3) Countermeasures for Waste Water Containing Oil from around Light Oil Tank Yard

Since there is possibility of oil leakage from light oil tanks and light oil pumps at the light oil tank yard, drainage ditches are provided around the oil tank yard and contaminated water containing oil is first led to an oil separator. After separating the oil and water at the oil separator, the water is led to the neutralization tank, and following neutralization it is discharged to the discharge tunnel by the drainage pump. The oil separated at the oil separator will be periodically ladled out manually.

4-5-5 Noise Countermeasures

Sources of noises which could be of nuisance level at the site boundary line are of the two categories, those which continuously generate noises and those which irregularly generate noises. Sources which continuously generate noises are boiler feedwater pumps, forced draft fans (FDF), air compressors, mills, circulating water pumps (CWP) and transformers, but boiler feedwater pumps, mills, and air compressors are located inside the powerhouse, so that noise level outside is very small.

As for noises generated irregularly such as the steam blowing from safety valves, silencers will be attached to hold down the noise,

and the blowing nozzles will be directed to the opposite side of the living quarters.

4-5-6 Ash Disposal Waste Water Countermeasures

Ashes produced at a coal-fired boiler may be divided into bottom ash deposited at the boiler furnace bottom and fly ash in the flue gas.

Ash falling into the clinker hopper at the boiler bottom is discharged at regular intervals by the jet pump. The clinker ash falling into the clinker hopper sealed with water is crushed into even-sized particles by a crusher provided at the outlet of the clinker hopper, and then sluiced by a jet pump through the ash sluice line to the ash disposal pond.

Fly ash caught at air preheater and dust collector hoppers is discharged sequentially at regular intervals. The fly ash collected in the hoppers is discharged by the vacuum made by the hydraulic exhauster and sluiced with water through the ash sluice pipe to the ash disposal pond.

The water from the ash disposal pond will be discharged into Gulf of Suez, after ash is completely removed by such facilities as the curtain-wall type floating ash retainer and ash filters.

4-5-7 Stack Height

The height of stack is determined in consideration of the maximum concentration of sulphur oxides coming down to the ground surface and the distance of the point where the maximum concentration occurs on the ground surface, together with the wind rose at the site.

Stack heights of 50 m and 85 m were studied for this Project.

Sulfur contents of Australia, America, Poland, Columbia and South Africa coals range from 0.21% to 1.3%, and do not exceed 2%. Sulfur content of the blended coal of Maghara coal (sulfur content: 2.97%) and the imported coals will be approximately 1.1%, and therefore, stack height was determined on the basis that the sulfur content of coal used is less than 2% and sulfur content of oil is less than 3%, while the sulfur content standard of Egyptian Petroleum Authority is 2.5% at the maximum.

Judging from the wind rose, north-northwest winds are dominant as the prevailing wind and south-southeast winds are not so dominant. However, as Suez City is situated at about 8 km to the northwest of the power plant site, in consideration of the influence to the city, the 85 m stack height is selected. Stack height of 85 m satisfies the emission limits of 0.074 ppm of Egyptian standard and 0.056 ppm USA EPA standard.

The maximum concentration on the ground surface (Cmax) and the distance of the point of maximum concentration (Xmax) are given on the following table.

Table 4-23

SOx Concentration on the Ground Surface along Wind Axis

Exclusive Coal Firing

Stack height: 85m/50m

Sulphur Content (%)		1.0	1.3	1.5	2.0	
Cmax (ppm)	Units 1 & 2	0.029/ 0.038	0.038/ 0.049	0.044/ 0.057	0.059/ 0.076	/
	Unit 1	0.027/ 0.038	0.035 0.050	0.040/ 0.058	0.054/ 0.077	/
Xmax (km)	Units 1 & 2	13.5/ 11.6	13.5/ 11.6	13.5/ 11.6	13.5/ 11.6	/
	Unit 1	9.5/ 7.8	9.5/ 7.8	9.5/ 7.8	9.5/ 7.8	/

Exclusive Oil Firing

Stack height: 85m/50m

Sulphur Content (%)		1.0	1.3	1.5	2.0	3.0
Cmax (ppm)	Units 1 & 2	0.020/ 0.027	0.031/ 0.040	0.041/ 0.053	0.051/ 0.066	0.062/ 0.080
	Unit 1	0.019/ 0.027	0.028/ 0.040	0.037/ 0.054	0.047/ 0.067	0.056/ 0.081
Xmax (km)	Units 1 & 2	13.5/ 11.6	13.5/ 11.6	13.5/ 11.6	13.5/ 11.6	13.5/ 11.6
	Unit 1	9.5/ 7.8	9.5/ 7.8	9.5/ 7.8	9.5/ 7.8	9.5/ 7.8

Table 4—24

Calculation Sheet of Exclusive Coal Firing

	Unit 1	Units 1 & 2
1) Calculation of Exhaust Gas Volume		
a) Theoretical Air Volume (Ao)		
$Ao = [8.89C+26.7(H - \frac{O}{8})+3.33S](1-W)$	$Ao = [8.89x0.75+26.7(0.049 - \frac{0.114}{8})$ $+3.33x0.02](1-0.122)$ $= 6.7$	Same as left
where, C: Carbon 75% H: Hydrogen 49% O: Oxygen 11.4% S: Sulphur 2.0%		
W is total moisture.		
W = Surface moisture + Inherent moisture (1 - Surface moisture)	$W = 0.07+0.056(1-0.07)$ $= 0.122$	Same as left
Surface moisture: 70%	Moisture (Inherent moisture): 5.6%	
b) Theoretical Combustion Gas Volume (Qo)		
$Qo = 0.79Ao+(1.867C+0.75+0.8N$ $+11.2H)x(1-W)+1.244W$	$Qo = 0.79x6.7+(1.867x0.57+0.7x0.02$ $+0.8x0.014+11.2x0.049)x$ $(1-0.122)+1.244x0.122$ $= 6.9$	Same as left
N: Nitrogen 1.4%		

	Unit 1	Units 1 & 2
c) Actual Combustion Gas Volume (Q')		
$Q' = Qo+(\lambda-1)Ao$	A' = 6.9+(1.35-1)x6.7	Same as left
λ : Excess air ratio 1.35	= 9.25	
d) Fuel Consumed (F)	$\frac{320 \text{ MWh} \times 1 \text{ unit} \times 860 \text{ kcal}}{0.39 \times 6{,}500 \text{ kcal/kg}}$	$\frac{320 \text{ MWh} \times 2 \text{ units} \times 860 \text{ kcal}}{0.39 \times 6{,}500 \text{ kcal/kg}}$
	= 108,600 (kg/h)	= 217,200 (kg/h)
e) Exhaust Gas Volume at Boiler Outlet (Q_B)		
$Q_B = Q' \times F$	9.25 x 108,600	9.25 x 217,200
	= 1,005 x 10^3 (Nm^3/h)	= 2,009 x 10^3 (Nm^3/h)
	= 279 (Nm^3/s)	= 558 (Nm^3/s)
	= 294 (m^3/s at 15°C)	= 589 (m^3/s at 15°C)
f) Emission Temperature	135°C (Plan)	
g) Emission Velocity	28 m/s (Plan)	

	Unit 1	Units 1 & 2
2) Calculation of Effective Height of Exhaust	$Ho = 85$ m	$Ho = 85$ m
$He = Ho+0.65(Hm+Ht)$ (m)	$He = 85+0.65(66+131)$ $= 213$ (m)	$He = 85+0.65(93+220)$ $= 288$ (m)
$Hm = \frac{0.795\sqrt{QxV}}{1+\frac{2.58}{V}}$	$Hm = \frac{0.795\sqrt{294x28}}{1+\frac{2.58}{28}}$ $= 66$ (m)	$Hm = \frac{0.795\sqrt{589x28}}{1+\frac{2.58}{28}}$ $= 93$ (m)
$Ht = 2.01x10^{-3}xQ(T-288)$ $(2.3\log 10J + \frac{1}{J} - 1)$	$Ht = 2.01x10^{-3}x294(408-288)$ $(2.3\log 16.3 + \frac{1}{16.3} - 1)$ $= 131$ (m)	$Ht = 2.01x10^{-3}x589(408-288)$ $(2.3\log 11.8 + \frac{1}{11.8} - 1)$ $= 220$ (m)
$J = \frac{1}{\sqrt{QxV}}(1.460-296\frac{V}{T-288})+1$	$J = \frac{1}{\sqrt{294x28}}(1,460-296\frac{28}{408-288})+1$ $= 16.3$	$J = \frac{1}{\sqrt{589x28}}(1,460-296\frac{28}{408-288})+1$ $= 11.8$
where, He: Effective height of exhaust Ho: Actual height of exhaust (m) Q : Exhaust gas volume at 15°C (m^3/s) V : Emission Velocity (m/s) T : Emission temperature (°K)	$Ho = 50$ m $He = 50+0.65(66+131)$ $= 178$ (m)	$Ho = 50$ m $He = 50+0.65(93+220)$ $= 253$ (m)

	Unit 1	Units 1 & 2
3) Calculation of Sulphur Oxides Emission	$S = 2.0\%$	$S = 2.0\%$
$q = 0.7 \times \frac{S}{100} \times F \times (1 - Moisture)$ (Nm³/h)	$q = 0.7 \times \frac{2.0}{100} \times 108{,}600 \times (1-0.07)$ $= 1{,}414$ (Nm³/h)	$q = 0.7 \times \frac{2.0}{100} \times 217{,}200 \times (1-0.07)$ $= 2{,}828$ (Nm³/h)
where, q: Emission volume of sulphur oxides S: Sulphur (%) F: Fuel consumption (kg/h) Surface moisture 7%	$S = 1.5$ $q = 1{,}060$ (Nm³/h) $S = 1.3$ $q = 919$ (Nm³/h) $S = 1.0$ $q = 707$ (Nm³/h)	$S = 1.5$ $q = 2{,}120$ (Nm³/h) $S = 1.3$ $q = 1{,}838$ (Nm³/h) $S = 1.0$ $q = 1{,}414$ (Nm³/h)
4) Cmax and Xmax	Ho = 85 m $S = 2.0\%$	Ho = 85 m $S = 2.0\%$
a) $Cmax = 1.72 \times \frac{q}{He^2}$ (ppm)	$Cmax = 1.72 \times \frac{1{,}414}{213^2} = 0.054$ (ppm)	$Cmax = 1.72 \times \frac{2{,}828}{288^2} = 0.059$ (ppm)
where, Cmax: Maximum ground concentration q : Emission of SO_x He : Effective height of emission (m)	Ho = 85 m $S = 1.5\%$ $Cmax = 1.72 \times \frac{1{,}060}{213^2} = 0.040$ (ppm) Ho = 85 m $S = 1.3\%$ $Cmax = 1.72 \times \frac{919}{213^2} = 0.035$ (ppm)	Ho = 85 m $S = 1.5\%$ $Cmax = 1.72 \times \frac{2{,}120}{288^2} = 0.044$ (ppm) Ho = 85 m $S = 1.3\%$ $Cmax = 1.72 \times \frac{1{,}838}{288^2} = 0.038$ (ppm)

