Appendix 3.8-3

[Appendix 3.8-3] Caluculations

[Appendix 3.8-3-10] Generator Output of Main Pumps of Relay Pumping Station

No. 1 & 3 Pump Station ... { ∘ 2 nos. of 45kW duty motor / ∘ 10kVA auxiliary power supply,

Calculation of Generator Output

Calculation of generator output

The following items must be considered when calculating generator Output.

- Maximum continuous load .... PG_1
- Instantaneous voltage drop due to starting load, etc. within the allowable value .... PG_2
- Current required to start the load .... PG_3

1. Output required for normal service operation of load

The capacity (PG1) required for normal service operation of full load can be obtained from the following equation.

$$PG1 = a\left(\frac{P1}{\eta_1 \times Pf1} + \frac{P2}{\eta_2 \times Pf2} + \frac{P3}{\eta_3 \times Pf3} + \text{------} + \frac{Pn}{\eta_n \times Pfn}\right)$$

Where, PG1: Generator output (kVA)
Pn: Load output (kW)
Pfn: Load power factor
η_n: Load efficiency
a: Coefficient obtained through consideration of load factor, demand factor, and allowance etc.

Since the load is limited when a generator is used as an emergency power supply or peak load power supply, its capacity should be examined assuming that a = 1.

$P1 = 45\text{kW}$, $\eta_1 = 0.9$, $Pf1 = 0.72$

$$PG1 = 1.0 \times \left(\frac{45}{0.9 \times 0.72} \times 2 + 10\right)$$

$$= 1.0 \times (69.4 \times 2 + 10) = 148.8\ \text{kVA}$$

2. Output calcuation when the instantaneous voltage drop due to starting load is considered

The capacity (P_{G2}) taking into account the Instaneous voltage drop due to the load starting effect, can be obtained from the following equation.

$$P_{G2} = P_{Lmax.} \times Xd'' \times \frac{1-\Delta V}{\Delta V} \text{ [kVA]}$$

where, P_{G2}: Generator output [kVA]
ΔV: Allowable Instantaneous voltage drop [V] = 0.2
$P_{Lmax.}$: Maximum starting capacity of load [kVA]
Xd'': Direct-axis subtransient reactance of generator = 0.25

$P_{Lmax} = \frac{1}{3} \times 416.7 = 138.9$ kVA by Closed star-delta starter
(416.7: Motor starting capacity)

$PG2 = 138.9 \times 0.25 \times \frac{1-0.2}{0.2} = 138.9$ kVA

3. Output when allowable overcurrent of generator is taken into consideration

The output (P_{G3}) when the allowable overcurrent is taken into consideration, can be obtained from the following equation.

$$P_{G3} = \frac{\sqrt{(PB + P_{ms})^2 + (QB + Q_{ms})^2}}{Gw}$$

where, P_{G3}: Generator output [kVA]
Gw: Allowable overcurrent of generator ≒ 1.5

PB: Effective capacity of base load (kW)
QB: Reactive capacity of base load (kVAR)
P_{ms}: Effective capacity of starting motor (kW)
Q_{ms}: Reactive capacity of starting motor (kVAR)

$PB = 69.4 \times 0.72 + 10 = 60.0$ kW
$QB = 69.4 \times \sqrt{1-0.72^2} = 48.2$ kVAR
$P_{ms} = 138.9 \times 0.4 = 55.6$ kW
$Q_{ms} = 138.9 \times \sqrt{1-0.4^2} = 127.3$ kVAR
$PG3 = \frac{\sqrt{(60+55.6)^2 + (48.2+127.3)^2}}{1.5} = 140.1$ kVA

4. According to PG1, PG2, PG3, minimum required capacity of the generator is 148.8 kVA

No.2. Pump Station { ∘ 2 nos. of 37kW duty motor
∘ 10 kVA auxiliary power supply }

Calculation of Generator Output

Calculation of generator output

The following items must be considered when calculating generator Output.

- Maximum continuous load .... P_{G_1}
- Instantaneous voltage drop due to starting load, etc. within the allowable value .... P_{G_2}
- Current required to start the load .... P_{G_3}

1. Output required for normal service operation of load

The capacity (PG1) required for normal service operation of full load can be obtained from the following equation.

$$PG1 = a\left(\frac{P1}{\eta_1 \times Pf1} + \frac{P2}{\eta_2 \times Pf2} + \frac{P3}{\eta_3 \times Pf3} + \text{-----} + \frac{Pn}{\eta_n \times Pfn}\right)$$

Where, PG1: Generator output (kVA)
Pn: Load output (kW)
Pfn: Load power factor
η_n: Load efficiency
a: Coefficient obtained through consideration of load factor, demand factor and allowance etc.

Since the load is limited when a generator is used as an emergency power supply or peak load power supply, its capacity should be examined assuming that a = 1.

$P1 = 37kW \quad \eta_1 = 0.9 \quad Pf_1 = 0.72$

$$PG1 = 1.0 \times \left(\frac{37}{0.9 \times 0.72} \times 2 + 10\right)$$

$$= 1.0 \times (57.1 \times 2 + 10) = 124.2 kVA$$

2. Output calcuation when the instantaneous voltage drop due to starting load is considered

The capacity (P_{G2}) taking into account the Instaneous voltage drop due to the load starting effect, can be obtained from the following equation.

$$P_{G2} = P_{Lmax.} \times X_d'' \times \frac{1 - \Delta V}{\Delta V} \text{ [kVA]}$$

where, P_{G2}: Generator output [kVA]
ΔV: Allowable instantaneous voltage drop [V] = 0.2
$P_{Lmax.}$: Maximum starting capacity of load [kVA]
X_d'': Direct-axis subtransient reactance of generator = 0.25

$$P_{Lmax} = \frac{1}{3} \times 342.6 = 114.2 \text{ kVA}$$ by Closed star-delta starter

(342.6: Motor starting capacity.)

$$PG2 = 114.2 \times 0.25 \times \frac{1 - 0.2}{0.2} = 114.2 \text{ kVA}$$

3. Output when allowable overcurrent of generator is taken into consideration

The output (P_{G3}) when the allowable overcurrent is taken into consideration, can be obtained from the following equation.

$$P_{G3} = \frac{\sqrt{(PB + P_{ms})^2 + (QB + Q_{ms})^2}}{G_W}$$

where, P_{G3}: Generator output [kVA]
G_W: Allowable overcurrent of generator ≒ 1.5

PB: Effective capacity of base load [kW]
QB: Reactive capacity of base load [kVAR]
P_{ms}: Effective capacity of starting motor [kW]
Q_{ms}: Reactive capacity of starting motor [kVAR]

$$PB = 57.1 \times 0.72 + 10 = 47.0 \text{ kW}$$
$$QB = 57.1 \times \sqrt{1 - 0.72^2} = 39.6 \text{ kVAR}$$
$$P_{ms} = 114.2 \times 0.4 = 45.7 \text{ kW}$$
$$Q_{ms} = 114.2 \times \sqrt{1 - 0.4^2} = 104.7 \text{ kVAR}$$
$$PG3 = \frac{\sqrt{(47 + 45.7)^2 + (39.6 + 104.7)^2}}{1.5} = 114.3 \text{ kVA}$$

4. According to PG1, PG2, PG3, minimum required capacity of the generator is 124.2 kVA

3.9 POWER SUPPLY

3.9.1 Scope of Works

The section of Power supply shall consist of the following main items;

a. Site allocation for the 220/66kV Substation
All systems of the 220/66kV Substation will be designed,constructed and maintained by the National ElectricityAuthority (EEA), so that the allocation and site dimension based on the preliminary design shall be planed in this work.

b. Site allocation for two 66/22kV Substations
All systems of the 66/22kV Substation will be designed, constructed and maintained by the EEA, so that the allocation and site area based on the preliminary design shall be studied and presented in this work.

c. All 66kV transmission lines between 220/66kV Substation and two 66/22kV Substations will be designed, constructed and maintained by the EEA.

However, the cable route of these transmission lines shall be tentatively studied to decide the requirements of the detail design works.

d. Conduits for 66kV transmission lines which will be installed crossing under the paved road and manholes located at the both side of the conduit lines shall be designed in this work.

e. Detail design of the following Local substations.
- Water treatment plant
- Water intake pump station
- Wastewater treatment plant
- Grain silo terminal
- Bulk cargo terminal
- Railway facilities
- Center A
- Center B
- Center C

f. Detail design of Unit substations for road lighting and small equipment in the project site.

g. Detail design of 22kV loop distribution lines from 66/22kV Substation to each consumer.

However, 22kV loop distribution lines from 66/22kV Substation-B to wastewater treatment plant will be designed and constructed by the Canal Electricity Distribution Company(CEDC).

Also, 11kV loop distribution lines for the Water intake pump station will be designed and constructed by the CEDC because the plant is remotely located from the project area.

h. Detail design of Road lighting system

i. Estimation for Telephone demand and Detail design of telephone conduit system in the project area.

However the telephone lines to Wastewater treatment plant and Water intake pump station will be designed and constructed by the Arab Republic of Egypt National Telephone Authority(ARENTO).

3.9.2 Power demand in the project area.

Connecting load of each facility is estimated to each category classified as following items;

a. Density of power demand in each industrial lot
b. Public facilities
c. Road lighting
d. Public use Small equipment such as drainage pumps, traffic signal etc.
e. Residential area

(1) Density of power demand in each industrial lot

Density of power demand in each industrial lot is calculated by the following formula;

P = A * Up [VA]
Up = c (Pb + Pp + Pa) [VA/m2]

Where, P : Power demand in the industrial lot
A : Area of the lot [m2]
c : Ratio of the area occupied by facilities, such as buildings and equipment which constructed in the lot and total lot areasupposed as c = 0.3
Pb: Average unit power consumption of the general building equipment; supposed as Pb = 30 [VA/m2]
Pp: Average unit power consumption of the plant equipment; supposed as Pp = 50 [VA/m2]
Pa: Average unit power consumption of the other items in the lot; supposed as Pa = 3 [VA/m2]
Up: Unit power consumption in the lot;

Up = 0.3 x (30 + 50 + 3) = 25 [VA/m2]

Calculated demand of each lot is as shown in Table 3.9-2-1A, Table 3.9-2-1B and Figure 3.9-2-1 LAND ALLOCATION MAP.

Table 3.9-2-1A Electrical Power Demand of Industrial Lots - ATAQA I.E. -

CODE OF LOT	AREA m2	DEMAND OF EACH LOT		NOS. OF LOT	CALCULATED DEMAND KVA	ADOPTED DEMAND KVA
		UNIT LOAD VA/m2	DEMAND KVA			
LOT-A	95,000	25	2,375	3	7,125	7,200
LOT-B	143,000	25	3,575	3	10,725	10,800
LOT-C	122,000	25	3,050	3	9,150	9,300
LOT-D	303,000	25	7,575	1	7,575	7,600
LOT-E	259,000	25	6,475	1	6,475	6,500
LOT-F	110,000	25	2,750	1	2,750	2,800
LOT-G	30,000	PUBLIC UTI	LITY AREA			
LOT-H	45,000	PUBLIC UTI	LITY AREA			
LOT-I	39,000	PUBLIC UTI	LITY AREA			
LOT-J	194,000	25	4,850	1	4,850	4,900
LOT-K	338,000	25	8,450	1	8,450	8,500
LOT-L	131,000	25	3,275	1	3,275	3,300
LOT-M	34,000	25	850	1	850	900
LOT-N	385,000	25	9,625	1	9,625	9,600
LOT-O	134,000	25	3,350	1	3,350	3,400
LOT-P	61,000	25	1,525	1	1,525	1,600
			0			
TOTAL	2,423,000	25	60,575		75,725	76,400

Table 3.9-2-1B Electrical Power Demand of Industrial Lots - ADABIYA I.F.Z. -

CODE OF LOT	AREA m2	DEMAND OF EACH LOT		NOS. OF LOT	CALCULATED DEMAND KVA	ADOPTED DEMAND KVA
		UNIT LOAD VA/m2	DEMAND KVA			
LOT-FA	65,000	25	1,625	8	13,000	12,800
LOT-FB	31,000	25	775	2	1,550	1,600
TOTAL	96,000				14,550	14,400

