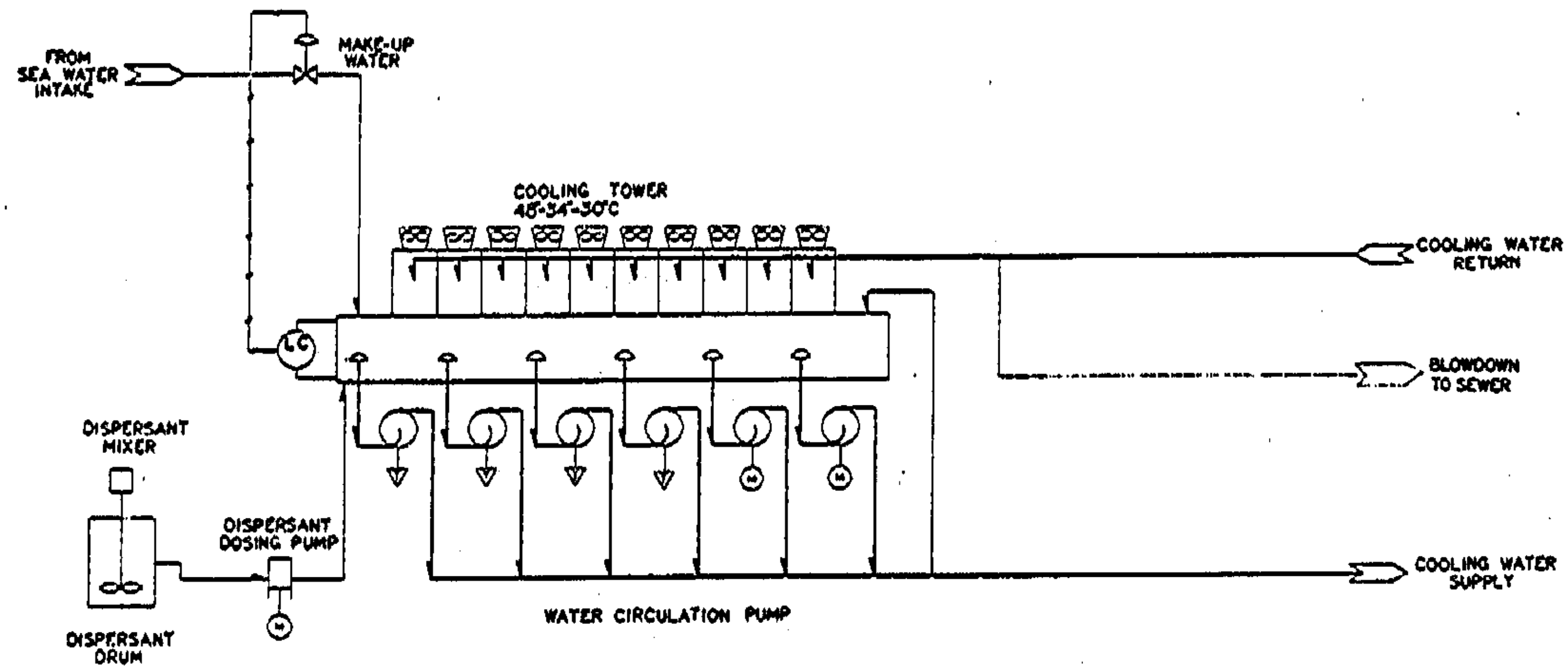

CHLORINATOR
CHLORINE BOMBE
DESALINATED WATER
FI
MANUAL FLOW SET VALVE
ON-OFF
POTABLE WATER TANK
LS
LIA
POTABLE WATER
MINERAL
DRY FEEDER
ADDITIVE TANK
MIXER
LG
SELECT SWITCH
ADDITIVE PUMP
R.O.
PSL
WATER COOLER
FS
COOLING WATER RETURN
COOLING WATER SUPPLY
TO USER IN REFINERY
TO TANKER
POTABLE WATER SUPPLY PUMP
SHIP SERVICE PUMP
SIMPLIFIED FLOW DIAGRAM
FOR
POTABLE WATER FACILITY
NONE
241 - 10 - SK - 001
0



SIMPLIFIED FLOW DIAGRAM FOR BFW TREATMENT FACILITY

250-10-SK-001

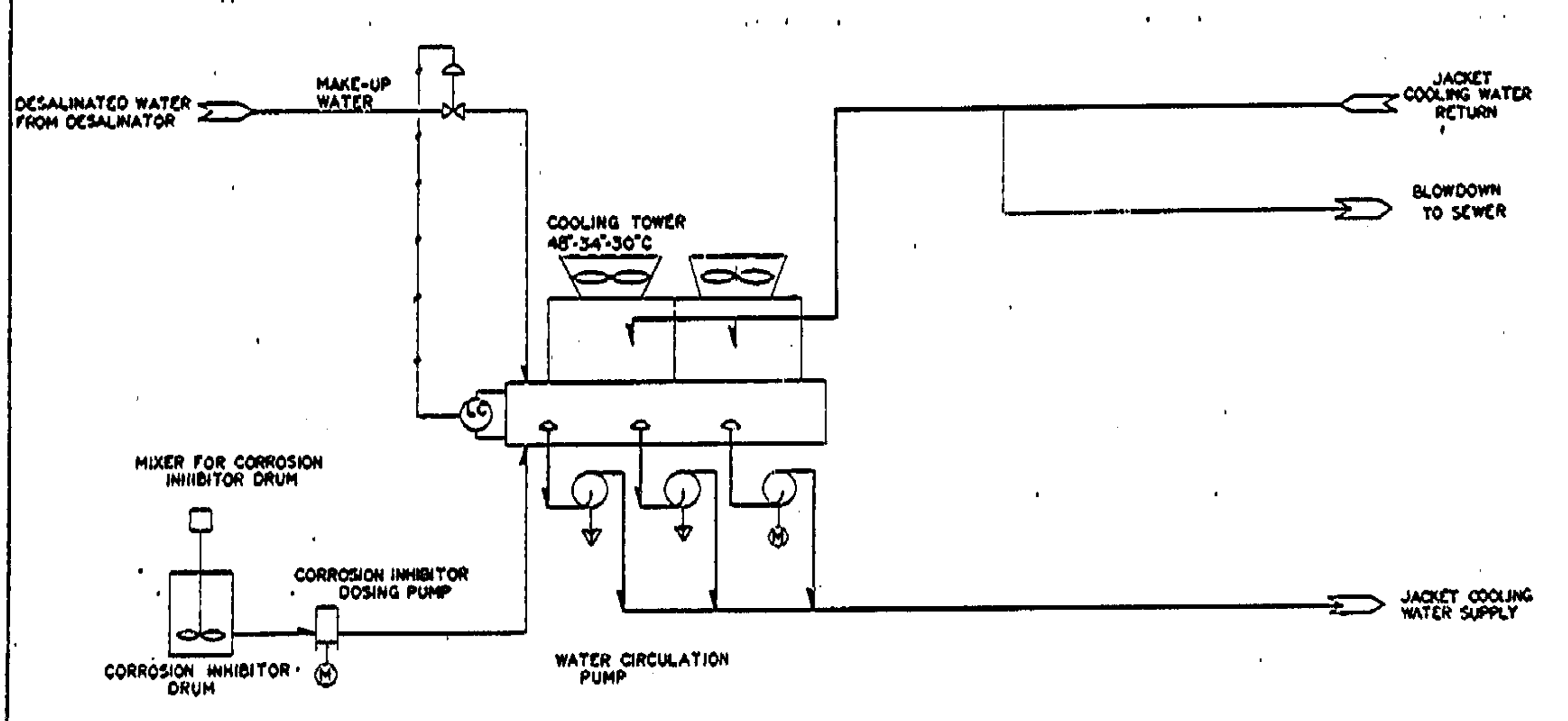

DESALINATED WATER FROM SEA WATER DESALINATOR
OIL FREE CONDENSATE DRUM
CONDENSATE DRUM
CONDENSATE TANK
DESALINATED WATER TANK
CONDENSATE
OIL FREE CONDENSATE
CONDENSATE COOLER
LIA
FS
LICA
TIC
COOLING WATER SUPPLY
COOLING WATER RETURN
R.O
TURBIDITY & CONDUCTIVITY
ARA
OIL
TURBIDITY ARA
FI
TO BFW TREATMENT FACILITY
TO WASTE WATER TREATMENT FACILITY
OIL FREE CONDENSATE RECOVERY PUMP
CONDENSATE RECOVERY PUMP
CONDENSATE FILTER
CONDENSATE TRANSFER PUMP
DESALINATED WATER PUMP
SIMPLIFIED FLOW DIAGRAM
FOR
CONDENSATE RECOVERY FACILITY
NONE
251 - 10 - SK - 001
0



THIS DIAGRAM IS TYPICALLY SHOWN ON THE FACILITIES FOR 250,000 BPSD REFINERY.