	Unit 1	Units 1 & 2
	Ho = 85 m S = 1.0%	Ho = 85 m S = 1.0%
	$Cmax = 1.72x\frac{707}{213^2} = 0.027$ (ppm)	$Cmax = 1.72x\frac{1,414}{288^2} = 0.029$ (ppm)
	Ho = 50 m S = 2.0%	Ho = 50 m S = 2.0%
	$Cmax = 1.72x\frac{1,414}{178^2} = 0.077$ (ppm)	$Cmax = 1.72x\frac{2,828}{253^2} = 0.076$ (ppm)
	Ho = 50 m S = 1.5%	Ho = 50 m S = 1.5%
	$Cmax = 1.72x\frac{1,060}{178^2} = 0.058$ (ppm)	$Cmax = 1.72x\frac{2,120}{253^2} = 0.057$ (ppm)
	Ho = 50 m S = 1.3%	Ho = 50 m S = 1.3%
	$Cmax = 1.72x\frac{919}{178^2} = 0.050$ (ppm)	$Cmax = 1.72x\frac{1,838}{253^2} = 0.049$ (ppm)
	Ho = 50 m S = 1.0%	Ho = 50 m S = 1.3%
	$Cmax = 1.72x\frac{707}{178^2} = 0.038$ (ppm)	$Cmax = 1.72x\frac{1,414}{253^2} = 0.038$ (ppm)
b) $Xmax = 20.8xHe^{1.143}$ (m)	Ho = 85 m S = 1.0 - 2.0%	Ho = 85 m S = 1.0 - 2.0%
where,	$Xmax = 20.8x213^{1.143} = 9,537$ (m)	$Xmax = 20.8x288^{1.143} = 13,463$ (m)
Xmax: Distance of maximum concentration point He : Effective height of emission	= 9.5 (km)	= 13.5 (km)

Table 4—25
Calculation Sheet of Exclusive Heavy Oil Firing

	Unit 1	Units 1 & 2
1) Calculation of Exhaust Gas Volume		
a) Theoretical Air Volume (Ao)		
Ao = 8.89C+26.7H+3.33S	Ao = 8.89x0.862+26.7x0.13+3.33x0.03 = 11.2 (Nm^3/kg)	Same as left
C: Carbon 86.2% H: Hydrogen 13.0% S: Sulphur 3.0%		
b) Theoretical Combustion Gas Volume (Qo)		
Qo = 8.89C+32.3H+3.33S	Qo = 8.89x0.862+32.3x0.13+3.33x0.03 = 12.0 (Nm^3/kg)	Same as left
c) Actual Combustion Gas Volume (Q')		
Q' = Qo+(λ-1)Ao	Q' = 12+(1.2-1)11.2 = 14.2 (Nm^3/kg)	Same as left
d) Fuel Consumed (F)	$F = \frac{320\ MWH \times 1\ unit \times 860\ kcal}{0.39 \times 10{,}000\ kcal/kg}$ = 70,600 (kg/h)	$F = \frac{320\ MWH \times 2\ unit \times 860\ kcal}{0.39 \times 10{,}000\ kcal/kg}$ = 141,200 (kg/h)

	Unit 1	Units 1 & 2
e) Exhaust Gas Volume at Boiler Outlet (Q)		
$Q = Q' \times F$	$Q = 14.2 \times 70{,}600$	$Q = 14.2 \times 141{,}200$
	$= 1{,}003 \times 10^3$ (Nm^3/h)	$= 2{,}006 \times 10^3$ (Nm^3/h)
	279 (Nm^3/s)	558 (m^3/s)
	294 (Nm^3/s)	588 (m^3/s)
f) Emission Temperature	135°C (Plan)	
g) Emission Velocity	28 m/s (Plan)	
2) Calculation of Effective Height of Emission	Ho = 85 m	Ho = 85 m
$He = Ho + 0.65(Hm + Ht)$ (m)	$He = 85 + 0.65(66 + 131)$	$He = 85 + 0.65(93 + 220)$
	$= 213$ (m)	$= 288$ (m)
$Hm = \dfrac{0.795\sqrt{Q \times V}}{1 + \dfrac{2.58}{V}}$	$Hm = \dfrac{0.795\sqrt{294 \times 28}}{1 + \dfrac{2.58}{28}}$	$Hm = \dfrac{0.795\sqrt{588 \times 28}}{1 + \dfrac{2.58}{28}}$
	$= 66$ (m)	$= 93$ (m)
$Ht = 2.01 \times 10^{-3} \times Q(T - 288)$	$Ht = 2.01 \times 10^{-3} \times 294(408 - 288)$	$Ht = 2.01 \times 10^{-3} \times 588(408 - 288)$
$(2.3\log J + \dfrac{1}{J} - 1)$	$(2.3\log 16.3 + \dfrac{1}{16.3} - 1)$	$(2.3\log 11.8 + \dfrac{1}{11.8} - 1)$
	$= 131$ (m)	$= 220$ (m)

	Unit 1	Units 1 & 2
$J = \frac{1}{\sqrt{Q \times V}}(1,460-296\frac{V}{T-288})+1$	$J = \frac{1}{\sqrt{294 \times 28}}(1,460-296\frac{28}{408-288})+1$	$J = \frac{1}{\sqrt{588 \times 28}}(1,460-296\frac{28}{408-288})+1$
where,	$= 16.3$	$= 11.8$
He: Effective height		
Ho: Actual height of emission	Ho = 50 m	Ho = 50 m
Q : Exhaust gas volume at 15°C	He = 50+0.65(66+131)	He = 50+0.65(93+220)
V : Emission velocity (m/s)	= 178 (m)	= 253 (m)
T : Emission temperature (°K)		
3) Calculation of SO_x Emission	S = 3.0%	S = 3.0%
$q = 0.7 \times \frac{S}{100} \times F$ (Nm^3/h)	$q = 0.7 \times \frac{3.0}{100} \times 70,600$ (Nm^3/h)	$q = 0.7 \times \frac{3.0}{100} \times 141,200$ (Nm^3/h)
	= 1,483 (Nm^3/h)	= 2,966 (Nm^3/h)
where,	S = 2.5 Q = 1,236 (Nm^3/h)	S = 2.5 Q = 2,472 (Nm^3/h)
q: Emission of SO_x	S = 2.0 Q = 988 (Nm^3/h)	S = 2.0 Q = 1,976 (Nm^3/h)
S: Sulphur (%)		
F: Fuel consumption (kg/h)	S = 1.5 Q = 741 (Nm^3/h)	S = 1.5 Q = 1,482 (Nm^3/h)
	S = 1.0 Q = 494 (Nm^3/h)	S = 1.0 Q = 988 (Nm^3/h)

	Unit 1	Units 1 & 2
4) Cmax and Xmas a) $Cmax = 1.72x\frac{q}{He^2}$ (ppm) where, Cmax: Maximum ground concentration q : SO_x emission (Nm^3/h) He : Effective height of emission (m)	Ho = 85 m S = 3.0% $Cmax = 1.72x\frac{1,483}{213^2} = 0.056$ (ppm)	Ho = 85 m S = 3.0% $Cmax = 1.72x\frac{2,966}{288^2} = 0.062$ (ppm)
	Ho = 85 m S = 2.5% $Cmax = 1.72x\frac{1,236}{213^2} = 0.047$ (ppm)	Ho = 85 m S = 2.5% $Cmax = 1.72x\frac{2,472}{288^2} = 0.051$ (ppm)
	Ho = 85 m S = 2.0% $Cmax = 1.72x\frac{988}{213^2} = 0.037$ (ppm)	Ho = 85 m S = 2.0% $Cmax = 1.72x\frac{1,976}{288^2} = 0.041$ (ppm)
	Ho = 85 m S = 1.5% $Cmax = 1.72x\frac{741}{213^2} = 0.028$ (ppm)	Ho = 85 m S = 1.5% $Cmax = 1.72x\frac{1,482}{288^2} = 0.031$ (ppm)
	Ho = 85 m S = 1.0% $Cmax = 1.72x\frac{494}{213^2} = 0.019$ (ppm)	Ho = 85 m S = 1.0% $Cmax = 1.72x\frac{988}{288^2} = 0.020$ (ppm)
	Ho = 50 m S = 3.0% $Cmax = 1.72x\frac{1,483}{178^2} = 0.081$ (ppm)	Ho = 50 m S = 3.0% $Cmax = 1.72x\frac{2,966}{253^2} = 0.080$ (ppm)
	Ho = 50 m S = 2.5% $Cmax = 1.72x\frac{1,236}{178^2} = 0.067$ (ppm)	Ho = 50 m S = 2.5% $Cmax = 1.72x\frac{2,472}{253^2} = 0.066$ (ppm)

	Unit 1	Units 1 & 2
	Ho = 50 m S = 2.0%	Ho = 50 m S = 2.0%
	$Cmax = 1.72 \times \frac{988}{178^2} = 0.054$ (ppm)	$Cmax = 1.72 \times \frac{1,976}{253^2} = 0.053$ (ppm)
	Ho = 50 m S = 1.5%	Ho = 50 m S = 1.5%
	$Cmax = 1.72 \times \frac{741}{178^2} = 0.040$ (ppm)	$Cmax = 1.72 \times \frac{1,482}{253^2} = 0.040$ (ppm)
	Ho = 50 m S = 1.0%	Ho = 50 m S = 1.0%
	$Cmax = 1.72 \times \frac{494}{178^2} = 0.027$ (ppm)	$Cmax = 1.72 \times \frac{988}{253^2} = 0.027$ (ppm)
b) $Xmax = 20.8 \times He^{1.143}$ (m)	Ho = 85 m S = 1.0 - 3.0%	Ho = 85 m S = 1.0 - 3.0%
	$Xmax = 20.8 \times 213^{1.143} = 9,537$ (m)	$Xmax = 20.8 \times 288^{1.143} = 13,463$ (m)
where,	9.5 (km)	13.5 (km)
Xmax: Distance of maximum ground concentration point	Ho = 50 m S = 1.0 - 3.0%	Ho = 50 m S = 1.0 - 3.0%
He : Effective height of emission	$Xmax = 20.8 \times 178^{1.143} = 7,768$ (m)	$Xmax = 20.8 \times 253^{1.143} = 11,610$ (m)
	7.8 (km)	11.6 (km)

	Unit 1	Units 1 & 2
	Ho = 50 m $X_{max} = 20.8 \times 178^{1.143} = 7{,}768$ (m) = 7.8 (km)	Ho = 50 m $X_{max} = 20.8 \times 253^{1.143} = 11{,}610$ (m) = 11.6 (km)

Table 4—26 Emmission Limit

Egypt	USEPA Limit	Japan
200 g/m³	150 g/m³	0.038 ppm (100 g/m³)
$\frac{200\times10^{-6}\times22.4}{64\times10^{3}} \times \frac{273+15}{273}$ $= 7.38^{-8}$ 0.074 ppm	$\frac{150\times10^{-6}\times22.4}{64\times10^{3}} \times \frac{273+15}{273}$ $= 5.54^{-8}$ 0.055 ppm	