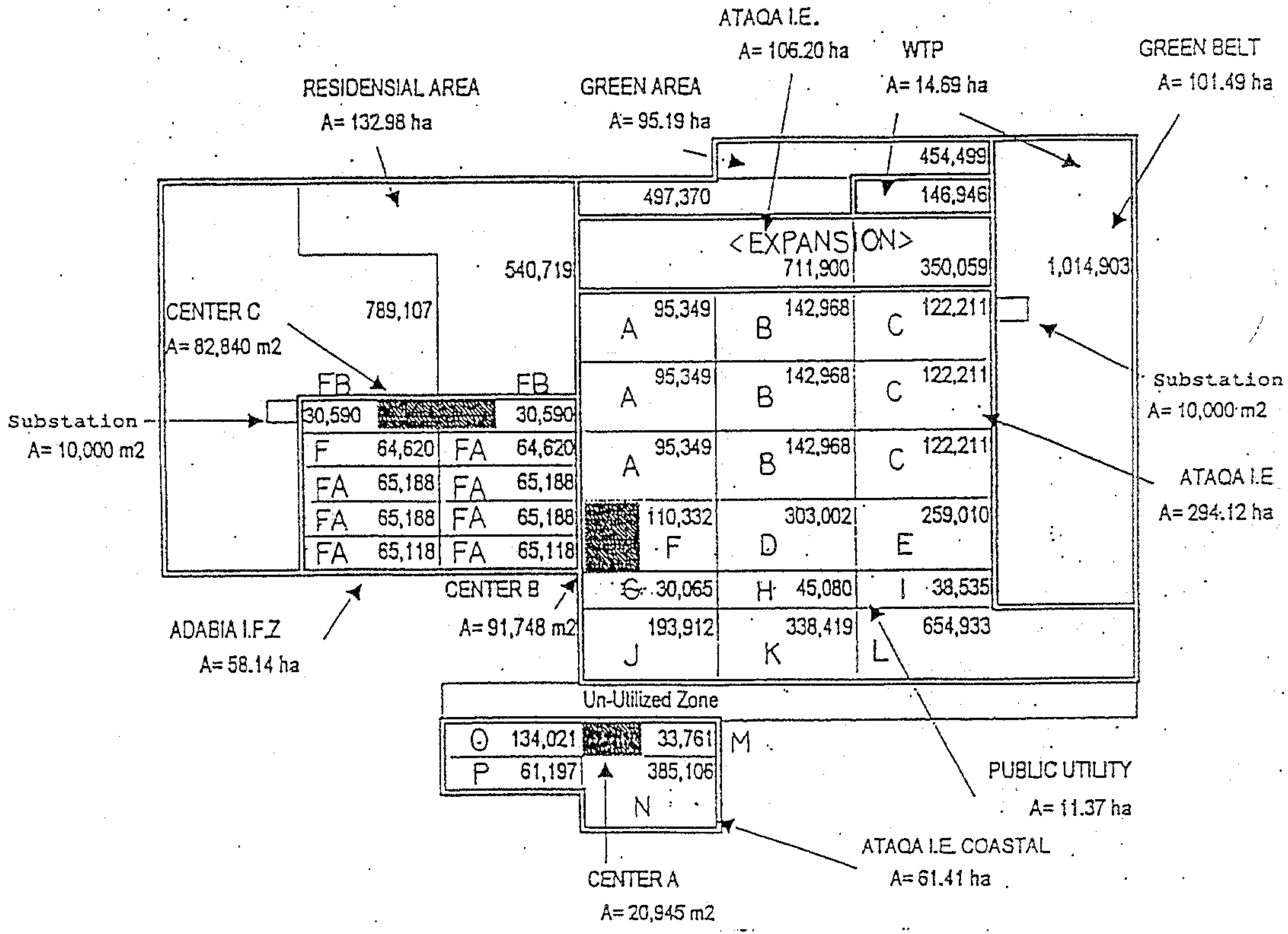

Figure 3.9-2-1 Land Allocation Map

(2) Connecting load of public facilities

The connecting electrical load of each public facilities listed hereinafter are estimated as follows;

- Center-A, Center-B, Center-C
- Water treatment plant
- Water intake pump station
- Wastewater treatment plant
- Grain silo terminal
- Bulk cargo terminal
- Railway facilities
- Public use small equipment
- Road lighting

a. Center A, B and C

Connecting load of each center is shown in Table 3.9-2-2.

Table 3.9-2.2 Connecting Load Schedule of Each Center

TYPE OF LOAD	CENTER-A	CENTER-B	CENTER-C
1.BUILDING EQUIPMENT	232	568	369
2.KITCHEN EQUIPMENT	30	80	50
3.OTHERS	10	30	20
TOTAL (KVA)	272	678	439
DEMAND FACTOR(%)	75	75	75
MAXIMUM DEMAND(KVA)	204	509	329

b. Water treatment plant

Connecting load is 1,245[kVA] as shown in Appendix 3.9-1-1 and Section 3.7 WATER SUPPLY SYSTEM of this report.

c. Wastewater treatment plant

Connecting load is 1,913[kVA] as shown in Appendix 3.9-1-2 and Section 8 SEWERAGE SYSTEM of this report.

d. Grain silo terminal

Connecting load is 4,961[kVA] as shown in Appendix 3.9-1-3 and Section 10 GRAIN HANDLING EQUIPMENT of this report.

e. Bulk cargo terminal

Connecting load is 223[kVA] as shown in Appendix 3.9-1-4 and Section 3 PORTS of this report.

f. Railway facilities

Connecting load is 200 [kVA] as shown in Section 5 RAILWAY of this report.

g. Public use Small equipment

Public use small equipment means the equipment or facility which will be supplied power by low tension system and will be installed near the roads, such as drainage pumps and traffic signal etc.

Connecting load is 508 [kVA] as shown in Table 3.9-2-3.

Table 3.9-2-3 Public Use Small Equipment

Type of equipment	Connecting load	Supplied by the Unit Substation
a. Sewage pump station PS-1	146 [kW] or 172 [kVA]	US-A8
b. Sewage pump station PS-2	122 [kW] or 144 [kVA]	US-B9
c. Sewage pump station PS-3	146 [kW] or 172 [kVA]	US-B5
d. Traffic signals	20 [kW] or 20 [kVA]	US-B7
TOTAL	434 [Kw] or 508 [kVA]	

h. Road lighting

Connecting load is 578 [kVA] as shown in Table 3.9-2-4.

Table 3.9-2-4 Type and Numbers of Road Lighting Fixture

Lighting fixture type and lamp	Unit load	Installed numbers	Total load
TYPE-A SON250W-1	300 VA	1,638 each	491 [kVA]
TYPE-B SON250W-2	600	50	30
TYPE-C SON400W-1	450	127	57
TOTAL			578 [kVA]

SON : Sodium vapor lamp

(3) Power demand of Urban area

Power demand of dormitories constructed in the urban area is estimated as 60,000kVA by the following formula;

$$Pa = Sa * Upa \text{ [kVA]}$$

Where,

Pa : Power demand of urban area

Sa : Site area [ha]

Sa=133 [ha]

Upa : Unit power demand for urban areasupposed as Upa=450 [kVA/ha]

Then, $Pa = 133 * 450 = 59,850$ [kVA]

(4) Future increase of power demand in each facility

Increase ratio will be estimated as 20 percent for all industrial consumers and 15 percent for others, during several years after starting operation.

(5) Maximum power consumption in the project area

The maximum demand of project to be estimated with consideration diversity factor of each area.

As a result of estimation, total power demand of the project will be 148MVA as shown in Table 3.9-2-5.

Table 3.9-2-5 Electriccal Power Demand in Project Area

ITEM NO.	FACILITY	MAX. DEMAND OF EACH KVA	DIVERSITY FACTOR IN AREA	MAX. DEMAND IN AREA KVA
A.	INDUSTRIAL AREA			
1.	ATAQA INDUSTRIAL LOTS	76,400		
2.	ADABIYA INDUSTRIAL LOTS	14,400		
3.	CENTER-A	204		
4.	CENTER-B	509		
5.	CENTER-C	329		
6.	WATER TREATMENT PLANT	1,245		
7.	SEWAGE PLANT	1,913		
8.	GRAIN TERMINAL	4,961		
9.	BULK CARGO TERMINAL	223		
10.	RAILWAY FACILITIES	200		
11.	ROAD LIGHTING	578		
12.	PUBLIC USE SMALL EQUIP.	498		
TA:	TOTAL IN INDUSTRIAL AREA	101,460	1.65	61,491
B :	RESIDENSIAL AREQA			
21.	RESIDENSIAL AREA	60,000		
TB:	TOTAL IN URBAN AREA	60,000	1.85	32,432
C :	FUTURE EXPANSION AREA			
31.	INDUSTRIAL LOTS	30,000		
32.	OTHERS	3,000		
TC:	TOTAL IN EXPANSION AREA	33,000	1.65	20,000
TT:	TOTAL OF ITEM A,B,C	(TA+TB+TC)		113,923
E :	FUTURE INCREASE IN EACH FACILITIES			
41.	FACTORIES (20% OF ITEM 1+2)			18,160
42.	OTHERS (15% OF ALL OTHER ITEM)			15,726
TE:	TOTAL OF FUTURE INCREASE			33,886
	GRAND TOTAL	(TT+TE)		147,809

3.9.3 220/66kV substation

(1) Site allocation for 220/66kV Substation

The site for 220/66kV Substation which will be constructed by the EEA is allocated on the west side of the project area as shown on the general layout plan, in accordance with the following reasons.

a. The site is closely located to 220kV transmission lines which will supply power to the substation.

b. As the site will be directly connected to ADABIYA-SUEZ/CAIRO ROAD, then a convenience to construction and maintenance is expected.

c. The site is located far from seaside, then a damage from sea wind will be decreased.

The dimension of the planned site is 100m by 200m as shown on the drawing, and it is decided by the preliminary design of the substation as shown on the drawings No.A1-1.5-0-01 and 04.

(2) Preliminary design for 220/66kV substation

Two incoming and outgoing 220kV transmission lines will be connected to the substation.

The substation will consist of the following main equipment;

a. Three 75MVA, 3 Phase, 220/66kV transformers
b. 220kV class Gas Insulated Switch gear (GIS)
c. 66kV class GIS
d. Station transformers

The connection diagram of the substation is as shown on the drawing No.A1-1.5-0-01.

As an example, layout plan of the substation building is shown on the drawing No.A1-1.5-0-04

For future extension some suitable space for one 75MVA transformer and related equipment is provided in the building.

3.9.4 66/22kV substations

(1) Site allocation for two 66/22kV Substations

It was required by the EEA that two 66/22kV substations shall be constructed as near to the power consumers as possible.

So that, the site for 66/22kV Substations which will be constructed by the EEA is allocated on the north and south side of the project area as shown on the general layout plan, drawing A1-1.5-0-01, in accordance with the following reasons.

a. The site is closely located to consumers.

b. Both of these sites will be directory connected to wide road, then, a convenience to construction and maintenance is expected.

c. These sites is located fairly far from seaside.

The dimension of each planned site is 100m by 100m and it is decided by the preliminary design of the substation as shown on the drawings No.A1-1.5-0-05 to 08.

(2) Preliminary design for 66/22kV substations

Three 66kV transmission lines will be connected between 220/66kV substation and each 66/22kV substations.

Each 66/22kV substation will consist of the following main equipment;

a. Three 25MVA, 3 Phase, 66/22kV transformers
b. 66kV class Gas Insulated Switch gear (GIS)
c. 22kV class Vacuum Circuit Breaker (VCB) type Switch gear
d. Station transformers

The connection diagram of each substation is as shown on the drawing No.A1-1.5-0-05 and A1-1.5-0-08.

As an example, layout plan of substation building is shown on the drawing No.A1-1.5-0-05 and 08.

For future extension some suitable space for one 25MVA transformer and related equipment is provided in each substation building.

3.9.5 Conduit lines for 66kV transmission lines

The EEA will install 66kV underground transmission lines from 220/66kV substation to two 66/22kV substations.

Route of the transmission lines are planed as shown on the drawing No.A1-1.5-0-01 and there are three road crossing on the way to south side substation (66/22kV Substation-B).

Only these road crossing conduit system shall be designed in this works, and these road crossing conduits will be constructed on the same construction stage of the road.

The conduit system shall be constructed in accordance with the standards and specification of the EEA.

The size and numbers of conduits installed crossing under the road shall be as follows;

a. For 66kV poser cables;

diameter	:	200mm
numbers	:	9-conduits

b For signal/communication cables;

diameter	:	200MM
numbers	:	3-conduits

These conduits shall be cased by reinforced concrete to protect a damage by weighting of heavy vehicles.

Detail of the conduit system shall be as shown on the drawing No.A1-1.5-0-02.

3.9.6 22kV loop distribution lines

(1) Electrical power supply manner in the area

Electric power in the project area will supply in the following manners.