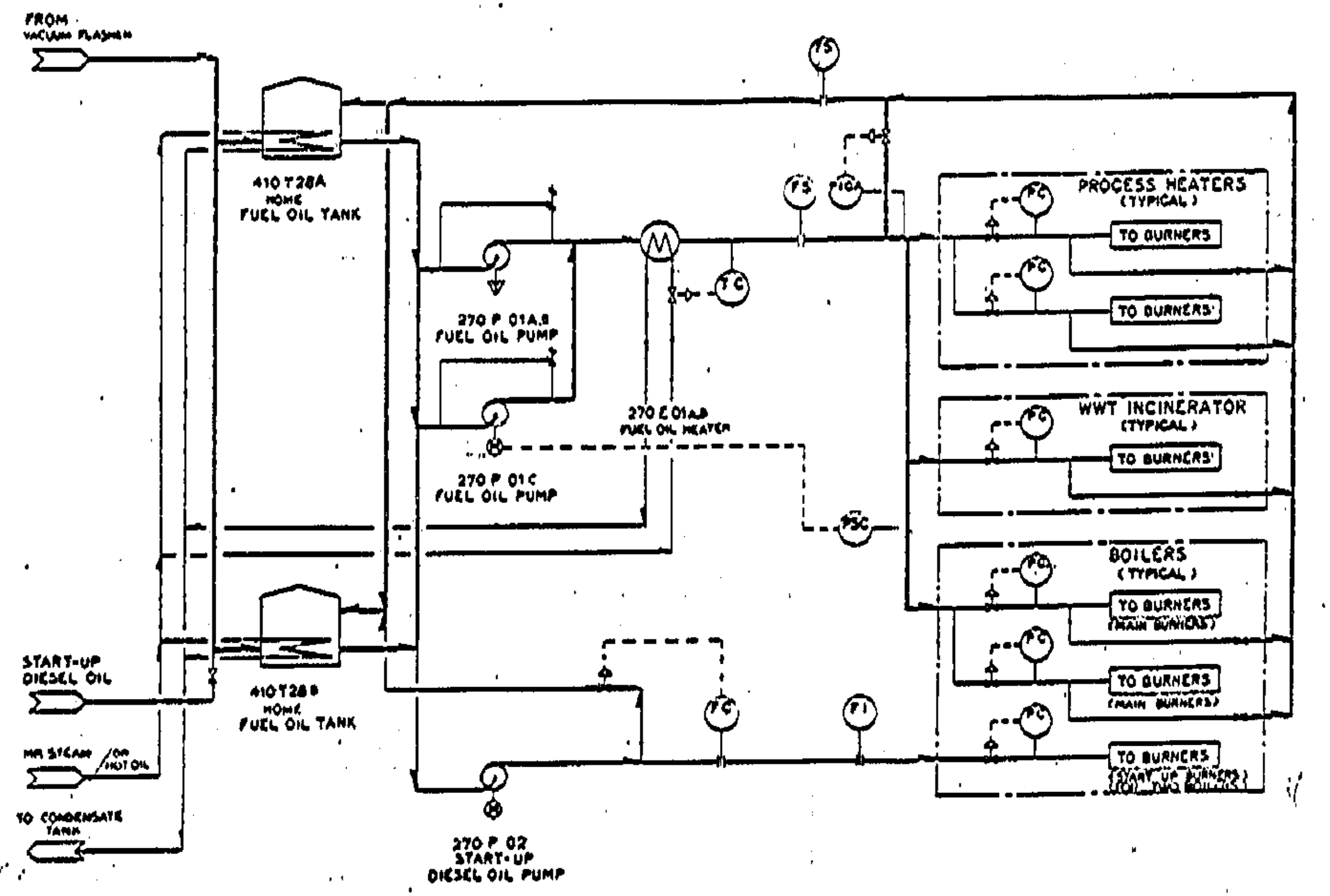
SIMPLIFIED FLOW DIAGRAM FOR SEA WATER COOLING FACILITY

260-10-SK-001



SIMPLIFIED FLOW DIAGRAM
FOR
JACKET WATER COOLING FACILITY

260-10-SK-002



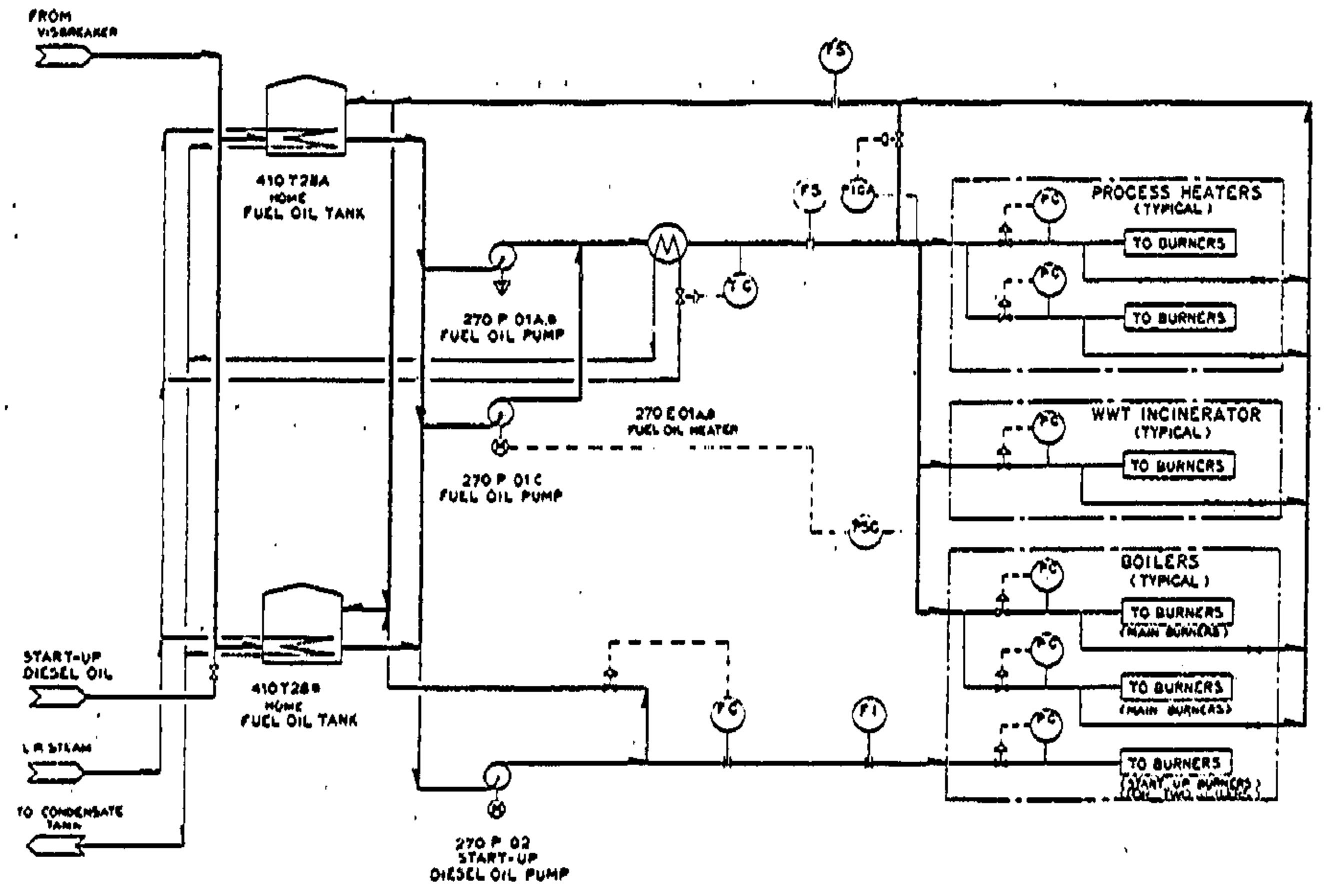
CASE 1 HYDRO SKIMMING

SIMPLIFIED FLOW DIAGRAM
FOR
FUEL OIL FACILITY

760 273

270-10-SK-001

0



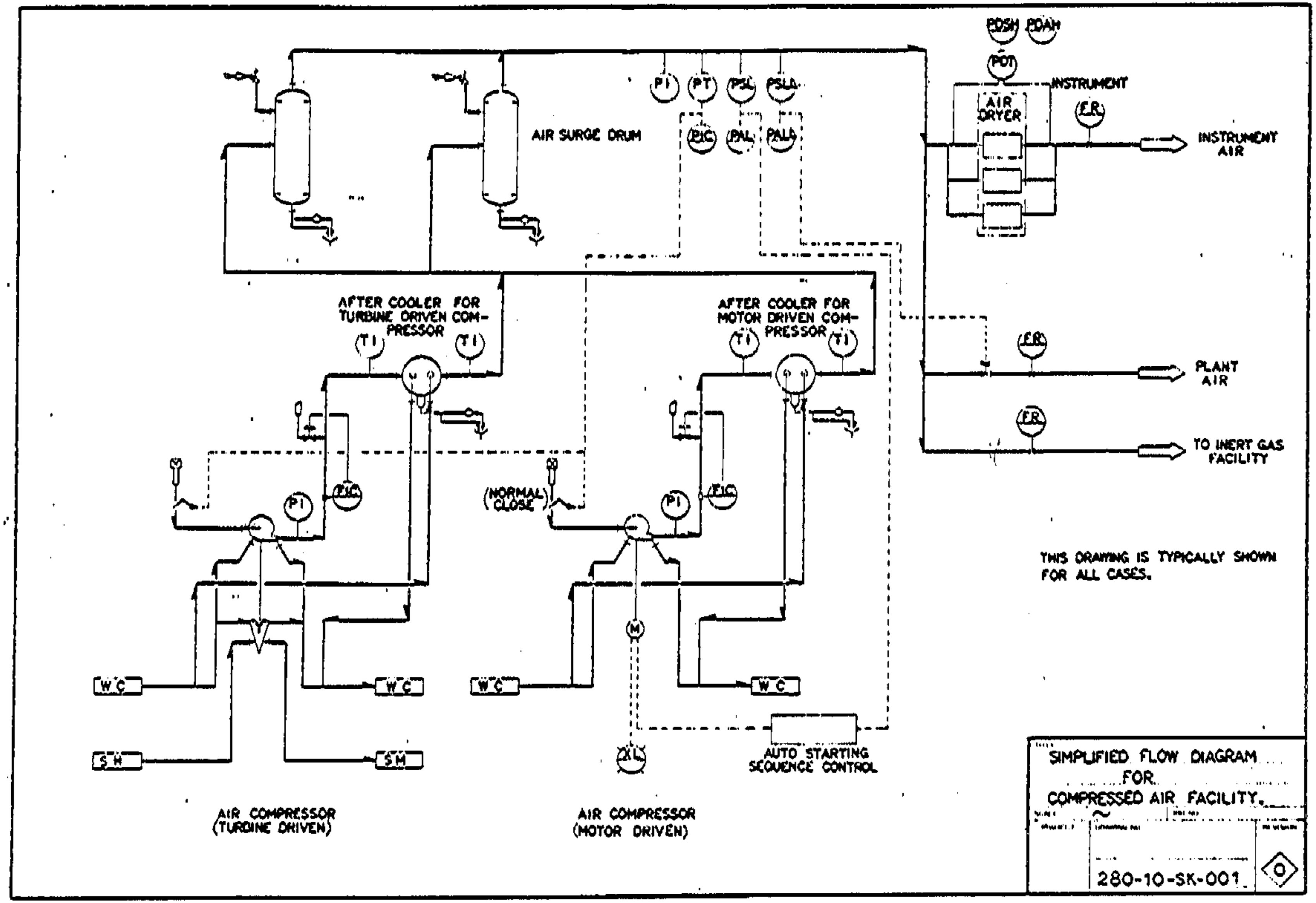
CASE 2. HYDRO CRACKING

SIMPLIFIED FLOW DIAGRAM FOR FUEL OIL FACILITY

760275

270-10-SK-002

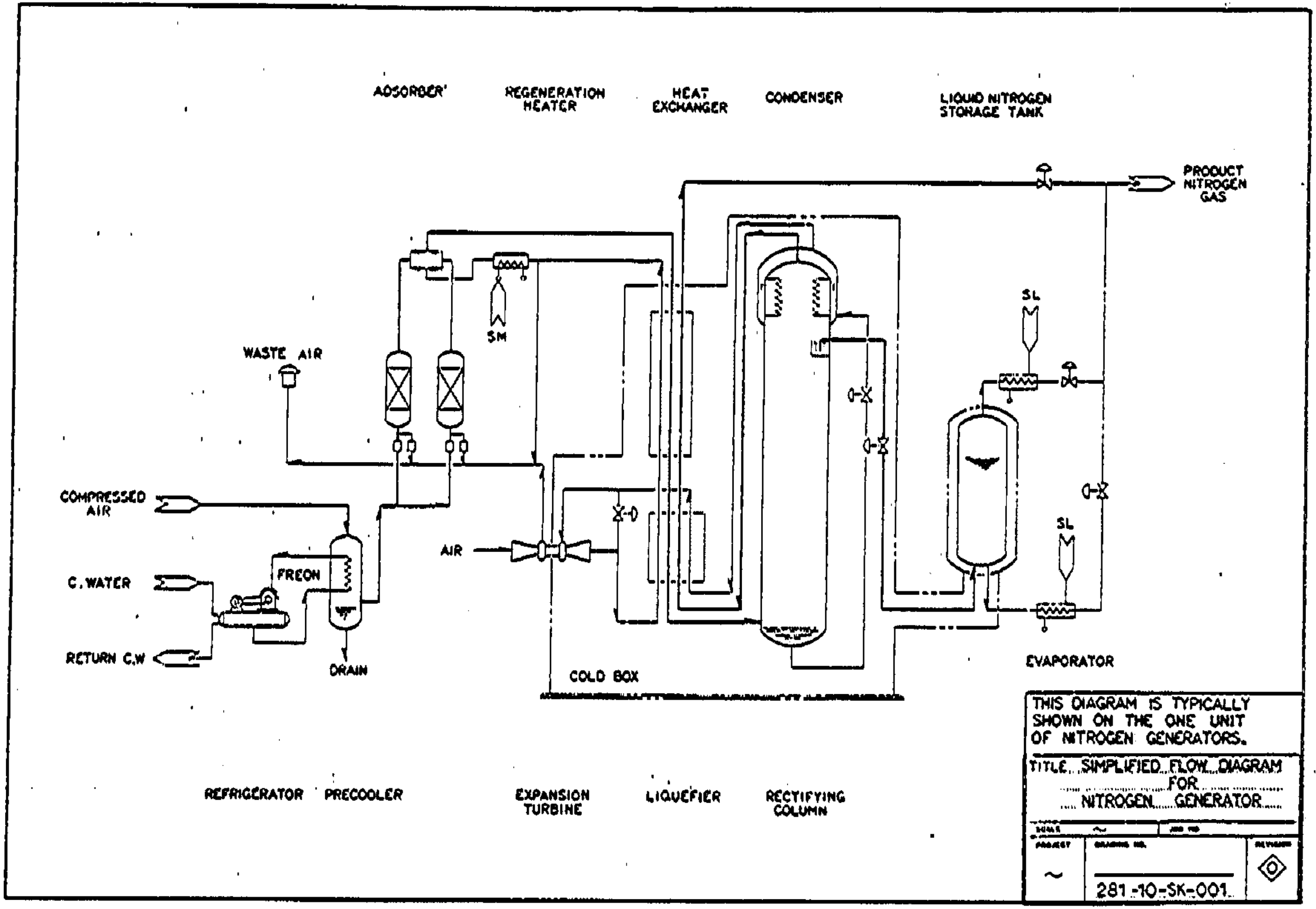
0

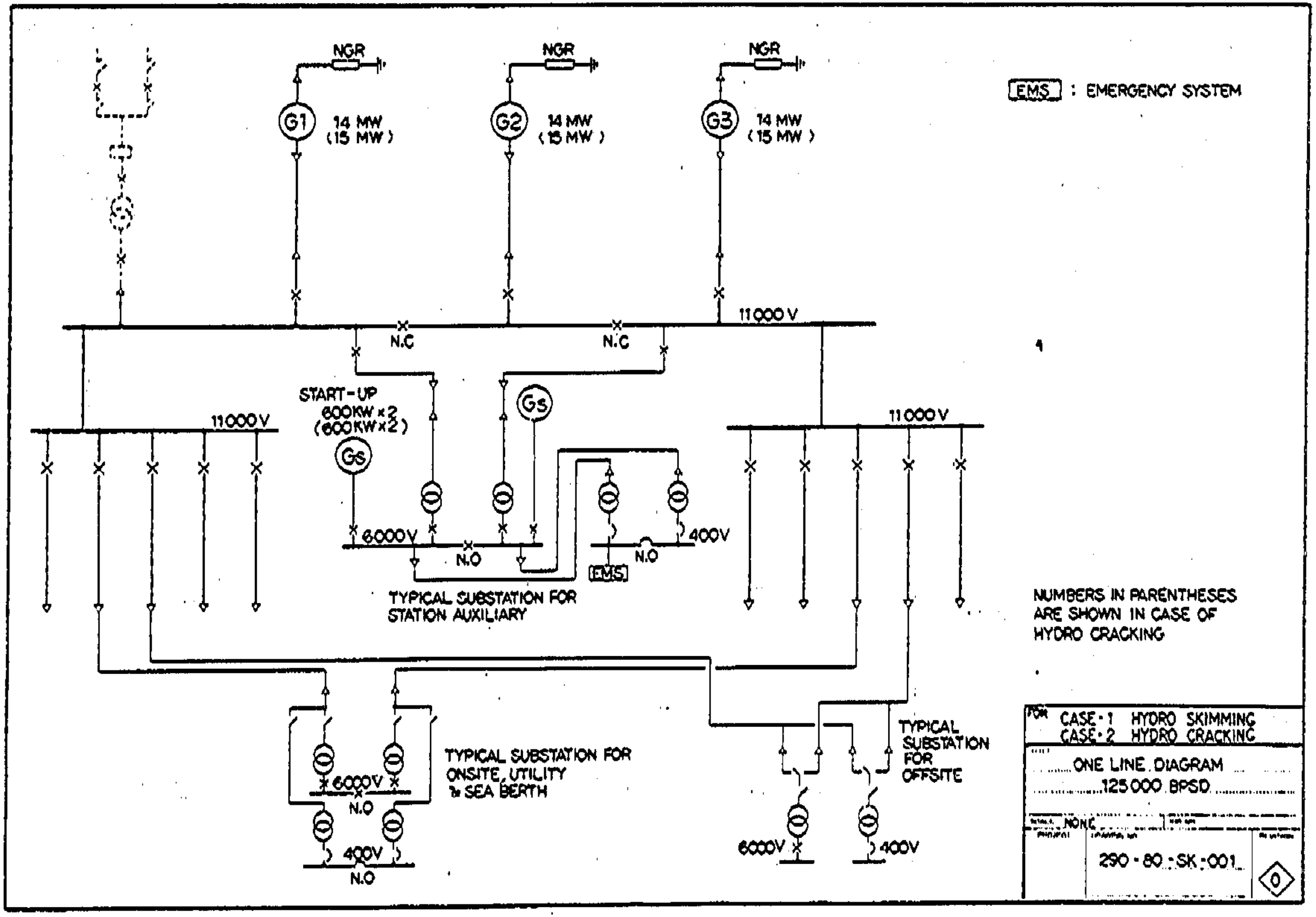


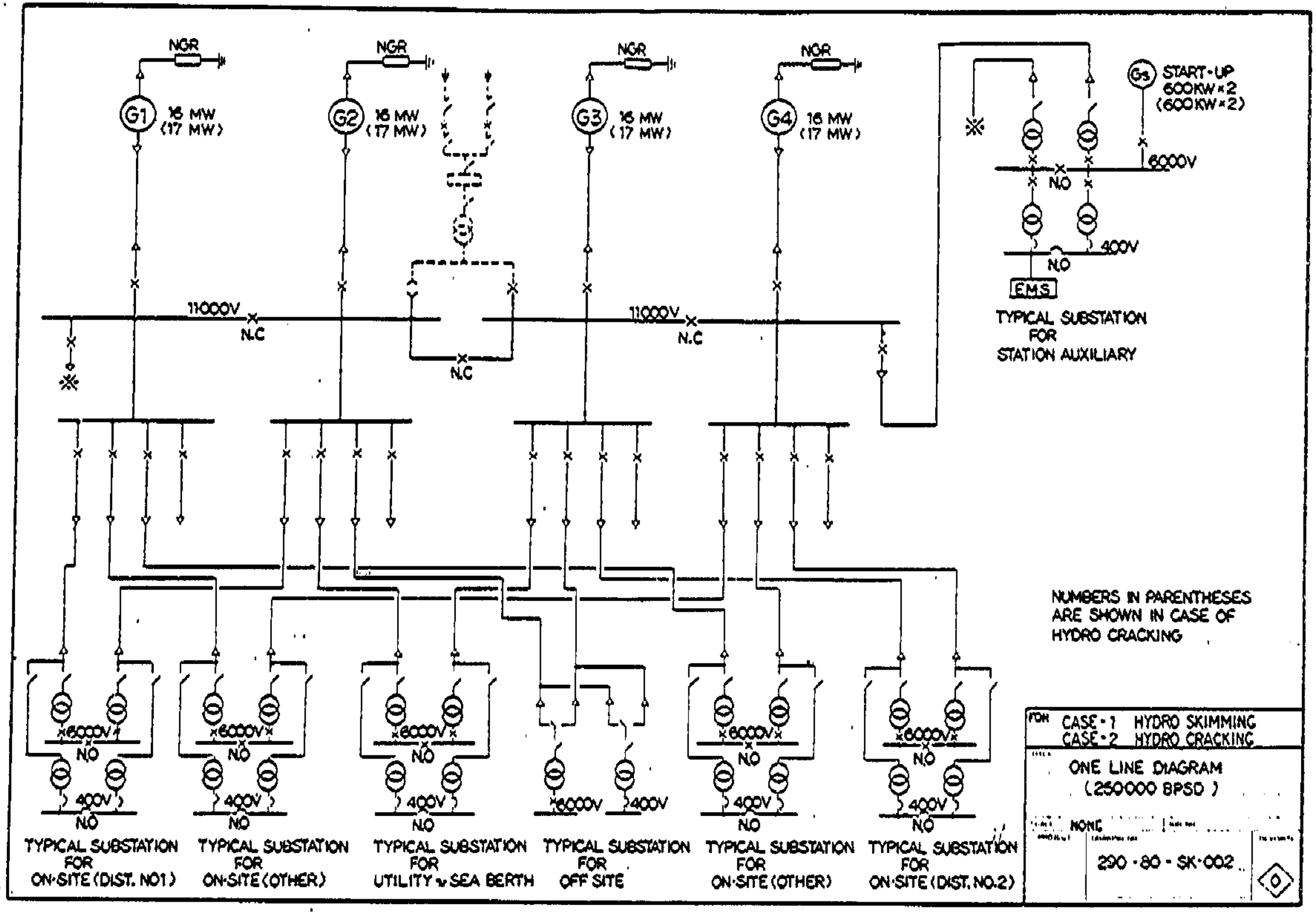
SIMPLIFIED FLOW DIAGRAM FOR COMPRESSED AIR FACILITY

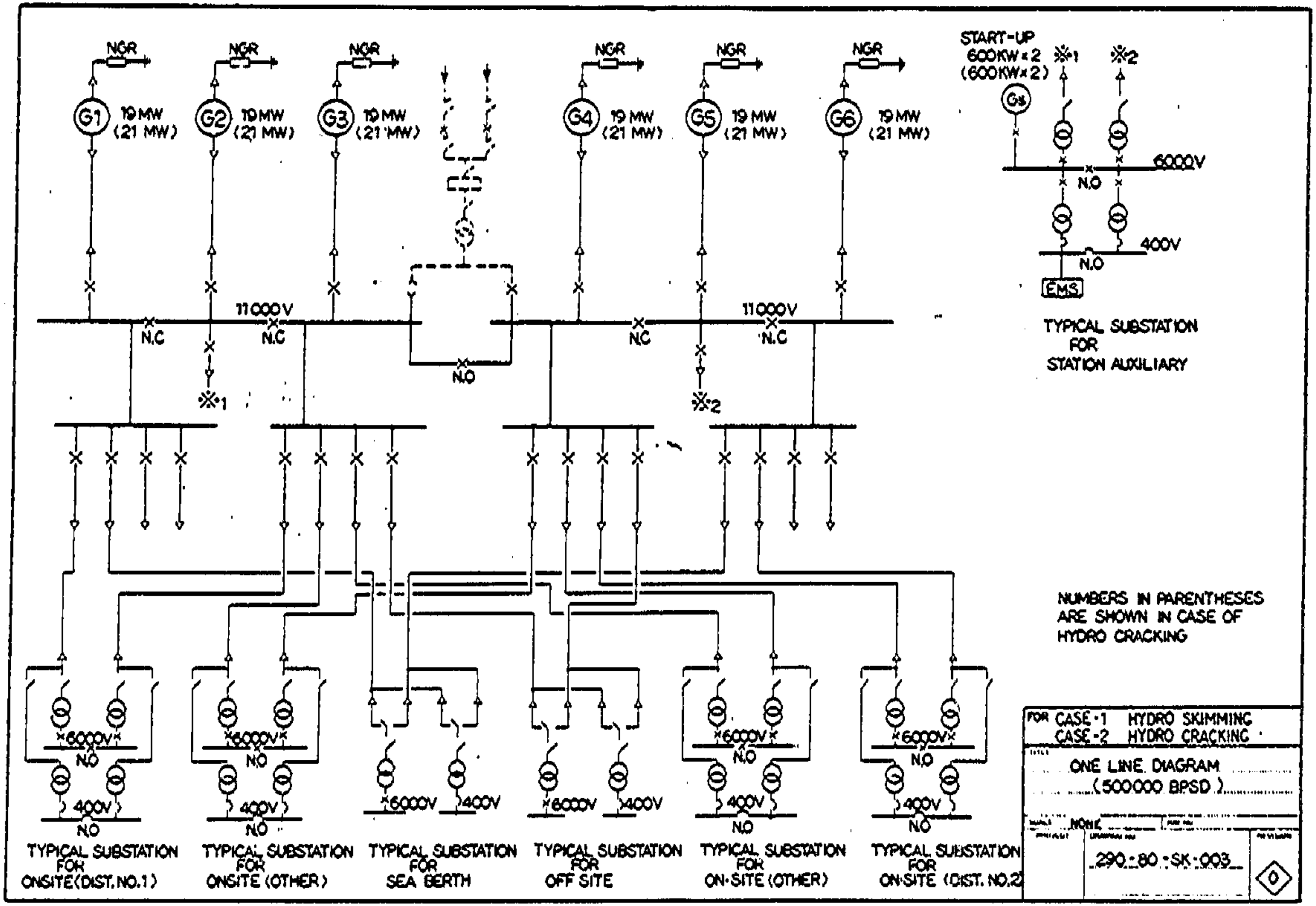
280-10-SK-001

0


ADSORBER'
REGENERATION HEATER
HEAT EXCHANGER
CONDENSER
LIQUID NITROGEN STORAGE TANK
PRODUCT NITROGEN GAS
SL
SM
WASTE AIR
COMPRESSED AIR
C. WATER
RETURN C.W
FREON
DRAIN
AIR
SL
COLD BOX
EVAPORATOR
REFRIGERATOR
PRECOOLER
EXPANSION TURBINE
LIQUEFIER
RECTIFYING COLUMN
THIS DIAGRAM IS TYPICALLY SHOWN ON THE ONE UNIT OF NITROGEN GENERATORS.
TITLE SIMPLIFIED FLOW DIAGRAM FOR NITROGEN GENERATOR
~
~
281-10-SK-001


EMS : EMERGENCY SYSTEM
NGR
G1 14 MW (15 MW)
G2 14 MW (15 MW)
G3 14 MW (15 MW)
11000 V
N.C
N.C
START-UP 600KW x 2 (600KW x 2)
Gs
Gs
6000V
N.O
400V
N.O
EMS
TYPICAL SUBSTATION FOR STATION AUXILIARY
11000V
11000V
NUMBERS IN PARENTHESES ARE SHOWN IN CASE OF HYDRO CRACKING
TYPICAL SUBSTATION FOR ONSITE, UTILITY & SEA BERTH
6000V
N.O
400V
N.O
TYPICAL SUBSTATION FOR OFFSITE
6000V
400V
FOR CASE-1 HYDRO SKIMMING
CASE-2 HYDRO CRACKING
ONE LINE DIAGRAM
125000 BPSD
NONE
290-80-SK-001
0


NGR
G1
16 MW
(17 MW)
G2
16 MW
(17 MW)
G3
16 MW
(17 MW)
G4
16 MW
(17 MW)
11000V
N.C
N.C
11000V
N.C
Gs
START-UP
600KW×2
(600KW×2)
6000V
N.O
400V
N.O
EMS
TYPICAL SUBSTATION
FOR
STATION AUXILIARY
NUMBERS IN PARENTHESES
ARE SHOWN IN CASE OF
HYDRO CRACKING
6000V
N.O
400V
TYPICAL SUBSTATION
FOR
ON-SITE (DIST. NO1)
TYPICAL SUBSTATION
FOR
ON-SITE (OTHER)
TYPICAL SUBSTATION
FOR
UTILITY & SEA BERTH
TYPICAL SUBSTATION
FOR
OFF SITE
TYPICAL SUBSTATION
FOR
ON-SITE (OTHER)
TYPICAL SUBSTATION
FOR
ON-SITE (DIST. NO.2)
CASE-1 HYDRO SKIMMING
CASE-2 HYDRO CRACKING
ONE LINE DIAGRAM
(250000 BPSD)
NONE
290-80-SK-002



NUMBERS IN PARENTHESES ARE SHOWN IN CASE OF HYDRO CRACKING

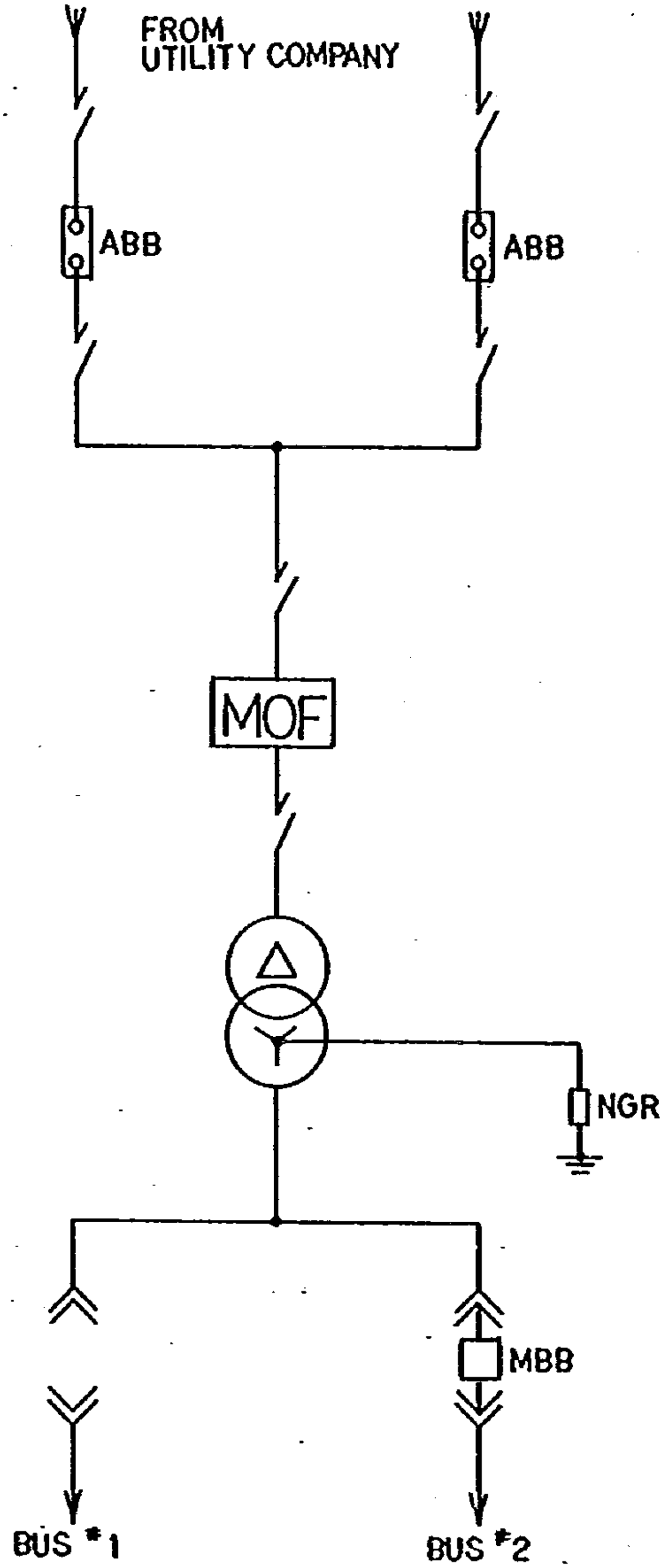
FOR CASE-1 HYDRO SKIMMING
CASE-2 HYDRO CRACKING