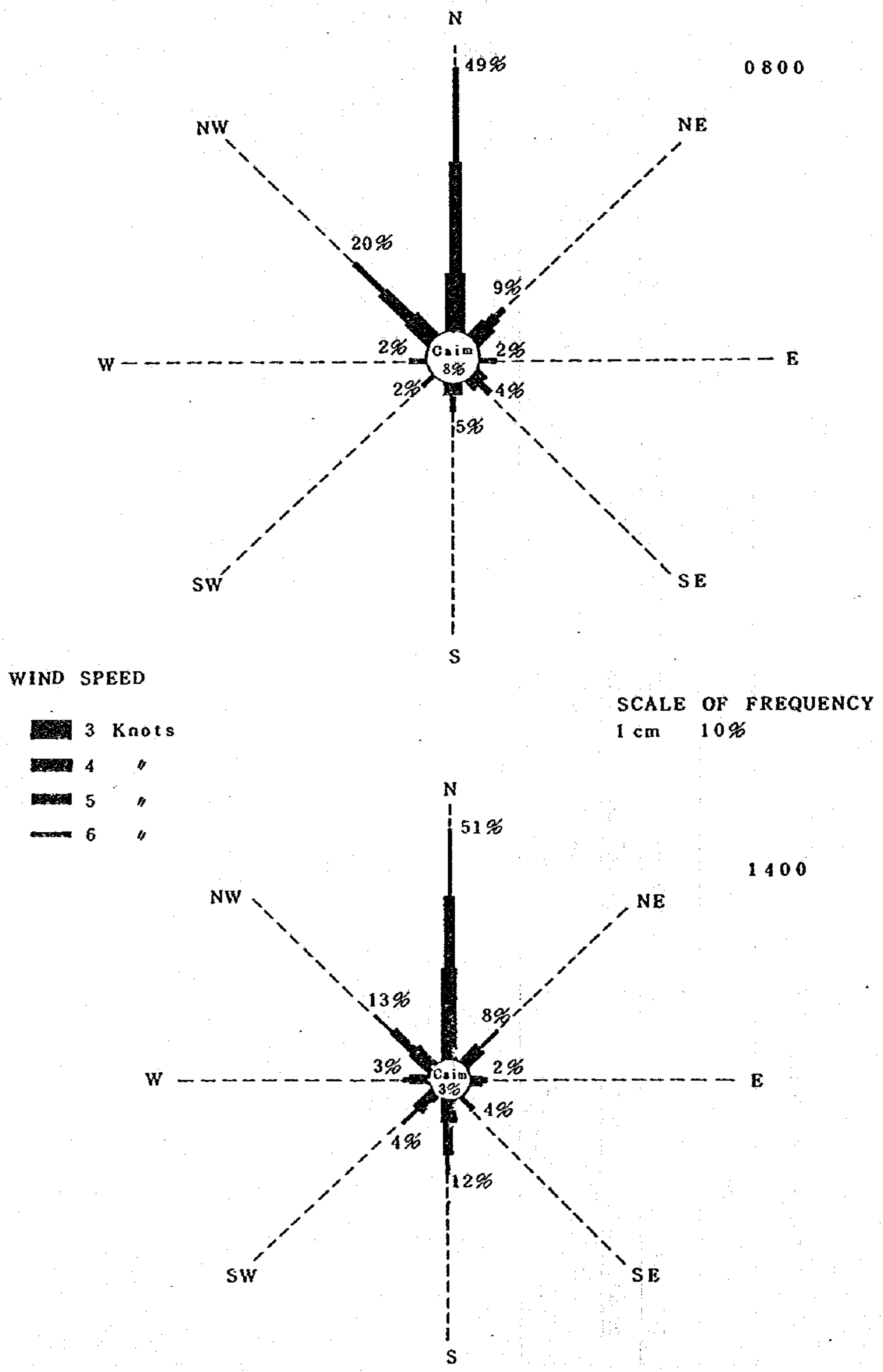
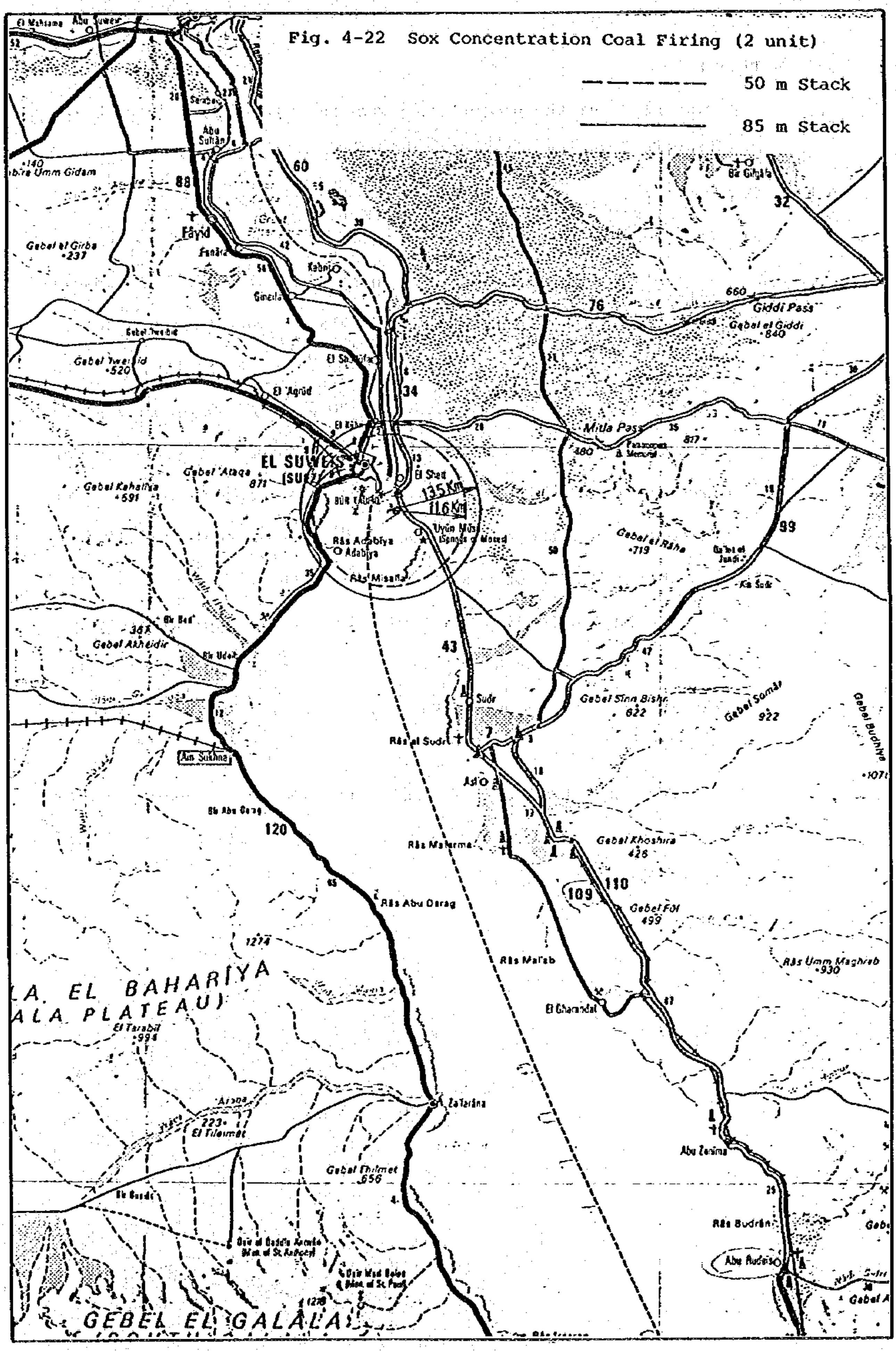


Fig. 4-21 WIND ROSES

Fig. 4-22 Sox Concentration Coal Firing (2 unit)



4-6 PLOT PLAN

Plot plan for the project is shown in Fig. 4-23, and the brief description about the plan will be outlined as follows.

4-6-1 Power Plant

1) Location and Area for Power Plant

The power plant site is located on the Sinai Peninsula along the Gulf of Suez in lat. 29°55'N. and long. 32°36'E., approximately eight (8) km southeast from Suez City, and the site has an area of 60 hectares (500 m x 1, 200 m) in a place approximately 2 km to the southwest (Sinai Peninsula side) from an intersection located on the point approximately 2.8 km northeast from the site on the national road Route No. 66.

2) Location and Size of Fuel Unloading Berth

The fuel unloading berth will be located approximately 2.7 km to the north-north-west from the sea coast belonging to the power plant site, and approximately 1.7 km from sea route of Suez Canal.

For 60,000 DWT coaler and 5,000 DWT oil tanker, a pier with sizes of 25 m x 30 m and 30 m x 190 m will be constructed in the above location.

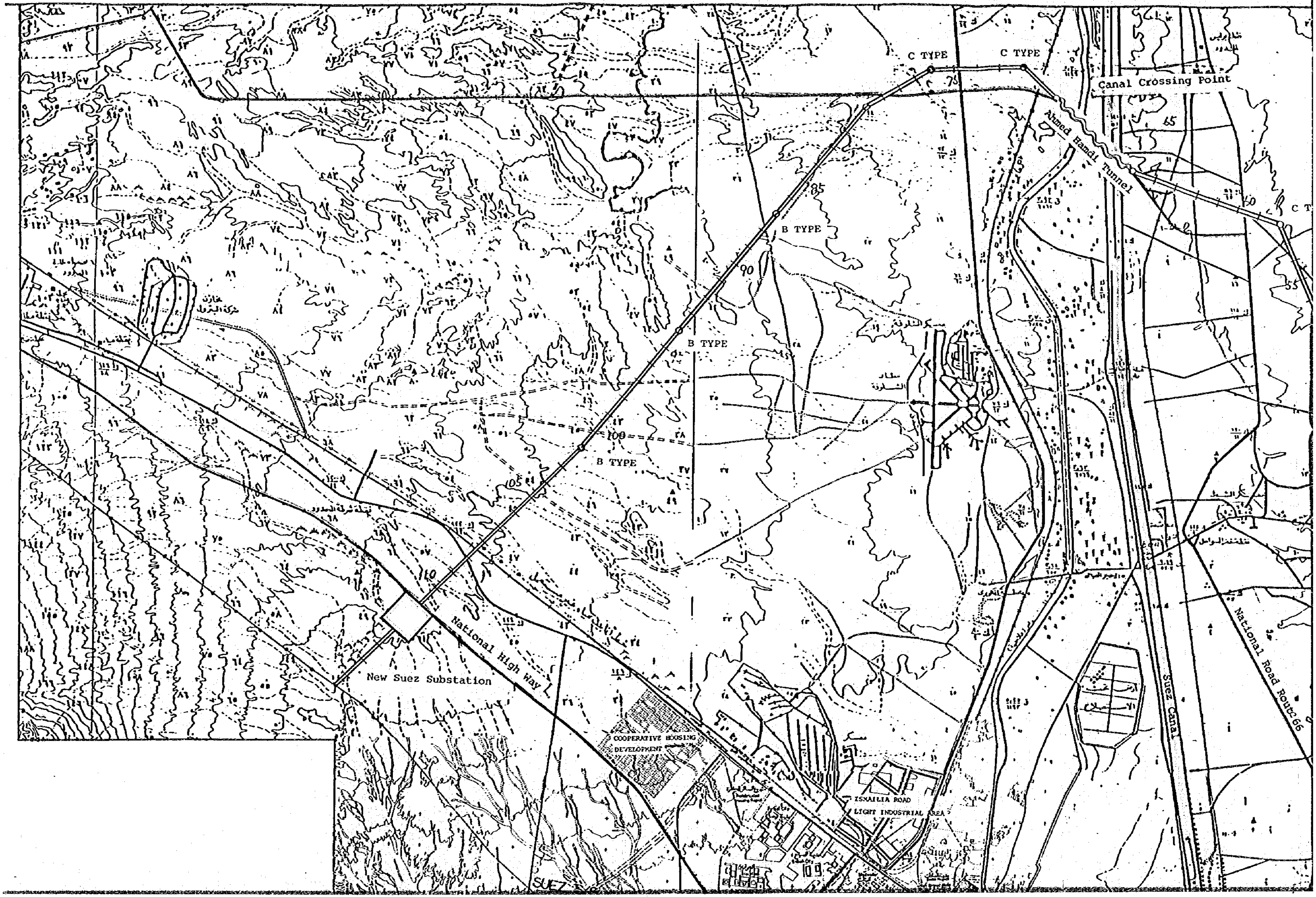
4-6-2 Transmission Line Route and Location of Substation