1) Supplying manner to consumer

a. When maximum power demand is less than 200 kW, supply system is, 380/220V, 3-Phase, 4-wire system.

b. When maximum power demand is 200 kW or more than 200 kW, supply system is, 22 kV, 3-Phase, 3-wire system.

c. When maximum power demand is 3,000 kW or more than3,000 kW, supply system is, Multiple circuits of 22 kV, 3-Phase, 3-wire system.

2) Substation in private factories

a. All consumers which will be supplied power by 22kV distribution system shall be required to install private substation in their site by themselves.

b. The private substation shall be constructed in accordance with technical specification of the EEA and the CEDC.

(2) Stage construction of the system

Several numbers of 22kV loop distribution lines shall be installed between 66/22kV substations and each consumer as shown on the drawing No.A1-1.5-1-01 and A1-1.5-1-02.

These distribution lines shall be installed separately to fit the operation starting date of each consumer connected to the loop line.

The 22kV loop distribution system shall consist of the following main items;

a. 22kV underground cable lines
b. Conduit system
c. Road crossing conduit lines

The outline of these items are as follows;

(3) 22kV underground cable lines

1) Cable type

The 22kV three core steel wire armored XLPE(SWAXLPE) aluminum conductor cable shall be adopted.

2) Installation method

Installation method of these cables shall be as follows;

a. Cables installed under sidewalk

Direct burial, spacing of each cable is twice of maximum overall diameter of the cable as shown on the drawing No. A1-1.5-4-01.

b. Cables installed under vehicle road

Installed in the PVC conduit encased by reinforced concrete encasement and these conduits shall be installed as to be 0.6 meter under the road surface as shown on the drawing No.A1-1.5-5-01 and A1-1.5-5-02.

c. Cables installed in the conduit system

Where ten or more cables installed on the same route, all cables shall be installed in the conduit system which is composed with PVC conduits encased by reinforced concrete as shown on the drawing No.A1-1.5-6-01 and A1-1.5-6-02.

3) Current-carrying capacity

Current-carrying capacity of the cable is calculated by the APPENDIX 9 of IEE WIRING REGULATIONS published by The Institution of Electrical Engineers (UK).

Maximum load of each 22kV loop line is estimated as shown in Table 3.9-6-1.

Table 3.9-6-1 Maximum Load of Each 22kV Loop Line

LOOP NO.	CONNECTED LOAD (kW)	DIVERSITY FACTOR	MAX.LOAD (kW)
a. 66/22kV SUBSTATION-A			
1	7,050	1.5	4,700
2	7,600	1.5	5,070
4	7,050	1.5	4,700
5	6,700	1.5	4,470
6	3,500	1.2	2,920
10	500	1.0	500
b. 66/22kV SUBSTATION-B			
1	5,000	1.5	3,340
2	5,840	1.2	4,870
3	7,700	1.5	5,140
4	7,200	1.5	4,800
5	5,700	1.5	3,800
6	4,800	1.5	3,200
7	900	1.0	900
9	7,200	1.5	4,800
10	1,913	1.2	1,590
11	1,071	1.3	830

Where, maximum supplying capacity of one distribution loop is supposed as 5,140 kW of feeder No.3 of Substation-B,this means 6,047 kVA when the power factor is 85% percent.

Thus, maximum load is estimated about 6,000 kVA, then current [I] is 184 amp. as follows;

$$I = \frac{6000[kva]}{1.732 \times 22[kv]} = 158[amp]$$

Correction factor for ambient temperature [Kt] is 0.87 when the temperature is 40C. (Refer TABLE 9D3 of IEE REGULATIONS)

Correction factor for grouping [Kg] is 1.0, because the cables are installed in the spacing twice of overall diameter.
(Refer TABLE 9B NOTES 2 of IEE REGULATIONS)

4) Conductor size

All cables used to each underground distribution lines shall be same type and same size for the convenience of maintenance work.

Required current-carrying capacity [If] of the feeder cableis 181 [amp] as calculated by the following formula;

$$If = \frac{I}{Kt} = \frac{158}{0.87} = 181[amp]$$

The applicable aluminum conductor size is 70 sq.mm, current rating at 40'C , on the Table 3.9-6-2 SPECIFICATION OF CABLE.

(4) Conduit system

Four type of conduit system will be constructed to each location as shown on the drawing No.A1-1.5-6-01 and A1-1.5-6-02.

all conduit systems to be consist of PVC conduits, reinforced concrete encasement and manholes.

Table 3.9-6-2 Specification of Cable

ALUMINIUM CONDUCTOR XLPE INSULATION, DST. ARMOURING AND P. V. C. SHEATHING 18/30 (36) K.V.

CABLE CODE	NOMINAL CROSS SECTIONAL AREA	CONDUCTOR RESISTANCE DC 20°C	OPERATING CAPACITY	CHARGING CURRENT	CURRENT RATING UNDER GROUND	CURRENT RATING ABOVE GROUND	THERMAL SHORT CIRCUIT CURRENT OF 1 SEC KA CONDUCTOR	THERMAL SHORT CIRCUIT CURRENT OF 1 SEC KA SCREEN	APPROX. OVERALL DIAM.	APPROX. NET WEIGHT
	MM²	Ω/KM	μF/KM	A/KM	AMP	AMP	KAMP	KAMP	MM	KG/KM
Three Core Armoured Cable										
AX5-T103-A14	50	0.641	0.14	0.79	150	155	4.7?	3.3	72.9	5952
AX5-T103-A15	70	0.443	0.15	0.85	180	190	6.6	3.3	76.5	6542
AX5-T103-A16	95	0.320	0.17	0.96	215	230	8.9	3.3	82.2	8142
AX5-T103-A17	120	0.253	0.18	1.02	240	260	11.3	3.3	86.3	8857
AX5-T103-A18	150	0.206	0.20	1.13	270	280	14.1	5.1	89.9	9483
AX5-T103-A19	185	0.164	0.21	1.19	300	330	17.4	5.1	94.2	10716
AX5-T103-A20	240	0.125	0.23	1.30	345	385	22.6	5.1	100.6	12106
AX5-T103-A30	300	0.100	0.25	1.41	385	430	28.2	5.1	106.2	13601

These conduit systems will be used to arrange many cables in order where ten or more power cables are installed.

All PVC conduits in one conduit system shall be arranged in order and separate each other by spacer as shown on the drawings.

1) Location

The conduit systems will be constructed at the following places.

a. From 66/22kV Substation-A to road intersection T10
b. From 66/22kV Substation-B to road intersection T24
c. From road intersection T1 to C1
d. From road intersection C1 to T44

2) Manholes

The manhole shall be installed the ends of conduit system for the convenience of cable installation.

All manhole shall be made of reinforced concrete with cast iron cover.

Dimensions of each manhole shall be as shown on the drawing No. A1-1.5-7-01.

These manhole shall be installed in the cabling area located next of each walkway and they shall be separated at least 600mm from the manhole of telephone conduit lines.

(5) Road crossing conduits

The size and numbers of conduits installed crossing under the road shall be as follows;

diameter : 100mm
numbers : as shown on the drawing No.A1-1.5-5-01 and A1-1.5-5-02.

These conduits shall be cased by reinforced concrete to protect a damage by weighting of heavy vehicles.

Detail of the road crossing system shall be as shown on the drawings.

3.9.7 22kV distribution lines to Wastewater treatment plant

The wastewater treatment plant will be supplied power from 66/22kV Substation-B, and the plant is located at remote site from the project area.

The route of these distribution lines is planed as located along the ADABIYA-SUEZ/CAIRO road, this means the distribution lines are installed outside of this project area.

Then, the distribution lines will be designed and constructed by the CEDC.

3.9.8 Local substations

Local substations shall be installed in each public facilities as follows;

a. For water treatment plant (LS-WT)
b. For water intake pump station (LS-WI)
c. For wastewater treatment plant (LS-SW)
d. For grain silo terminal (LS-GT)
e. For bulk cargo terminal (LS-BT)
f. For railway facilities (LS-RW)
g. For center A (LS-CA)
h. For center B (LS-CB)
i. For center C (LS-CC)

These public consumers are installed electricity load more than 200 kW, then the power shall be supplied by 22kV as mentioned hereinbefore.

Outline of each local substation is as follows;

(1) Local substation for water treatment plant (LS-WT)

The water treatment plant is very important facility in this area so that the substation shall be provided with high reliability as for power supply, such as double capacity of power source.

Then, one out of two transformers having a capacity large enough to supply to all equipment in the plant, shall be installed.

1) System constitution
The substation shall consist of 22kV loop distribution line receiving switchgear, two load disconnecting switchgear for transformers, two 1500KVA, 22kV/380-220V transformers and low tension switchgear, as shown on the drawing No.A2-2.3-4-01 to 03.

Also, one 750KVA, 380/220V emergency generator and change over switch shall be provided to supply power to essential equipment when the normal supply is interrupted.

2) Operation manner

a. Under normal condition

Power will be supplied by the 22kV loop distribution lines and the emergency generator is separated from the low tension bus bars.

The ACB bus tie is opened but ACB bus tie-2 is closed, then each transformer supply to each half of the equipment in the plant, this means that each transformer will be loaded about 50 percent of the rating capacity.

b. Under one 22kV loop cable is interrupted

Operation manner is same as normal condition because each distribution line is provided with enough capacity to supply to all connected consumers even if one section of the loop is failed.

c. Under emergency condition

When both of loop lines are interrupted, both 22kV power receiving VCB and ACB bus tie are turned off, then the emergency generator is automatically driven and connected to the bus bar.

The essential equipment of the plant is operated same as normal condition by the power of the generator.

d. Under breakdown of one transformer

Even if one transformer is broken down, the other one shall supplyto all equipment in the plant.

3) Calculation for transformer and generator capacity

This shall be shown in Appendix 3.9-1-1.

4) Outline specification of main equipment

a. 22kV switch gear

Two Power receiving panels :	Disconnecting switch (DS) 3-pole, 24kV, 600A, 25kA VCB 3-pole, 24kV, 1200 A, 25kA
One metering outfit panel :	DS 3-pole, 24kV, 25kA watt hour meter, reactive kilo volt ampere meter and maximum demand indicator
Two feeder panels :	Load disconnecting switch(LDS) 3-pole, 24kV, 600A, 25kA

b. Transformers

Two Transformers :	Oil immersed natural cooling, 3-phase, 1500kVA,22kV/380-220V out door type

c. 380/220V Switchgear

Two 380/220V main panels :	Air circuit breaker(ACB) 4-pole, 600V, 2500A, 50kA
Two 380/220V bus tie panels :	ACB 4-pole, 600V, 2500A, 50kA
Six 380/220V feeder panels :	ACB 4-pole, 600V, 1000A, 1200A or 1600A, 40kA or 65kA as shown
One change over panel :	ACB 4-pole, 600V, 1200A, 50kVA

d. Emergency generator

One emergency generator :	Diesel engine driven, radiator cooling type, 3-phase, 4-wire, 380/220V, 50Hz, 750kVA
One generator panel :	ACB 4-pole, 600V, 1200A, 50kA,

e. DC power source for control system

One DC power panel :	Alkaline type batteries, 110V, 100Ah and charger

f. 22kV conductors to transformers :
22kV Aluminum conductor XLPE 35mm2-3C

g. 380/220V conductor between transformer and 380/220V switch gear :
600V class insulated typebus-duct 4-aluminum conductors 2500A

(2) Local substation for Water intake pump station (LS-WI)

The station is remotely located from the project site and the electrical power shall be supplied to a separate distribution network with 3 phase, 11kV, 50Hz.

The water intake pump station is very important facility for the project area, so that the substation shall be provided with high reliability as for power supply, such as double capacity of power source.

The motor of main pumps are type of rating that 6kV, 3 phase, 500kW, then, 11kV/6.6kV transformers shall be installed to supply power to the station.

All secondary equipment such as 6.6kV switchgear, control equipment of the motor and 6kV/380-220V transformer for small equipment in the station shall be installed in the other electrical room designed by the pump station.

Then, two 11kV/6.6kV transformers and related equipment, each one provided with a capacity large enough to supply to all equipment shall be installed in this substation.

Power shall be supplied from these transformers to 6.6kV power receiving panel installed in the electrical room of the pump station.

1) System constitution

The substation shall consist of 11kV loop distribution line receiving switchgear, two load disconnecting switchgear for transformers, two 3,500KVA, 11kV/6.6kV transformers and 6.6kV switchgear as shown on the drawing No.A2-2.1-3-01 to 03.