ONE LINE DIAGRAM
(500000 BPSD)

NONE

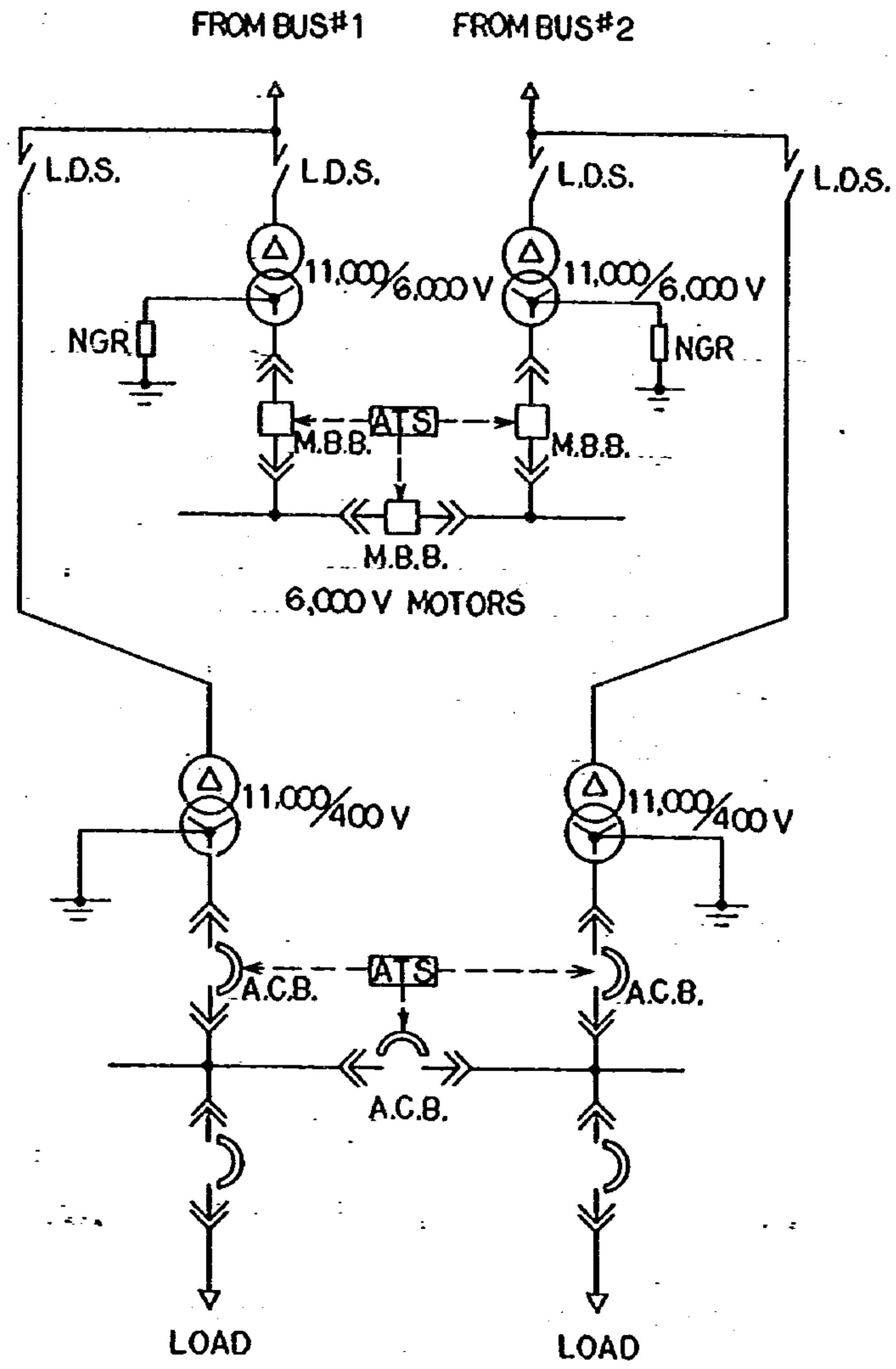
290-80-SK-003

0

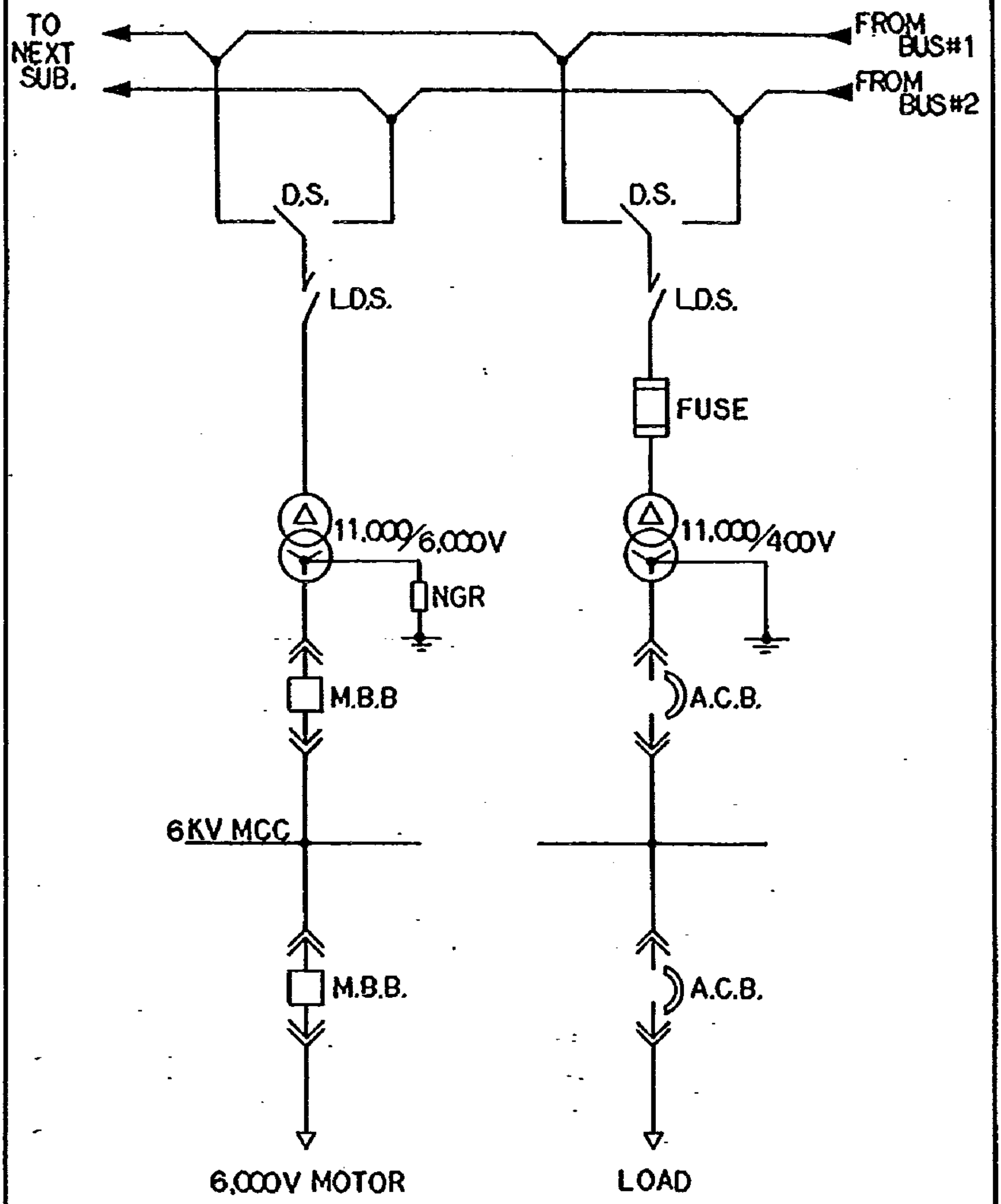


TITLE TYPICAL ONE LINE DIAGRAM FOR RECEIVING SYSTEM

PROJECT	DRAWING NO.	REV
	290-80-SK-004	0

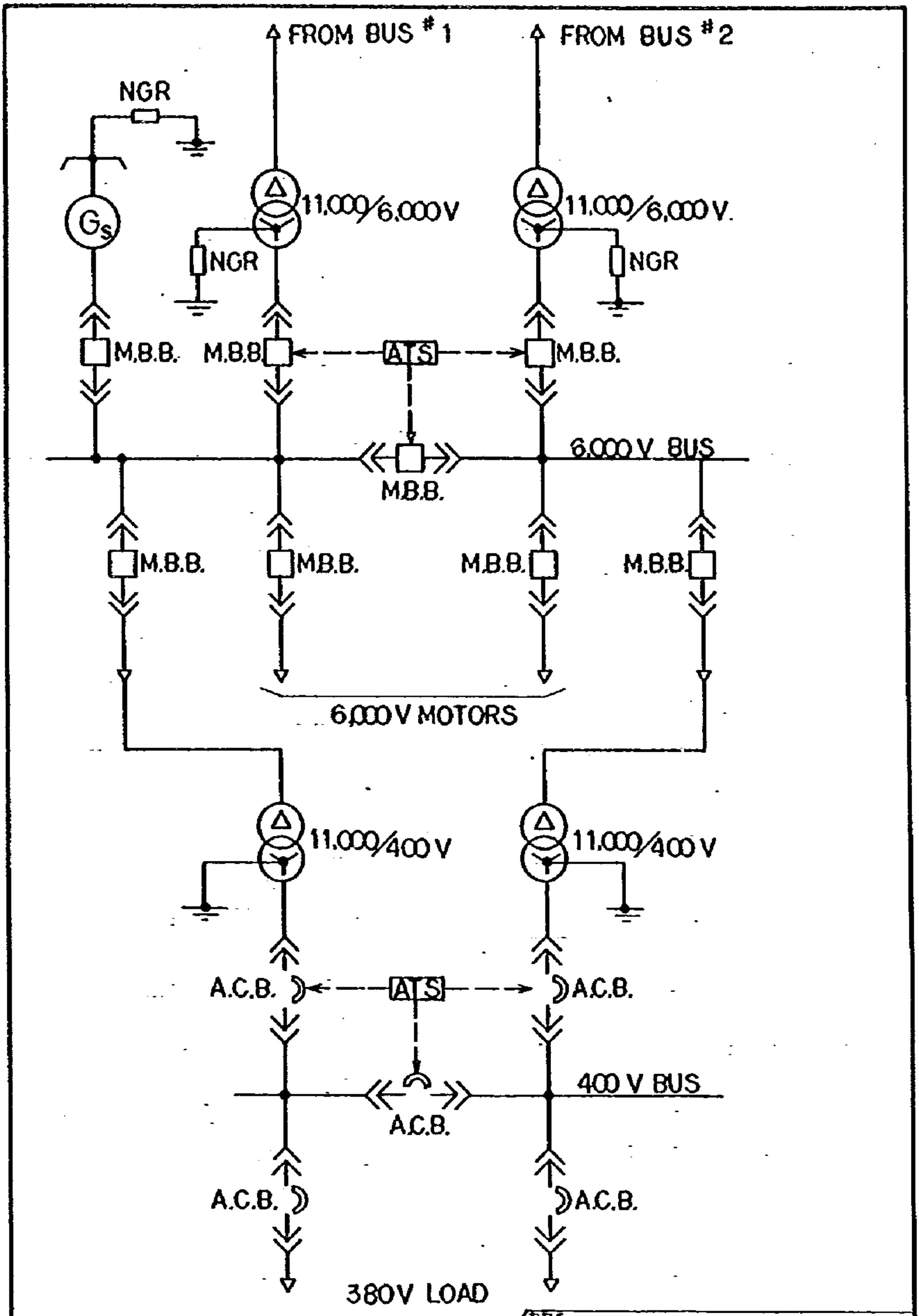


TITLE TYPICAL ONE LINE DIAGRAM FOR ONSITE SUBSTATION AND UTILITY SUBSTATION		
PROJECT	DRAWING NO. 290·80·SK·005	REV 0



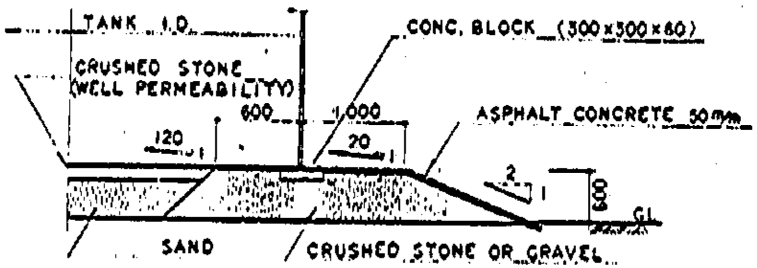
TITLE TYPICAL ONE LINE DIAGRAM FOR OFF-SITE SUBSTATION

PROJECT	DRAWING NO.	REV
	290-80-SK-006	0

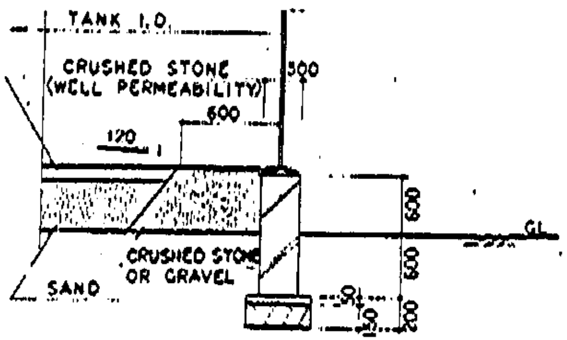


TITLE TYPICAL ONE LINE DIAGRAM FOR STATION AUXILIARY SUBSTATION

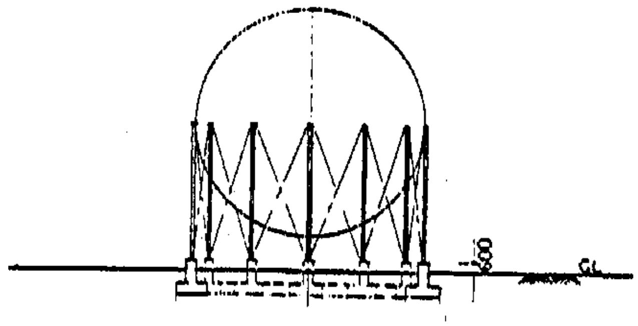
PROJECT	DRAWING NO.	REV
	290-80-SK-007	0



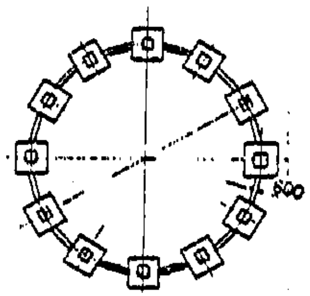
LARGE TANK FOUNDATION
(CRUDE TANK, SEMI-PRODUCT TANK, PRODUCT TANK, etc.)



SMALL TANK FOUNDATION
(FOR ONSITE/UTILITY AREA)



SECTION



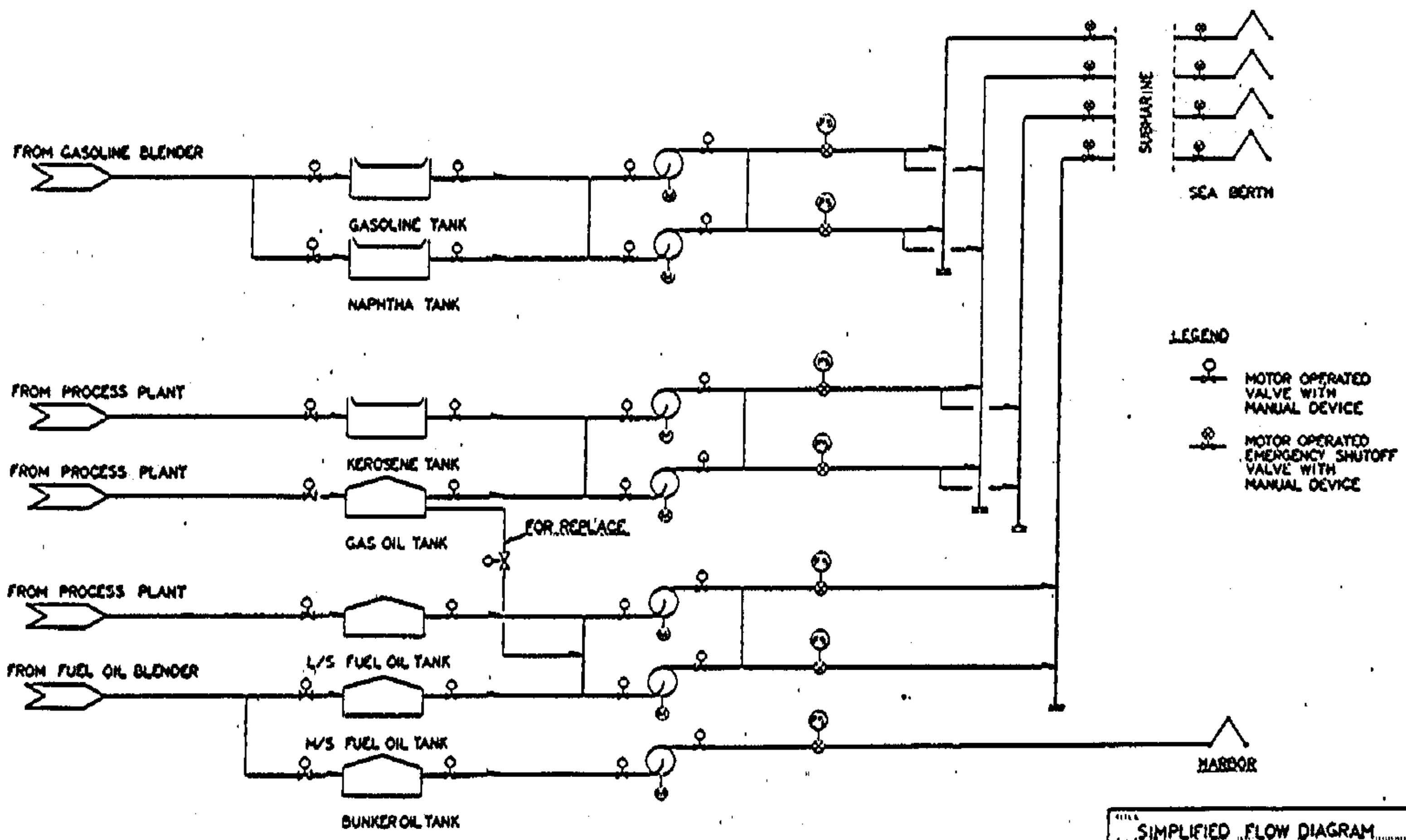
PLAN

SPHERICAL TANK FOUNDATION
(L.P.G TANK)