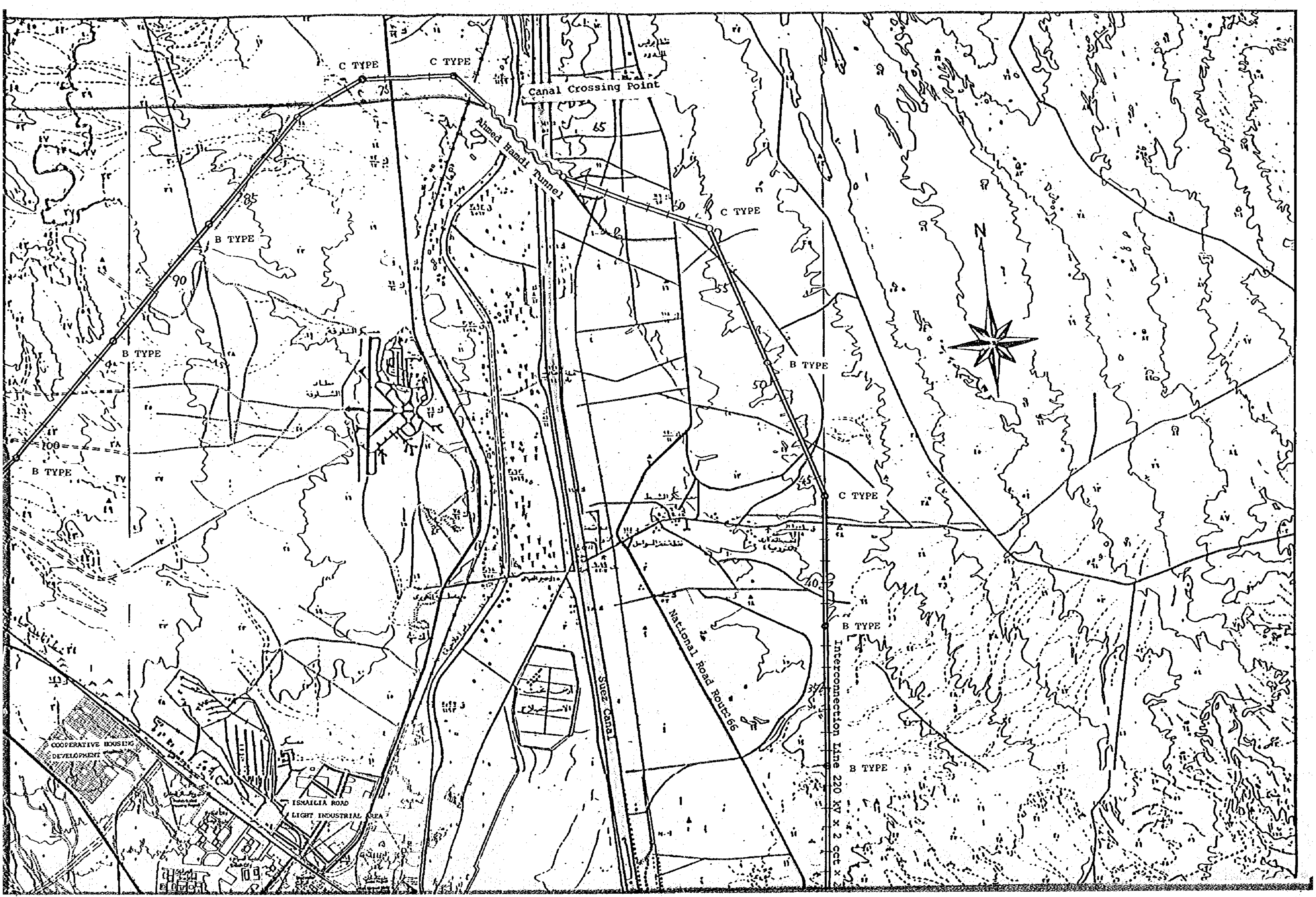
1) Transmission Line Route

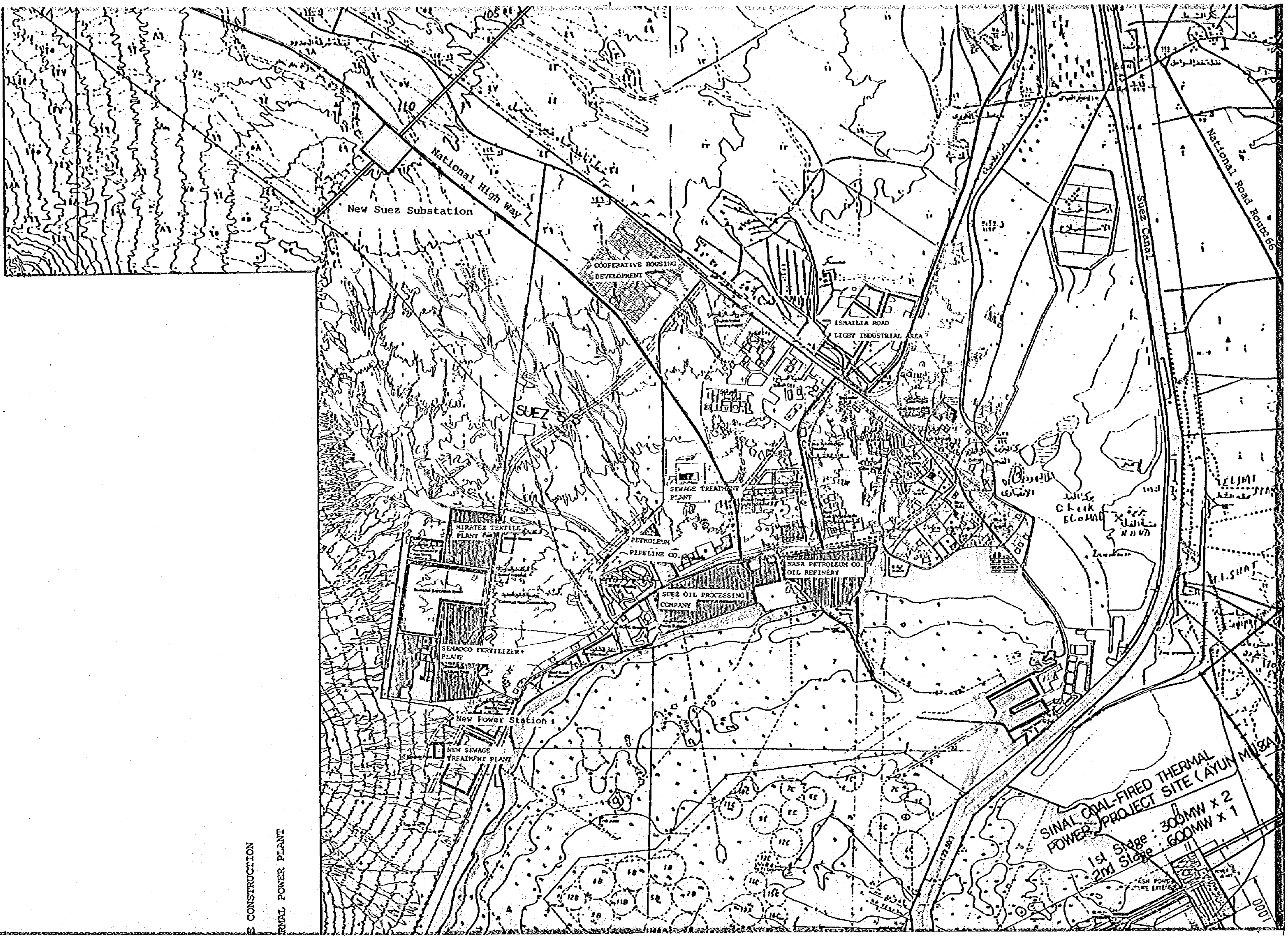
Transmission line route is from the 220 kV switching yard station located on the northern part of the power plant compound to the proximity of Ahmed Hamdi Tunnel (approximately 142.8 km south of Port Said) along the national road Route No. 66, with a length of approximately 22.5 km, and from the canal crossing point to New Suez Substation, transmission line with a length of 19.5 km including 2 km canal crossing cable and branch line with a length of 1.5 km, total length of about 43.5 km will be constructed under this Project.