2) Operation manner

a. Under normal condition

Power will be supplied by the 11kV loop distribution lines and the emergency generator (installed in the electrical room of pump station) is separated from the low tension busbars.

The bus tie VCB is opened then each transformer supply to each half of the equipment in the plant, this means that each transformer will be loaded almost 50 percent of the rating capacity.

b. Under one 11kV loop cable is interrupted
Operation manner is same as normal condition because each distribution line is provided with enough capacity to supply to all connected consumers even if one section of loop is failed.

c. Under emergency condition
When the both loop line are interrupted, both of 11kV power receiving VCB are turned off, then the emergency generator is automatically driven and connected to the 6.6kV line in the electrical room.

All equipment in the station are operated same as normal condition.

d. Under breakdown of one transformer
Even if one transformer is broken down, the other one shall supply to all equipment in the plant.

3) Calculation for transformer and generator capacity
This shall be shown in Appendix 3.9-1-2.

4) Outline specifications of main equipment

a. 11kV switchgear

Two Power receiving panels :	Disconnecting switch (DS) 3-pole, 11kV, 600A, 25kA VCB 3-pole, 11kV, 1200 A, 25kA
One metering outfit panel :	DS 3-pole, 11kV, 25kA watt hour meter, reactive kilo volt ampere meter and maximum demand indicator
Two feeder panels :	Load disconnecting switch(LDS) 3-pole, 11kV, 600A, 25kA

b. Transformers

Two Transformers : Oil immersed natural cooling, 3-phase, 3500kVA, 11kV/6.6kV out door type

c. DC power source

One DC power panel : Alkaline type batteries, 110V, 100Ah and charger

d. 11kV conductors to transformers :

11kV Aluminum conductor XLPE 70mm2-3C

g. 6.6kV conductor between transformer and 6.6kV switchgear

6kV Aluminum conductor XLPE 185mm2-3C

(3) Local substation for wastewater treatment plant (LS-SW)

The wastewater treatment plant is very important facility in this area so that the substation shall be provided with high reliability as for power supply, such as double capacity of power source.

Then, two transformers which one provide enough capacity supplying to all equipment in the plant, shall be installed.

1) System constitution

The substation shall consist of 22kV loop distribution line receiving switchgear, two load disconnecting switchgear for transformers, two 2500KVA, 22kV/380-220V transformers and low tension switchgear, as shown on the drawing No.A3-3.1-3-38 to 40.

Also, two 1250KVA, 380/220V emergency generators and change over switches shall be provided supplying power to all equipment when the normal supply is interrupted.

2) Operation manner

a. Under normal condition

Power will supply by the 22kV loop distribution lines and the emergency generators are separated from the low tension bus bars.

The bus tie ACB is opened then each transformer supply to each half of equipment in the plant, this means each transformer will loaded about 50 percent of the rating capacity.

b. Under one 22kV loop cable is interrupted
Operation manner is same as normal condition because each distribution line is provided with enough capacity supplying to all connected consumers even if one section of the loop is failed.

c. Under emergency condition
When both loop lines are interrupted, both of 22kV power receiving VCB are turned off, then, the emergency generators are automatically driven and connected to the bus bar.

All equipment of the plant are operated as same as normal condition by the power of the generators.

d. Under breakdown of one transformer
Even if one transformer is broken down, the other one supplys to all equipment in the plant.

3) Calculation for transformer and generator capacity
Shall be shown in Appendix 3.9-1-3.

4) Outline specification of main equipment

a. 22kV switch gear

Two Power receiving panels :	Disconnecting switch (DS) 3-pole, 24kV, 600A, 25kA VCB 3-pole, 24kV, 1200 A, 25kA
One metering outfit panel :	DS 3-pole, 24kV, 25kA watt hour meter, reactive kilo volt ampere meter and maximum demand indicator

b. Transformers

Two Transformers :	Oil immersed natural cooling, 3-phase, 2500kVA,22kV/380-220V out door type

c. 380/220V Switchgear

Two feeder panels :	Load disconnecting switch(LDS) 3-pole, 24kV, 600A, 25kA
Two 380/220V main panels :	Air circuit breaker(ACB) 4-pole, 600V, 4000A, 50kA
One 380/220V bus tie panel :	ACB 4-pole, 600V, 4000A, 50kA
Eight 380/220V feeder panels :	ACB 4-pole, 600V, 1200A, 40kA
Two change over panels :	ACB 4-pole, 600V, 2000A, 50kVA

d. Emergency generators

Two emergency generators :	Diesel engine driven, radiator cooling type, 3-phase, 4-wire, 380/220V, 50Hz, 1250kVA
Two generator panels :	ACB 4-pole, 600V, 2000A, 50kA, with parallel operation control

e. DC power source for control system

One DC power panel :	Alkaline type batteries, 110V, 100Ah and charger

f. 22kV conductors to transformers :

22kV Aluminum conductor XLPE 35mm2-3C

g. 380/220V conductor between transformer and 380/220V switch gear :

600V class insulated type busduct 4-Aluminum conductors 4000A

(4) Local substation for grain silo terminal (LS-GT)

The grain terminal is important facility, however, interruption of the equipment in this plant shall not cause a serious damage.

Each transformer out of two having a capacity to supply fifty (50) percent of the equipment in the plant shall be installed.

1) System constitution

The substation shall consist of 22kV loop distribution line receiving switchgear, two load disconnecting switchgear for transformers, two 3000KVA, 22kV/380-220V transformers and low tension switchgear as shown on the drawing No.A5-5.3-1-01 to 03.

Also, one 1250KVA, 380-220V emergency generator and change over switch shall be provided supplying power to important equipment when the normal supply is interrupted.

2) Operation manner

a. Under normal condition

Power will supply by the 22kV loop distribution lines and the emergency generator is separated from the low tension bus bars.

The ACB bus tie is opened but ACB bus tie-2 is closed then each transformer supply to each half of the equipment in the plant. This means each transformer will be loaded almost
80 percent of the rating capacity.

b. Under one 22kV loop cable is interrupted

Operation manner is same as normal condition because each distribution line is provided with enough capacity supplying to all connected consumers even if one section of the loop is failed.

c. Under emergency condition

When both loop lines are in interrupted, both of 22kV power receiving VCB and ACB bus tie-2 are turned off, then the emergency generator is automatically driven and connected to the bus bar.

Only important equipment of the plant is put into operation same as normal condition supplying by the generator.

3) Calculation for transformer and generator capacity

This is shown in Appendix 3.9-1-4.

4) Outline specification of main equipment

a. 22kV switchgear

Two Power receiving panels :	Disconnecting switch (DS) 3-pole, 24kV, 600A, 25kA VCB 3-pole, 24kV, 1200 A, 25kA
One metering outfit panel :	DS 3-pole, 24kV, 25kA watt hour meter, reactive kilo volt ampere meter and maximum demand indicator
Two feeder panels :	Load disconnecting switch(LDS) 3-pole, 24kV, 600A, 25kA

b. Transformers

Two Transformers:	Oil immersed natural cooling, 3-phase, 3000kVA,22kV/380-220V out door type

c. 380/220V Switchgear

Two 380/220V main panels :	Air circuit breaker(ACB4-pole, 600V, 5000A, 50kA
Two 380/220V bus tie panels :	ACB 4-pole, 600V, 5000A, 50kA
Two sets of 380/220V feeder panels:	Molded case circuit breaker (MCCB) 4-pole, 600V, 40kA each provided with 10-400A, and 10-225A
One change over panel :	ACB 4-pole, 600V, 2000A, 50kVA

d. Emergency generator

One emergency generator :	Diesel engine driven, radiatorcooling type, 3-phase, 4-wire, 380/220V, 50Hz, 1250kVA
One generator panel :	ACB 4-pole, 600V, 2000A, 50kA,

e. DC power source for control system

One DC power panel :	Alkaline type batteries, 110V, 100Ah and charger

f. 22kV conductors to transformers :

22kV Aluminum conductor XLPE 35mm2-3C

g. 380/220V conductor between transformer and 380/220V switchgear :

600V class insulated type bus-duct 4-Aluminum conductors of 5000A

(5) Local substation for Bulk cargo terminal (LS-BT)

The bulk cargo terminal is important facility, however, any interruption of the equipment in this plant shall not cause a serious damage.

Then, one transformer provided with a capacity supplying to 100 percent of equipment in the plant, shall be installed.

1) System constitution

The substation shall consist of 22kV loop distribution line receiving switchgear, load disconnecting switchgear for transformer, one 500KVA, 22kV/380-220V transformer and low tension switchgear, as shown on the drawing No.A6-6.3-01 to 03.

Emergency generator system shall be not installed.

2) Operation manner

a. Under normal condition

Power will be supplied by the 22kV loop distribution lines, and transformer will supply power by 380/220V 3-phase, 4-wires distribution system to all equipment at site.

b. Under one 22kV loop cable is interrupted

Operation manner is same as normal condition, because each distribution line is provided with enough capacity to supply to all connected consumers even if one section of the loop is failed.

c. Under emergency condition

When both loop lines are interrupted, all equipment in the plant will be stopped.

3) Calculation for transformer and generator capacity

This shall be as shown in Appendix 3.9-1-5.

4) Outline specification of main equipment

The substation shall be Unit Cubicle outdoor type and be installed on site enclosed by a fence.

a. 22kV switchgear

Two Power receiving panels :	Disconnecting switch (DS)3-pole, 24kV, 600A, 25kA VCB 3-pole, 24kV, 1200 A, 25kA
One metering outfit panel :	DS 3-pole, 24kV, 25kA watt hour meter, reactive kilo volt ampere meter and maximum demand indicator
One feeder panel :	Load disconnecting switch(LDS) 3-pole, 24kV, 600A, 25kA

b. Transformer

One Transformer :	Oil immersed natural cooling, 3-phase, 500kVA,22kV/380-220V out door type

c. 380/220V Switchgear

One 380/220V main panel :	Air circuit breaker(ACB) 4-pole, 600V, 800A, 50kA
380/220V feeder panel :	Molded case circuit breaker (MCCB) 4-pole, 600V, 40kA provided with 5-225A, and 5-100A

d. DC power source for control system

One DC power panel : Alkaline type batteries, 110V, 30Ah and charger

e. 22kV conductors to transformer:

22kV Aluminum conductor XLPE 35mm2-3C

f. 380/220V conductor between transformer and 380/220V switchgear :

600V Aluminum conductors XLPE240MM2-4C double

(6) Local substation for Railway facilities (LS-RW)

The railway facilities are important, however, any interruption of the equipment in these facilities shall not cause a serious damage.

Then, one transformer provided with a capacity to supply to 100 percent of the equipment in the plant, shall be installed.

1) System constitution

The substation shall consist of 22kV loop distribution line receiving switchgear, load disconnecting switchgear for transformer, one 500KVA, 22kV/380-220V transformer and low tension switchgear as shown on the drawing No.A7-7.4-1-01 to 03.

Emergency generator system shall not be installed.

2) Operation manner

a. Under normal condition

Power will be supplied by the 22kV loop distribution lines and transformer will supply power by 380/220V 3-phase, 4-wires distribution system to all equipment at site.

b. Under one 22kV loop cable is interrupted

Operation manner is same as normal condition, because each distribution line is provided with enough capacity to supply to all connected consumers even if one section of the loop is failed.

c. Under emergency condition

When both loop lines are interrupted, all equipment in the plant will be stopped.

3) Calculation for transformer and generator capacity

This shall be shown in Appendix 3.9-1-6.

4) Outline specification of main equipment

The substation shall be Unit Cubicle outdoor type and be installed on site enclosed by a fence.

a. 22kV switchgear

Two Power receiving panels :	Disconnecting switch (DS) 3-pole, 24kV, 600A, 25kA VCB 3-pole, 24kV, 1200 A, 25kA
One metering outfit panel :	DS 3-pole, 24kV, 25kA watt hour meter, reactive kilo volt ampere meter and maximum demand indicator
One feeder panel :	Load disconnecting switch(LDS) 3-pole, 24kV, 600A, 25kA

b. Transformer

One Transformer : Oil immersed natural cooling, 3-phase, 500kVA,22kV/380-220V out door type

c. 380/220V Switchgear

One 380/220V main panel : Air circuit breaker(ACB) 4-pole, 600V, 800A, 50kA

380/220V feeder panel : Molded case circuit breaker (MCCB) 4-pole, 600V, 40kAprovided with 5-225A, and 5-100A

d. DC power source for control system

One DC power panel : Alkaline type batteries, 110V, 30Ah and charger

e. 22kV conductors to transformer:

22kV Aluminum conductor XLPE 35mm2-3C

f. 380/220V conductor between transformer and 380/220V switchgear :

600V Aluminum conductors XLPE 240MM2-4C double

(7) Local substation for Center A (LS-CA)

The center is important facility, however, any interruption of the equipment in the area shall not cause a serious damage.