FOUNDATION FOR TANK

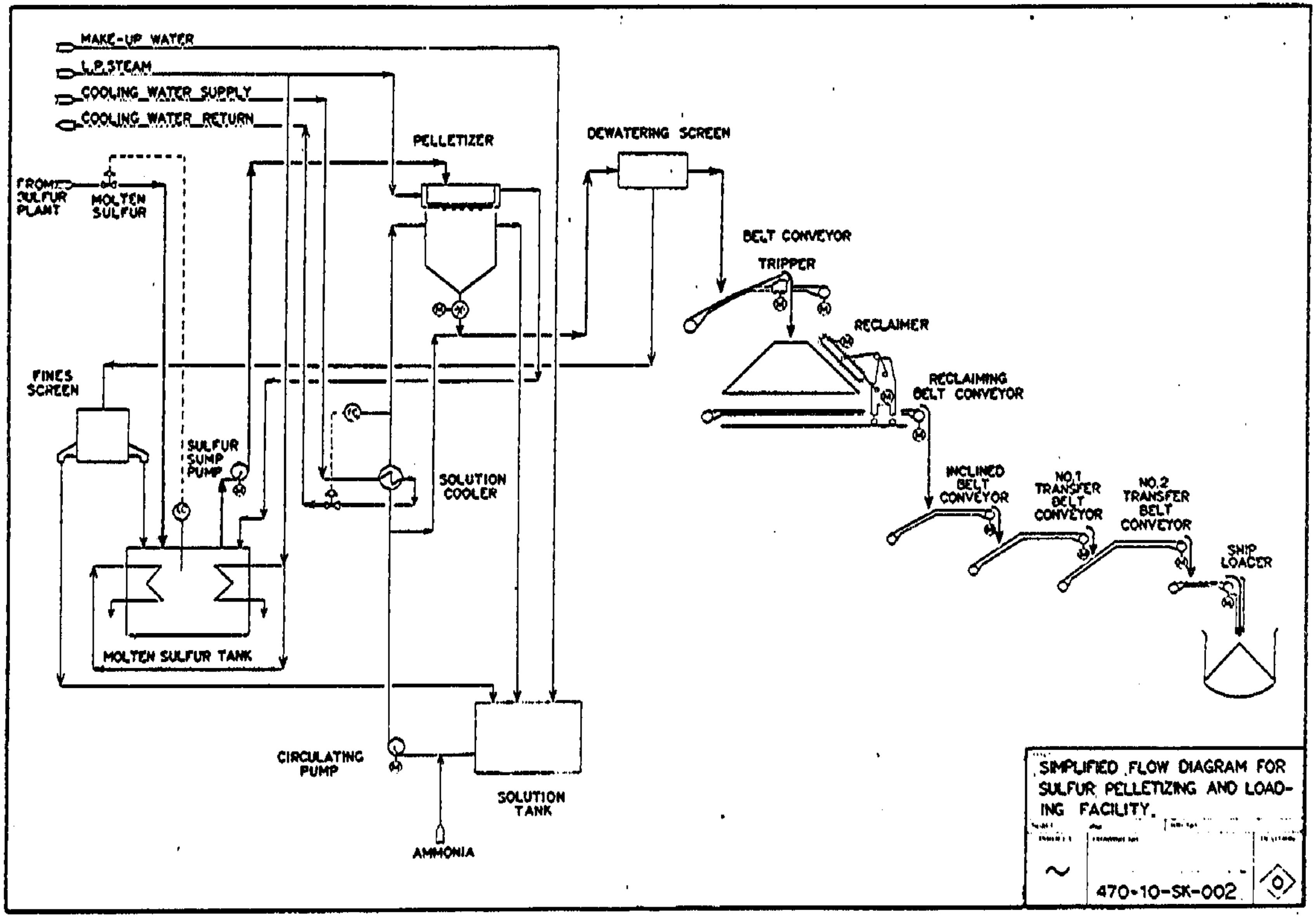
410-50-SK-001

0



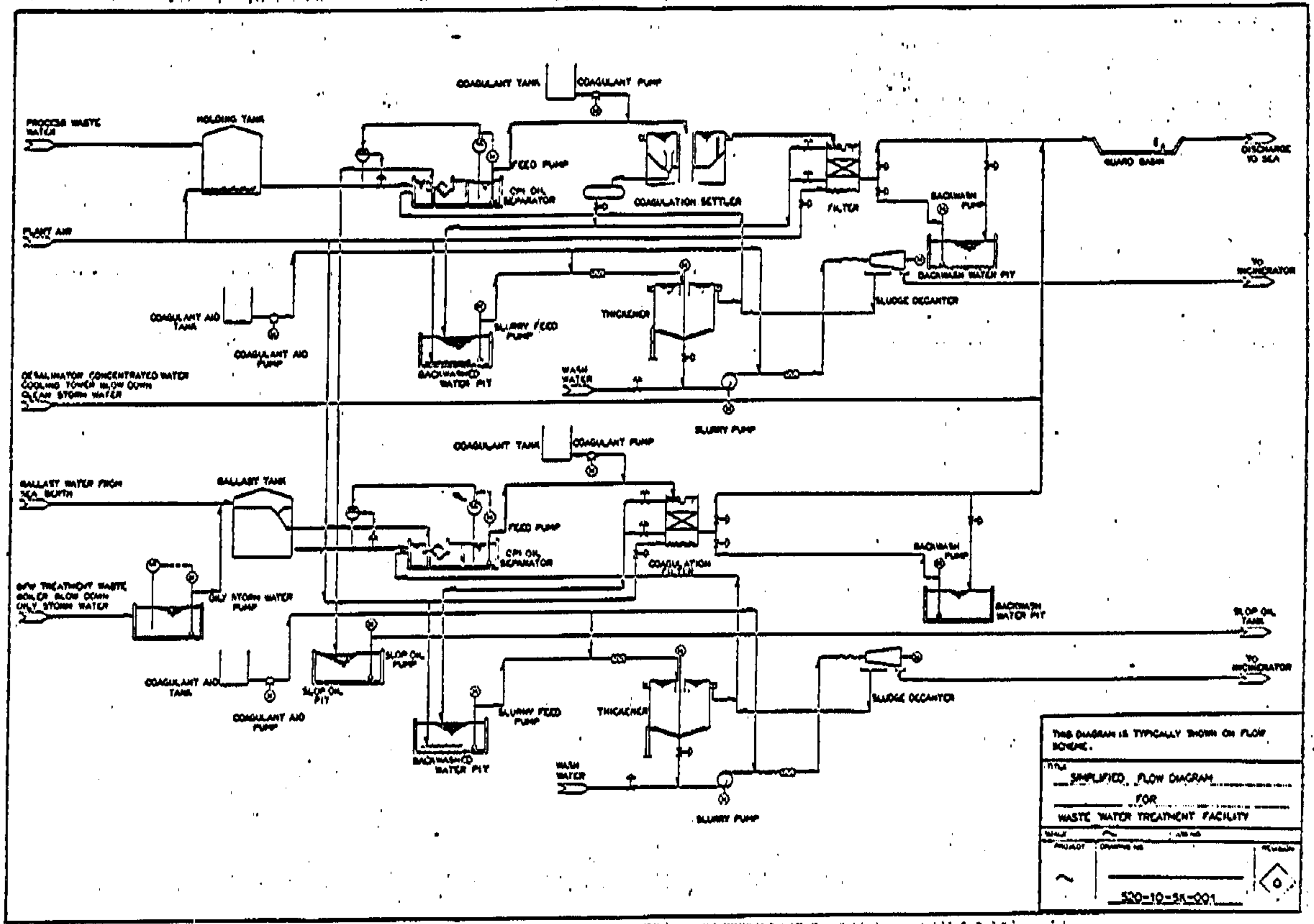
SIMPLIFIED FLOW DIAGRAM
FOR
PRODUCT SHIPPING FACILITY

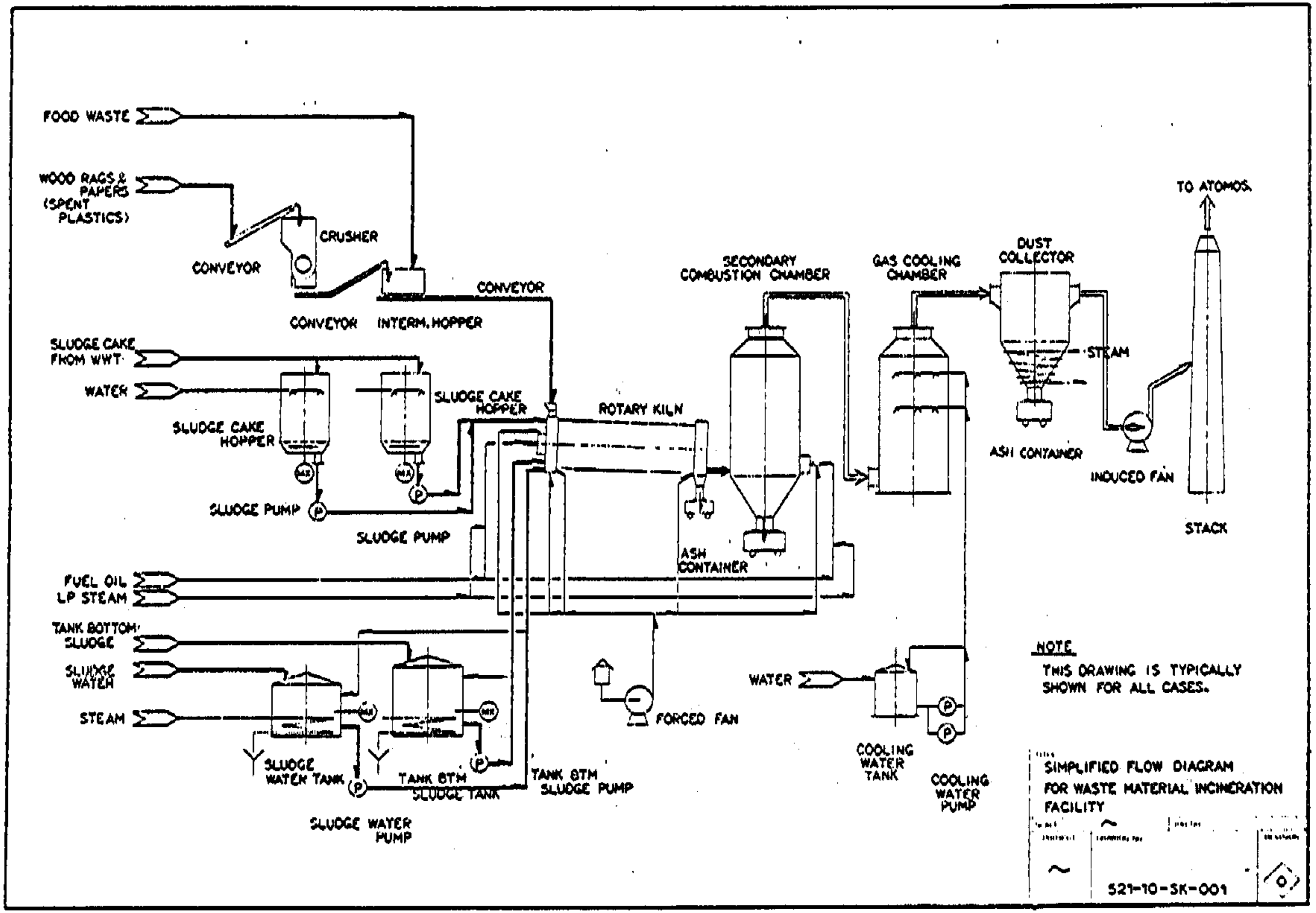
440-10-SK-001

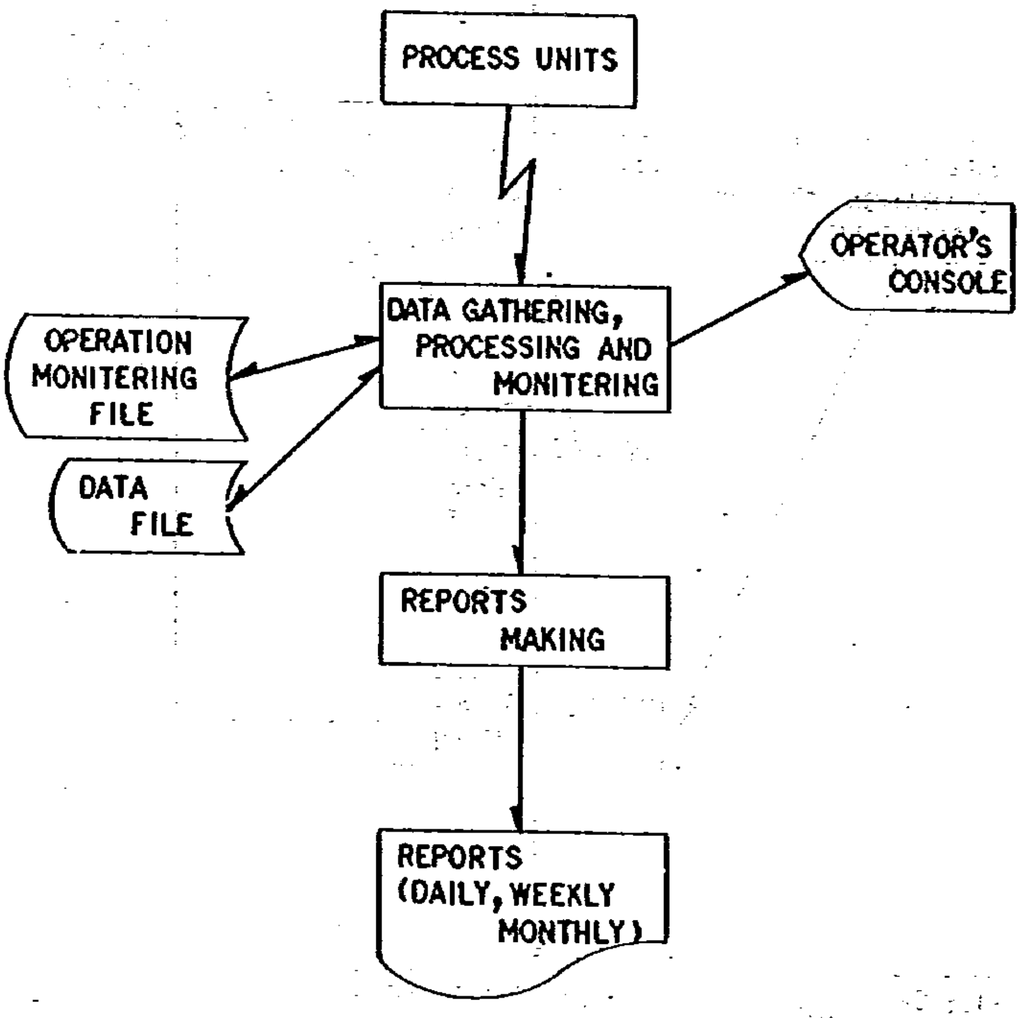


SIMPLIFIED FLOW DIAGRAM FOR SULFUR PELLETIZING AND LOADING FACILITY.

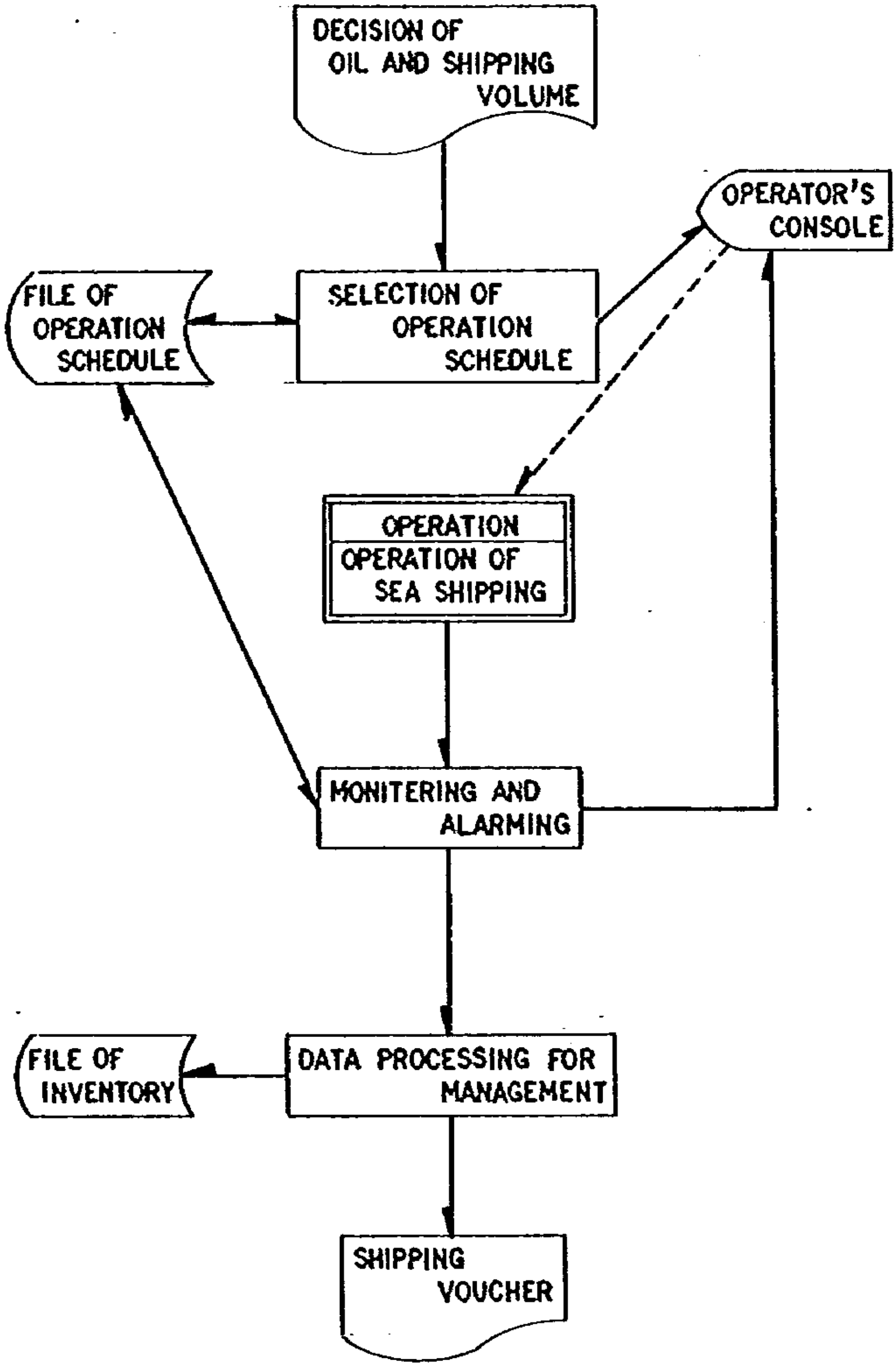
470-10-SK-002


PROCESS WASTE WATER
HOLDING TANK
COAGULANT TANK
COAGULANT PUMP
FEED PUMP
CPI OIL SEPARATOR
COAGULATION SETTLER
FILTER
BACKWASH PUMP
GUARD BASIN
DISCHARGE TO SEA
PLANT AIR
BACKWASH WATER PIT
TO INCINERATOR
SLUDGE DECANTER
COAGULANT AID TANK
COAGULANT AID PUMP
SLURRY FEED PUMP
THICKENER
BACKWASHED WATER PIT
DESALINATOR CONCENTRATED WATER
COOLING TOWER BLOW DOWN
CLEAN STORM WATER
WASH WATER
SLURRY PUMP
BALLAST WATER FROM SEA BERTH
BALLAST TANK
COAGULATION FILTER
BFW TREATMENT WASTE
BOILER BLOW DOWN
OILY STORM WATER
OILY STORM WATER PUMP
SLOP OIL PUMP
SLOP OIL PIT
SLOP OIL TANK
THIS DIAGRAM IS TYPICALLY SHOWN ON FLOW SCHEME.
SIMPLIFIED FLOW DIAGRAM
FOR
WASTE WATER TREATMENT FACILITY
520-10-SK-001

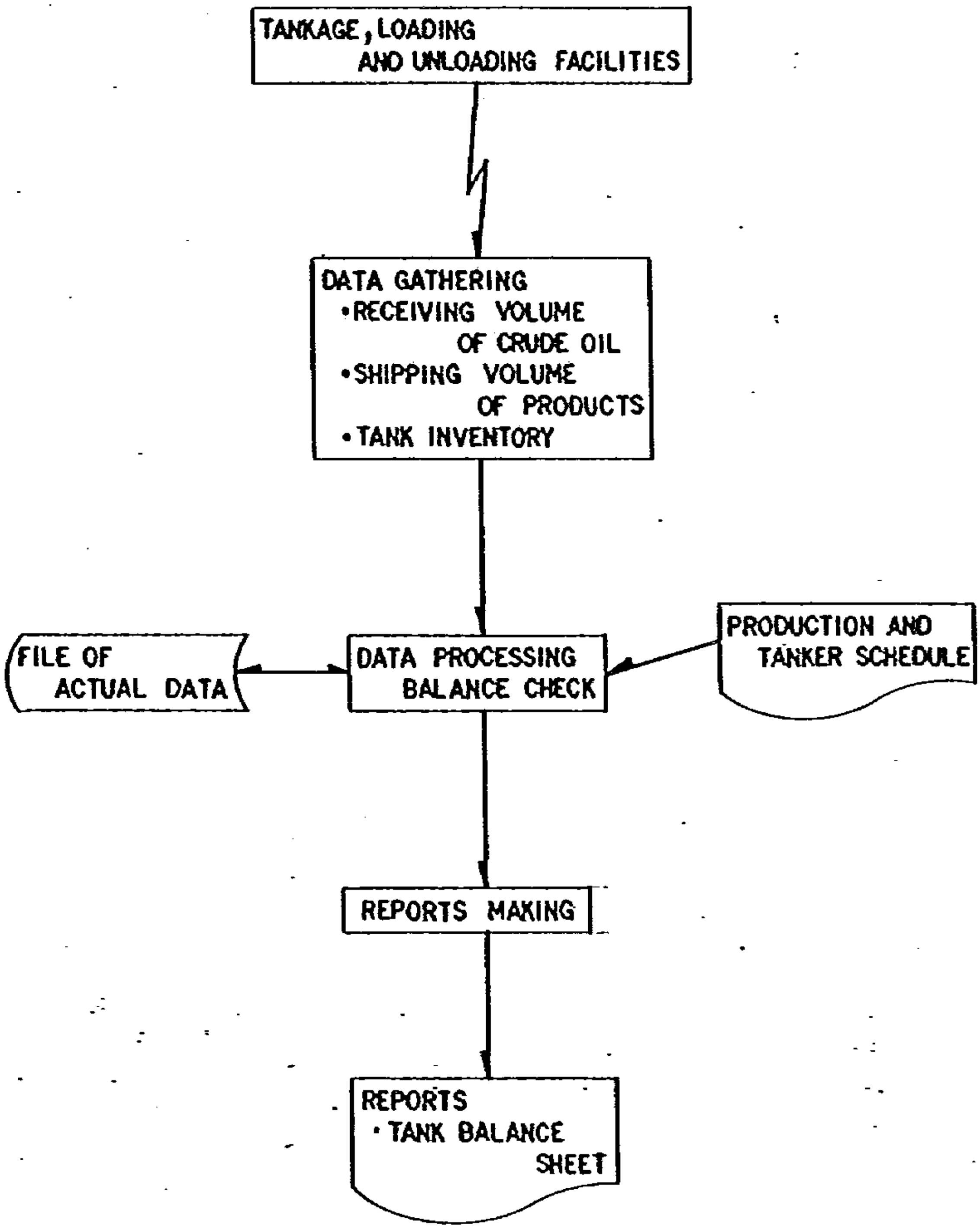

FOOD WASTE
WOOD RAGS & PAPERS (SPENT PLASTICS)
CONVEYOR
CRUSHER
CONVEYOR
INTERM. HOPPER
CONVEYOR
SLUDGE CAKE FROM WWT
WATER
SLUDGE CAKE HOPPER
SLUDGE CAKE HOPPER
SLUDGE PUMP
SLUDGE PUMP
ROTARY KILN
SECONDARY COMBUSTION CHAMBER
ASH CONTAINER
GAS COOLING CHAMBER
DUST COLLECTOR
STEAM
ASH CONTAINER
INDUCED FAN
TO ATOMOS.
STACK
FUEL OIL
LP STEAM
TANK BOTTOM SLUDGE
SLUDGE WATER
STEAM
SLUDGE WATER TANK
TANK BTM SLUDGE TANK
TANK BTM SLUDGE PUMP
SLUDGE WATER PUMP
FORCED FAN
WATER
COOLING WATER TANK
COOLING WATER PUMP
NOTE
THIS DRAWING IS TYPICALLY SHOWN FOR ALL CASES.
SIMPLIFIED FLOW DIAGRAM FOR WASTE MATERIAL INCINERATION FACILITY
521-10-SK-001