2) Location and Area of the Substation

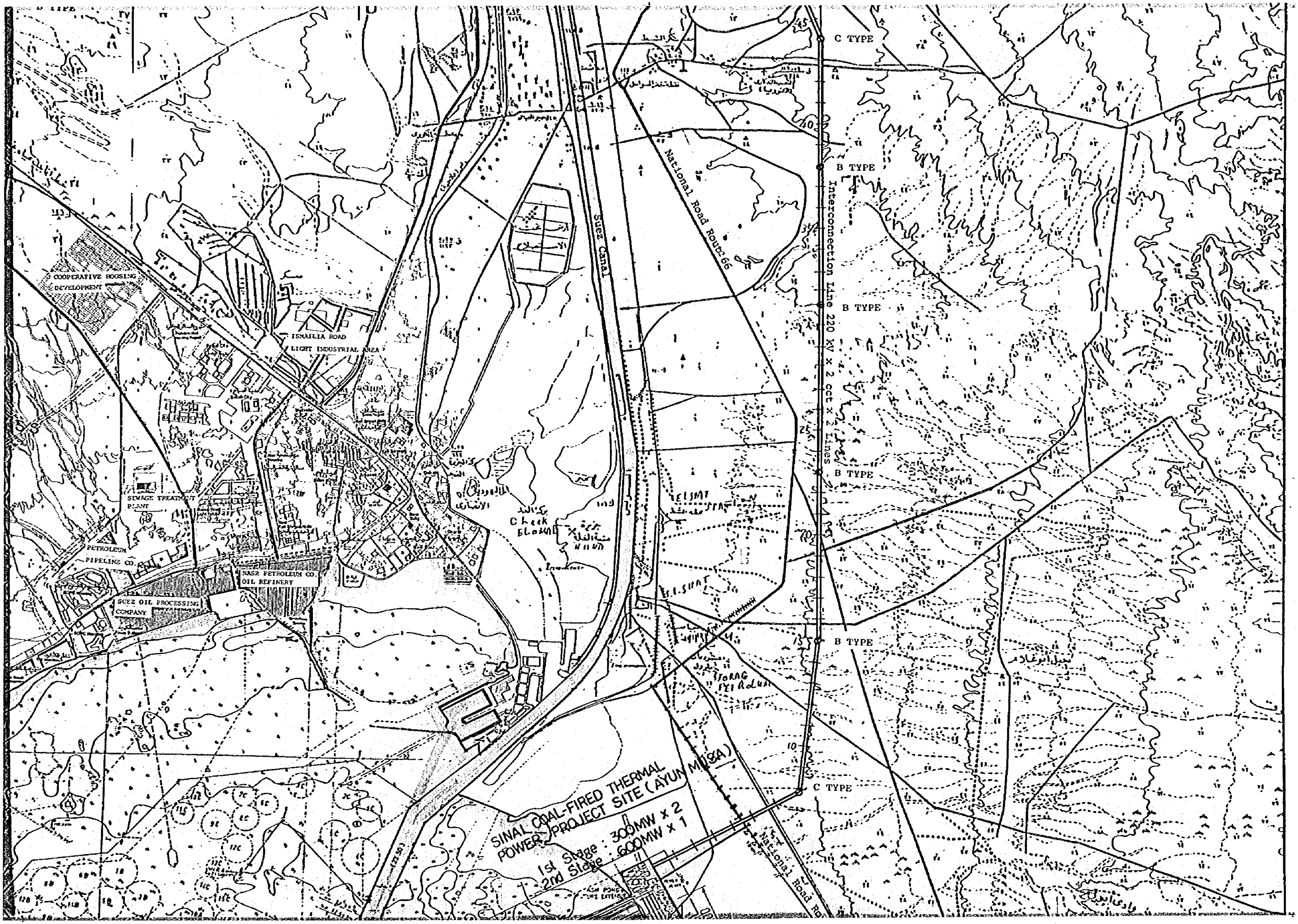
New Suez Substation will be located on a place approximately 10 km northeast from Suez City along the national road Route No. 134 and area for the Substation will be 600 m x 600 m.


C TYPE
C TYPE
Canal Crossing Point
Ahmed Hamdi Tunnel
B TYPE
B TYPE
B TYPE
New Suez Substation
National High Way
COOPERATIVE HOUSING
DEVELOPMENT
ISMAILIA ROAD
LIGHT INDUSTRIAL AREA
Suez Canal
National Road Route 66
SUEZ

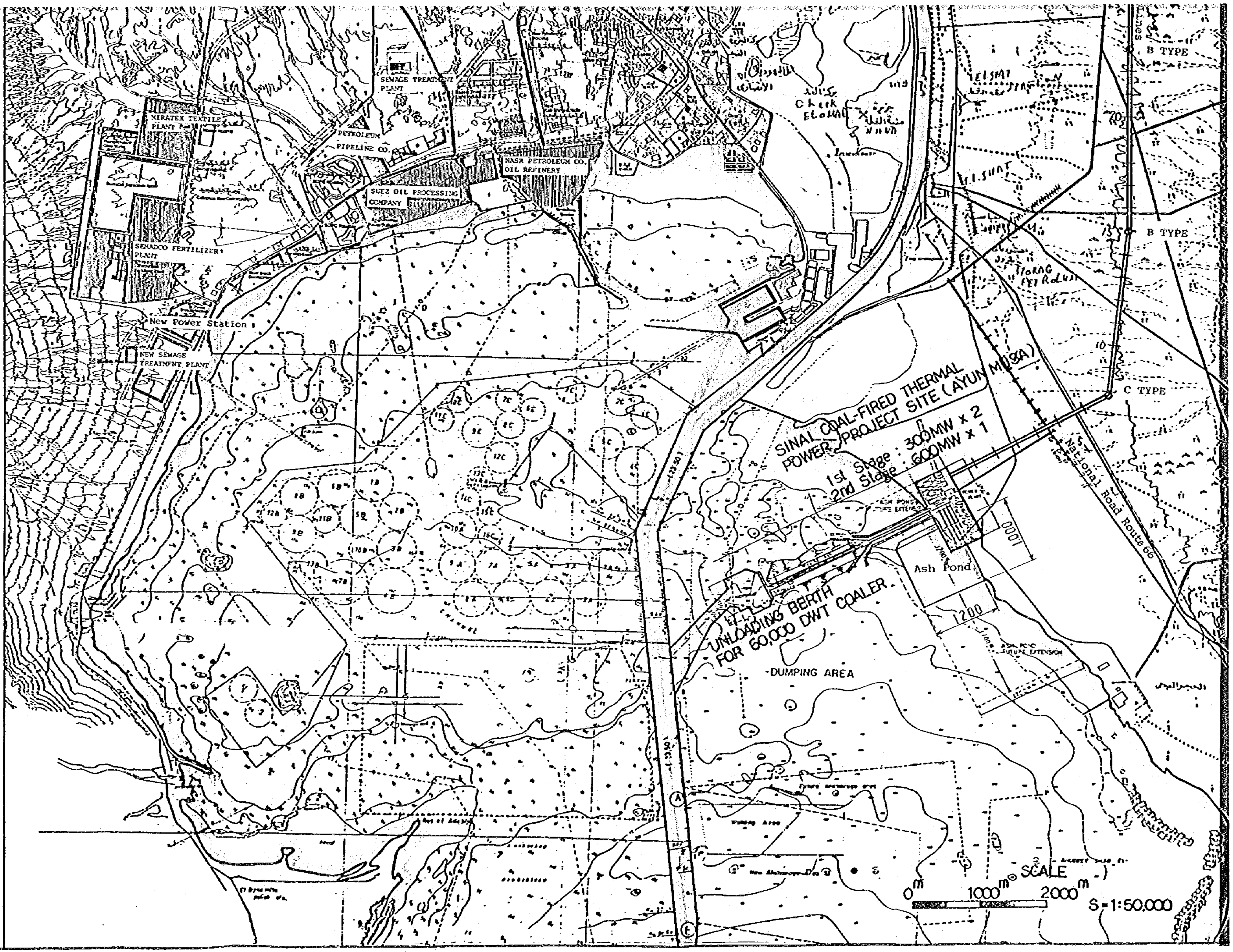

C TYPE
C TYPE
Canal Crossing Point
Ahmed Hamdi Tunnel
C TYPE
B TYPE
B TYPE
B TYPE
B TYPE
C TYPE
B TYPE
B TYPE
N
Suez Canal
National Road Route 66
Interconnection Line 220 kV x 2 cct x 2
COOPERATIVE HOUSING DEVELOPMENT
ISMAILIA ROAD
LIGHT INDUSTRIAL AREA

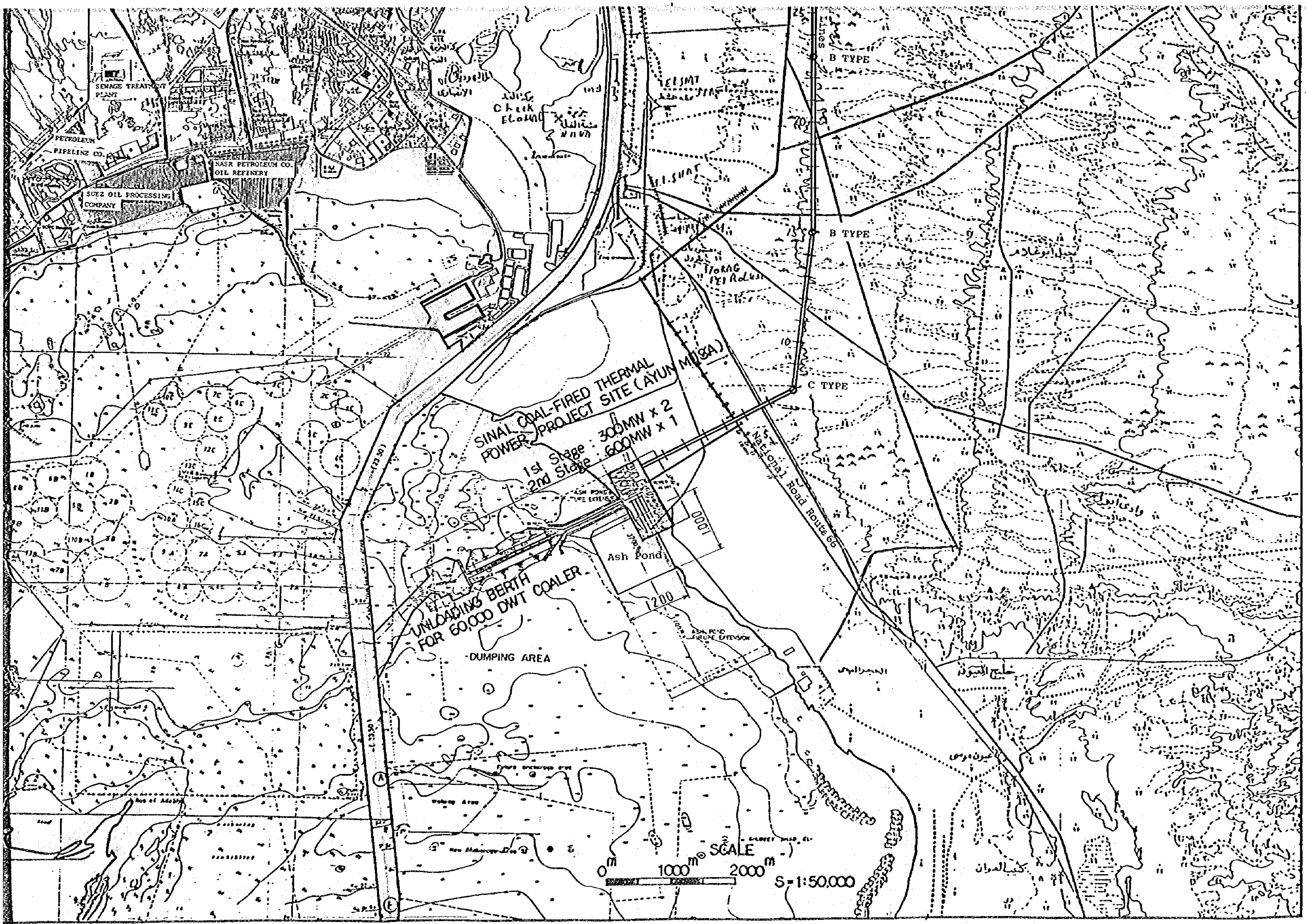


S CONSTRUCTION
RMAL POWER PLANT


C TYPE
B TYPE
B TYPE
B TYPE
B TYPE
C TYPE
Interconnection Line 220 KV x 2 cct x 2 Lines
National Road Route 66
Suez Canal
COOPERATIVE HOUSING DEVELOPMENT
ISMAILIA ROAD LIGHT INDUSTRIAL AREA
SEWAGE TREATMENT PLANT
PETROLEUM PIPELINE CO.
NASR PETROLEUM CO. OIL REFINERY
SUEZ OIL PROCESSING COMPANY
SINAI COAL-FIRED THERMAL POWER PROJECT SITE (AYUN MUSA)
1st Stage : 300MW x 2
2nd Stage : 600MW x 1
National Road Ro

GENERAL PLAN FOR THE CONSTRUCTION
OF
THE FIRST COAL-FIRED THERMAL POWER PLANT
IN
SINAI





SEWAGE TREATMENT PLANT
PETROLEUM PIPELINE CO.
NASR PETROLEUM CO. OIL REFINERY
SUEZ OIL PROCESSING COMPANY
B TYPE
B TYPE
C TYPE
SINAI COAL-FIRED THERMAL POWER PROJECT SITE (AYUN MUSA)
1st Stage : 300MW x 2
2nd Stage : 600MW x 1
Ash Pond
1000
1200
UNLOADING BERTH FOR 60,000 DWT COALER
DUMPING AREA
National Road Route 66
SCALE
0m 1000m 2000m
S=1:50,000

4-7 FACILITIES PLAN

4-7-1 Generating Facilities

1) Generating Plant

a. Type of Generating Facilities

Ultimate output of the Sinai Coal-fired Thermal Power Plant will be 1,200 MW. In this project, 600 MW generating facilities are needed to be constructed, therefore, in consideration of transmission system, operating system, financial planning and construction schedule, two (2) generating units of 320 MW unit capacity each will be desirable to be constructed on the assumption that the auxiliary power ratio will be approximately 6.25%.