Then, one transformer provided with a capacity of supplying to 100 percent of equipment in the center shall be installed.

However, a space for installation of one more transformer and related equipment shall be provided for future extension of the facilities.

1) System constitution

The substation shall consist of 22kV loop distribution line receiving switchgear, one load disconnecting switchgear for transformer, one 500KVA, 22kV/380-220V transformer and low tension switchgear as shown on the relevant drawings.

Also, one 100KVA, 380-220V emergency generator and change over switch shall be provided to supply power to important equipment when the normal supply is interrupted.

2) Operation manner

a. Under normal condition
Power will be supplied by the 22kV loop distribution lines and the emergency generator is separated from the low tension busbars.

The transformer will supply power to all equipment at site.

b. Under one 22kV loop cable is interrupted
Operation manner is same as normal condition, because each distribution line is provided with enough capacity to supply to all connected consumers even if one section is failed.

c. Under emergency condition
When both loop lines are interrupted, both 22kV power receiving VCB and ACB bus tie-2 are turned off, then the emergency generator is automatically driven and connected to the bus bar.

Important equipment of the center is operated same as the normal condition.

3) Calculation for transformer and generator capacity
This shall be as shown in Appendix 3.9-1-7.

4) Outline specification of main equipment

a. 22kV switchgear

Two Power receiving panels :	Disconnecting switch (DS) 3-pole, 24kV, 600A, 25kA VCB 3-pole, 24kV, 1200 A, 25kA
One metering outfit panel :	DS 3-pole, 24kV, 25kAwatt hour meter, reactive kilo volt ampere meter and maximum demand indicator

One feeder panel : Load disconnecting switch(LDS) 3-pole, 24kV, 600A, 25kA

b. Transformer

One Transformer : Oil immersed natural cooling, 3-phase, 500kVA,22kV/380-220V out door type

c. 380/220V Switchgear

One 380/220V main panel : Air circuit breaker(ACB) 4-pole, 600V, 800A, 50kA

One 380/220V bus tie panel : ACB 4-pole, 600V, 1000A, 50kA

One sets of 380/220V feeder panels: Molded case circuit breaker (MCCB) 4-pole, 600V, 40kA provided with 3-225A, and 6-100A

One change over panel : ACB 4-pole, 600V, 600A, 50kVA

d. Emergency generator

One emergency generator: Diesel engine driven, radiator cooling type, 3-phase, 4-wire, 380/220V, 50Hz, 100kVA

One generator panel : ACB 4-pole, 600V, 600A, 50kA,

e. DC power source

One DC power source for control system :

Alkaline type batteries, 110V, 30Ah and charger

f. 22kV conductor to transformer :

22kV Aluminum conductor XLPE 35mm2-3C

g. 380/220V conductor between transformer and 380/220V switchgear :

600V Aluminum conductor XLPE 240mm2-4C double

(8) Local substation for Center B (LS-CB)

The center is important facility, however, any interruption of the equipment in the area shall not cause a serious damage.

Then, one transformer provided with a capacity of supplying to 100 percent of equipment in the center shall be installed.

However, a space for installation of one more transformer and related equipment shall be provided for future extension of the facilities.

1) System constitution

The substation shall consist of 22kV loop distribution line receiving switchgear, one load disconnecting switchgear for transformer, 300KVA, 22kV/380-220V transformer and low tension switchgear as shown on the relevant drawings.

Also, one 150KVA, 380-220V emergency generator and change over switch shall be provided to supply power to important equipment when the normal supply is interrupted.

2) Operation manner

a. Under normal condition

Power will be supplied by the 22kV loop distribution lines and the emergency generator is separated from the low tension busbars.

The transformer will supply power to all equipment at site.

b. Under one 22kV loop cable is interrupted

Operation manner is same as normal condition, because each distribution line is provided with an enough capacity to supply to all connected consumers even if one section of loop is failed.

c. Under emergency condition

When both loop lines are interrupted, both 22kV powerreceiving VCB and ACB bus tie-2 are turned off, then the emergency generator is automatically driven and connected to the bus bar.

Important equipment of the center is put into operation same as the normal condition.

3) Calculation for transformer and generator capacity

Shall be shown on the Appendix 3.9-1.8.

4) Outline specification of main equipment

a. 22kV switchgear

Two Power receiving panels :	Disconnecting switch (DS) 3-pole, 24kV, 600A, 25kA VCB 3-pole, 24kV, 1200 A, 25kA
One metering outfit panel :	DS 3-pole, 24kV, 25kA watt hour meter, reactive kilo volt ampere meter and maximum demand indicator
One feeder panel :	Load disconnecting switch(LDS) 3-pole, 24kV, 600A, 25kA

b. Transformer

One Transformer :	Oil immersed natural cooling, 3-phase, 500kVA,22kV/380-220V out door type

c. 380/220V Switchgear

One 380/220V main panel :	Air circuit breaker(ACB) 4-pole, 600V, 800A, 50kA
One 380/220V bus tie panel :	ACB 4-pole, 600V, 1000A, 50kA
One sets of 380/220V feeder panel:	Molded case circuit breaker (MCCB) 4-pole, 600V, 40kA provided with 3-225A, and 6-100A
One change over panel :	ACB 4-pole, 600V, 600A, 50kVA

d. Emergency generator

One emergency generator :	Diesel engine driven, radiator cooling type, 3-phase, 4-wire, 380/220V, 50Hz, 150kVA
One generator panel :	ACB 4-pole, 600V, 600A, 50kA,

e. DC power source for control system:

One DC power panel :	Alkaline type batteries, 110V, 30Ah and charger

f. 22kV conductor to transformer :

22kV Aluminum conductor XLPE 35mm2-3C

g. 380/220V conductor between transformer and 380/220V switchgear :
600V Aluminum conductor XLPE 240mm2-4C double

(9) Local substation for Center C (LS-CC)

The center is important facility, however, any interruption of the equipment in this area shall not cause a serious damage.

Then, one transformer provided with a capacity of supplying to 100 percent of equipment in the center shall be installed.

However, a space for installation of one more transformer and related equipment shall be provided for future extension of the facilities.

1) System constitution
The substation shall consist of 22kV loop distribution line receiving switchgear, one load disconnecting switchgear for transformer, one 500KVA, 22kV/380-220V transformer and low tension switchgear as shown on the relevant drawings.

Also, one 100KVA, 380-220V emergency generator and change over switch shall be provided to supply power to important equipment when the normal supply is interrupted.

2) Operation manner

a. Under normal condition
Power will be supplied by the 22kV loop distribution lines and the emergency generator is separated from the low tension busbars.

The transformer will supply power to all equipment at site.

b. Under one 22kV loop cable is interrupted
Operation manner is same as normal condition, because each distribution line is provided with enough capacity to supply to all connected consumers even if one section is failed.

c. Under emergency condition

When both loop line are interrupted, 22kV power receiving VCB and ACB bus tie-2 are turned off, then the emergency generator is automatically driven and connected to the bus bar.

Important equipment of the center is put into operation same as normal condition.

3) Calculation for transformer and generator capacity

This shall be shown in Appendix 3.9-1.9.

4) Outline specification of main equipment

a. 22kV switchgear

Two Power receiving panels :	Disconnecting switch (DS) 3-pole, 24kV, 600A, 25kA VCB 3-pole, 24kV, 1200 A, 25kA
One metering outfit panel :	DS 3-pole, 24kV, 25kA watt hour meter, reactive kilo volt ampere meter and maximum demand indicator
One feeder panel :	Load disconnecting switch(LDS) 3-pole, 24kV, 600A, 25kA

b. Transformer

One Transformer :	Oil immersed natural cooling, 3-phase, 500kVA,22kV/380-220V out door type

c. 380/220V Switchgear

One 380/220V main panel :	Air circuit breaker(ACB)4-pole, 600V, 800A, 50kA
One 380/220V bus tie panel :	ACB 4-pole, 600V, 1000A, 50kA
One set of 380/220V feeder panel :	Molded case circuit breaker (MCCB) 4-pole, 600V, 40kA provided with 3-225A, and 6-100A
One change over panel :	ACB 4-pole, 600V, 600A, 50kVA

d. Emergency generator

One emergency generator : Diesel engine driven, radiator cooling type, 3-phase, 4-wire, 380/220V, 50Hz, 100kVA

One generator panel : ACB 4-pole, 600V, 600A, 50kA,

e. DC power source for control system:

One DC power panel : Alkaline type batteries, 110V, 30Ah and charger

f. 22kV conductor to transformer :

22kV Aluminum conductor XLPE 35mm2-3C

g. 380/220V conductor between transformer and 380/220V switchgear :

600V Aluminum conductor XLPE 240mm2-4C double.

3.9.9 Unit substation and small consumers

Unit substations shall be installed beside the walkway as shown on the drawing No.A1-1.5-2-01 to 05.

The unit substation will supply power to all road lighting fixtures and sewage pump stations.

Also, the consumers who made a request low tension(380/220V) power such as small factories and public facilities constructed in the industrial estate or industrial free zone will be supplied the power from the nearest unit substation.

1) System constitution

The unit substation shall consist of 22kV loop distribution line receiving switchgear, load disconnecting switchgear for transformer, one 500KVA, 22kV/380-220V transformer,low tension switchgear and road lighting controllers as shown on the drawing No.A1-1.6-4-01 to 03 and A1-1.6-1-01 to 09.

2) Outline specification of main equipment

The substation shall be Unit Cubicle outdoor type and be installed on site enclosed by a fence.

a. 22kV switchgear

Two Power receiving panels :	Disconnecting switch (DS) 3-pole, 24kV, 600A, 25kA VCB 3-pole, 24kV, 1200 A, 25kA
One metering outfit panel :	DS 3-pole, 24kV, 25kA watt hour meter, reactive kilo volt ampere meter and maximum demand indicator
One feeder panel :	Load disconnecting switch(LDS) 3-pole, 24kV, 600A, 25kA

b. Transformer

One Transformer :	Oil immersed natural cooling, 3-phase, 500kVA,22kV/380-220V \out door type

c. 380/220V Switchgear

One 380/220V main panels :	Air circuit breaker(ACB) 4-pole, 600V, 800A, 50kA
380/220V feeder panels:	Molded case circuit breaker rating and numbers shall be as shown on the drawings.

d. DC power source for control system:

One DC power panel :	Alkaline type batteries, 110V, 30Ah and charger

e. 22kV conductor to transformer:
22kV Aluminum conductor XLPE 35mm2-3C

f. 380/220V conductor between transformer and 380/220V switchgear :
600V Aluminum conductor XLPE 240mm2-4C double

The connecting load and allowable supplying capacity of each Unit substation is as shown in Table 3.9-9-1.

Table 3.9-9-1 Load Analysis and Supplying Capacity of Unit Substations

CODE OF SUB-STATION	TRANSFORMER CAPACITY (A) (KVA)	CONNECTING LOAD: ROAD LIGHTING (B) (KVA)	CONNECTING LOAD: SMALL EQUIPMENT AND OTHERS	(C) (KVA)	ALLOWABLE SUPPLYING CAPACITY TO 380/220V FACTORY (D)=(A-B-C) (KVA)
US-A1	500	18			482
US-A2	500	22			478
US-A3	500	43			457
US-A4	500	34			466
US-A5	500	12			488
US-A6	500	21			479
US-A7	500	23			477
US-A8	500	22	SEWAGE PUMPS	172	306
US-A9	500	43			457
US-B1	500	16			484
US-B2	500	26			474
US-B3	500	49			451
US-B4	500	43			457
US-B5	500	39	SEWAGE PUMPS	172	289
US-B6	500	54			446
US-B7	500	31	TRAFFIC SIGNAL	10	459
US-B8	500	50			450
US-B9	500	22	SEWAGE PUMPS	144	334
US-B10	500	24			476
	TOTAL	592		498	8,410

3.9.10 Distribution cables to each factory

Generally, completion date of the the construction of facteries / plants in Ataqa I.E. and /or Adabiya I.F.Z. by investors will probably not be the same necessarily. Should it be so, the commencement date of the power supply thereto will be different as a metter of course.

As mentioned in section 3.9.6 of this report, 22kV loop distribution network is designed to be connected with each lot in good order in accordance with the location.