TITLE	FLOW SCHEME FOR ON-SITE SUBSYSTEM	
PROJECT	DRAWING NO. 540-10-SK-001	REV 0



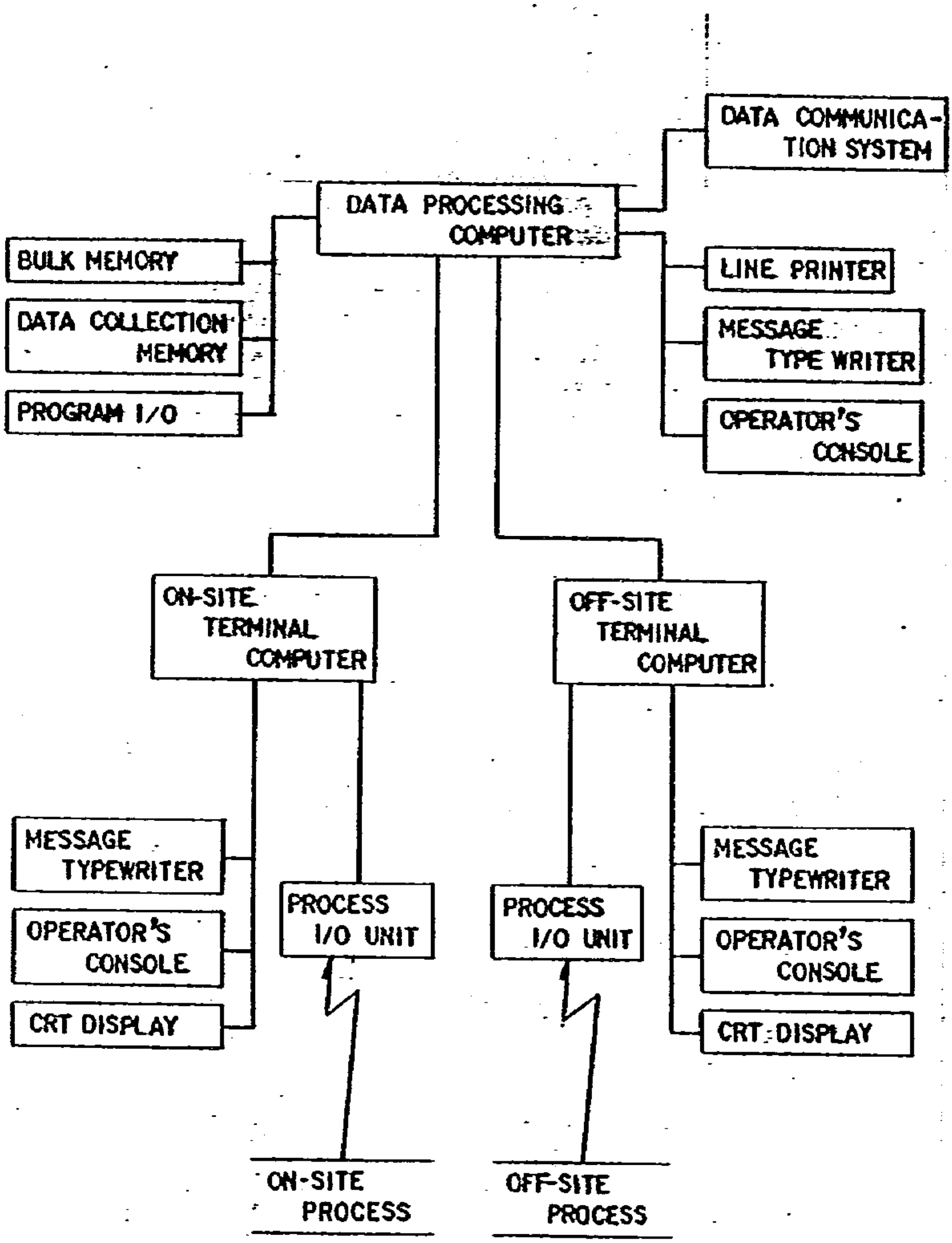
TITLE FLOW SCHEME FOR SHIPPING CONTROL SUBSYSTEM		
PROJECT	DRAWING NO. 540-10-SK-002	REV 0



TITLE

FLOW SCHEME FOR OIL MOVEMENT CONTROL SUBSYSTEM

PROJECT	DRAWING NO.	REV
	540-10-SK-003	0



TITLE	FLOW SCHEME FOR CONFIGURATION OF COMPUTER HARDWARE	
PROJECT	DRAWING NO. 540-10-SK-004	REV 0

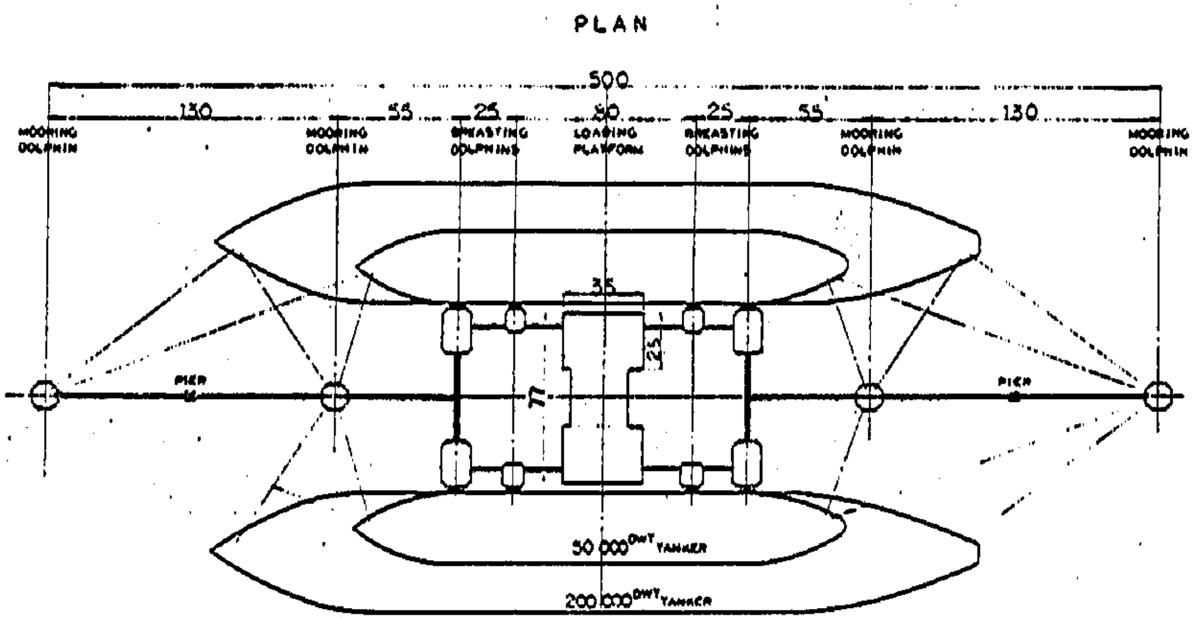
Attachment 3

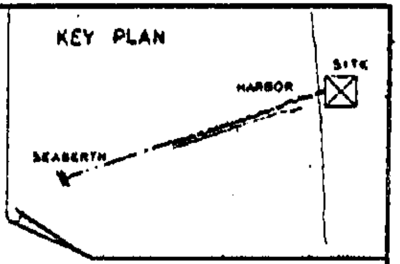
Drawings for Marine Facilities

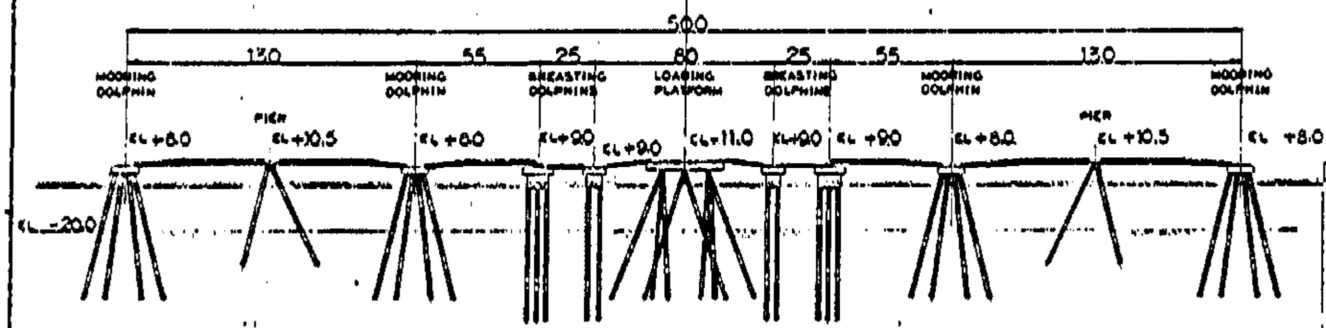
DRAWING LIST (3)

MARINE FACILITIES

TITLE	DWG NO.
Grand View of Sea Berth	450-50-SK-001
General Dimension of Sea Berth (Loading Platform)	450-50-SK-002
General Dimension of Sea Berth (Breasting, Mooring Dolphins)	450-50-SK-003
General Plan of Harbor	460-50-SK-001
General Section of Causeway	460-50-SK-002
General Section of Quay Wall	460-50-SK-003
General Section of Dredged Channel	460-50-SK-004
General Dimension of Bunker Oil Berth	460-50-SK-005
General Section of Breakwater, Revetment and Jetty	460-50-SK-006
Simplified Flow Diagram for Sea Water Intake Facility	230-10-SK-001







NOTE:

DOUBLE-FACED BERTH IS PROVIDED IN CASE OF 500,000 BPSD.
DIMENSION IN METERS.