Although two types of generating facilities are considered in this project; one is header system and the other unit system, the unit system will be applied to this project in consideration of easy operation, safety, simple plant protection system of boiler, turbine, generator and main transformer, centralized monitoring and operating system in the central control room, and easy controllability of the plant.

b. Type of Boiler

There are several kinds of boiler depending upon the fuels used; coal-fired, oil-fired, gas-fired, etc. In this project dual type boiler (coal and oil-fired) will be applied based on the fuel plan, and furthermore this type of boiler can fire coal and oil simultaneously.

Since the meteorological condition around the plant site is good, outdoor type will be applied to reduce the construction cost.

c. Type of Turbine

Type of turbine is mainly classified into condensing type and back-pressure type. However, since the power plant under this project has no planning to use turbine exhaust steam for other purposes, condensing type turbine will be adopted.

In addition four-flow turbine will be selected by reason that the four-flow turbine has advantage over thermal efficiency than that of two-flow turbine.

d. Type of Boiler Feedwater Pump

There are two types of drive system of boiler feedwater pump, or turbine-driven type and motor-driven type.

In this project turbine-driven type will be applied to reduce auxiliary power consumption, and also one motor-driven boiler feedwater pump will be installed for boiler water feeding during unit start-up and stand-by unit during normal operation.

e. Generator

To increase generator efficiency, hydrogen-cooled type will be applied to the plant since it has been widely applied in utility companies in the world.

f. Station Auxiliary Power System

For the power for auxiliaries 6.6 kV auxiliary power will be supplied from 220 kV switching yard station through starting transformer, and from the high voltage auxiliary power will be stepped down to 380 V for the low voltage machines through auxiliary transformers. Furthermore, station service transformer will supply auxiliary power to auxiliaries after generator synchronization.

In the event of power failure of 220 kV transmission lines or of starting transformer due to an accident, the auxiliary power will be supplied by an emergency gas turbine generator as backup.

g. Condenser Cooling Water Intake Facilities

Exhaust steam from the turbine is introduced into condenser,and the steam is cooled down into condensate to be reused as feedwater to the boiler.

Condenser cooling system is classified into two; one is cooling tower system, the other is condenser system. Condenser system will be applied to this Project since the power plant site is located near sea.

Discharge seawater cooled down by the condenser is led to the sea through discharge channel.

h. Fuel Handling Facilities

a) Coal Handling

i. Stackers and reclaimers will be installed so that considerable volume of the imported coal and domestic coal can be treated in a short time, the respective coal will be stored separately in the coal storage yard.

ii. Coal blending equipment will be installed so as to blend the imported and the domestic coals.

iii. Coal receiving equipment for the domestic coal will be considered.

b) Heavy oil handling

The heavy oil will be unloaded at the berth from the oil tanker, and transmitted to the oil storage tanks through pipeline.

c) Light oil will be unloaded from tank-lorry directly and stored in the light oil storage tank.

i. Station Service Water System

Since there is no appropriate water source like river and lake near the power plant site, the Nile River water will be transported from Suez City through water pipeline. However, the pipeline has not yet completed evaporation type seawater desalination plant which utilizes turbine extraction steam will be installed and supply boiler make-up water, station service water, drinking water, etc.

j. Outdoor Substation Facilities

Electricity generated by the turbine generators is transmitted to New Suez Substation through 220 kV step-up transformers and a part of the electricity is planned to be transmitted to Sinai district, and also transmitted to Ayun Musa district through 220 kV/22kV step-down distribution transformers. The necessary substation facilities for the above such as circuit breakers, transformers, etc. will be installed.

k. Communication Facilities

For the smooth operations of the power plant, microwave and power line carrier communication systems and station communication system will be installed.

2) Civil Facilities

a. Power Plant Ground Formation

The power plant site area is planned for the ultimate capacity of 1,200 MW, including the future addition of 600 MW. The power plant site will be of a rectangular shape of 1,200 m north to south and 500 m east to west, covering 600,000 m². (The space area requirement was decided by the equipment layout plan.) The ground level of this 600,000 m² site area is planned at EL+4 m, in consideration of the tidal level, wave height, etc.

The present ground surface is at about EL+2 m of an average elevation and is covered with loose sandy soil. Therefore, banking of more than 2 m would be necessary after the loose surface soil is removed.

The soil for banking will be taken from the site of good soil located close on the east of the site.

The slopes at the periphery will be protected with pitched stone on the slope facing the sea, and the others with tamping and sodding.

b. Access Road

The access road will be branched from the National Highway No. 66 and lead perpendicular to the power plant grounds and will be connected with the main station road. The access road will be about 1,600 m in length and practically level.

Two lanes of 4 m width will be separated by a green belt and paved with asphalt.

c. Condenser Cooling Water Channel (Intake)

There are the following types of cooling water intake.

a) Deep layer intake by pipeline

b) Open channel intake

c) Curtain wall method

Type (a) is generally adopted at sea coasts where the sea is shallow for considerable distance off shore, and the water is taken near the bottom and transmitted through pressure pipes. This method is adaptable to locations where the space is limited by existing structures and other coal conditions. However, this method involves the demerits of large head losses through the pressure piping and the trouble of deposits inside the piping.

The cleaning of deposits would need unit shutdown and is costly.

Type (b) is the most general method, and can be adopted at sea coast where the sea is shallow to some distance off shore, if it does not affect the existing vested interests and structures.

This method is economical and of easy maintenance. Practically no works needing unit shutdown is necessary.

Type (c) is commonly used at relatively deep sea coasts where intake of water is possible directly into the intake pit by small-scale dredging.

The Ayun Musa site is located on the coast where the sea is shallow to a considerable distance off shore, and if 61 m^3/sec of water (for 1,200 MW) is to be taken at a lower temperature than 27°C, the intake point must be located about 1,500 m off from the shore.

There are no vested interests or existing structures in this coast line and the causeway of 2,700 m length will be built for receiving fuel. And the open channel intake system utilizing a part of this causeway is adopted for the project.

The causeway from the coal unloading berth to the power plant will be utilized and the open channel for intake will be built along the south side of the causeway and the discharge channel along the north side.

This arrangement serves to the complete separation between the intake and the discharge and recirculation of warm discharged water to the intake is prevented. For the intake, the south side of the causeway is more favorable in maintaining of water quality and water depth, judging from the oceanographic conditions.

The intake point is located near EL-5 m at about 1,500 m off shore and water channel is built to the intake pit.

The discharge channel will be extended to a point where the sea bottom is at EL-0.7 m, the same level as L.W.L. The length of the discharge channel is about 600 m.

Both the intake channel and the discharge channel will be open channels of natural flow.

d. Condenser Cooling Water Facilities

a) Pump pit

The pump pit is planned for the first stage of 600 MW, and for the future extension, provisions will be made so that the construction of the adjacent pump pit may be carried out without disturbing the operation of the existing units.

b) Water pipe

The intake water piping is planned for the first stage of 600 MW. Provisions will be made for the future extension so that the construction works may not disturb operation.

c) Discharge facilities

The discharge channel will be the concrete box culvert in the area of major equipment and buildings, and open channel to the sea. The discharge facilities are planned for 1,200 MW in the first stage, because future addition would be difficult.

e. Ash Pond

Ash pond is planned on the south of the intake channel for ten (10) years operation of 600 MW.

The area of 950,000 m² has the capacity of ash disposal of about 3,000,000 m³.

Ash pond has a spillway at the south-west part of the pond.

Ash disposal area for 30 years of operation at 1,200 MW would easily be obtained by extending the pond step by step into the south direction. (Refer to page 5-185 to 5-187)

f. Coal Storage and Coal Handling

Coal yard of 600 m x 300 m will be built in the south-west part of the power station.

The area of 300 m x 300 m is for the first 600 MW, and the rest for the future extension. Four lanes of railways are built for the stackers and reclaimers.

The foundations of the belt conveyors for the stackers and reclaimers are also built in the railway line. Besides, the foundations of coal conveyors from unloading jetty to coal yard will be constructed.

g. Heavy Oil Tank Foundations and Dykes

Heavy oil tanks are located at the south-east part of the power station.

The tank yard covers 300 m x 100 m of area for the first 600 MW.

The foundations for the tanks and the oil retaining dykes are built.

h. Road, Drainage and Plantation in the Power Station Grounds

Road:

Station roads will be laid all along the periphery of the grounds inside the fence and around the major equipment, buildings and oil storage tanks.

Drainage:

Gutter is constructed along the peripheral road along the inside of the fence.

Several water collecting tanks are constructed connecting the gutters at the same intervals, to prevent overflow of rain water from the grounds to the outside.

Miscellaneous service water after use is collected to the above-mentioned tanks, which are interconnected with underground pipes.

The collected water is estimated to be approximately 500 m^3.

Individual tanks will have submerged pumps and the water will be used for irrigation of the plantation in the grounds.

Plantation:

Trees will be planted around the buildings and along both sides of the main road in the power station, and lawns will be planted on the slopes around the land.

i. Miscellaneous Works

Miscellaneous works include,

Ash sluice pipe, cable duct, oil pipe foundation, demineralized water tank foundation, neutralization tank, desalination plant foundation, etc.

These miscellaneous works will be planned materially as the general plan is established.

3) Harbor Facilities

The sea in front of Ayun Musa is shallow to a considerable distance from the shore, and it is 1.7 km to the depth of -5 m and 3.7 km to -10 m. The sea faces the Gulf of Suez and Suez Port to the north and continues to the Red Sea in the south.

There is the designated waiting area of Adabiya Port and the designated waiting area for boats passing Suez Canal and the dump area of dredged sand. The tidal current is 1.5 knot and the tidal range is 1.5 m.