Each 22kV loop distribution line shall be constructed by the completion date of the first factory connected to the loop line.

(1) 22kV distribution lines to each consumer.

The factory which requires maximum demand of 200 kW or more, the power will be supplied from nearby 22kV distribution cable in accordance with the designed network system.

These distribution lines will be installed in order according to the requirement of the factory when the private substation is completed.

Therefore, composition of the designed 22kV loop network system may be revised in accordance with the important factors, such as power demand, starting date of supply, location of the consumers, to satisfy the requirement of the consumers.

(2) Low tension distribution lines to consumer.

The factory which requires maximum demand of less than 200 kW, the power will be supplied from nearby Unit Substation which will be existing for road lighting and small equipment or new one installed for the factory, in a manner of 3 Phase 380-220V distribution system.

These distribution lines and new Unit substations will be installed in order when the factory is completed.

3.9.11 Road lighting system

All roads and walkways in the project area shall be provided with road lighting system as described in this report and as shown on the drawings.

Also, road lighting system for the existing SUEZ-ADABIYA road subject to inprovement shall be included in this work.

Four types of vehicle road are planed in the project area as follows:

a. 35m width, 4-lane road
b. 30m width, 4-lane road
c. 21m width, 2-lane road
d. 18m width, 2-lane road

Layout plan of these roads is as shown in Figure "ROAD NETWORK PLAN" in Section 3.4 of this report.

(1) Lighting intensity of each type road

Lighting intensity of each road is planed as shown in Table 3.9-11-1.

Table 3.9-11-1 Lighting Intensity of Road

ROAD	AVERAGE INTENSITY
EW-1	15 lx
EW-2	12
EW-3	12
EW-4	12
EW-11	12
EW-12	12
EW-13	12
SN-1	12
SN-2	12
SN-3	12
SN-4	12
SN-5	12
SN-6	12
SN-11	12
SN-12	12
SN-13	12
SUEZ ADABIYA	11

Walkway shall be lighted in minimum intensity of 3 lx.

(2) Lighting fixture type and installation method

All road lighting fixtures shall be pole mounted type and installed as shown in Table 3.9-11-2.

Table 3.9-11-2 Fixture Type and Installation

ROAD TYPE	LAMP TYPE AND WATT	HEIGHT FROM GROUND	INTERVALS OF EACH POLE
EW-1	SON400 WATT	13m	40m
OTHERS	SON250 WATT	13m	40m

(3) Power distribution and Control system

Electrical power for road lighting shall be supplied from nearby unit substation by 3 phase, 4 wire, 380/220V with earthing cable system.

Each phase line of each branch circuit shall be separately controlled by time switch and photo switch, so that, the lighting fixtures connected to a lane may be orderly turned on and off every second or third.

Distribution board and control equipment for the road lighting system shall be installed in each Unit Substation.

(4) Cable and installation method

600V Steel Tape Armored Aluminum conductor XLPE (STAXLPE) cable shall be adopted.

This cable shall be installed under the pavement or cable space located next to the walkway by a direct burial method.

The voltage drop of each road light circuit shall be less than 13 volt (6% of 220V).

3.9.12 Telephone conduit system

(1) Estimation for Telephone demand

1) Public facilities

The telephone demand of each public facility is estimated according to the size and function of the facility as shown in Table 3.9-12-1.

2) Industrial lots

The telephone demand density of each industrial lot is estimated by the following method.

a. Average number of telephone city lines required by each factory is supposed as 15 lines.

b. Total number of factories to be constructed in the project area is planned as 469 as described in Chapter 2 in this report.

c. Total site area of ATAQA and ADABIYA industrial lot is about 414 ha.

d. Then average site area of one factory is 0.88 ha.

e. This implies that the telephone demand per hectare or unit demand can be calculated as follow;

$$\frac{15(\text{lines})}{0.88(\text{ha})} = 17(\text{line/ha})$$

f. Telephone demand in the industrial lot is estimated as follows;

TD = A x Ut

TD : Telephone demand in the estate [lines]
A : Area of the lot [ha]
Ut : Telephone Unit demand is supposed as;
17 [lines/ha] for ATAQA I.E.
16 [lines/ha] for ADABIYA I.F.Z.
18 [lines/ha] for extension area

Where, unit demand of ADABIYA I.F.Z will be estimated a little less than ATAQA I.E because of difference of the performance between the industrial estate and free zone, and the unit demand of extension area will be a little more than that because of the general increase of the telephone demand in future.

The calculated demand of the each lot is as shown in Table 3.9-12-1.

Table 3.9-12-1 Telephone Demand Estimation

NO.	FACILITY	ESTIMATED DEMAND (LINES)	
1.	CENTER-A	20	
2.	CENTER-B	20	
3.	CENTER-C	20	
4.	220/66KV SUBSTATION	10	
5.	66/22KV SUBSTATION-A	10	
6.	66/22KV SUBSTATION-B	10	
7.	WATER TREATMENT PLANT	20	
8.	SEWERAGE PLANT	20	
9.	GRAIN TERMINAL	20	
10.	BULK CARGO TERMINAL	10	
11.	RAILWAY FACILITIES	20	
12.	ADABIYA I.F.Z.	920	58ha*16L/ha
13.	ATAQA I.E.	4,120	242ha*17L/ha
14.	ATAQA I.E. COASTAL	1,050	61ha*17L/ha
15.	TOTAL (1)	6,270	
16.	FUTURE EXTENTION AREA	2,000	110ha*18L/ha
17.	RESIDENTIAL AREA	2,600	1L/dwelling
18.	TOTAL (2)	4,600	
19.	TOTAL (1)+(2)	10,870	

3) Residential area

Telephone demand density of residential area is estimated by the following method:

a. Total site area of residential zone is about 133 ha.

b. About 80 percent of total area will be occupied by dwellings, and the area of one dwelling is supposed as 400 sq.meter.

c. Numbers of dwelling is calculated with this hypothesis about 2,600 as follows;

$$\frac{1,330,000 \times 0.8}{400} = 2,600$$

d. Telephone demand in this area supposed as 2,600 lines.

(2) Location of Telephone exchange station

It is temporarily planed that the telephone exchange station will be located in the area of Center-B.

In accordance with the estimated telephone demand density, a tentative cable plan is designed as shown on the drawing No.A1-1.7-1-01.

Capacity of one telephone cable is supposed as 200 lines.

(3) Telephone main lines

The main lines will be installed from the existing SUEZ Exchange Station located about 7 km from the project site.

All cables and conduit lines from SUEZ Exchange Station to boundary will be designed and installed by the ARENTO.

All conduit lines and manholes for telephone main lines installed in the project area or from the manhole located at the boundary to a new exchange station in the project area (Center-B) shall be designed and constructed in under this project.

(4) Telephone conduit lines

Telephone conduit line in the project area shall consist of PVC conduits and manholes and installed in a manner of direct burial at the cable space located next to the walkway as shown on the drawing No.A1-1.7-3-01.

type of conduit	:	PVC
diameter	:	100mm
numbers	:	as shown on the drawing
arrangement	:	as shown on the drawing

(5) Manholes and others.

A manhole, or cabinethole shall be installed at an interval of 240 meter or less than 240 meter on each conduit lines.

All manholes and cabinetholes shall be made of reinforced concrete with cast iron cover to meet the requirements of the standard set forth by ARENTO.

Dimensions of each manhole and cabinethole shall be as shown on the drawing No. A1-1.7-4-01 and 03.

These manholes and cabinetholes shall be installed in the cabling area located next to the walkway of each road and they shall be separated at least 600mm from the manhole of 22kV power cables.

(6) Handholes

A handhole shall be installed at the site of the following facilities as teminal of the telephone condceit line.

a. 220/66 KV Substation
b. 66/22 KV Substations
c. Water treatment plant
d. Railway facility
e. Sewerage pump stations

f. Grain silo/Bulk cargo terminal

(7) Road crossing conduits

The size and number of conduits installed crossing under the road shall be as follows;

type of conduit	:	PVC
diameter	:	100mm
numbers	:	as shown on the drawing
arrangement	:	as shown on the drawing

CALCULATION FOR CAPACITY OF TRANSFORMER AND EMERGENCY GENERATOR OF LOCAL SUBSTATIONS

1.	LOCAL SUBSTATION	LS-WT	WATER TREATMENT PLANT
2.	LOCAL SUBSTATION	LS-WI	WATER INTAKE PUMP STATION
3.	LOCAL SUBSTATION	LS-SW	WASTEWATER TREATMENT PLANT
4.	LOCAL SUBSTATION	LS-GT	GRAIN SILO TERMINAL
5.	LOCAL SUBSTATION	LS-BT	BULK CARGO TERMINAL
6.	LOCAL SUBSTATION	LS-RW	RAILWAY FACILITIES
7.	LOCAL SUBSTATION	LS-CA	CENTER-A
8.	LOCAL SUBSTATION	LS-CB	CENTER-B
9.	LOCAL SUBSTATION	LS-CC	CENTER-C

CALCULATION FOR CAPACITY OF TRANSFORMER AND EMERGENCY GENERATOR OF LOCAL SUBSTATIONS

1. LOCAL SUBSTATION LS-WT WATER TREATMENT PLANT

(1) LOAD ANALYSIS

NO.	TYPE OF LOAD	CONNECTING LOAD (KW)	P.F %	D.F %	MAXIMUM DEMAND (KVA)
1.	PLANT EQUIPMENT	640	85	80	602
2.	BUILDING EQUIPMENT	470	80	90	529
3.	AREA LIGHTING ETC.	80	70	100	114
4.	TOTAL(1+2+3)				1,245
5.	FUTURE EXTENSION	(4)x20%			249
6.	TOTAL(4+5)				1,494
7.	ESSENTIAL LOAD	(6)x100%			1,494

(2) CAPACITY OF TRANSFORMER AND EMERGENCY GENERATOR

	REQUIRED CAPACITY (KVA)		NOS.	ADOPTED CAPACITY (KVA)
TRNASFORMER	1,494		2	1,500
GENERATOR	1,494		2	750

NOTE : ONE TRANSFORMER SHALL BE USED AS STANDBY.
P.F : POWER FACTOR
D.F : DEMAND FACTOR

CALCULATION FOR CAPACITY OF TRANSFORMER AND EMERGENCY GENERATOR OF LOCAL SUBSTATIONS

2. LOCAL SUBSTATION LS-WI WATER INTAKE PUMP STATION

(1) LOAD ANALYSIS

NO.	TYPE OF LOAD	CONNECTING LOAD (KW)	P.F %	D.F %	MAXIMUM DEMAND(KVA)
1.	EQUIPMENT 6KV	3,000	85	70	2,471
2.	EQUIPMENT 380/220V	70	85	70	58
3.	BUILDING EQUIPMENT	90	80	90	101
4	AREA LIGHTING ETC.	30	70	100	43
4.	TOTAL(1+2+3)				2,672
5.	FUTURE EXTENSION	(4)x20%			534
6.	TOTAL(4+5)				3,207
7.	ESSENTIAL LOAD	(6)x20%			641

(2) CAPACITY OF TRANSFORMER AND EMERGENCY GENERATOR

	REQUIRED CAPACITY (KVA)		NOS.	ADOPTED CAPACITY (KVA)
TRNASFORMER	3,207		2	3,500

NOTE : ONE TRANSFORMER SHALL BE USED AS STANDBY
P.F : POWER FACTOR
D.F : DEMAND FACTOR

CALCULATION FOR CAPACITY OF TRANSFORMER AND EMERGENCY GENERATOR OF LOCAL SUBSTATIONS

3. LOCAL SUBSTATION LS-SW wastewater TREATMENT PLANT

(1) LOAD ANALYSIS

NO.	TYPE OF LOAD	CONNECTING LOAD (KW)	P.F %	D.F %	MAXIMUM DEMAND (KVA)
1.	PLANT EQUIPMENT	1,550	85	80	1,459
2.	BUILDING EQUIPMENT	340	80	90	383
3.	AREA LIGHTING ETC.	50	70	100	71
4.	TOTAL(1+2+3)				1,913
5.	FUTURE EXTENSION	(4)x20%			383
6.	TOTAL(4+5)				2,295
7.	ESSENTIAL LOAD	(6)x100%			2,295