H.W.L. EL. +2.0
L.W.L. EL. ±0

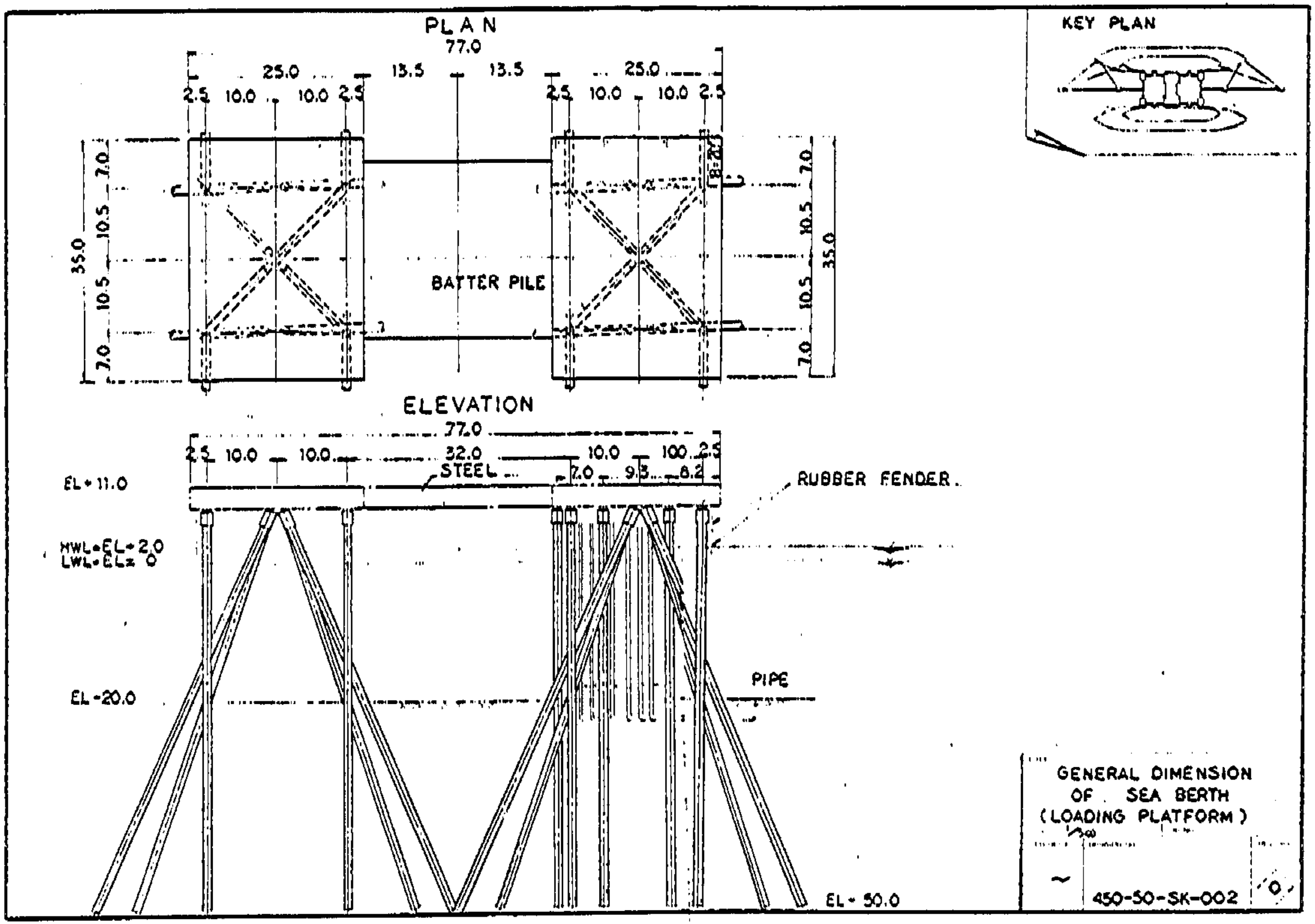
TITLE GRAND VIEW OF SEA BERTH

SCALE 1/2000

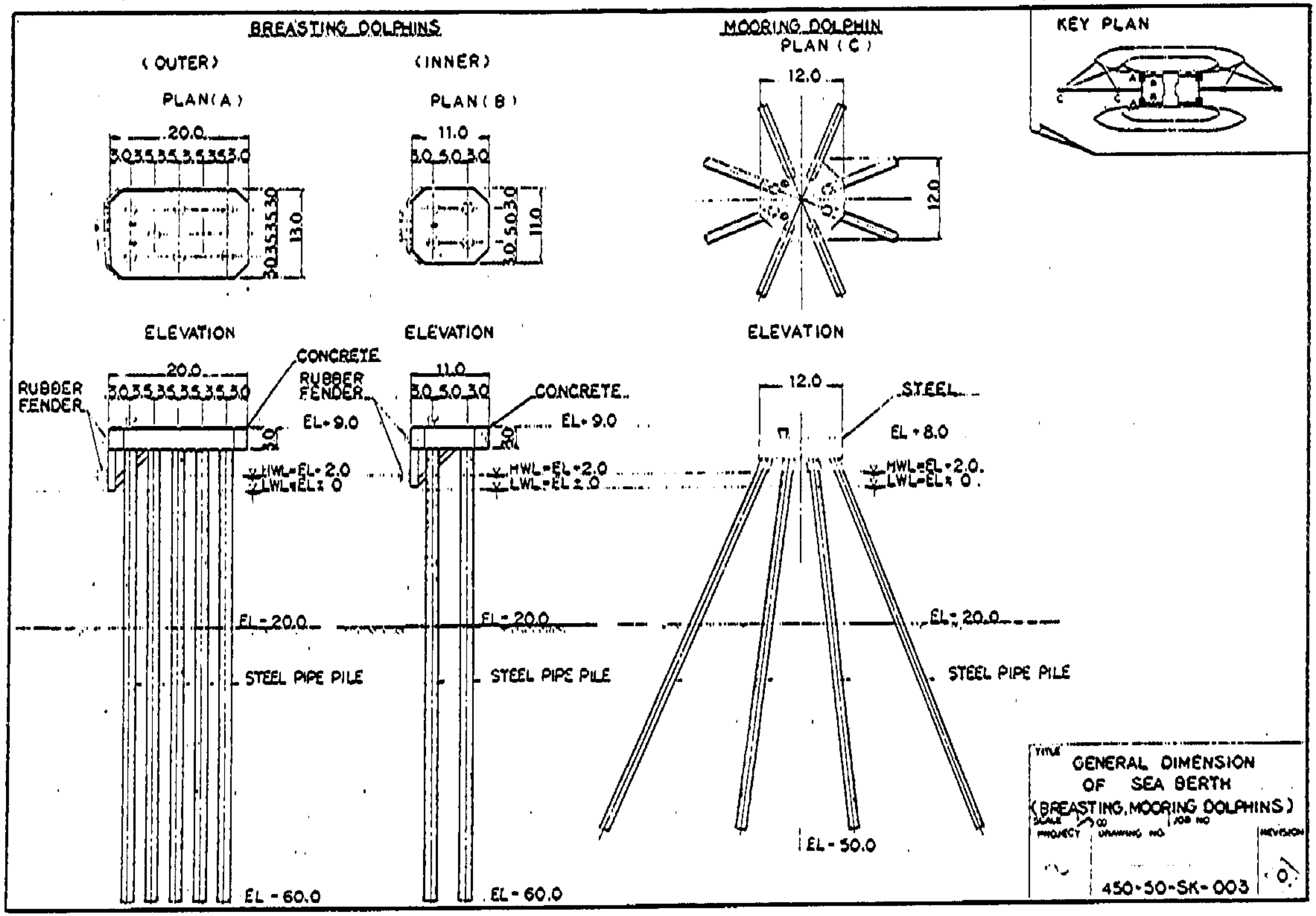
PROJECT ~

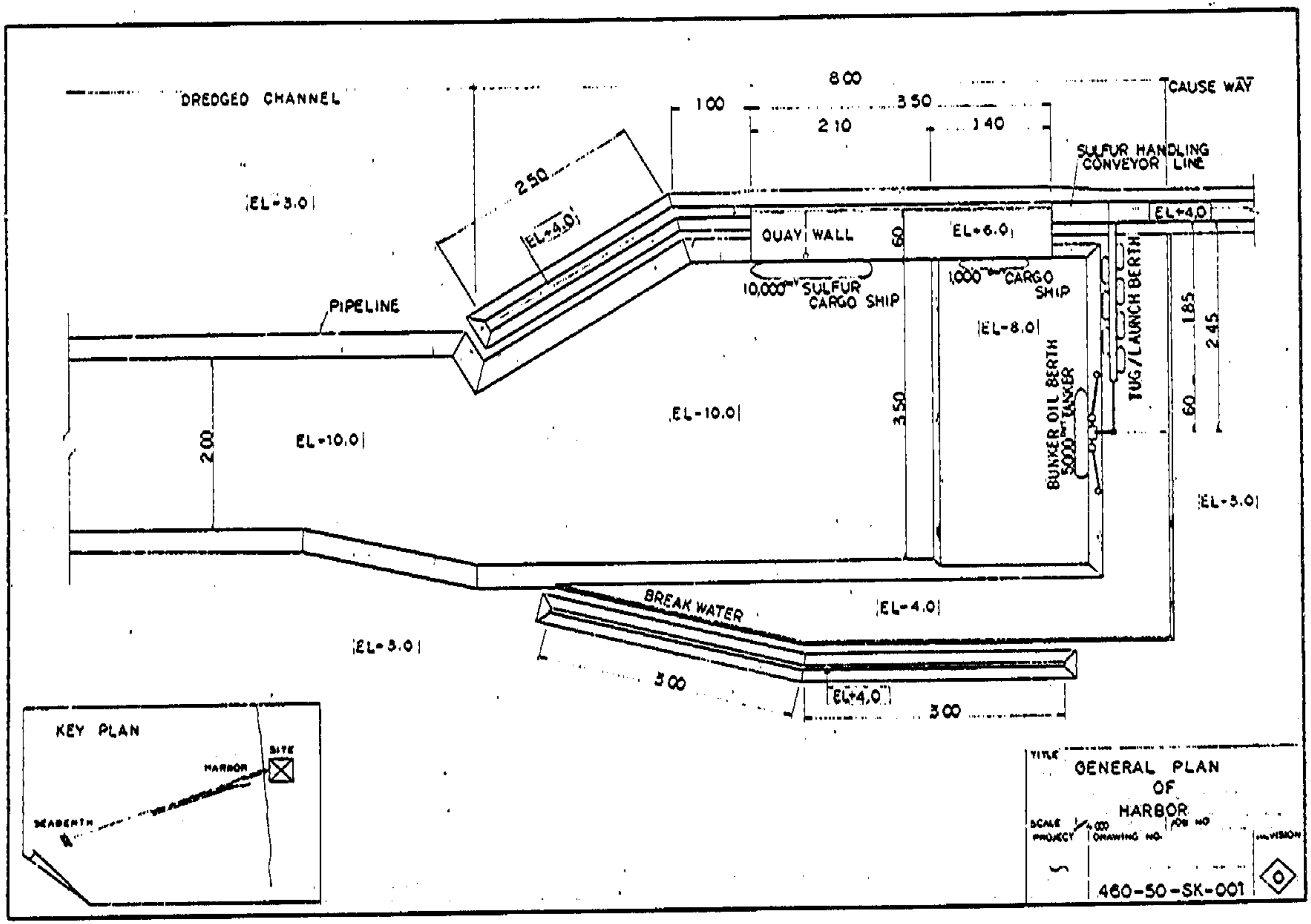
DRAWING NO. 450-50-SK-001

REVISION 0

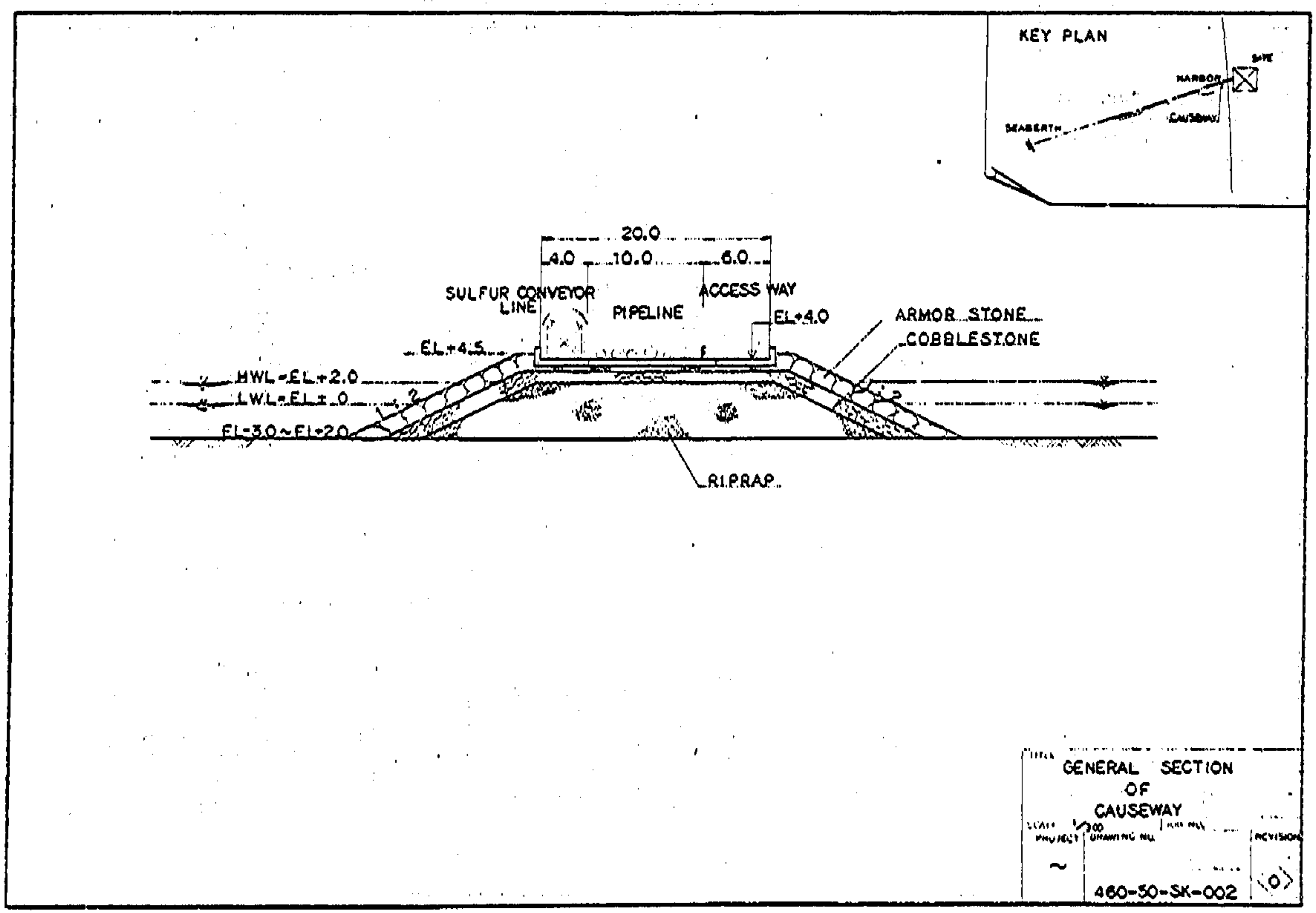


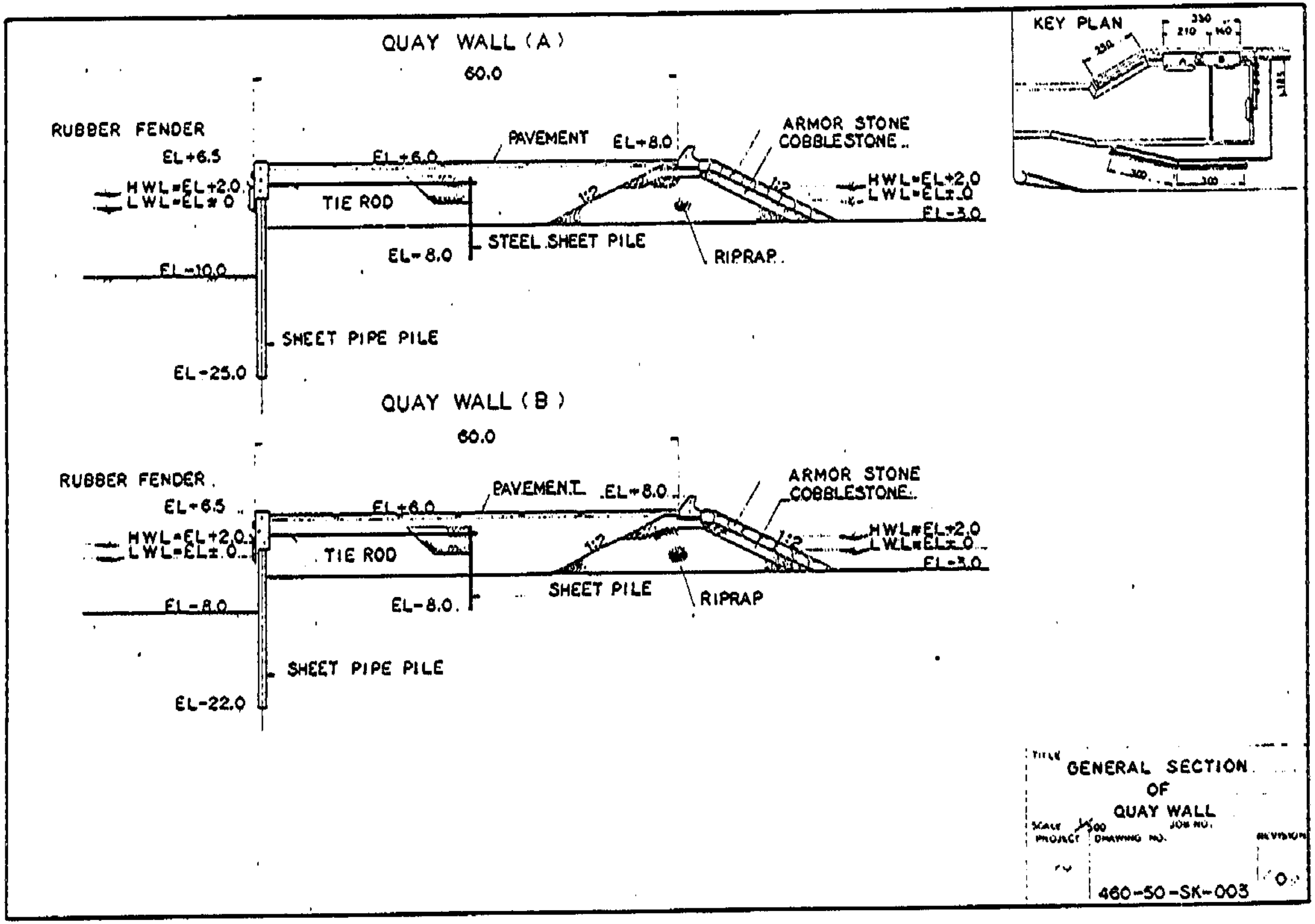
KEY PLAN
PLAN
77.0
25.0
13.5
13.5
25.0
2.5
10.0
10.0
2.5
7.0
10.5
10.5
7.0
35.0
BATTER PILE
ELEVATION
77.0
32.0
STEEL
7.0
9.3
8.2
100
RUBBER FENDER
EL+11.0
HWL=EL+2.0
LWL=EL=0
EL-20.0
PIPE
EL-50.0
GENERAL DIMENSION
OF SEA BERTH
(LOADING PLATFORM)
450-50-SK-002
0

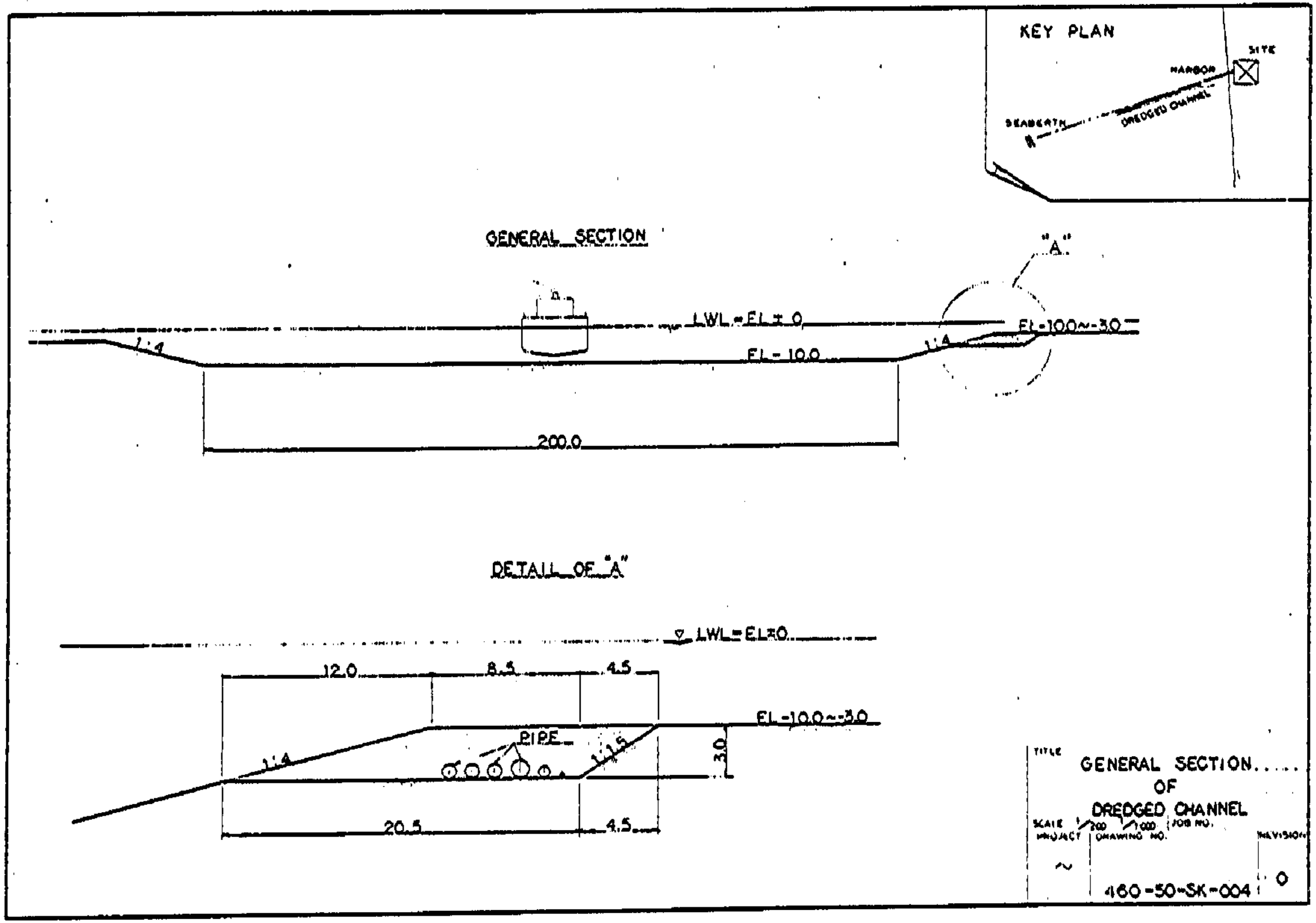

BREASTING DOLPHINS
(OUTER)
PLAN(A)
20.0
3.0 3.5 3.5 3.5 3.5 3.0
13.0
ELEVATION
RUBBER FENDER
CONCRETE
EL+9.0
HWL=EL+2.0
LWL=EL±0
EL-20.0
STEEL PIPE PILE
EL-60.0
(INNER)
PLAN(B)
11.0
3.0 5.0 3.0
ELEVATION
RUBBER FENDER
CONCRETE
EL+9.0
HWL=EL+2.0
LWL=EL±0
EL-20.0
STEEL PIPE PILE
EL-60.0
MOORING DOLPHIN
PLAN (C)
12.0
ELEVATION
STEEL
EL+8.0
HWL=EL+2.0
LWL=EL±0
EL-20.0
STEEL PIPE PILE
EL-50.0
KEY PLAN
TITLE GENERAL DIMENSION OF SEA BERTH (BREASTING, MOORING DOLPHINS)
SCALE
JOB NO
PROJECT
DRAWING NO
REVISION
450-50-SK-003
0

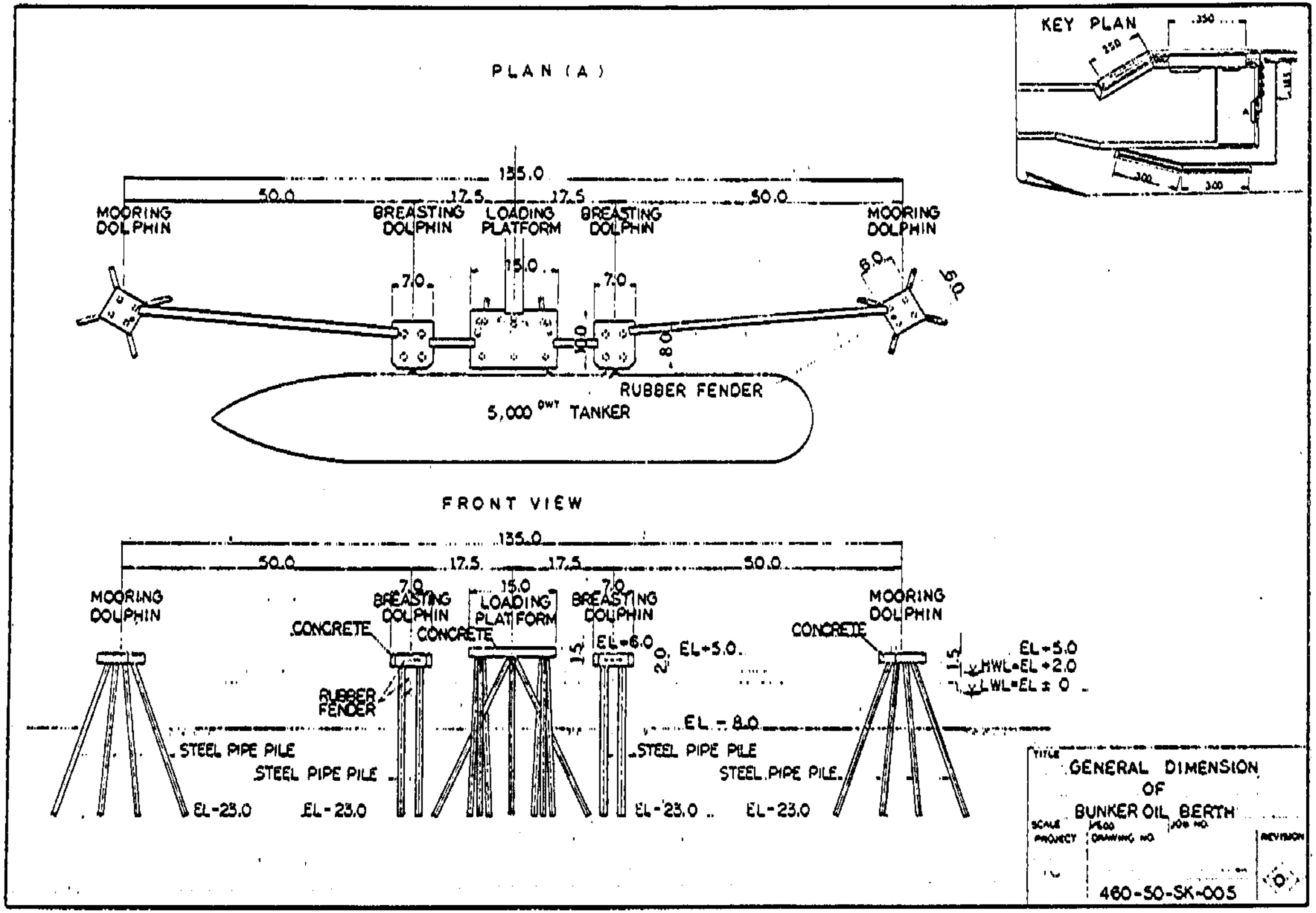


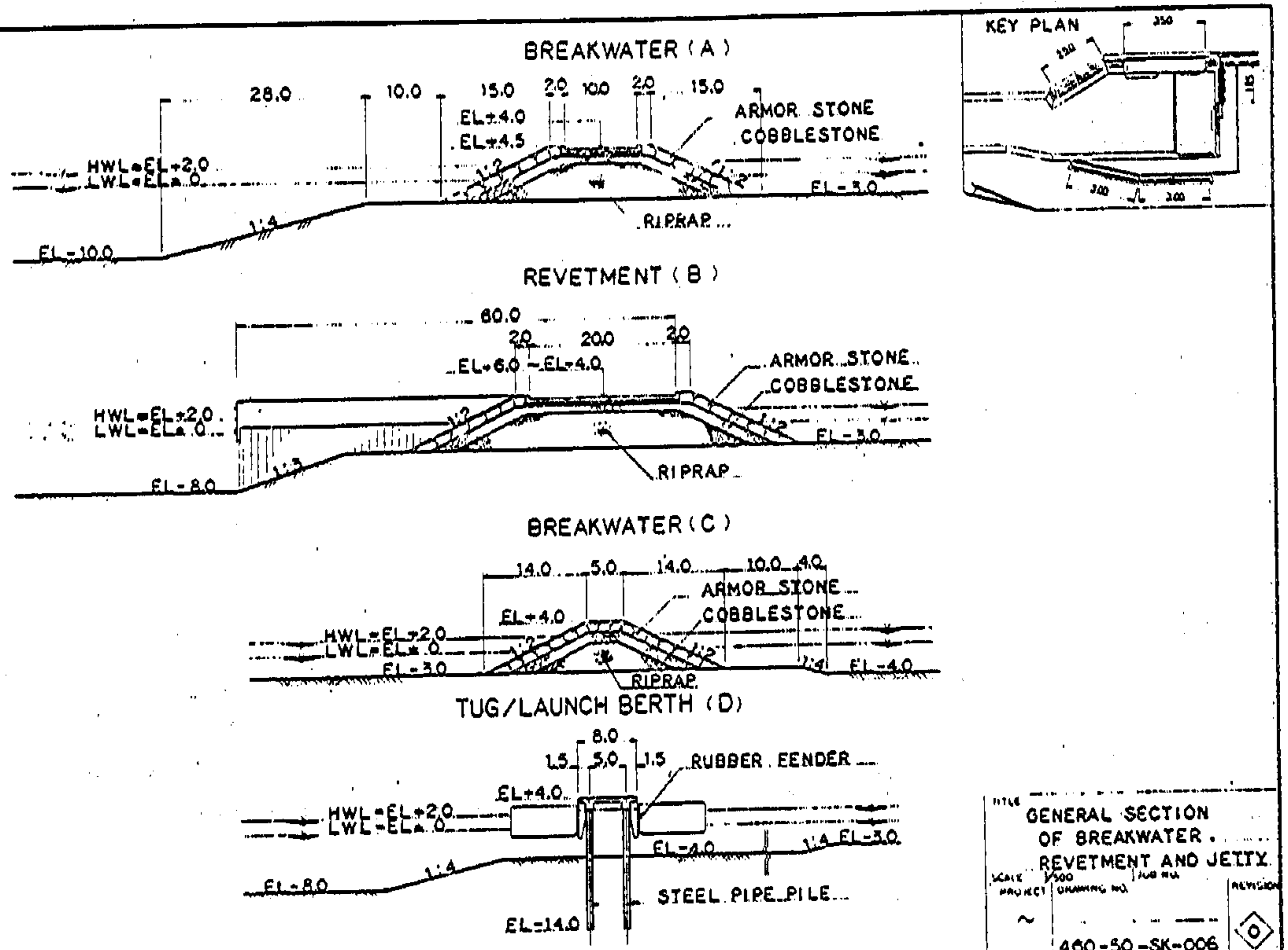
DREDGED CHANNEL
CAUSE WAY
800
100
350
210
140
SULFUR HANDLING CONVEYOR LINE
250
EL-3.0
EL+4.0
QUAY WALL
60
EL+6.0
10,000 DWT SULFUR CARGO SHIP
1,000 DWT CARGO SHIP
PIPELINE
EL-8.0
TUG/LAUNCH BERTH
BUNKER OIL BERTH
5000 DWT TANKER
185
245
60
EL-10.0
350
200
EL-3.0
BREAK WATER
EL-4.0
300
KEY PLAN
SITE
HARBOR
SEABERTH
GENERAL PLAN OF HARBOR
SCALE 1/4,000
PROJECT
DRAWING NO.
JOB NO
REVISION
460-50-SK-001
0