Under these basic conditions, the piled wharf type would be the most suitable for the harbor with the main purpose of unloading of imported coal for the power plant.

Since the harbor facilities are a part of appurtenant facilities of the power plant, it is necessary to economize the construction cost as much as possible. The distance from the coast of Ayun Musa site to Suez Channel is approximately 4 km in straight line, and in planning the waterway for the coalers from this Suez Channel to Ayun Musa and the harbor facilities at Ayun Musa, considerations were made to balance the volume of dredging in the waterway and anchorage and the volume of banking so that the construction cost may be best economized.

For the condenser circulating water intake, a depth of more than -5 m is required, and the side wall of the causeway will be utilized for the intake channel and the other side wall for the discharge channel, and the recirculation of warm discharged water to the intake could be completely shut out.

a. Type of Ships

a) Coalers

For transportation of imported coal for the coal fired thermal power plants of over 600 MW, two types (60,000 DWT and 120,000 DWT) of coalers are conceivable.

These two types are compared under the site conditions of Ayun Musa in the following.

i. Construction of branch waterway from the access channel to the unloading wharf

	60,000 DWT	120,000 DWT
Width of entrance	600 m	900 m
Width of waterway	Min. 200 m	Min. 280 m
Length of waterway	Approx. 1,300 m	Approx. 2,400 m

ii. Shipping ports at exporting countries

The ports that can accept the large ships of 120,000 DWT class are only three, namely Port Kembla and Hay Point in Australia and Richards Bay in South Africa.

iii. Construction Costs

See attached table.

As seen from the above, it is advisable to adopt 60,000 ton coalers. If 120,000 coalers are to be adopted, further detailed studies are needed with respect to the construction of the branch waterway in the Gulf of Suez and shipping ports in the coal exporting countries.

Comparative Table 60,000 DWT and 120,000 DWT

Item	60,000 DWT	120,000 DWT
Construction Cost		
Channel and basin	LE 14,100,000	LE 73,000,000
Mooring facilities	LE 17,600,000	LE 29,500,000
Causeway	LE 4,100,000	LE 4,500,000
Total	LE 35,800,000	LE 107,000,000
Unit Price		
Dredging work	3.5 LE/m³	4.8 LE/m³
Berth construction	2,300 LE/m²	3,200 LE/m²
Major Quantities		
Dredging volume	3,900,000 m³	15,000,000 m³
Water depth	EL -16 m	EL -20 m
Channel length	1,300 m	2,400 m
Channel width	200 m	280 m
Basin area	275,000 m²	390,000 m²
Length of coaler berth	300 m	360 m
Area of platform	7,500 m²	9,000 m²
Steel pipe pile		
Weight	5,500 t	13,500 t
Number	440 nos	528 nos
Size	ø900 mm, t=16 mm	ø1,200 mm, t=20 mm

b) Heavy oil tanker

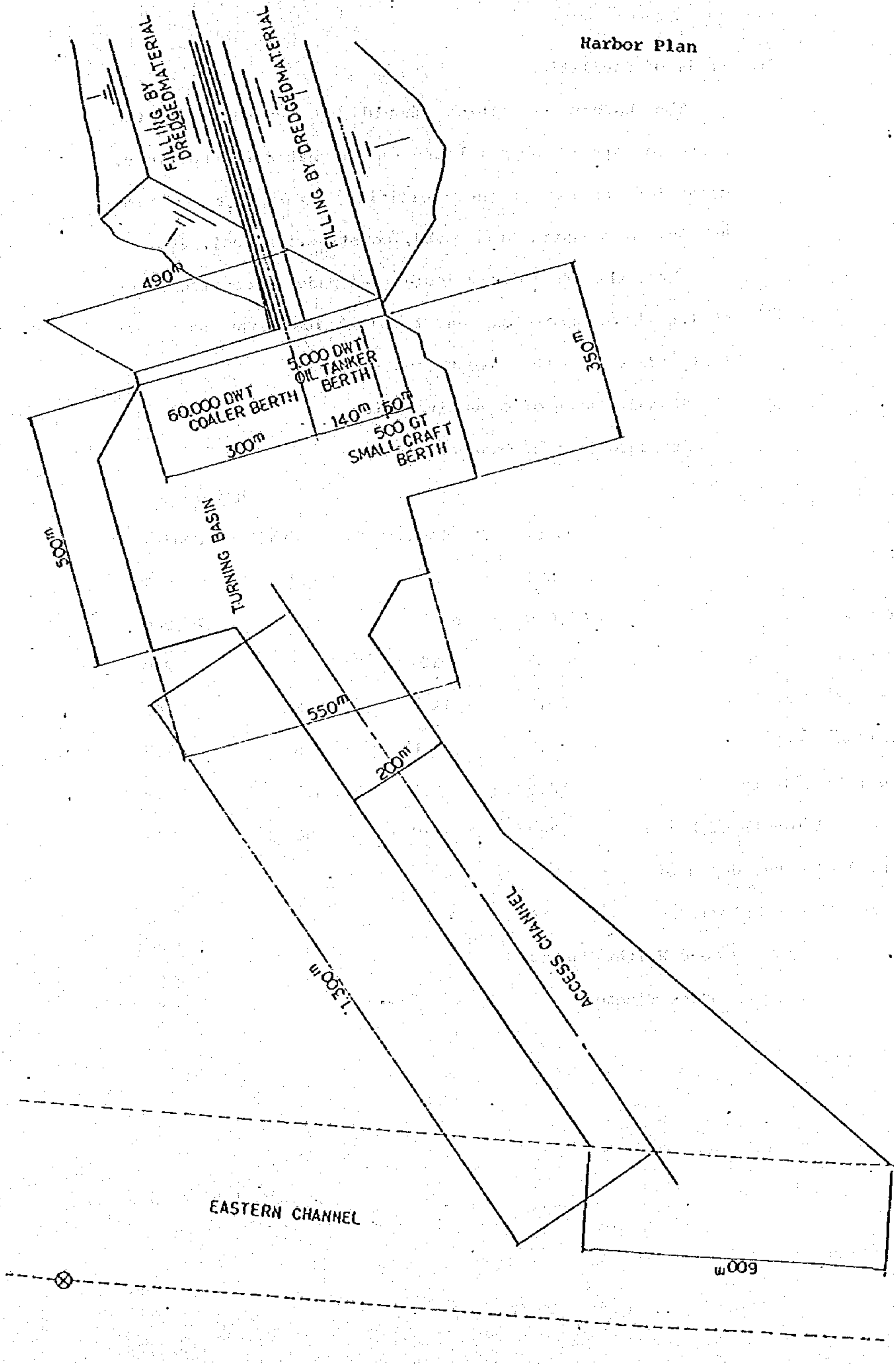
The stand-by fuel will be the domestic heavy oil and 30 days consumption will be stored. The tank size to match this requirement is decided to be 5,000 DWT.

c) Others

Besides the above, 500 GT class tug boats for maneuvering of coalers at entering and leaving the port and commutation boats will be considered.

In planning the above coal receiving harbor, efforts were made to limit the number of berths and the volume of dredging so that the construction cost may be minimized.

Harbor Plan


FILLING BY DREDGEDMATERIAL
FILLING BY DREDGEDMATERIAL
490m
5,000 DWT OIL TANKER BERTH
60,000 DWT COALER BERTH
300m
140m
50m
500 GT SMALL CRAFT BERTH
350m
500m
TURNING BASIN
550m
200m
ACCESS CHANNEL
1,300m
EASTERN CHANNEL
600m

b. Scale of Facilities

The harbor facilities should be designed for the selected type of ships, based on the natural conditions, conditions of use of the facilities, conditions and time schedule of construction works, construction cost, etc.

Thus, the preliminary design was made in consideration of the above conditions and the technical standards commonly adopted in the harbor construction.

a) Standard size of objective ships

Standard Size of Objective Ships

Unit: m

	Coaler	Oil Tanker	Small craft	Coaler
	*DWT	DWT	*GT	DWT
Tonnage	60,000	5,000	500	120,000
Overall length	233	102	43	290
Molded breadth	35.2	14.7	7.8	43
Molded depth	17.8	7.6	3.8	23.7
Full load draft	12.6	6.9	3.5	16.9
Standard length of berth	280	130	50	345
Standard water depth of berth (C.D.L below)	-14	-7.5	-4	-19

*DWT - Dead Weight Tonnage

GT - Gross Tonnage

b) Dimension of mooring facilities

Length of berth, width of berth and water depth of berth of mooring facilities may be determined in reference to standard size of objective ships (item a), taking methods of ship maneuverability, unloading and cargo handling, around environmental of construction site, soil characteristics of sea bottom, currents, sea waves and etc. into consideration.

Determined sizes of berths are shown below table.

Kind of Facilities	Type	Number of Berth	Length of Berth	Water Depth of Berth	Bread of Berth
Coal unloading wharf	DWT 60,000	1	300 m	EL = 0 below 16 m (C.D.L=0 " 14.855)	25 m
Oil tanker quay wall	DWT 5,000	1	140 m	" 8.5 m (" 7.355)	10 m
Small craft quay wall	GT 500	1	50 m	" 5 m (" 3.855)	5 m

Crown heights:

Coaler and oil tanker wharf EL = 0 above 3 m

(C.D.L = 0 above 4.145 m)

Smaller craft wharf EL = 0 above 2 m

(C.D.L = 0 above 3.145 m)

c) Structural types of mooring facilities

There are many kind of structural types of mooring facilities, but usable types for this project are as follows.

- Gravity type quay walls	- Caisson
	- Concrete block
	- L-shaped concrete block
	- Cellular concrete block
- Sheet pile type quay walls	- Sheet pile
- Open type wharves	- With vertical piles
	- With coupled batter piles
- Dolphin	

The structural types of mooring facilities shall be determined by considering the characteristics for respective structural types and examining the following matters.

. Natural conditions

. Conditions of use

. Conditions of execution

. Construction period

. Construction cost

. Others

i. Coaler berth

i) Comparison of structural type

Item	Open type	Caisson	Block	Sheet Pile
. Natural matters	O			O
. Condition of use	O	O	O	O
. Condition of execution				
of water depth	O	O	X	
of working place	O		O	O
. Construction period	O	X	X	O
. Construction cost	O		X	X
. Others				
Move/domebi of plant	O	X	O	O

As the result considering water depth (-16 m), open type wharf applied.

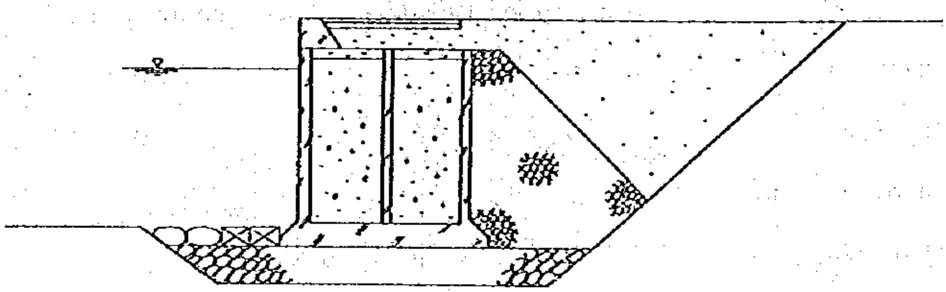
Open type wharf with coupled batter piles shall apply to resist horizontal force as external force produced by a ship.