(2) CAPACITY OF TRANSFORMER AND EMERGENCY GENERATOR

	REQUIRED CAPACITY (KVA)		NOS.	ADOPTED CAPACITY (KVA)
TRNASFORMER	2,295		2	2,500
GENERATOR	2,295		2	1,250

NOTE : ONE TRANSFORMER SHALL BE USED AS STANDBY.
P.F : POWER FACTOR
D.F : DEMAND FACTOR

CALCULATION FOR CAPACITY OF TRANSFORMER AND EMERGENCY GENERATOR OF LOCAL SUBSTATIONS

4. LOCAL SUBSTATION LS-GT GRAIN SILO TERMINAL

(1) LOAD ANALYSIS

NO.	TYPE OF LOAD	CONNECTING LOAD (KW)	P.F %	D.F %	MAXIMUM DEMAND(KVA)
1.	PLANT EQUIPMENT	5,500	85	70	4,529
2.	BUILDING EQUIPMENT	320	80	90	360
3.	AREA LIGHTING ETC.	50	70	100	71
4.	TOTAL(1+2+3)				4,961
5.	FUTURE EXTENSION	(4)x20%			992
6.	TOTAL(4+5)				5,953
7.	ESSENTIAL LOAD	(6)x20%			1,191

(2) CAPACITY OF TRANSFORMER AND EMERGENCY GENERATOR

	REQUIRED CAPACITY (KVA)		NOS.	ADOPTED CAPACITY (KVA)
TRNASFORMER	5,953		2	3,000
GENERATOR	1,191		1	1,250

NOTE : P.F : POWER FACTOR
D.F : DEMAND FACTOR

CALCULATION FOR CAPACITY OF TRANSFORMER AND EMERGENCY GENERATOR OF LOCAL SUBSTATIONS

5. LOCAL SUBSTATION LS-BT BULK CARGO TERMINAL

(1) LOAD ANALYSIS

NO.	TYPE OF LOAD	CONNECTING LOAD (KW)	P.F %	D.F %	MAXIMUM DEMAND(KVA)
1.	PLANT EQUIPMENT	100	85	70	82
2.	BUILDING EQUIPMENT	100	80	90	113
3.	AREA LIGHTING ETC.	20	70	100	29
4.	TOTAL(1+2+3)				223
5.	FUTURE EXTENSION	(4)x20%			45
6.	TOTAL(4+5)				268
7.	ESSENTIAL LOAD				

(2) CAPACITY OF TRANSFORMER AND EMERGENCY GENERATOR

	REQUIRED CAPACITY (KVA)		NOS.	ADOPTED CAPACITY (KVA)
TRNASFORMER	268		1	500

NOTE : MINIMUM STANDARD CAPACITY OF 22KV TRANSFORMER IS 500KVA
P.F : POWER FACTOR
D.F : DEMAND FACTOR

CALCULATION FOR CAPACITY OF TRANSFORMER AND EMERGENCY GENERATOR OF LOCAL SUBSTATIONS

6. LOCAL SUBSTATION LS-RW RAILWAY FACILITIES

(1) LOAD ANALYSIS

NO.	TYPE OF LOAD	CONNECTING LOAD (KW)	P.F %	D.F %	MAXIMUM DEMAND(KVA)
1.	PLANT EQUIPMENT				
2.	BUILDING EQUIPMENT	140	80	90	158
3.	AREA LIGHTING ETC.	30	70	100	43
4.	TOTAL(1+2+3)				200
5.	FUTURE EXTENSION	(4)x20%			40
6.	TOTAL(4+5)				240
7.	ESSENTIAL LOAD				

(2) CAPACITY OF TRANSFORMER AND EMERGENCY GENERATOR

	REQUIRED CAPACITY (KVA)		NOS.	ADOPTED CAPACITY (KVA)
TRNASFORMER	240		1	500

NOTE : MINIMUM STANDARD CAPACITY OF 22KV TRANSFORMER IS 500KVA
P.F : POWER FACTOR
D.F : DEMAND FACTOR

CALCULATION FOR CAPACITY OF TRANSFORMER AND EMERGENCY GENERATOR OF LOCAL SUBSTATIONS

7. LOCAL SUBSTATION LS-CA CENTER-A

(1) LOAD ANALYSIS

NO.	TYPE OF LOAD	CONNECTING LOAD (KVA)	P.F %	D.F %	MAXIMUM DEMAND(KVA)
1.	BUILDING EQUIPMENT	232			
2.	KITCHEN EQUIPMENT	30			
3.	AREA LIGHTING ETC.	10			
4.	TOTAL(1+2+3)	272		75	204
5.	FUTURE EXTENSION	(4)x20%			41
6.	TOTAL(4+5)				245
7.	ESSENTIAL LOAD	(6)x20%			49

(2) CAPACITY OF TRANSFORMER AND EMERGENCY GENERATOR

	REQUIRED CAPACITY (KVA)		NOS.	ADOPTED CAPACITY (KVA)
TRNASFORMER	245		1	500
GENERATOR	49		1	100

NOTE : MINIMUM STANDARD CAPACITY OF 22KV TRANSFORMER IS 500KVA
P.F : POWER FACTOR
D.F : DEMAND FACTOR

CALCULATION FOR CAPACITY OF TRANSFORMER AND EMERGENCY GENERATOR OF LOCAL SUBSTATIONS

8. LOCAL SUBSTATION LS-CB CENTER-B

(1) LOAD ANALYSIS

NO.	TYPE OF LOAD	CONNECTING LOAD (KVA)	P.F %	D.F %	MAXIMUM DEMAND(KVA)
1.	BUILDING EQUIPMENT	568			
2.	KITCHEN EQUIPMENT	80			
3.	AREA LIGHTING ETC.	30			
4.	TOTAL(1+2+3)	678		75	509
5.	FUTURE EXTENSION	(4)x20%			102
6.	TOTAL(4+5)				610
7.	ESSENTIAL LOAD	(6)x20%			122

(2) CAPACITY OF TRANSFORMER AND EMERGENCY GENERATOR

	REQUIRED CAPACITY (KVA)		NOS.	ADOPTED CAPACITY (KVA)
TRNASFORMER	610		1	500
GENERATOR	122		1	150

NOTE : MINIMUM STANDARD CAPACITY OF 22KV TRANSFORMER IS 500KVA
P.F : POWER FACTOR
D.F : DEMAND FACTOR

CALCULATION FOR CAPACITY OF TRANSFORMER AND EMERGENCY GENERATOR OF LOCAL SUBSTATIONS

9. LOCAL SUBSTATION LS-CC CENTER-C

(1) LOAD ANALYSIS

NO.	TYPE OF LOAD	CONNECTING LOAD (KVA)	P.F %	D.F %	MAXIMUM DEMAND (KVA)
1.	BUILDING EQUIPMENT	369			
2.	KITCHEN EQUIPMENT	50			
3.	AREA LIGHTING ETC.	20			
4.	TOTAL (1+2+3)	439		75	329
5.	FUTURE EXTENSION	(4)x20%			66
6.	TOTAL (4+5)				395
7.	ESSENTIAL LOAD	(6)x20%			79

(2) CAPACITY OF TRANSFORMER AND EMERGENCY GENERATOR

	REQUIRED CAPACITY (KVA)		NOS.	ADOPTED CAPACITY (KVA)
TRNASFORMER	418		1	500
GENERATOR	79		1	100

NOTE : MINIMUM STANDARD CAPACITY OF 22KV TRANSFORMER IS 500KVA
P.F : POWER FACTOR
D.F : DEMAND FACTOR

3.10 GRAIN HANDLING EQUIPMENT

3.10.1 PREFACE

The previous design which was conducted in F/S stage has been re-viewed in view of the up-to-date demand forecast and technical level. Furthermore, in consideration of the operation and maintenance of the facilities to be built, the consultant have studied the existing similar facilities and local conditions in the country and collected / examined the opinions and suggestions of the users.

The main items considered in this design stage are as follows ;

1. Local conditions (Ambient, Technical)
2. Initial Investment and Operation Cost
3. Ease of Operation and Maintenance
4. Reliability of the facilities
5. Safety and Environment

The main items revised from the F/S report, as results of detailed design, are as follows:

(1) Type of unloader

A pneumatic unloader for grain handling was very popular in former times. However, a continuous mechanical type unloader which is recently developed is more excellent and advantageous in performance ; specially in power save. Thus the type of unloader is changed from the pneumatic type to the mechanical continuous type.

(2) Capacity of unloader

The desirable capacity on economical view point has been calculated and determined as 630 t/h (600 t/h in F/S stage).

(3) Type of silo bins

From due consideration of the type of existing silo bins in Egypt and the local conditions, the cylindrical reinforced type is selected.

(4) Capacity of silo

Judging from the cargo volume to be handled, the Vessel size to be called and the period of stored, the total capacity of the silo has been determined as 100,000 t.

3.10.2 DESIGN CONDITIONS

(1) Design Conditions (General)

(a) Grain

1) Kind of grain

The main grain to be handled at the terminal of Ataqa Port is wheat. However, the handling equipment has been designed to be able to handle other grain (corn, soybean, etc.) also without any modification in the future.

a) Apparent Specific Gravity	0.75
b) Angle of Repose	28 - 32 degree
c) Moisture	12 - 14 percent

2) Volume

a) Unloading

in 2000	1,300,000	t/year
in 2010	1,800,000	t/year

b) Discharge

	in 2000	in 2010
Rail (in Bulk)	70 percent	70 percent
Truck (in Bulk)	24 percent	30 percent
Truck (in Bag)	6 percent	Nil
Conveyor (in Bulk)	Nil	Nil

In addition, a necessary connection space for conveyor is also considered.

3) Space for Future Cargo

The design has been prepared taking into account the type of grain products as mentioned below. With regard to a loading facility which would be required in future, the space deemed necessary for its purpose has been considered. (The handling equipment itself is not included in the design.)

Kind of grain

Local wheat, rice

Volume

Loading to ship	1	Million t/year
Receiving from land side		
Rail (in Bulk)	500,000	t/year
Trucks (in Bulk)	500,000	t/year

(b) Berth

1) Length	300 m
2) Depth (below C, D)	-15 m
3) Crown height of quay (above C, D)	3.6 m
4) Tidal range	1.5 m
5) Thickness of fender	1.5 m
6) Apron	
Width	20 m
Grade	2 %

(c) Yard

1) Elevation (above C,D) 4.0 m (EL. +2.863 m)

(d) Vessel

1) Kind of Vessel	Mainly bulk carriers
Size	
Max.	80,000 DWT
Min.	30,000 DWT
2) Breadth (mold)	
Max.	38.5 m
Min.	26 m
3) Depth	21.6 m
4) Draft	
Full load	13.2 m
5) Hatch width	16.6 m

(e) Ambient conditions

1) Temperature	
Max.	60 degree C.
Min.	5 degree C.
2) Humidity	
Max.	95 %

3) Wind pressure

Wind pressure according to the height (h) in meters above ground level is as follows:

	Pressure kg/m^2		Wind speed
Condition	$h < 16$	$h > 16$	m/sec
Service	17	$8.5\ h^{1/4}$	16
Rest	42	$21\ h^{1/4}$	25
Anchorage	82	$41\ h^{1/4}$	35

(f) Power source conditions for operating facilities

1) Voltage 380 volt
2) Phase 3
3) Frequency 50 Hz
4) Deviation
   a) Voltage (at rated frequency) not more or less than +/- 10%
   b) Frequency (at rated voltage) not more or less than +/- 5%
   c) Total deviation (at the same time) (c) = (a) + (b)
   not more or less than +/- 10%

(g) Working days and working hours:

1) Working days

The number of working days considered in the design is 295 days/year excluding national holidays and Fridays.

2) Working hours

For Unloading	24 hours
For Discharge (Truck)	12 hours (in Summer)
	8 hours (in Winter)
For Discharge (Rail Wagon)	24 hours

(h) Environmental Conditions

1) Noise levels

Cargo hatch and on board	less than 85 db (A)
Inside operator's cab	less than 70 db (A)
Inside building	less than 85 db (A)

2) Density of dust

Outlet of dust removal air tube	less than 150 mg/m3
Operator's working area	less than 10 mg/m3

3) Density of gas for fumigation

Operator's working area	less than 1 mg/m3

(2) Design Conditions for Unloader

(a) Wheel load and rail conditions

1) Wheel load

a) At service conditions (maximum)

Sea side	35 t/wheel	Land side	17.5 t/wheel

b) At rest conditions (maximum)

Sea side	30 t/wheel	Land side	30 t/wheel

2) Wheel pitch not less than 1.0 m

3) Rail conditions

Construction standards for the traveling rails are as follows:

a) Rail size	50 kg/m
b) Horizontal alignment not more or less than	+/- 20 mm
c) Gauge -ditto-	+/- 10 mm
d) Level -ditto-	+/- 20 mm
e) Relative level between Sea side and land side Rail -ditto-	+/- 20 mm
f) Rail alignment at rail Joint -ditto-	+/- 0.5 mm

(b) Rail position and height

1) Position

Sea side rail	2.5	m (from face of berth)
Land side rail	11.5	m (-ditto-)

2) Height

Sea side rail (A, C, D)	+3.65	m
Land side rail (A, C, D)	+3.83	m
3) Length	275	m

(3) Design Conditions for Silo Bins

(a) Capacity 100,000 t

(b) Earthquake

Earthquake load : 0.05 g (g : acceleration of gravity, horizontal)

3.10.3 DESIGN CRITERIA

(1) Unit of Measurement

The design including drawings and technical data shall be based on the "Metric System".