KEY PLAN
SITE
HARBOR
CAUSEWAY
SEABERTH
20.0
4.0
10.0
6.0
SULFUR CONVEYOR LINE
PIPELINE
ACCESS WAY
EL+4.0
EL+4.5
ARMOR STONE
COBBLESTONE
HWL=EL+2.0
LWL=EL±0
EL-3.0~EL+2.0
RIPRAP
GENERAL SECTION OF CAUSEWAY
1/200
~
460-30-SK-002
0


QUAY WALL (A)
60.0
RUBBER FENDER
EL+6.5
HWL=EL+2.0
LWL=EL±0
EL+6.0
PAVEMENT
EL+8.0
ARMOR STONE
COBBLESTONE
TIE ROD
1:2
EL-3.0
EL-8.0
STEEL SHEET PILE
RIPRAP
EL-10.0
SHEET PIPE PILE
EL-25.0
QUAY WALL (B)
60.0
RUBBER FENDER
EL+6.5
HWL=EL+2.0
LWL=EL±0
EL+6.0
PAVEMENT
EL+8.0
ARMOR STONE
COBBLESTONE
TIE ROD
1:2
EL-3.0
EL-8.0
SHEET PILE
RIPRAP
EL-8.0
SHEET PIPE PILE
EL-22.0
KEY PLAN
330
210
120
250
A
B
300
GENERAL SECTION
OF
QUAY WALL
460-50-SK-003


KEY PLAN
SITE
HARBOR
DREDGED CHANNEL
SEABERTH
GENERAL SECTION
"A"
LWL = EL ± 0
EL -10.0~-3.0
EL -10.0
1:4
1:4
200.0
DETAIL OF "A"
LWL = EL ± 0
12.0
8.5
4.5
EL -10.0~-3.0
PIPE
1:4
1:1.5
3.0
20.5
4.5
TITLE
GENERAL SECTION
OF
DREDGED CHANNEL
SCALE 1/200 1/1000
JOB NO.
PROJECT
DRAWING NO.
REVISION
460-50-SK-004
0


KEY PLAN
PLAN (A)
135.0
50.0
17.5
17.5
50.0
MOORING DOLPHIN
BREASTING DOLPHIN
LOADING PLATFORM
BREASTING DOLPHIN
MOORING DOLPHIN
7.0
15.0
7.0
8.0
6.0
RUBBER FENDER
5,000 DWT TANKER
FRONT VIEW
CONCRETE
RUBBER FENDER
EL+6.0
EL+5.0
EL+5.0
HWL=EL+2.0
LWL=EL±0
EL-8.0
STEEL PIPE PILE
EL-23.0
TITLE GENERAL DIMENSION OF BUNKER OIL BERTH
SCALE
PROJECT
DRAWING NO.
JOB NO.
REVISION
460-50-SK-005
0

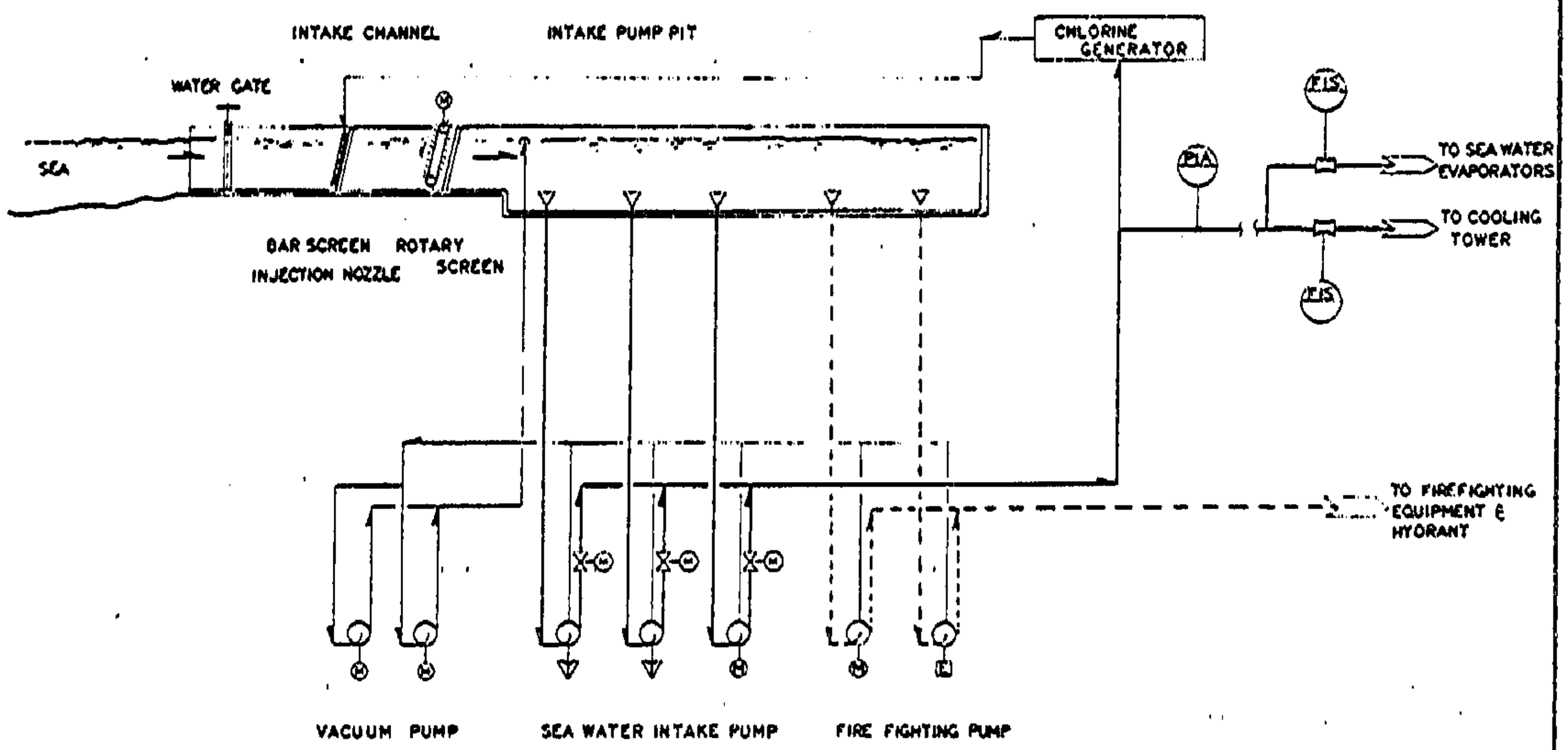


TITLE: GENERAL SECTION OF BREAKWATER, REVETMENT AND JETTY

SCALE: 1/500

DRAWING NO.: 460-50-SK-006

REVISION: 0



SIMPLIFIED FLOW DIAGRAM FOR SEA WATER INTAKE FACILITY

230-10-SK-001

Attachment 4

Preliminary Basic Engineering Design Data

1 METEOROLOGICAL DATA

1.1 AMBIENT TEMPERATURE

Maximum Temperature	
Max. Value of Monthly Av. Max. Temp., °C	38.3 @Aug.
Absolute maximum temperature °C	50.0 @Jul.
Minimum Temperature	
Min. Value of Monthly Av. Min. Temp., °C	9.7 @Jan.
Absolute minimum temperature °C	-1.0 @Jan.

1.2 RELATIVE HUMIDITY

Maximum Humidity	
Max. Value of Monthly Humidity @03 GMT, %	84 @ Dec.,Jan.
Minimum Humidity	
Min. Value of Monthly Humidity @09 GMT, %	45 @ May.

1.3 DESIGN TEMPERATURE CONDITION

Service	Dry – Bulb Temp., °C	Wet – Bulb Temp., °C
Air Cooler	38	30
Air Compressor, max./min.	38/10	30/8
Cooling Tower	50	30

1.4 BAROMETRIC PRESSURE

Maximum Barometric Pressure	mb	1039
Minimum Barometric Pressure	mb	997
Annual Average Bar. Press.	mb	1011

1.5 PRECIPITATION

Annual Precipitation (av.)	mm / year	274
Daily Precipitation (max.)	mm / day	155
Design Precipitation Intensity,	mm / hour	30

1.6 WIND

Predominant Wind Direction		NNW
Mean Wind Speed	m / sec.	3.1
Wind of 17.5 m / sec. or more,	day	41
Wind in General		Gales in Winter Summer Shamal
Design Wind Speed	m/sec.	36

2 OCEANOGRAPHICAL DATA

2.1 SEA CONDITION

Currents	knot	1.6
Tides (Max.)	m	1.8
Seas and Swell (Height of Waves)		Significant Swells in Winter

2.2 DESIGN WAVE CONDITION

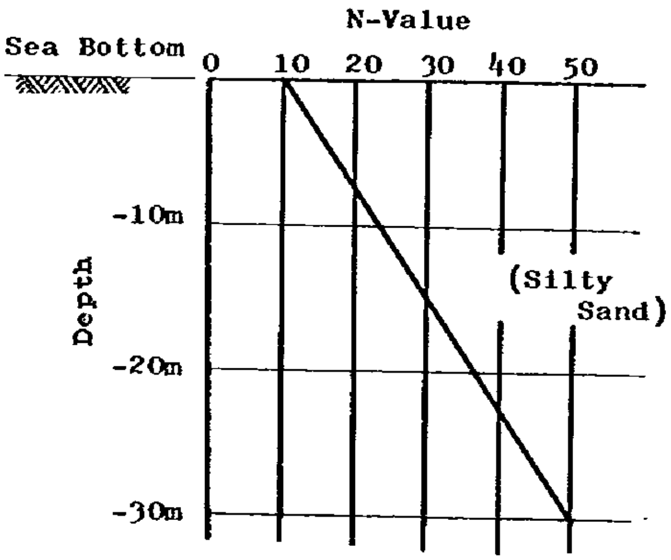
Wave Height	H_o Max.	m	9.4
Period	T_o Max.	sec.	9.4
Wave Length	L_o	m	125
Significant Wave Height	$H_{o\,1/3}$	m	6.0

2.3 CHART DATUM

Sea Level	m	FAO MSL -1.06

3 SOIL CONDITION

Off Shore ----- To be assumed below



On Shore ---- Reffer to the boring data

4 SEISMIC DESIGN CONDITION

Seismic Coefficient	K_H	0.2
	K_V	0

5 UTILITY CONDITIONS

5.1 STEAM

(1) Steam at Boiler Plant Area

	High Pressure (SH)	Medium Pressure (SM)	Low Pressure (SL)
Pressure, Kg/cm^{2}G max.	53.0	18.0	5.0
norm.	44.0	16.0	4.0
Temperature, ^oC max.	412	320	225
norm.	405	275	200

(2) Steam at Any Point in Steam Distribution System

	High Pressure (SH)	Medium Pressure (SM)	Low Pressure (SL)
Pressure, Kg/cm^{2}G max.	53.0	18.0	5.0
norm.	43.0	15.0	3.5
Temperature, ^oC max.	412	320	225
norm.	400	270	Saturated
min.	395	265	Saturated

5.11 AIR and INERT GAS

(1) AIR

		Service Air	Instrument Air
Supply Pressure	Kg/cm^2G, max.	10.0	10.0
	norm.	6.0	6.0
	min.	-	4.0
Supply Temperature,	^oC	Max.40	Max.40
Dew Point	^oC	-	-10
Oil Free	(Yes or No)	Yes	Yes

(2) INERT GAS

		N_2 Gas
Supply Pressure	Kg/cm^2G, max.	10.0
	norm.	6.0
Supply Temperature,	^oC	Approx.35
Oil Free	(Yes or No)	Yes
Purity	%	99.8

5.2 RAW WATER (SEA WATER)

Supply, From / To	Sea Water Intake / Desalinator, Cooling Tower
Max. Supply Temp., °C	35 (@ Sept.)
Min. Supply Temp., °C	17 (@ Jan.)
Analysis (Suggested Data)	
Total Salinity, wt %	Approx. 4.2
PH,	8.3
Free Caustic (NaOH), ppm	Nil
Total Caustic (NaOH), ppm	Nil
Total Alkalinity ($CaCO_3$), ppm	130
Chlorides (Cl), ppm	24,800
Sulphates (SO_4), ppm	3,500
Phosphates (PO_4), ppm	Nil
Total Hardness ($CaCO_3$), ppm	8,050
Permanent Hardness ($CaCO_3$), ppm	7,950
Temporary Hardness ($CaCO_3$), ppm	100
Bromine (Br), ppm	80
Calcium Hardness (Ca), ppm	400
Magnesium Hardness (Mg), ppm	1,690
Total Silica (SiO_2), ppm	5

Note: The sea water may contain chlorine up to 0.5 ppm by chlorine injection, normally the cholorine content will be 0.2 ppm.

5.3 DESALINATED WATER

Supply, From / To	Desalinator / Desalinated Water Tank
Max. Supply Temp., °C	less than 45
Property	
PH	6.0 ~ 7.0
Specific Conductivity, μ℧/cm	10
SiO_2	Nil
Fe , ppm	less than 0.3
Cu , ppm	less than 0.05
$CaCO_3$, ppm	0.3
Total Dissolved Solid, ppm	less than 5

5.4 BOILER FEED WATER

Supply, From / To	BFW Tank/Dearator
Supply Temp., °C	Approx. 60
Property	
PH,	8.0 ~ 9.0
Specific Conductivity, μ℧/cm	less than 1.0
Total Hardness ($CaCO_3$), ppm	Approx. 0
Fe, ppm	less than 0.05
Cu, ppm	less than 0.02
SiO_2, ppm	less than 0.05
O_2 Content, ppm	less than 1.0

5.5 COOLING WATER (COOLING TOWER WATER)

(1) PROCESS COOLING WATER

Supply, From/To	Cooling Tower/Cooler & Equip.
Make up Water	Sea Water
Supply Press., Kg/cm^2G	3.5
Return Press., Kg/cm^2G	2.0
Max. Supply Temp., °C	34
Max. Return Temp., °C	48
Mechanical Design Press., Kg/cm^2G	6.0
Mechanical Design Temp., °C	60
PH	8.3

(2) JACKET COOLING WATER

Supply, From/To	Cooling Tower/Jacket of Equip
Make up Water	Desalinated Water
Supply Press., kg/cm^2G	3.5
Return Press., kg/cm^2G	2.0
Max. Supply Temp., °C	34
Max. Return Temp., °C	48
Mechanical Design Press., kg/cm^2G	6.0
Mechanical Design Temp., °C	60
PH	8.3

5.6 PROCESS WATER

Source	Desalinated Water
Supply Temp., °C	45
Supply Press., Kg/cm^2	3.0

5.7 FIRE WATER

Source	Sea Water

5.8 POTABLE WATER

Source	Desalinated Water
Supply Temp., °C	less than 40
Supply Press., Kg/cm^2	3.0

Note:

(1) Quality of the water shall be meet the requirements of WHO's standards for drinking water.

(2) Chiller for drinking water shall be provided at each building.

5.9 ELECTRICAL POWER

Category and Service	Ph.	Hz	Nominal System Voltage (V)	Equipment Nameplate Voltage (V)
Medium Voltage System				
Generating & Distribution	3	50	11,000	11,000
Motor in excess of 1500KW	3	50	11,000	11,000
Motor 150KW to 1500KW	3	50	6,000	6,000
Low Voltage System				
Motor 0.4KW to 150KW	3	50	400	380
Motor to 0.4KW	1	50	230	220
Electrical Control	1	50	230	220
Instrument	1	50	110	110
Lighting	1	50	230	220
DC Voltage				
Instrument				
Electronic Transmission	-	-	24	24
Interlock System	-	-	110	110
Electrical Control	-	-	110	110

5.10 FUEL

(1) FUEL OIL

	CASE-1	CASE-2
Specific Gravity,	Approx. 1.024	Approx. 1.056
Sulfur Content, wt%	Approx. 3.4	Approx. 3.8
Viscosity, cst, @ 50°C	600,000	360,000
@ 140°C	190	60
@ 160°C	80	32
@ 180°C	40	18
Lower Heating Value, Kcal/Kg	9,600	9,600

(2) FUEL GAS

	CASE-1	CASE-2
Specific Gravity,		
Sulfur Content,		
Lower Heating Value, Kcal/Kg		
Header Pressure, Kg/cm^2		

(3) DIESEL OIL

	CASE-1	CASE-2
Specific Gravity,	0.856	0.853
Sulfur Content, wt%	0.06	0.04
Viscosity, cst, @ 50°C	3.4	3.4
Lower Heating Value, Kcal/Kg		

Note; CASE-1 ···· Hydroskimming
CASE-2 ···· Hydrocracking

Attachment 5

Codes and Standards

Attached list shows design codes and standards for study on Iran-Japan Export Refinery Project. These listed codes and standards will be applied as general guidance to keep reliable quality, grade and level for the refinery and its associated facilities. However, in order to facilitate worldwide procurement, materials and manufacturer's products conforming to the code and standards of country's origine are also to be applicable.