Structural type of the coaler berth shall be more studyed, if it is possible to find other more economical one after soil investigation.

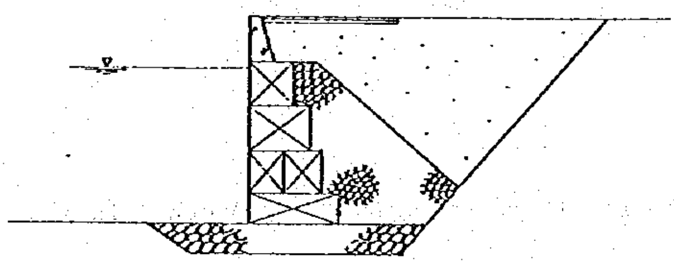
Kind of mooring facilities

Cravity Type Quaywalls

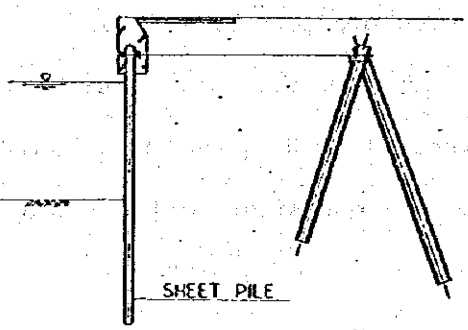
Wall of Caisson Type Quaywall



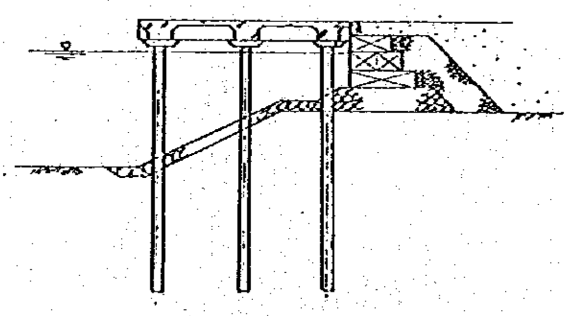
Wall of Concrete Block Type Quaywall



Sheet pile Type Quaywall



Open-Type Wharf with Vertical Piles



ii) Studies of pile

As the kind of foundation pile, steel pipe pile and prestressed concrete pile were studied as comparison showing below.

Condition	Steel Pipe	Pr. Concrete Pile
Execution		
Pile driving	O	X (Vertical pile only)
Pile joint	O	X
Kind of hummer	O	△ (Steam hummer only)
Cut pile	O	△
Pile caping work	O	△
Corrosion	X	O
Construction Period	15 months	22 months
Construction cost for pile production plant	-	LE 2,500,000

The use of steel pipe piles for foundation shall be available for this project, but some methods for controlling corrosion must be applied for steel pipe piles.

ii. Oil tanker and small craft berth

<u>Comparison of Structural Type</u>

Conditions	Open Type	Block	Caisson	Sheet Pile
. Natural conditions				
Soil	O	O	O	O
. Use	O	O	O	O
. Execution				
Water depth	O	O	O	△
Working procedure	O	O	△	△
. Period	O	O	△	△
. Construction cost	△	O	△	△

Gravity type of concrete blocks was applied for these berths.

d) Channel and basin

The preliminary design of channel and basin was made on base Technical Standards for port and harbor facilities in Japan.

i. Channel

Water depth	EL = 0 below 16 m
	(C.D.L = 0 below 14.85 m)
Width (Mini)	200 m
Length	1,300 m

ii. Basin

i) Coaler

Area about 275,000 m^2

Water depth EL = 0 below 16 m

(C.D.L = 0 below 14.855 m)

ii) Oil tanker

Area about 133,000 m^2

Water depth EL = 0 below 8.5 m

(C.D.L = 0 below 7.355 m)

iii) Small craft

Area about 21,000 m^2

Water depth EL = 0 below 5 m

(C.D.L = 0 below 3.855 m)

e) Causeway

Length: 2,700 m

Width : 20 m

f) Beacon, range light and buoy

i. Beacon 2 sets on the channel inlet, 2 sets on the channel end and 1 set on the bend point at the middle of channel, total 5 sets

ii. Range light each 1 pole on the shoreline and land, on the center line of the channel, total 2 poles

iii. Light buoy Each 1 set on the corner of basin, total 8 sets

g) Others

. Water hydrant

. Water hydrant	Water service for ships and water supply for fire, 3 points on the coaler wharf, 1 point on the tanker wharf and 1 point on the small craft wharf, total 5 points.
. 1 set	Lighting facilities for night works on the causeway and berths
. 1 set	Electric power source for repair works of ships
. 1	Harbor administration office (100 m²)
. 1	Miscellaneous warehouse (150 m²)
. 1 set	Communication system between power plant and berths
. 1	Fire boat (50 ton class)

4) Architectural Facilities

a. Area and Arrangement

The required site area for the project, total area of 600,000 m² (500 m x 1,200 m), consists of approximately 500 m x 700 m for fuel storage facilities (coal and heavy oil) and approximately 500 m x 500 m for the power generating facilities (300 MW x 4 units).

In consideration of the statistical data such as wind direction and velocity, the power generating facilities will be arranged in the northern part of the site.

The required areas for powerhouse for 300 MW x 2 units and service building are approximately 6,800 m² and 1,400 m² respectively. Ground level of the site is approximately EL+2.00 m, since site reclamation height is planned to be EL+4.00 m, approximately additional 2.00 m of filling is needed. Building structure planning of the powerhouse is based on the layout plan in consideration of economical frame work.

The service building will be located on the convenient place for the most efficient operations of plant facilities. As for the building size, two-storied building will be considered taking number of operators and maintenance personnel and administrative functions into consideration. In addition, as for the other appurtenant buildings, the building structures will satisfy the respective minimum requirements suited for the purposes.

b. Structure of Buildings

a) Powerhouse

Two alternatives are considered for the structure of the powerhouse; one is of reinforced concrete structure, and the other is of steel structure.

Comparison of the Structures

In the powerhouse for 300 MW class power plant, span of the building will be more than 12.0 m since the equipment sizes are very large.

In case of reinforced concrete structure, the deadweight of columns and beams becomes approximately 4 times in comparison with weight of steel in steel structure construction.

Therefore, increase of the weight will affect the yield strength against lateral force due to earthquake and about 20% of number of piles will be increased to cope with the strength.

By reason of the above, reinforced concrete structure is disadvantageous in the economic aspects.

In case of the steel structure, rolled steel used for columns and beams can be easily fabricated and endures the stress satisfactorily. The deadweight of columns and beams will be approximately fourth of that in case of reinforced concrete structure, thus reducing the total weight of the building.

Since number of foundation piles will be reduced by approximately 20%, the steel structure is economical.

Comparison of Construction Schedules

In comparison with both the construction schedules, the construction period for steel structure is approximately one half of that for the reinforced concrete structure, and therefore, it is very effective for shortening the schedule and for reducing the construction cost.

As result of the above review, the reinforced concrete structure will be applied to the powerhouse in consideration of the structure, schedule and construction cost.

b) Service building and auxiliary buildings

i. Service building

Building area for the service building is approximately 1,400 m^2 and the total floor area is approximately 2,800 m^2.

The construction schedule for the service building does not dominate the overall construction schedule. the construction of service building can be conducted independently as separate works from installation works of electromechanical equipment and civil works.

In addition, the spread foundation will be applied to the foundation of the service building because of light load condition on the structure.

As a result of the above, the foundation and superstructure will be of reinforced concrete structure construction.

ii. Auxiliary buildings

i) Coal handling control house and coal sample reduction house

Coal handling control house will be of 4-storied house with a height of 16 m, and coal sample reduction house will be of 4-storied house with a height of 19 m. The both houses will be united in a body.

Since the coal handling control house and coal sample reduction house are planned to be laid out in almost the center of the plant site, adjacent to northern portion of coal storage yard and circulating water pipe, the construction works will be intricated and complicated around the location.

The construction works for the houses will be limited, however, the houses should be completed 6 months before the commissioning of the first unit.

From the above considerations, steel structure will be adopted to the houses with a floor area of 3,200 m^2 for simplification of construction works.

ii) Central shop

Since the central shop will be used for the purpose of repairs, machining, welding, etc., the construction with wide space will be required, and steel structure should be suitable for machining works.

The shop will be of three single-storey houses with a floor area of 900 m^2.

iii) circulating water pump house

The circulating water pump house includes the rotary screen house, and it will be located on the water intake pit. The purpose of the house is inspection and maintenance of the equipment and prevention of entering foreign matters.

Overhead crane with a lifting capacity of about 30 tons will be required for the maintenance purpose in the house.

Since construction of the house will be started after the completion of circulating water intake pit, the construction schedule will be tight.

For the purpose of reducing live load of the circulating water intake pit and avoiding differential settlement of the foundation, and from the view point of tight schedule and functions of the facilities, steel structure will be adopted to the house with a floor area of 220 m^2.

iv) Other houses

There are about 23 other houses such as workers houses, warehouse, water treatment control house, etc. with a total floor area of about 4,000 m^2.

There is no special difficulty in load conditions and the construction schedule, and reinforced concrete structure will be adopted to these houses.

c. Foundations

a) Powerhouse foundation

According to the boring data, the available bearing stratum will be located 20 to 30 m under the ground surface.

Therefore, pile foundation will be adopted, and either high strength prestressed concrete pile or steel pipe pile will be considered for the foundations.

However, the high strength prestressed concrete pile will be adopted as a result of economic comparison of both types shown in the below table.

For confirmation of bearing capacity of soil, pile driving tests and load tests should be conducted before construction works start.

Comparison Table

(One set is assumed to be 10 m + 10 m)

Pile	Bearing Capacity	Unit	Material Cost	Transportation Cost	Weight (ton)	Total
Steel pipe pile	120 ton/pile	1 set	¥660,000	¥162,000	3.25	¥822,000
High strength prestressed concrete pile	120 ton/pile	1 set	¥200,000	¥370,000	7.5	¥570,000

Transportation is based on ocean freight.

As shown in the above comparison table, high strength prestressed concrete pile can be procured at a price lower by 30% than that of steel pipe pile.

b) Auxiliary building foundations

Since the auxiliary buildings are light, the spread foundations will be adopted for auxiliary building foundations by soil improvement based on removal of loose surface sand, replacement of the sand and consolidation.

d. Materials

a) Exterior wall for powerhouse

Corrugated resin coated steel sheet with insulation material will be applied to the exterior wall of the powerhouse since it is flexible for structural frame of steel structure, light weight, easy for installation and superior in insulation and durability.

b) Turbine room roof

Corrugated resin coated steel sheet with insulation material will be applied to the roof for reduction of the weight of roof beams and columns since the turbine room roof will be heavy weight.

c) Exterior walls of other buildings

Materials for exterior walls of other buildings will be of hollow concrete block masonry.

e. Appurtenant Facilities

Appurtenant facilities such as ventilating, water supply and drainage, sanitary, lighting systems will be equipped with the buildings. Especially control rooms in the powerhouse, service building and workers shift rooms will be equipped with airconditioning systems.