(2) Codes and Standard for Structures

The design of civil structures and silo facilities and outer ditches shall conform to the following Japanese standards or internationally acceptable standards.

	Japanese Standards
General	JIS
Material	JIS
Concrete Structure	AIJ Standard for Structural Calculation of Reinforced Concrete Structure
R.C.Silo	American Concrete Institutes (ACI)
Steel Structure	SIJ Design Standard for Steel Structures
Painting	JIS, SSPC
Fire	NFPA

JIS	:	Japanese Industrial Standard
AIJ	:	Architectural Institute of Japan
SSPC	:	Steel Structures Painting Council
NFPA	:	Standard of National Fire Protection Association

(3) Codes and Standards for mechanical Equipment

The design of mechanical and electrical equipment shall conform to the following Japanese Codes and Standards or internationally recognized standards.

	Japanese Standards
General	JIS
Material	JIS
Steel Structure	AIJ Design Standard for Steel Structures
Fumigation	The Plant Protection Law
Painting	JIS
Electrical Equipemnt	JEC, JEM
Unloader	SCC

JEC : Japan Electro-technical Committee

JEM : Japan Electric Machine Industry Association

SCC : Safety Code for Cranes by Ministry of Labour Japanese Government

3.10.4 BASIC DESIGN

(1) Cargo Handling

(a) General

The grain to be carried from foreign country by vessel will be unloaded by the unloader(s). After unloading, the grain will be stored in silo bins, after which it will be delivered to in-land.

(b) General arrangement

Around the grain silos at the terminal center, a machinery tower, an official building, a bagging house and miscellaneous buildings are effectively arranged. Ship unloaders are installed on rails on the berth for ocean vessels and connected to silo facilities by a transfer conveying system installed on the wharf. A loading facility for rail and truck is located behind the silos and the grain will be supplied by conveyors from the silos to wagons and trucks.

(c) Description of each system

1) Cargo Handling System (Ref. Flow Chart of Grain)

a) Unloading from ship and taking-in to Grain Silo

Grain will be unloaded by two unloaders (mechanical type) installed at Quay Side. After unloading, it will be transferred by conveyors into silos through magnetic separators, net separators, auto samplers and automatic hopper scales. Furthermore, it must be changeable, when necessary, the combination of the lines comprise the unloader, receiving line, hopper scale and each group of silo bins.

b) Taking-out grain and bagging

Grain stored in silo bins will be taken out by four taking-out conveyor lines and is led to bagging facilities, or to tanks for truck and wagon loading. Each of four conveyor lines can be operated separately. Furthermore, it is also possible to change, as the occasion demands, the combination of the lines comprising of a discharge line from silo bins, hopper scale lines, and loading lines for bagging truck or rail wagon lines.

c) Recycle line

Grain in any silo bins can be moved to other bins by recycle lines.

2) Operation System

a) Silo operation

1. Unloader

Most of the operation of the unloader shall be done from the panel in the operator's room installed on the unloader.

2. Loading facilities for wagon and truck

All of the operations of the facilities shall be done from the panel in the control room installed at site.

b) Remote operation

All the required operations to the receiving bins, discharge line and recycle line, shall be done from control panel in the central control room in the machinery tower.

(2) REMOVAL SYSTEM FOR FOREIGN MATERIAL

(a) Magnetic Separator

A magnetic separator will be installed to remove ferrous materials on each unloader. Furthermore a magnetic separator will be installed on each receiving line in the machinery tower.

(b) Net Screen

A net screen will be installed to remove a large of size foreign material on each receiving line in the machinery tower.

(3) WEIGHING SYSTEM

(a) Receiving line

Hopper scales are installed in the machinery tower for business.

(b) Discharge

Truck scales for trucks and Wagon scale for wagon are installed at the site for business. Furthermore hopper scales are installed on the discharge lines to control silo bins.

(4) FUMI GATION SYSTEM

A fumigation system is normally classified into two systems i.e. gas system and tablet system. Either system has some merits and demerits. Both system will be prepared taking into consideration user's requests in this terminal, and the use of either system will depend on appearance of the cargo grain.

(5) DUST COLLECTION SYSTEM

From the view point of environmental preservation and to prevent dust explosion, all dust occurred in place will be cllected by a dust collection apparatus. The collected dust will be discharged by special-type trucks outward.

(6) SAMPLING SYSTEM

An auto-sampler will be installed on each receiving line to examine the quality of unloaded grain.

(7) UNLOADER

(a) Type (Refer to Reference Material No.1)

A pneumatic unloader for grain handling was very popular in former times. However, a continuous mechanical type unloader is recently developed. The Study Team studied the feature of the both types of unloader. The results of the study are shown in Refference Material No.1. Judging from the Refference Material No.1, the continuous mechanical type unloader is more excellent in performance ; especially in power save. Therefore, the continuous mechanical type is selected to be installed for this project.

REFERENCE MATERIAL NO.1

COMPARISON BETWEEN MECHANICAL AND PNEUMATIC GRAIN UNLOADERS

TYPE OF UNLOADERS	MECHANICAL UNLOADER	PNEUMATIC UNLOADER
1. Principle of Unloading	Unloading by transport machinery such as belts and chains	Unloading by high-speed pneumatic flow through pipelines
2. Component Machinery	a) Feeder (chain, paddle) b) Conveyor (belt, chain) c) Luffing, slewing and traveling slewing and traveling mechanism d) Device for removal of ferrous materials e) Dust collecting device f) Electrical equipment and control system	a) Transportation pipe b) Vacuum pump c) Luffing and traveling mechanism d) Same as Mechanical Unloader e) Same as Mechanical Unloader f) Same as Mechanical Unloader
3. Efficiency	Minimum fluctuation of unloading capacity affected by postures of unloaders, and kinds, and fluidity of grain	Unstable unloading capacity easily affected by postures of unloaders and kinds, and fluidity of grain
4. Operation in Vessels		
4.1 Operation Staff	1 person to operate and unloader	2-4 persons to operate and unloader with 2 nozzles (1-2 persons to attend a nozzle)
4-2 Cleaning out	Requires labor and/or a bulldozer to clean out cargo	Enables through cleaning, although the efficiency is lower
5. Maintenance	Least wear and tear and minimum exhaustion, and easy exchange of parts	Wear and tear of parts and much exhaustion, and time-consuming for exchange of parts
6. Costs		
6-1 Initial Cost	105-120	100
6-2 Operation Cost	30-40	100
6-3 Maintenance Cost	60-80	100
7. Suitable Materials	Suitable for grain, cereals and pellets with least damage	More likely to damage compared to Mechanical Unloader, unsuitable for pellets
8. Pollution		
8-1 Noise	Approx. 20 db lower than pneumatic Unloader	Big noise of vacuum pump necessitates preventive measures
8-2 Dust	A little at cleaning up	Almost none by labor or bulldozers and occasional during operation.

(b) Number of Unloader

Considering the vessel size to be berthed,cargo volume to be handled in the target year and break down of the unloader and receiving line;
two (2) set of unloader is desirable.
Therefore, two sets of unloader will be installed.

(c) Capacity of the unloader (Refer to Reference material No.2)

The minimum required capacity to cope with the volume to be handled in the target year should normally be calculated with a formula. However, the above minimum required capacity does not mean the desirable capacity economically sometimes. Thus the Study Team calculated the desirable capacity on economical point. Result of both calculations shows that the minimum required capacity is 540 t/h and the desrable capacity is 630 t/h. The capacity of the unloader is decided to employ 630 t/h.

REFERENCE MATERIAL NO.2

1. Determination of the unloader capacity

1-1. Minimum required capacity

The minimum capacity required to cope with the volume to be handled in the target year is calculated with the following formula:

$$Qm = \frac{V}{D \times B \times 24 \times Y1 \times Y2 \times Y3 \times N}$$

Qm	:	Minimum (required) capacity	(t/h)
V	:	Cargo volume	(t/y, 1,800,000)
D	:	Workable days	(D/Y, 295)
B	:	Berth occupancy	(0.6)
Y1	:	Working time efficiency	(0.7)
Y2	:	Mechanical efficiency	(0.65)
Y3	:	Operation efficiency	(0.87)
Nm	:	Number of cranes	(2)

$$Qm = \frac{1,800,000}{295 \times 0.6 \times 24 \times 0.7 \times 0.65 \times 0.87 \times 2}$$

$$= 535.2 \qquad 540t/h$$

1-2. Desirable capacity on economical point

The desirable capacity of the unloader on economical point will be influenced on the charterage of ships calling at this port.

The formula for the minimum cost is as follows:

$$Y = Y1 + Y2$$

Y	:	Total cost
Y1	:	Ship cost
Y2	:	Facilities cost

A) Ship cost (Y1)

$Y1 = Dw/Qs \times Cw/24 \times V/Dw$

Dw	:	Ship size	(60,000DWT)
Cw	:	Charterage of the ship per day	
		(1,200,000 yen/day on 60,000 DWT)	
Qs	:	Actual handling capacity of the unloader line	(t/h)

Y1 values are shown in Table 1.

Nominal capacity	540	600	700	800	900	1,000
Actual capacity	216	240	280	320	360	400
Handling hours	139	125	107	94	84	75
Charterage	6.95	6.25	5.35	4.7	4.2	3.75
Total ship cost	208.5	187.5	160.5	141	126	112.5

B) Facilities cost (Y2)

$Y2 = CQ2/3 \times C1$

CQ	:	Initial investment
C1	:	Cost coefficient

$C1 = C2 + C3$

C2	:	Repayment cost coefficient	
		(Repayment of the loan and interest)	(0.059)
C3	:	Maintenance cost coefficient	(0.021)

Initial investment CQ540 (unit: Million yen)

Unloader	1,700
Conveyor (Receiving line)	1,400
Others	300
Total	3,400

Y2 values are shown in Table 2.

Nominal capacity (Qn)	540	600	700	800	900	1,000
Enlarged ratio (K)	1	1,111	1,296	1,481	1,667	18,518
Coefficient (K2/3)	1	1,073	1,189	1,297	1,406	1.51
Initial investment	3,400	3,648	4,042	4,417	4,780	5,134
Facilities cost	272	292	323	353	382	411

Value of (Y1 + Y2) are shown in Table 3.

Nominal capacity	540	600	700	800	900	1,000
Y1	208.5	187.5	160.5	141	126	112.5
Y2	272	292	323.4	353.5	382.4	410.7
TOTAL	480.5	479.5	483.9	494.5	508.4	523.2

From Table 3., the most economical point can be found and the most suitable unloader capacity is about 630 t/h each. Therefore, the unloader capacity has been determined as 630 t/h.

(8) DISCHARGE LINES (Refer to Reference material No.4)

(a) Number of Discharge line

1) It is requested to provide the facilities for three types of discharging works (for

truck, wagon and bagging).

2) At least two (2) kinds of works have to be done at the same time and it is better to be done three kinds of works at the same time if possible.

3) Considering a break down of the discharge line, two lines for each works are requested at least. As revealed by the results of the study on the above conditions, four (4) trunk lines will be required.

(b) Capacity of each trunk line

The minimum required capacity to cope with the volume to be handled in the target year will be calculated with a formula. The largest cargo volume on each kind of works will be used in compliance with the formula. The capacity of each trunk line will be same because it has to be capable to change from each trunk line and to each branch line. From the results of the calculation, the capacity on each trunk and branch will be determined as 300 t/h.

(9) SILO

(a) Capacity

Judging from the cargo volume to be handled, vessel size to be called, period of storage and others, the total capacity of the silo bins has been determined as 100,000 t.

(b) Type of silo bins

A type of silo bins is usually classified into a cylindrical reinforced type and steel structure with concrete hopper bottom. Either system has some merits and demerits. From due consideration of the type of existing silo bins in Egypt and local conditions, a cylindrical reinforced type is selected.