A. <u>CRUDE OIL PIPELINE</u>

ANSI B31.4	US Standard Code for Liquid Petroleum Transportation Piping System
ANSI B16.5	Forged Flanges
ANSI B16.9	Welding Fittings
MSS SP44	Large Diameter Flanges
API RP-5LI	Recommended Practice for Railroad Transportation of Line Pipe
API STD 1104	Standard for Welding Pipelines and Related Facilities
API SPEC 6D	Specification of Pipeline Valves
API RP-500C	Recommended Practice for Classification of Areas for Electrical Installation at Petroleum and Gas Pipeline Transportation Facilities
API RP-1102	Recommended Practice for Liquid Petroleum Crossing Railroads and Highways
API RP-1100	Recommended Practice for Pressure Testing of Liquid Petroleum Pipelines
API RP-1109	Recommended Practice for Marking Petroleum Pipeline Facilities
DOT PART 195	Minimum Federal Safety Standards for Liquid Pipelines
API 5L	API Specification for Line Pipe
API 5LX	API Specification for High - Test Line Pipe

B. REFINERY AND MARINE FACILITIES

1 Standards for Tanks and Pressure Vessels

1)	JPI	Japanese Petroleum Institute
2)	API 650	Welded Steel Tanks for Oil Storage
3)	API 620	Design and Construction of Large Welded, Low-Pressure Storage Tanks
4)	ANSI B96.1	Welded Aluminum-Alloy Field-Erected Storage Tanks
5)	ASME	Boiler and Pressure Vessel Code Sect. VIII div. 1 & 2
6)	ASME	Sect. I Power Boilers Sect. II Material Specification Sect. IV Low Pressure Heating Boilers Sect. IX Welding Qualifications
7)	API 2550	Method for Measurement and Calibration of Upright Cylindrical Tank
8)	BS 1515	Pressure Vessels for Chemical Petroleum and Allied Industries
9)	DIN	Deutscher Normenausschus
10)	AD - Merkblatt	
11)	TRD	Technische Regal für Dampfkessel
12)	BS 1500	Pressure Vessels

2 Rotating Equipment Standards

1)	API 610	Centrifugal Pumps for General Refinery Services
2)	API 611	General-Purpose Steam Turbines for Refinery Services
3)	API 612	Special-Purpose Steam Turbines for Refinery Services
4)	API 613	High-Speed, Special-Purpose Gear Units for Refinery Services
5)	API 615	Mechanical-Drive Steam Turbines for General Refinery Services
6)	API 616	Combustion Gas Turbines for General Refinery Services
7)	API 617	Centrifugal Compressors for General Refinery Services
8)	API 618	Reciprocating Compressors for General Refinery Services
9)	ASME PTC 7.1	Displacement Pumps
10)	ASME PTC 8.2	Centrifugal Pumps
11)	ASME PTC 9	Displacement Compressor, Vacuum Pumps and Blowers
12)	ASME PTC 10	Centrifugal Compressor

3 Heat Exchanger Standards

Shell and Tube Heat Exchangers

1) TEMA Class R

2) API 660 — Heat Exchanger for General Refinery Services

Air-Cooled Heat Exchangers

1) API 661 — Air-Cooled Heat Exchangers for General Refinery Services

4 Instrumentation Standards

1)	API RP500A	Recommended Practice for Classification of Areas for Electrical Installations in Petroleum Refineries
2)	API RP550	Manual on Installation of Refinery Instruments and Control Systems
3)	API 1101	Measurement of Petroleum Liquid Hydrocarbons by Positive Displacement Meter
4)	API 2000	Venting Atmospheric and Low Pressure Storage Tanks
5)	API 2545	Method of Gauging Petroleum and Petroleum Products
6)	API RP500C	Recommended Practice for Classification of Areas for Electrical Installation at Petroleum and Gas Pipe Line Transportation Facilities
7)	API 2531	Mechanical Displacement Meter Provers
8)	ANSI C1	National Electrical Code (NEC) (NFPA NO. 70)
9)	NEMA	National Electrical Manufacturers Association
10)	NFPA 493	Intrisically Safe Process Control Equipment for Use in Hazardous Location
11)	NFPA 496	Purged Enclosures for Electrical Equipment
12)	IEC	International Electro Technical Commission

5 Electrical Standards

1)	NEC	The National Electrical Code
2)	API RP500A	Recommended Practice for Classification of Areas for Electrical Installations in Petroleum Refineries
3)	API RP540	Recommended Practice for Electrical Installation in Petroleum Refineries
4)	API RP2003	Recommended Practice for Protection Against Ignitions Arising Out of Static, Lighting and Stray Currents
5)	NEMA	National Electrical Manufacturers Association Standares
6)	NFPA 493	Standard for Intrisically Safe Process Control Equipment for Use in Hazardous Location
7)	NFPA 496	Standard for Purged and Ventilated Enclosures for Electrical Equipment in Hazardous Locations
8)	API RP500C	Recommended Practice for Classification of Areas for Electrical Installation at Petroleum and Gas Pipeline Transportation Facilities

6 Structural,Building, and Foundation Standards

1)	ACI	American Concrete Institute
2)	AISC	American Institute of Steel Construction
3)	AIJ	Architectural Institute of Japan
4)	JASS	Japanese Architectural Standard Specification
5)	CEIJ	Civil Engineer Institute of Japan

7 Mechanical Equipment Standard

1) CTI Cooling Tower Institute

8 **Fire Fighting Standard**

1) **NFPA** **The National Fire Protection Assn.**

9. Piping Standards and Codes

1)	ANSI B31.3	US Standard Code for Petroleum Refinery Piping System
2)	ANSI B31.4	US Standard Code for Liquid Petroleum Transportation Piping System
3)	ANSI B16.5	Forged Flanges
4)	ANSI B16.9	Welding Fittings
5)	MSS SP44	Large Diameter Flanges
6)	API 5L	Specification for Line Pipe
7)	API 5LX	Specification for High-Test Line Pipe
8)	API RP5L1	Recommended Practice for Railroad Transportation of Line Pipe
9)	API SP6D	Spcification of Pipeline Valves
10)	API RP1110	Recommended Practice for Pressure Testing of Liquid Petroleum Pipelines
11)	API RP1102	Recommended Practice for Liquid Petroleum Crossing Railroads and Highways
12)	API RP1109	Recommended Practice for Marking Petroleum Pipeline Facilities
13)	DOT Part 195	Minimum Federal Safety Standards for Liquid Pipelines
14)	PFI	Pipe Fubrication Institute

15)	API 1104	Standard for Welding Pipelines and Related Facilities
16)	ANSI B31.1	Power Piping
17)	ANSI B31.5	Refrigeration Piping
18)	ANSI A21.10	Cast Iron Fittings, 2 inch through 48 inch, for Water Other Liquid
19)	ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings, 25, 125, 250, and 800 lb.
20)	ANSI B16.10	Face-to-Face and End-to-End Dimensions of Ferrous Valves
21)	ANSI B16.11	Forged Steel Fittings, Socket Welding and Threaded
22)	ANSI B16.34	Steel Buttwelding End Valves
23)	API 526	Flanged Steel Safety Relief Valves
24)	API 595	Cast-Iron Gate Valves, Flanged Ends
25)	API 599	Steel Plug Valves
26)	API 600	Steel Gate Valves, Flanged or Buttwelding End
27)	API 601	Metallic Gaskets for Refinery Piping, Double-Jaketed Corrugated and Spiral Work
28)	API 602	Small Carbon Steel Gate Valves, Compact Design
29)	API 604	Ductile Iron Gate Valves, Flanged Ends

30)	API 605	Large Diameter Carbon Steel Flanges (Size; 26 inch to 60 inch inclusive; Nominal Pressure Rating: 75, 150, and 300 lb.)
31)	API 609	Butterfly Valves, to 150 psig and 150 F
32)	MSS SP43	Wrought Stainless Steel Buttwelding Fittings
33)	MSS SP58	Pipe Hangers & Supports-Materials and Design
34)	ANSI B2.1	Pipe Threads (Except Dryseal)
35)	ANSI B16.20	Ring-Joint Gaskets and Grooves for Steel Pipe Flanges
36)	ANSI B16.21	Non-Matallic Gaskets for Pipe Flanges
37)	ANSI B16.25	Buttwelding Ends for Pipe, Valves, Flanges, and Fittings
38)	API 1105	Bulletin on Construction Practices for Oil and Products Pipelines
39)	API 2201	Welding or Hot Tapping on Equipment Containing Flammables
40)	ASME	Boiler and Pressure Vessel Code, Section VIII Pressure Vessels-Division1, Section VIII Alternate Rules for Pressure Vessels-Division2, and Section IX, Welding Qualifications
41)	NACE RP-01-69	Recommended Practice-Control of External Corrosion on Underground or Submerged Metallic Piping Systems
42)	NFPA 30	Flammable and Combustible Liquids Code

43)	JPI-7S-1-65	Steel Butt Welding Fittings for Special Piping Use
44)	JPI-7S-2-65	Steel Butt Welding Fittings for Ordinary Piping Use
45)	JPI-7S-3-65	Steel Socket Welding Fittings for Special Piping Use
46)	JPI-7S-4-71	Asbestos-Sheets for Petroleum Industry
47)	JPI-7S-14-61	Electric-Arc-Welded Carbon Steel Pipes for Petroleum Industry
48)	JPI-7S-15-70	Steel Pipe Flanges for The Petroleum Industry
49)	JPI-7S-16-72	Non-Metallic Gaskets Dimension for Petroleum Industry
50)	JPI-7S-18-62T	Mortar-Lining Steel Pipe for Ordinary Piping
51)	JPI-7S-23-72	Ring-Joint Gaskets and Grooves for Petroleum Industry
52)	JPI-7S-24-74	Standard Marking System for Valves
53)	JPI-7S-31-71	Welder Performance Qualification
54)	JPI-7S-36-75	Cast and Forged Steel Small Valves for the Petroleum Industry (Class 600, Threaded or Socket-Welding Ends)
55)	JPI-7S-37-65	Standard for Flanged Cast-Iron Outside Screw Gate Valves

56)	JPI-7S-39-74	Valve Inspection and Test
57)	JPI-7S-41-70	Spiral Wound Gaskets for Petroleum Industry
58)	JPI-7S-43-72	Large Diameter Carbon Steel Flanges for Petroleum Industry
59)	JPI-7S-46-74	Cast Steel Flanged Valves for the Petroleum Industry (Class 150, 300)
60)	JPI-7S-47-74	Cast Steel Valves for the Petroleum Industry Flanged or Buttwelding Ends (Class 600 to 2500)
61)	JPI-7S-48-74	Flanged Ball Valves for the Petroleum Industry

10 Building Mechanical Facilities-Standards

1)	ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
2)	ANSI	American National Standard Institute

11 Safety Standards, Codes and Practices for Plant Design

1)	IP	The Institute of Petroleum
2)	NFPA	National Fire Protection Association
3)	OSHA	Occupational Safety and Health Administration

12 Materials Standards

1)	ASTM	American Society for Testing and Materials
2)	JIS	Japanese Industrial Standards
3)	BS	British Standards Institution
4)	DIN	Deutscher Normenausschus

13 Analytical Methods for Waste Water

1) ASTM Standards Part 31 Water

2) WHO Standards for Drinking Water

14 Fired Heaters Standards

1)	AISC	Design, Fabrication and Erection of Structural Steel for Building
2)	ASME	Pressure Vessel Section VIII Div. 1
3)	ANSI B31.3	Petroleum Refinery Piping
4)	ASTM	American Society for Testing and Materials
5)	API RP 530	Recommended Practice for Calculation of Heater Tube Thickness in Petroleum Refineries
6)	API Std 630	Tube and Header Dimensions for Fired Heaters for Refinery Services

15 Painting & Coating Standards

1)	NAPCA	National Association of Pipe Coating Applicators Specifications
2)	AWWA C203	Coal-tar protective Coatings and Lining for Steel Water Pipelines - Enamel and Tape - Hot - Applied
3)	SIS 05-5900	Pictorial Surface Preparation Standards for Painting Steel Surfaces
4)	SIS 18.51.11	European Scale of Degree of Rusting for Anticorrosive Paints
5)	MUNSELL	Munsell Book of Colour
6)	JIS	Japanese Industrial Standards
7)	SSPC	Steel Structures Painting Council
8)	ASTM	American Society for Testing and Materials
9)	BS	British Standards Institution
10)	NACE	National Association of Corrosion Engineers

16 Insulation Standards

1)	JIS	Japanese Industrial Standards
2)	ASTM	American Society for Testing and Materials
3)	TIMA	Thermal Insulation Manufactures Association
4)	MIL	Military Specification
5)	USAEC	United States Atomic Energy Commission Regulatory Guide 1. 36

17. Civil & Marine Standards

1)	AASHTO	American Association of State Highway and Transportation Officials
2)	ACI	American Concrete Institute
3)	AISC	American Institute of Steel Construction
4)	AWWA	American Water Works Association
5)	AWS	American Welding Society
6)	UBC	Uniform Building Code
7)	ASTM	American Society for Testing and Materials
8)	IMCO	Inter-Governmental Maritime Consultative Organization
9)	API	American Petroleum Institute
10)	AIJ	Architectural Institute of Japan
11)	JASS	Japanese Architectural Standard Specification
12)	CEIF	Civil Engineer Institute of Japan
13)	JPHA	Japan Port and Harbor Association

VOLUME 4

ALTERNATIVE STUDIES

VOLUME 4

ALTERNATIVE STUDIES

C O N T E N T S

LIST OF TABLES

1. INTRODUCTION AND SUMMARY

A study is conducted to evaluate attractiveness of the technical alternatives for the refinery design compared with base case refineries.

The alternative cases studied are for the following:

a. Utility Alternatives:

- Purchase electric power
- Purchase natural gas
- Purchase soft water

b. Fuel Oil Sulfur Alternatives:

- LS (0.5%S): MS(1.5%S) = 4:1
- LS (0.5%S): MS(2.5%S) = 4:1
- LS (0.5%S): MS(1.5%S) = 1:1
- LS (0.5%S): MS(2.5%S) = 1:1
- LS (0.1%S): MS(2.5%S) = 4:1
- LS (0.1%S): MS(2.5%S) = 1:1

c. Process and other Alternatives:

- Mixed crude operation
- Different crude process ratio: IL: IH = 6:4
- Adoption of coker
- Less gasoline production: by 5% on crude
- No medium sulfur fuel oil production
- Utilize medium size tankers for product transport

In the evaluation, the gaps between the required gross margins and product values on an ex-CTS in Japan 1983 basis are used as criteria.

The results of evaluation are summarized in Table 1.1, in which the extent of attractiveness against the base case refinery is presented. The cases with negative figures indicate more attractive ones compared with the base case, while less attractive ones for those with positive figures.

The following are observed from the results of study:

- The utilities supply from external sources with attractive prices will make significant contributions to the refinery's economics.

- The fuel oils' sulfur levels and their production ratio will have considerable effects on the refinery's economics. Therefore, in developing definitive plans, the fuel oil production plans should be studied carefully with due consideration of their marketability.

- Mixed crude operation as well as changes in crude processing ratio will be less effective.

- Coker will not have significant contributions to the refinery's economics on the basis that price difference between middle distillates and fuel oils will be as it is in Japan.

- Production rate of gasoline will have, needless to say, remarkable effect on the economics.

- Reduction of investment costs resulted from the utilization of smaller tankers would be almost canceled out by increased freight cost, even for 125,000 BPSD crude capacity. Adoption of smaller tankers could only be justified when the tankers be available from the existing market sufficiently in tonnage and at an attractive rates and be transported directly without installing CTS, although these are not likely to realize.

Table 1.1

Summary of Alternative Studies

- Alternative Cases against Base Case -

	Changes for Base Case [1)]	
	Hydroskimming US$/BBL	Hydrocracking US$/BBL
1. <u>Utilities Alternatives</u>		
. Purchase Electric Power (0.05US$/kwh)	- 0.18	- 0.22
. Purchase Natural Gas (0.20 US$/MBTU)	- 0.53	- 0.51
. Purchase Soft Water (0.50US$/Ton)	- 0.11	- 0.08
2. <u>Fuel Oil Sulfur Alternatives</u>		
. LS (0.5%S): MS(1.5%S) = 4:1	- 0.22	- 0.06
. LS (0.5%S): MS(2.5%S) = 4:1	- 0.04	- 0.01
. LS (0.5%S): MS(1.5%S) = 1:1	- 0.05	- 0.01
. LS (0.5%S): MS(2.5%S) = 1:1	+ 0.21	+ 0.11
. LS (0.1%S): MS(2.5%S) = 4:1	+ 0.10	+ 0.08
. LS (0.1%S): MS(2.5%S) = 1:1	+ 0.34	+ 0.17
3. <u>Process Alternatives</u>		
. Mixed Crude Operation	+ 0.04	+ 0.13
. Crude Process Ratio: IL/IH=6:4	± 0	± 0.01
. Adoption of Coker	- 0.10	+ 0.27
. Gasoline Production: 5% on Crude Less	+ 0.37	-
. No Medium Sulfur Fuel Oil Production	- 0.01	-
. Utilize Medium Size Tankers 2)	+ 0.05	+ 0.07

Notes: 1) Figure are expressed by changes in gaps between the required average product prices and product values on an Ex-CTS basis in Japan, 1983.

2) For 125,000 BPSD crude capacity; the other cases are for 250,000 BPSD.

2. STUDY BASES AND CASE DEFINITION

The alternative studies are conducted using the same bases and procedures employed for base case refineries in the Report and by alternating single key factor. No discussion is made for the case of changing plural factors simulteneously.

The gist of study bases are presented in Tables 2.1 and 2.2 limited to those for economic evaluation.

The case definition is shown in Table 2.3, in which the changed factors are presented in contrast with base case.

Table 2.1

Basis of Estimation: Product Prices, Ocean Freight & Import Tariffs

Product	Product Prices in Japan, 1983 US$/BBL	Ocean Freights, US$/BBL		Import Tariffs US$/BBL
		Large	Medium*	
Gasoline: regular	25.90	1.69	2.46	1.54
Naphtha	16.90	1.64	2.39	0.78
Kerosene	16.70	1.81	2.63	0.73
Gas Oil	17.82	1.93	2.81	1.37
L/S Fuel Oil (0.1%S)	16.83	1.61	2.22	0.54
L/S Fuel Oil (0.5%S)	15.97	1.63	2.25	0.54
M/S Fuel Oil (1.5%S)	13.96	1.65	2.28	0.54
M/S Fuel Oil (2.5%S)	12.12	1.65	2.28	0.54

Note

* 60,000 DWT New Tankers for white oil,
and 90,000 DWT New Tanker for Black oil

Table 2.2

Basis of Required Margin Calculation

	Refinery	CTS
. Capacity	250,000 BPSD crude run	Corresponds to that of refinery
. Interest rate		
- Long-term loan	Up to US$1,000 millions 5.25%/Annum Over US$1,000 millions 8.00%/Annum	70% of total fixed investment less interest during construction 6.05%/Annum The balanced portion 8.00%/Annum
- Short-term loan	8.00%/Annum	For land 7.03%/Annum (average) For oil inventories 5.58%/Annum (average) For others 8.00%/Annum
. Crude oil cost	12.65 US$/BBL	-
. Depreciation	Straight line in 10 years; no salvage value	Straight line in 18 years; no salvage value
. On-Stream factor	85% but 60% for first 12 months	Corresponds to that of refinery
. Project life	20 years	20 years
. Income tax rate	55%	55%
. Tax holiday	None	None
. Equity capital invested	25% of total fixed investment less interest during construction	Same as for the refinery
. Scope of investment	Investment for industrial infrastructure excluded	-
. Dividend	10% max. for ordinary dividend; no preferred dividend	10% max. for ordinary dividend; no preferred dividend
. Required ROE (DCF)	11.8%	11.8%

Table 2.3

Case Difinition

Case No. 1)	Case Description	Base Case Condition	Remarks
Utility Alternatives			
U-11 & U-12	Purchase electric power	Self-supporting, no external utilities supply	Assumed cost at refinery's fence: 0.05 US$ 1 Kwh
U-21 & U-22	Purchase natural gas	ditto	Assumed cost at refinery's fence: 0.20 US$/MMBTU
U-31 & U-32	Purchase soft water	ditto	Assumed cost at refinery's fence: 0.50 US$ / Ton
Fuel Oil Alternatives			
S-11 & S-12	LS(0.5%S): MS(1.5%S)= 4:1	LS(0.1%S): MS(1.5%S)= 4:1	
S-21 & S-22	LS(0.5%S): MS(2.5%S)= 4:1	ditto	
S-31 & S-32	LS(0.5%S): MS(1.5%S)= 1:1	ditto	
S-41 & S-42	LS(0.5%S): MS(2.5%S)= 1:1	ditto	
S-51 & S-52	LS(0.1%S): MS(2.5%S)= 4:1	ditto	
S-61 & S-62	LS(0.1%S): MS(2.5%S)= 1:1	ditto	
Process and Other Alternatives			
P-11 & P-12	Mixed crude operation	Segregated crude operation.	
P-21 & P-22	Different crude process ratio	5:5 process ratio of Iranian light to Iranian heavy	6:4 process ratio of Iranian light to Iranian heavy
P-31 & P-32	Adoption of coker	Not provided	Coker is adopted in order to maximize middle distillate.
P-41	Less gasoline production	Production rate: 10% on crude	Production rate: 5% on crude
P-51	No medium sulfur fuel oil production	LS(0.1%S): MS(1.5%S)= 4:1	
P-61 & P-62	Utilize medium size tankers for product transport 2)	White oil: 130,000 DWT tanker Black oil: 200,000 DWT tanker	White oil: 60,000 DWT tanker Black oil: 90,000 DWT tanker

Notes:

1) Figures at Case No.'s end indicate the respective refinery configurations:
1: Hydroskimming ; 2: Hydrocracking

2) Based on 125,000 BPSD crude capacity